Executive Summary

1.1 Project Overview

Metro Mining Limited (Metro Mining) is proposing to develop the Bauxite Hills Project (the Project) located on the western coastline of Cape York, Queensland (Figure ES-1), approximately 35 km northeast of Mapoon. The proposed Project includes a small open cut operation, haul road and barge loading facility that will produce and transport a maximum of 1.95 million tonnes per annum (Mtpa) of ore over 27 years. The bauxite from the Project is suitable as a Direct Shipping Ore (DSO) product (i.e. ore is extracted and loaded directly to ships with no beneficiation (washing) or tailings dams required) and hence, minimal waste is generated which in turns minimises impacts to the surrounding environmental values (EVs). Bauxite will be transported by barge via the Skardon River to the transshipment site, approximately 12 kilometres (km) offshore, where it will be loaded into ocean going vessels (OGVs) and shipped to customers.

The Project is characterised by several shallow open cut pits that will be connected via internal haul roads, which in turn, will be connected to a main north-south haul road that will link with the Mine Infrastructure Area (MIA) and barge loading facility located to the north of the pits on the Skardon River (Figure ES-2). Bauxite will be hauled to the ROM stockpile using road train trucks. Overburden material will be initially stored ex-pit with in-pit overburden storage to commence within the first six months of production. The overburden volume is low for this deposit and as such, does not represent an issue in terms of waste storage or required capacity of mining equipment.

Key components of the Project include:

- Shallow open cut pits;
- Internal haul roads and access roads;
- Barge loading facility on the Skardon River;
- MIA including the run-of-mine (ROM) stockpile, bauxite stockpiles, barge loading conveyor load point, earthmoving equipment hard park, administration offices, workshops and fuelling facilities;
- Accommodation camp;
- Raw and potable water supply; and
- Sewage treatment plant.

The Project is expected to employ 105 employees, with additional contractors as needed. The Project workforce, comprising all staff and contractors throughout the life of the Project, will be required to follow Project workforce management plans and strategies to ensure environmental and social impacts are minimised.
LEGEND

- Town
- Watercourse
- Road
- Haul Road
- Alternate Haul Road
- Barge Loading Area
- Mine Lease Boundary
- Cook Shire LGA

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

DATA SOURCE
MEC Mining 2015; QLD Government Open Data Source; Australian Government Bureau of Meteorology.

CLIENT

DESIGNER

CHECKED

APPROVED

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DRG Ref: BES150115-001-R1_REGLOC

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Date

Scale @ A3 - 1:600,000

GCS GDA 1994 Zone 54

REGIONAL CONTEXT

Figure ES-1

DISCLAIMER

Details

Notes:

CHECKED

APPROVED

DATE

Notes:
1.2 Approval Process

Metro Mining has prepared this document to provide supporting information for a Site-Specific Environmental Authority (EA) to a Mining Lease Application for the Project based on the following considerations:

- A maximum of 1.95 Mtpa ROM;
- No beneficiation, therefore no tailings dams and minimal water and power requirements;
- No dredging or bed-leveling required for the transhipping operations;
- Transhipping and export ship movements are on the west coast of Cape York, therefore no involvement with, or movement through, the Great Barrier Reef;
- Simple, low impact mining methods e.g. shallow, free dig resource;
- No significant impact, and low potential risk, to surface water and groundwater resources;
- All mining pit areas are in Least Concern RE – predominantly Darwin stringybark;
- All general and regulated waste will be removed from site to licenced waste disposal facilities;
- No mining operations over the wet season;
- Minimal impact on existing local or State infrastructure; and
- Modelling indicates no discernible air or noise impact to the nearest sensitive receptors.

The level of assessment this document is based on has been determined through several pre-lodgement meetings with the Department of Environment and Heritage Protection (DEHP), the nature of the activity, reference to the Environmental Protection Act 1994 sections 142 and 143 and the EHO guideline: ‘Triggers for environmental impact statements under the Environmental Protection Act 1994 for mining and petroleum activities”. The assessment level triggers that are used to support DEHP’s decision-making under section 143 for greenfield projects are set out in Table ES-1. None of the criteria that require an EIS are triggered and commentary is provided on the applicability of each criterion to the proposed Project in Table ES-1.

### Table ES-1 EIS trigger criteria for greenfield resource projects

<table>
<thead>
<tr>
<th>EIS TRIGGER CRITERIA</th>
<th>Triggered</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The removal of two million tonnes/year (t/yr) or more of</td>
<td>No</td>
<td>The Project will involve the extraction of bauxite at a maximum rate of 1.95 Mtpa.</td>
</tr>
<tr>
<td>ROM ore or coal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The removal of one million t/y or more of ROM ore or coal</td>
<td>No</td>
<td>The Project site is not located on a floodplain or in a coastal hazard area.</td>
</tr>
<tr>
<td>on or under a floodplain or in a coastal hazard area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The introduction of a novel or unproven resource</td>
<td>No</td>
<td>The proposed operation will involve the conduct of conventional truck and shovel</td>
</tr>
<tr>
<td>extraction process, technology or activity</td>
<td></td>
<td>extraction practices. No new or unproven methodologies will be employed.</td>
</tr>
</tbody>
</table>

1.3 Tenure

The bauxite resource is contained in Exploration Permit for Minerals (EPM) 15376 and 16899. The proposed mining areas are referred as Bauxite Hills mining area 1 (BH1) and Bauxite Hills mining area 6 (BH6) and are located within EPM 15376 and EPM 16889, respectively (Figure ES-3). The
EPMs are held by Aldoga Minerals Proprietary Limited and Cape Alumina Proprietary Limited, both wholly owned subsidiaries of Metro Mining Limited. The tenements lie within the Aboriginal Freehold Land held by the Old Mapoon Aboriginal Corporation (OMAC) with whom the company has a Conduct and Compensation Agreement for exploration and is in the process of negotiating a Conduct and Compensation Agreement for mining.

To facilitate mining of the resource, Aldoga Minerals Pty Ltd lodged three initial MLAs (MLA 20676, MLA 20688 and MLA 20689) with the Department of Natural Resources and Mines (DNRM) on 19 October 2012.

MLA 20676 will include:
- Open cut BH1; and
- Internal access roads.

MLA 20688 will include:
- Open cut BH6 East;
- Workers camp; and
- Internal access roads.

MLA 20689 will include:
- Open cut BH6 West; and
- Internal access roads.

Aldoga lodged a further three MLAs, MLA 100051, MLA 100047 and MLA 100048, with DNRM on 10 July 2015 for infrastructure associated with the Project.

MLA 100051 will include:
- MIA and barge loading facility.

MLA 100047 will include
- Port haul road.

MLA 100048 will include:
- BH1 haul road.

Metro Mining will further require the granting by DNRM of two Mining Leases for Transportation (s.316 MR Act) to include two haul roads that cross ML 40082 that is currently held by Gulf Alumina.

1.4 Native Title

The Ankamuthi People (QUD6158/98) and the Northern Cape York Group #1 (QUD157/11) have been identified as being the relevant Aboriginal parties associated with the Project area (see Figure 3-1). The Right to Negotiate process is well advanced with both Aboriginal parties. The requirements of the Cultural Heritage Management Plans (CHMPs) will be incorporated into this document.
1.5 Resources Summary

The most recent exploration data, as outlined in the Metro Mining June 2015 announcement for the Australian Securities Exchange, show that the Australian Code for Reporting of Mineral Resources and Ore Reserves estimated resource is 41.8 million tonnes (MT) of Proved and 6.4 Mt of Probable Marketable Ore Reserves.

Bauxite within the Project area occurs in the upper geological layers with exploration drilling indicating the bauxite deposit commencing 0.6 below ground level and extending to 5 m below ground level with topsoil the predominant overburden material. Figure ES-4 presents a typical stratigraphic profile of the Western Cape region. At the Project site, the kaolinite clay locally reaches a thickness of up to 12 m (AGE, 2011).

1.6 Environment and Management

1.6.1 Climate

The Project lies within the Australian Monsoon Zone and has a Climate Classification of Equatorial – Tropical Savannah using the Bureau of Meteorology’s (BoM) modified Koppen classification system.

The hottest months of the year for the Project are typically October, November and December, ranging from 34 to 36.1 degrees Celsius (°C). The coolest months of the year across all weather stations are July and August, with monthly mean minimum temperatures ranging from 17.5 °C to 18.9 °C. Mean annual rainfall at the broader Project area ranges between 1,640 mm at Old Mapoon to 1,768.8 mm at Weipa 80% of the Project’s total yearly rainfall occurring in the wet season.
High winds occurring as a result of cyclones can cause structural damage and present a safety risk from flying debris. Rehabilitation is at risk of damage from high winds, including defoliation and windthrow of trees. Species adapted to the local climate will be utilised in rehabilitation to maximise the ability of revegetated areas to withstand these types of storms and regenerate quickly.

All plant and infrastructure facilities will be designed and constructed to the relevant Australian Standards to reduce the risk of structural damage caused by high wind speeds.

1.6.2 Land

The construction and operation of the Project will result in changes to topography in the areas mined for bauxite. The Project will not result in significant long-term impacts to soil characteristics in the locations outside of the mined areas. Topsoil Management Plans and Erosion and Sediment Control Plans (ESCP) will be implemented throughout the life of the Project to ensure surface and subsoils are managed and minimise erosion and sedimentation. The Project design footprint has also been minimised as far as practicable, such that 1,668.99 ha will be directly disturbed as the worst case scenario. These measures ensure that the Project will ultimately have minimal impacts on the landscape.

The Project will be operated in a way that protects the EVs of land. Project activities will be managed to prevent adverse effects on EVs through the minimisation of land disturbance and implementation of management plans for sediment and erosion control, topsoil management, progressive rehabilitation and monitoring against success criteria, and final decommissioning towards an agreed final land use. Any disturbed areas will be rehabilitated to meet the EP Regulation guideline criteria.

1.6.3 Landscape and Visual Amenity

No visual impacts are expected at the Mapoon township or the mouth of the Skardon River. There is potential impact to boat users that infrequently use the south arm of the Skardon River; however, this is expected to be limited to the MIA, barge loading conveyor and mooring infrastructure. With lighting required on the barge loading conveyor and associated barge mooring infrastructure there will be some visual impacts from lighting at night. This impact is expected to be minimal given the infrequent use of the river, particularly at night. Vegetation buffers and other mitigation measures are proposed where practicable to mitigate the potential visual impact to river users.

It is unlikely that daytime activities at sea will be observable from Mapoon or the Skardon River mouth. There may, be some lighting visible from ships at mooring or underway at night; however, this will be managed by not undertaking night time ship loading activities and limiting lighting to the minimum required under current shipping laws.

1.6.4 Marine Ecology

Water quality within and surrounding the Project are typical of the Western Gulf area. In most cases, whether describing freshwater or estuarine/marine environments, some parameters are either within ANZECC and ARMCANZ guideline trigger values or are very similar to other projects in the area. As mentioned in the QWQG, no specific WQOs have yet been established for the Cape York Region. Therefore, in accordance with the QWQG, the national ANZECC and ARMCANZ guidelines for fresh water have been used.

Some water quality impacts are likely to be encountered during both construction and facility operation. The processes of wharf construction and development across mangrove communities will impact water quality over the short term. Potential impacts to long-term water quality during
operation will include, potential dust emissions during the loading process, barge and vessel movements, potential spills and chemical release. However, the processing of the bauxite ore will not involve washing or beneficiation and the use of water on site will be limited to general operational usage.

The Skardon River and adjacent inshore and off-shore areas encompass several marine habitats, including: saltmarsh, mangroves, seagrass, rocky reef, oyster reef, coral reef, and broad areas of intertidal and sub tidal soft substrates. Construction of the proposed export infrastructure will require the disturbance of fringing mangrove and potential minor saltmarsh vegetation communities adjoining the adjacent melaleuca and eucalyptus woodlands of the plateau. However, the impacts to these communities are predicted to be relatively minor. For example, for mangroves, disturbances are predicted to account for only <0.07% of mangrove communities within the Skardon River. Implementing standard operational practices for mitigation and management will enable potential construction and operational impacts to be effectively controlled.

Several marine fauna species of State and/or Commonwealth importance either occur or have the potential to occur in and around the Project area including turtles, cetaceans, sharks, sawfishes, crocodile, dugong, sea snakes and migratory birds. During the construction and operational stages of the Project, physical interaction with significant marine species will be primarily based upon movement of bauxite barges, supply barges, and miscellaneous small vessel activity supporting the project (survey, monitoring, maintenance etc.). Habitat clearing at the proposed barge facilities may lead to a minor interaction, although the bulk of works are intertidal. Construction based noise will present a potential impact to any marine species in close proximity, particularly during pile driving activities. Given the topography of the Skardon River, the marine footprint of the project and the habitat requirements of potentially occurring species, residual impacts are considered to be relatively minor.

1.6.5 Freshwater Ecology

Key habitat for aquatic fauna identified through the assessment include perennial water sources associated with riparian corridors and wetlands of the Skardon River-Cotterell River Aggregation - in particular Bigfoot Swamp to the north and west of the Project area presented perennial wetland conditions, albeit reducing to minor ponding during the late dry season.

Land clearance and habitat loss associated with the establishment of the mine areas and supporting infrastructure will have a minor impact on riparian vegetation associated with Skardon River and Skardon River-Cotterell River Aggregation. Bigfoot Swamp will be potentially impacted by an increase of groundwater flows during mining operations, followed by a possible very slight decrease of groundwater flows following mining operations. During mining activities the size and depth of water in Bigfoot Swamp is likely to increase, returning to close to baseline conditions at the completion of mining. The potential impacts to Bigfoot Swamp are well within the existing natural climatic variations and are not expected to have any significant impact on the surrounding ecology.

Potential impacts on aquatic values should be mitigated through future Project design and will include:

- Minimising encroachment on the Skardon River and associated wetlands and floodplains to avoid impacts on riparian vegetation communities and important fauna habitats associated with the Skardon River;
- Measures to limit vegetation loss and impacts on connectivity where the mining footprint and infrastructure corridors occur between wetland habitats; and
Development of a REMP in alignment with DEHP’s Receiving Environment Monitoring Program guideline - For use with Environmental Relevant Activities under the Environmental Protection Act 1994 (EP Act) that includes annual monitoring of Bigfoot Swamp. Where significant changes in the swamp are observed, suitable mitigation measures can be developed and undertaken if necessary.

The Project area supports a relatively low diversity of aquatic flora and fauna species, largely due to the ephemeral nature of the watercourses within the Project area. No threatened aquatic species were recorded during the surveys. No threatened species are predicted as likely to occur within the Project area.

1.6.6 Terrestrial Ecology

The Project area supports a relatively low diversity of vegetation communities and terrestrial flora and fauna species. The Project will result in the clearing of approximately 1,650 ha of remnant vegetation of which, the majority (approximately 98% of all clearing) is confined to least concern Regional Ecosystem (RE) 3.5.2. While two of concern REs were mapped in the Project area, only one RE 3.3.12 will be impacted by the Project with the largest impact being 0.7 ha. There may be opportunities to reduce this impact through refining the location of haul roads. Other key areas of remnant and riparian vegetation associated with the Skardon River, and Skardon River-Cotterell River Aggregation occur in the Project area, but not within the mining footprints. Remnant vegetation in the Project area has linkages to recognised regional and state-significant biodiversity corridors but does not itself form part of these corridors. Intact landscape-scale linkages will remain around the Project area. No Threatened Ecological Communities (TECs) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) occur in the Project area.

Key habitat resources for fauna identified through the assessment include permanent water sources associated with riparian corridors and wetlands of the Skardon River-Cotterell River Aggregation, and large tracts of contiguous remnant vegetation to the south and east of the Project area. In particular wetland areas to the north and west of the Project area (including Big Foot Swamp) were observed to support a relatively high diversity of fauna species, when compared to the dominant Darwin stringybark community.

One threatened fauna species (palm cockatoo) was recorded during surveys and several other fauna and flora are known to occur in the area or have been recorded in previous studies. The broader Project area is also known to support several threatened flora species or their suitable habitat including the near threatened grasses Heterachne baileyi, Lepturus geminatus, Eremochloa ciliaris, and potential to support the vulnerable epiphytic orchids brown antelope orchid and Dendrobium bigibbum (see Table 11 of Appendix F).

The Project will result in no removal of permanent water sources but will result in minor areas of riparian habitat being removed and up to 14 ha (worst case scenario) of mangrove and intertidal areas being lost to accommodate haul roads and the proposed barge loading facility on the Skardon River.

To fully address the Project’s offset requirements a Biodiversity Offsets Strategy Report has been prepared and is included as Appendix F. This report aims to detail the Project’s estimated extent of significant, residual impacts to Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES).
1.6.7 Surface Water Resources

Flood modelling conducted for the Project illustrates the likely peak water levels and velocities for a range of Average Recurrence Interval (ARI) events. Results show that the proposed pit locations are not at risk from riverine flooding, even under the Probable Maximum Flood (PMF) event. This is due to the pits being located on the bauxite plateaus with buffer distances maintained between the pit shell and watercourse boundaries. Hence, the pits will naturally drain inward and due to the depth of the mine pits and fast infiltration rates through the bauxite layer, the mine pit areas act as a self-draining sediment trap for runoff from disturbed mine areas.

Construction of the pits is not likely to interfere with the current floodplain processes and no significant hydraulic impacts to the river in terms of changes to flows, water levels, or velocities are expected. Further, runoff from the network of haul roads will be captured in table drains and turned out to vegetated areas via spoon drains at regular intervals. Due to the generally flat topography it is not anticipated that the spoon and table drains will carry significant sediment load.

The overall impact on the water budget is shown to be minor due to the small scale of the mine affected areas (i.e. hardstand, open pit and rehabilitation) relative to the local catchments in which they reside.

The overall surface water quality in the area is considered high and it appears that there has been minimal impact to existing EVs pertaining to surface water. It is also considered that the surface water, at time of sampling, was of a suitable quality to be used as a potential source of site drinking and or process water with limited basic treatment.

1.6.8 Groundwater

Available geological and hydrogeological information was used to develop a hydrogeological conceptual model of the Project that describes the existing groundwater condition. Groundwater seasonally discharges to the Skardon River, Bigfoot Swamp and other areas where the water table intersects the ground surface at the height of the wet season. Ecosystems associated with these discharge zones are likely to seasonally depend on groundwater and associated ecological values have been identified with shallow groundwater. The modelling predicts a small post mining reduction in peak groundwater discharge rates to Bigfoot Swamp; albeit based on a largely conservative set of assumptions. Given that the connectivity of the swamp to shallow groundwater is likely to remain unaffected, the small potential reduction in the peak discharge rate is considered unlikely to affect ecosystems associated with Bigfoot Swamp.

Metro Mining will develop and implement a groundwater monitoring and management plan as part of the overall site Environmental Management Program (EMP) which will outline a comprehensive groundwater monitoring program, including details of management and mitigation for any groundwater related risks of the Project.

1.6.9 Air Quality

The main potential impacts to air quality from Project are expected to occur during operation. As such only the worst case operational phase impacts were modelled. The main air emissions from operational activities will be particulate matter during mining from dust generating activities include movement on haul roads, handling and transfer of materials and stockpiles. Additionally, wind-borne dust from exposed earth will be a contributing factor to the dust generation and has been considered in accordance with the National Pollutant Inventory (NPI) Manual for Mining. Emissions from vehicle exhausts, generators and ship movements were modelled as the emissions
are small in comparison to the dust generating activities and will be remote to sensitive receptors located approximately 16 km away from the mine lease boundary and 35 km from the MIA.

Air quality modelling showed:

- The highest annual TSP concentrations are below the 90 μg/m³ criterion at all receptors, with the results just above the background concentration of 40 μg/m³;

- The highest predicted 24-hour average ground-level PM10 concentration of 35.1 μg/m³ will occur at village accommodation (R46), which is below the 50 μg/m³ criterion. At the sensitive receptors located in Mapoon, the highest concentration will be 23.6 μg/m³;

- The highest predicted 24-hour average ground-level PM2.5 concentration of 8.0 μg/m³ will occur at the village accommodation (R46), which is below the 25 μg/m³ criterion. At the sensitive receptors located in Mapoon, the highest concentration will be 5.6 μg/m³; and

- The highest daily dust deposition results show that an incremental increase of 8.7 mg/m²/day will occur at the village accommodation (R46), with a total deposition of 58.7 mg/m²/day which is half of the 120 mg/m²/day criterion.

The greenhouse gas assessment for the Project indicates that the total greenhouse gas emissions from the construction and operation of the Project is estimated to be 271.6 kilotonnes CO₂-e. Annual operating emissions are estimated to be just over 5 kilotonnes CO₂-e, well below the 25 kilotonne trigger for reporting under the National Greenhouse and Energy Reporting framework.

1.6.10 Noise

Noise levels for the operation are expected to comply with the EHP Model Mining Conditions at all noise sensitive receivers under both average and worst case meteorological conditions. Noise levels are also predicted to comply with low frequency noise criteria, except at the airport where noise impacts are not expected to be significant as the airport will only be in use when flights are scheduled and the airport is a source of low-frequency noise during operation.

The cumulative impacts from the Bauxite Hills and Skardon River Projects comply at all sensitive receptors in Mapoon and the only exceedence is expected at the Mine Village; however, the residents of the accommodation camp will be working during the Project’s operational hours; therefore the Mine Village (R46) would not be adversely impacted by the noise from the Project.

1.6.11 Waste

Waste streams from construction and operation will be managed in accordance with the Waste Management Hierarchy and implemented waste management plans. No general waste landfill is proposed on site, therefore the majority of waste produced will be transported offsite in accordance with all relevant protocols to a licenced disposal facility. All waste water will be reused within the process; hence a wastewater stream will not be generated.

1.6.12 Indigenous Cultural Heritage

Various potential and confirmed sites of Indigenous cultural heritage have been identified within the Project area. All currently known areas of cultural heritage significance have been avoided by the mine plan. If any instances occur in the future where this cannot be avoided, measures to mitigate impacts will be undertaken with Aboriginal parties, in accordance with agreed processes within the Cultural Heritage Management Plan (CHMP) that is currently being developed.
Metro Mining commits to engagement and negotiations with the relevant Aboriginal parties and to develop and implement an approved CHMP with these parties. The CHMP will include procedures developed by the Aboriginal parties covering the management of cultural heritage sites and values. Metro Mining aims to promote an understanding of Aboriginal cultural heritage in the workplace through employee induction programs and other specific training activities.

1.6.13 Non-Indigenous Cultural Heritage

There are no listed non-Indigenous heritage sites in or within the vicinity of the Project area and separate studies of the project area have failed to identify potential non-Indigenous cultural heritage items. European activity in the area has been limited and studies of the area suggest that any remaining non-Indigenous items of cultural heritage significance are likely to be related to missions, pastoralist or mining activities. Despite, the lack of known non-Indigenous cultural heritage in the Project area, there is the potential to discover unknown sites during construction and operation. As such, management and mitigation measures will be implemented to identify any remaining items and, where necessary, appropriately deal with any discovery in accordance with the Queensland Heritage Act 1992.

1.6.14 Economic

The Project is expected to provide a positive economic impact to the local and regional community during construction and operation. The Project will provide employment opportunities for locals and Indigenous communities and the Project has the potential to generate flow on effects including improved local and regional services. Management and mitigation measures will be implemented to minimise any adverse economic impacts result from the Project’s construction and operational activities. Overall it is anticipated that with an operational life of 27 years, the Project will provide substantial economic and social benefits to the regional community.

1.6.15 Transport (Air and Land)

The main transport modes used during all Project phases (construction, operation and decommissioning) will be marine and air modes of travel. The use of any public roads will be very infrequent as barge and air modes of transport will be the predominate mechanisms serving the development. As such the road service network is unlikely to be impacted and no road improvements will be required. It is expected that there will be some minor traffic generated from the mining activity; however, this will be contained within the mining lease area.

In relation to air activities and travel, there will be no reduction in the level of service throughput at the Weipa and Cairns airports due to the anticipated low level of worker demands and that Metro Mining will charter private flights for FIFO employees. Hence, no significant impacts to existing land and air transport operations arising from the Project are expected.

1.6.16 Transport (Shipping)

Potential impacts to EVs from shipping activities can include discharges (ballast water, greywater, sewage, petroleum products, garbage or waste products), direct collision to marine fauna and damage to the sea floor during anchoring. Although potential impacts have been identified, the majority are predicted to be minimal due to the planned barge movement operating procedures and ensuring ship operators are competent, suitably qualified and aware of the existing navigation and pilotage aids and requirements. Potential shipping related impacts are also reduced as State and Commonwealth regulations determine to a large part, the requirements of ships and ship operators. Some low level persistent effects will exist, all of which are unavoidable results of shipping
operations. None of these are considered likely to present any unacceptable risks to the environment.

Abnormal events, such as vessel grounding or collision, do pose a heightened risk, but in common with similar shipping activities around Australia and elsewhere, these risks will be controlled by a range of vessel design, equipment fit and operational measures. These measures sit within a comprehensive framework of international, national and Queensland regulations, and are applicable to both the international ships and coastal vessels to be engaged in the development and operation of the Project’s shipping movements.

1.6.17 Hazards and Safety

The probability of accidents associated with the development and implementation of the Project is as low as reasonably practicable, given that the design, operating and control measures adopted by Metro Mining will focus on their prevention. Similarly, natural events of sufficient magnitude (e.g. those that occur during the monsoon season), that could cause significant damage and pose serious safety risks, have a very low probability of occurring during operation of the Project, particularly noting that operations will not be undertaken during the wet season.

Project construction and operational Preliminary Hazard Analysis (PHA) results indicated that the baseline health and safety risk profile varied from low to high. Once mitigation measures and design treatments were applied to the assessed hazards, residual risk scores were reduced to ‘low’ or ‘medium’.

Assessed hazards with ‘medium’ residual risks level include:

- Traffic collisions due to increased traffic as a result of the Project predominantly within the Project;
- Cumulative strain on emergency services. Metro Mining will work with emergency service agencies in the area to ensure that resources are sufficient to mitigate the increased risks associated with the Project;
- Human injury or death as a result of a construction or operational related accident. A Safety and Health Management System (SHMS) will be implemented and risks will be managed through detailed Standard Operating Procedures (SOP) and Job Safety Analysis (JSA);
- Human injury or death from tropical disease, infection or heat exposure. Metro Mining will have onsite first aid provisions and will undertake training in heat management and identification of tropical diseases; and
- Property damage, human injury or ecosystem damage from a marine incident, including collision, marine strike or grounding. Metro Mining will manage this risk by having a detailed shipping management plan, safety navigational aids, defined pilotage regimes and oil spill response equipment and training.

Importantly, the PHA did not identify any ‘extreme’ ranking risks outside the Project area.

Overall the risks to community receptors, environmental sensitive receptors and State and local government controlled roads can be considered acceptable. Metro Mining will implement a rigorous SHMS which will set out a framework and detailed safety procedures to manage the safety and health of its employees. A Project Risk Register and appropriate controls, including training, engineering, design, procedural and physical controls will be in place to manage any onsite hazards.

In the event of an emergency, Metro Mining will have detailed processes outlined in the Emergency Response Plan (ERP) and prior implemented arrangements with emergency management...
1.6.18 Social and Engagement

The Project’s main cultural and social area of influence is the local communities of Mapoon, Weipa, the broader Cook Shire Regional Council and the lands associated with the Traditional Owners. The development of the Project will create employment and business opportunities within this region, contributing to higher income levels and help sustain population growth. This growth is, and will continue to be, the necessary stimulus for improved infrastructure and services in the region.

Sustainable employment creation is key to regional economic development, and in securing genuine community support for new developments. Metro Mining is focussed on maximising this opportunity for the local people. To this end, Metro Mining is committed to working collaboratively with community stakeholders and government agencies, including relevant councils, the Chamber of Commerce, Traditional Owners, OMAC and various educational institutions to enhance education, training and employment for local Indigenous people and community residents, and support the ongoing development of emerging and existing businesses.

Although there are some potential social impacts associated with the Project, these impacts will be managed through the implementation of a CHMP, Stakeholder Engagement Plan (SEP) and ERP.

1.6 Environmental Management and Monitoring

An environmental management system (EMS) for both the construction and operational phases of the Project will be developed based on the principles of the AS/NZS ISO 14001:2004 Environmental Management Systems. The EMS will establish the framework for environmental management of Project activities, and will include the following:

- The Project’s environmental policy statement;
- Roles and responsibilities;
- Identification of potential environmental impacts;
- Presentation of objectives and targets for the mitigation of potential environmental impacts;
- Implementation of plans and procedures to ensure objectives and targets are met;
- A reporting procedure – internal and external;
- Induction, training and awareness programs to ensure Project personnel are aware and capable of fulfilling the Project’s environmental responsibilities;
- An emergency and incident procedure; and
- Management review process to search for opportunities for continuous improvement.

Environmental protection commitments and proposed environmental authority conditions have been included in the relevant sections of this document and an EMP for the Project activities. The environmental monitoring for the Project would include surface water and groundwater quality, groundwater levels, marine ecology, rehabilitation success, erosion, weeds, waste volume and type, sewage treatment plant water quality, community complaint records and cultural heritage assessments. The EMP prepared for the Project outlines the environmental monitoring program including monitoring sites, parameters and their frequency of measurement as per the proposed EA conditions, in addition to detailing monitoring procedures and records.
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Appendix B – Contaminated Land Register
Appendix C – Marine Ecology Technical Report
Appendix D – Bathymetry Survey Report
Appendix E – Freshwater Ecology Report
Appendix G – Biodiversity Offsets Strategy
Appendix H – Surface Water Technical Report
Appendix I – Groundwater Technical Report
Appendix J – Air Quality Technical Report
Appendix K – Noise Technical Report
Appendix L – Economics Technical Report
Appendix N – Transport (Shipping) Technical Report
Appendix O – Project Environmental Management Program
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Section 1  Introduction

Metro Mining Limited (Metro Mining) is proposing to develop the Bauxite Hills Project (the Project) located on the western coastline of Cape York, Queensland (Figure 1-1). The proposed Project includes a small open cut operation, haul road and barge loading facility that will produce and transport a maximum of 1.95 million tonnes per annum (Mtpa) over 27 years. The bauxite from the Project is suitable as a Direct Shipping Ore (DSO) product (i.e. ore is extracted and loaded directly to ships with no beneficiation (washing) or tailings dams required) and hence, minimal waste is generated which in turns minimises impacts to the surrounding environmental values (EVs). Bauxite will be transported by barge via the Skardon River to the transshipment site, approximately 12 kilometres (km) offshore, where it will be loaded into ocean going vessels (OGVs) and shipped to customers.

The Project site is remote from any township with the nearest town Mapoon, located approximately 16 km from the mining lease boundary and approximately 35 km to the southwest of the proposed mine infrastructure area (MIA). Access to Mapoon from the barge loading facility is approximately 40 km by sea and approximately 350 km by 4WD (via Weipa) from the workers camp, utilising 4WD only tracks. Employees and contractors will be flown in and accommodated on site. It is anticipated that there will be regular charter flights from either Cairns or Weipa bringing in stores, supplies and personnel.

It is anticipated that the Project will employ approximately 105 people including staff, equipment operators and barge / transshipment personnel working a two week on, and one week off roster on only a day shift. Employees will be drawn from the local community where possible as well as further afield. As the Project is located in the Cape York region with distinct wet and dry seasons, operation will occur only during the dry season from nominally March to November. Operating during the dry season simplifies drainage and sediment control and significantly reduces the impact on the EVs as well as health and safety risks.

The operation will be subject to all the laws and regulations of the Mineral Resources Act 1989 (MR Act) (Qld) and the Environmental Protection Act 1994 (EP Act) (Qld). There may also be further conditions if approvals are required under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Cwlth) and additional Queensland specific legislation. All activities within the mining lease areas and access to the mining lease areas will be controlled by Metro Mining.

This environmental assessment report has been prepared to support Metro Mining’s application for a site specific Environmental Authority (EA) and associated mining leases.
1.1 Scope, Purpose and Objectives

1.1.1 Scope

The scope of the assessment considers the design, construction, operation, decommissioning and rehabilitation of the development and all works reasonably anticipated to be associated with six existing Mining Lease Applications (MLA): MLA 20676, MLA 20688 and MLA 20689 and associated special purpose Mining Leases (i.e. for infrastructure purposes and transportation purposes) (MLA 100051, MLA 100047 and MLA 100048) that are currently under application. The assessment also addresses direct and indirect impacts on the environment and community.

The study area covered by the environmental assessment includes all the land and waters required for the proposed Project and the immediate surrounding areas as described in this report.

1.1.2 Scope of Technical Studies

This document has been based on ongoing consultation with the Department of Environment and Heritage Protection (DEHP) and is in accordance with DEHP’s ERA technical guidance documents for impacts to air, noise, water, waste and land. Metro Mining has included the following studies within the assessment of the proposed Project:

- **Air Quality**, considering:
  - Human health and wellbeing
  - Aesthetics of the environment
  - The health and biodiversity of ecosystems

- **Noise**, considering:
  - Proximity to noise sensitive places
  - Existing land use with low background noise levels
  - Conducting noise-generating activities outside standard business hours
  - Intrusive noises being generated by the activity (e.g. tonal or impulsive noises)

- **Water Resources**, considering:
  - Controlled/planned and uncontrolled/unplanned releases of water
  - Changes to the quantity and quality of stormwater runoff
  - Potential changes to the quantity and quality of groundwater

- **Waste**, considering:
  - Waste avoidance
  - Waste reuse
  - Waste recycling
  - Energy recovery
Section 6 of this document presents further details about each of the aforementioned studies and their context to the existing environment. The information presented to describe existing conditions is based on reviews of publically available desktop information, relevant field surveys and relevant information gathered from other nearby projects such as the proposed Skardon River Project (SRP), Hey Point Project and the Pisolite Hills Project. Data presented for the approved Rio Tinto Alcan South of Embley (SoE) Project was also reviewed.

1.1.3 Purpose

The purpose of this document is to ensure that potential direct, indirect and cumulative impacts associated with the Project, are assessed and where relevant, realistic and manageable mitigation measures are proposed. The objectives and commitments of this document have been developed to achieve the ongoing protection of the identified EVs in the area that have been defined as measurable and auditable.

1.1.4 Objectives

This report presents comprehensive information to:

- Provide the DEHP and other Government agencies with detailed and sufficient information to assess the potential adverse and beneficial impacts associated with the Project;
- Provide adequate supporting information for the approval of the Project; and
- Provide definitive commitments, measures, actions and monitoring programs to be undertaken in order to avoid and mitigate potential adverse impacts that may result from the Project.

This document should be read in conjunction with the relevant technical reports and associated documentation provided in the Appendices as outlined below.
1.1.5 Document Structure

This document consists of two volumes:

- Volume 1 – Site Specific EA Application supporting information that addresses DEHP’s five main Technical Guidelines for Site Specific EA applications. The Guideline Mining - Model Mining Conditions (EM944 Version 5 – 21/11/2014) is used as a basis for the proposed draft EA conditions that are presented in this volume; and

- Volume 2 – Appendices (technical reports, data searches and laboratory analyses).

Table 1-1 and Table 1-2 provide a summary of the structure of the document.

**Table 1-1 Volume 1 - structure and corresponding schedules**

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<td>- Indigenous Cultural Heritage</td>
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<tr>
<td></td>
<td>- Non-Indigenous Cultural Heritage</td>
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<tr>
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<td>- Economic</td>
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<td></td>
<td>- Transport (Air and Land)</td>
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<td>- Transport (Shipping)</td>
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<td>- Hazards and Safety</td>
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<td>Social and Engagement</td>
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<td>8</td>
<td>Draft Environmental Authority Conditions</td>
</tr>
<tr>
<td>9</td>
<td>Glossary</td>
</tr>
<tr>
<td>10</td>
<td>Acronyms, Abbreviations and Measurement Units</td>
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</tbody>
</table>

**Table 1-2 Volume 2 - appended technical reports, data searches and laboratory analyses**

<table>
<thead>
<tr>
<th>Appendix Number</th>
<th>Appendix Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Soil Sample Results</td>
</tr>
<tr>
<td>B</td>
<td>Contaminated Land Register Results</td>
</tr>
<tr>
<td>C</td>
<td>Marine Ecology and Coastal Processes – Existing Environment and Impact Review and Mitigation</td>
</tr>
<tr>
<td>D</td>
<td>Survey Report – Skardon River</td>
</tr>
<tr>
<td>E</td>
<td>Bauxite Hills Mine Project Aquatic Ecology Assessment</td>
</tr>
<tr>
<td>F</td>
<td>Bauxite Hills Mine Project Terrestrial Ecology Assessment</td>
</tr>
<tr>
<td>G</td>
<td>Bauxite Hills Mine Project Biodiversity Offsets Strategy</td>
</tr>
<tr>
<td>H</td>
<td>Bauxite Hills – Surface Water Assessment</td>
</tr>
<tr>
<td>I</td>
<td>Bauxite Hills Project Groundwater Technical Report</td>
</tr>
</tbody>
</table>
1.2 The Proponent

The Proponent for the Bauxite Hills Project is Aldoga Minerals Pty Ltd (Aldoga), a 100% owned subsidiary of Metro Mining Limited (Metro Mining). The mining tenements are held by Aldoga (99%) with the remaining 1% held by Cape Alumina Pty Ltd (Cape Alumina), a 100% owned subsidiary of Metro Mining.

Metro Mining is referred to throughout this document for convenience as Metro Mining is the ultimate holding company for the Project and is readily recognised as a public company listed on the Australian Securities Exchange.

The Environmental Authority will ultimately be issued to the tenement holders, Aldoga and Cape Alumina.

Metro Mining is headquartered in Brisbane, and holds approximately 1,400 square kilometres (km²) of bauxite exploration tenements, which makes Metro Mining one of the largest holders in Cape York. Metro Mining also holds over 4 billion tonnes of coal tenements in Queensland.

Metro Mining was formed after MetroCoal Limited undertook a takeover of Cape Alumina Limited, which was completed in mid-December 2014. Both companies were listed on the ASX in 2009 and have been focussed on developing projects in Queensland over the past six or more years. Metro Mining’s major shareholders are Dadi Engineering and Development Group (16.4%), Balance Property Group which holds 14.4% and China Xinfa Group Corporation Limited which holds 7.8%.

The relevant details regarding Metro Mining, including website and contact details, are summarised in Table 1-3.

### Table 1-3 Metro Mining and consultant details

<table>
<thead>
<tr>
<th>Entity</th>
<th>Metro Mining – Project Director</th>
<th>Metro Mining – Environmental Manager</th>
<th>Consultant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact</td>
<td>Mike O’Brien</td>
<td>Colleen Fish</td>
<td>Mark Imber</td>
</tr>
<tr>
<td>Address</td>
<td>PO Box 10955 Adelaide Street, Brisbane 4000</td>
<td>PO Box 10955 Adelaide Street, Brisbane 4000</td>
<td>PO Box 359 Fortitude Valley, QLD, 4163</td>
</tr>
<tr>
<td>Phone</td>
<td>P: (07) 3009 8000</td>
<td>P: (07) 3009 8000</td>
<td>P: (07) 3828 6900</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:mobrien@metromining.com.au">mobrien@metromining.com.au</a></td>
<td><a href="mailto:Cfish@metromining.com.au">Cfish@metromining.com.au</a></td>
<td><a href="mailto:imberms@cdmsmith.com">imberms@cdmsmith.com</a></td>
</tr>
</tbody>
</table>
Section 2  Description of the Project

2.1 Scope of the Project and Location

Metro Mining is proposing to develop an open cut bauxite mine and barging / transshipment operation on the western coastline of Cape York, Queensland (Figure 1-1). The Project is expected to have a life span of 27 years and is characterised by several shallow open cut pits that will be connected via internal haul roads, which in turn, will be connected to a main north-south haul road linking the MIA and barge loading facility located to the north of the pits on the Skardon River (Figure 2-1).

The plan in Figure 2-1 shows haul road locations situated within Metro’s EPM boundaries. Alternative haul road locations are also shown. These alternative haul road locations have a lesser impact on the environmental values (i.e. less disturbance to fringing mangrove and wetland communities); however, they are sited on mining tenements held by other companies. Metro Mining’s access to these locations requires the grant of s316 Infrastructure Leases which may be objected to by the other companies.

The Project area is remote from any township with the nearest town Mapoon, located approximately 35 km in a direct line to the southwest of the proposed MIA. Access to Mapoon from the barge loading facility is approximately 40 km by sea and approximately 350 km by 4WD (via Weipa) from the workers camp. There are no reserves, stock routes, easements or public road reserves within the Project area.

The Project is expected to employ 105 employees, with additional contractors as needed. The mine will operate one 12 hour shift per day for nine months of the year, shutting down operations during the wet season. Contractors may work a two week on, and one week off roster; however, this will be decided by the selected mine operator. The Project workforce, comprising all staff and contractors throughout the life of the Project, will be required to follow Project workforce management plans and strategies to ensure environmental and social impacts are minimised.

Key components of the Project include:

- Shallow open cut pits;
- Internal haul roads and access roads;
- Barge loading facility on the Skardon River;
- MIA including the run-of-mine (ROM) stockpile, bauxite stockpiles, barge loading conveyor load point, earthmoving equipment hard park, administration offices, workshops and fuelling facilities;
- Accommodation camp;
- Raw and potable water supply; and
- Sewage treatment plant.
FIGURE 2-1

DATA SOURCE
MEC Mining 2015; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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

GCS GDA 1994 MGA Zone 54

PROJECT INFRASTRUCTURE

 Legend
- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Pit Extends
- Mine Lease Area
- Camp Site

Legend

- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Pit Extends
- Mine Lease Area
- Camp Site

NOTE:

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DESIGNER

CLIENT

APPROVED

DRAWN

CHECKED

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Notes:

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SCALE @ A3 - 1:65,000

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DATA SOURCE
MEC Mining 2015; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

DESIGNER

CLIENT

APPROVED

DRAWN

CHECKED

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Notes:
2.1.1 Site Access

Access to the Project area will be by air, with secondary access via sea transport. Employees and contractors will be flown in to the shared Skardon River – SRP airstrip and accommodated on site. The existing Skardon River airstrip, approximately 1 km from the Project’s southern boundary will be used to transfer staff to and from the Project site.

The Skardon River airstrip is suitable for small commercial passenger aircrafts. Flights into the site will originate from either Weipa or Cairns and dependent on the originating destination of the work force, there may also be regular flights from the Cooktown Airport.

2.2 Key Construction and Operational Elements

2.2.1 Mining Method

The mining method for the Project will be open cut mining utilising front end loaders and trucks for hauling. The material does not need any drilling and blasting; however, some ripping by dozers is likely to be required. Front end loaders will be used for loading due to their high manoeuvrability.

Bauxite will be hauled to the ROM stockpile using road train trucks. Overburden material will be initially stored ex-pit. In-pit overburden storage is expected to commence within the first six months of production. The overburden volume is low for this deposit and it is not expected to represent an issue in terms of waste storage or required capacity of mining equipment.

2.2.2 Mine Plant and Equipment

The mobile plant and equipment expected to be used for the Project’s construction and operational activities to support a maximum production rate of 1.95 Mtpa include:

- 2 x Front end loaders (CAT 992);
- 2 x Front end loaders (CAT988);
- 6 x Road train trucks (Power Trans T1250);
- 1 x Excavator (CAT 329);
- 1 x Tracked dozer (CAT D10);
- 1 x Wheeled dozer (CAT 834);
- 1 x Grader (CAT 16H);
- 1 x Water truck (CAT 773);
- 1 x Service truck; and
- 3 x Lighting plants.

2.2.3 Construction

The construction works will include the concurrent construction of multiple infrastructure elements including: open cut mine pits, the MIA, barge loading facilities, workers camp, water infrastructure including small water storage dams, bores and internal access roads.
Construction of the Project will be subject to statutory approvals.

Key elements of the Project construction program include:

- Clearing, stripping and stockpiling topsoil for all mine disturbance areas;
- Construction of mine infrastructure:
  - Internal access roads
  - MIA (ROM and product stockpiles, load point for barge loading conveyor, earthmoving equipment hard park, administration offices, workshops and fuelling facilities) (Figure 2-2)
  - Raw water storage and mine surface water management systems
  - Services including power supply from diesel generators and solar panels
- Preparation of open cut pits:
  - Removal of overburden using front end loaders, excavators and trucks. Selected excavated material will be used as fill for construction work
- Construction of the barge loading infrastructure:
  - Clearing of vegetation for the trestle jetty structures
  - Conveyor
  - Jetty and mooring dolphins
- Installation of a sewage treatment plant; and
- Development of the workers camp facilities.

An indicative construction schedule is outlined in Table 2-1.

Table 2-1 Indicative construction schedule

<table>
<thead>
<tr>
<th>Works</th>
<th>Anticipated Start Date</th>
<th>Anticipated Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation clearance and site preparation</td>
<td>Q2 2016</td>
<td>April - July</td>
</tr>
<tr>
<td>MIA and associated infrastructure</td>
<td>Q2 2016</td>
<td>April - September</td>
</tr>
<tr>
<td>Development of BH6 Open Cut Pit</td>
<td>Q2 2016</td>
<td>April – September</td>
</tr>
<tr>
<td>Development of Barge Loading Facilities</td>
<td>Q2 2016</td>
<td>May - October</td>
</tr>
<tr>
<td>First bauxite export</td>
<td>Q4 2016</td>
<td>October</td>
</tr>
</tbody>
</table>
2.2.4 Operation

The bauxite resource is contained in Exploration Permit for Minerals (EPM) 15376 and 16899. The mining areas referred as Bauxite Hills mining area 1 (BH1) and Bauxite Hills mining area 6 (BH6) lie within EPM 15376 and EPM 16889 respectively (Figure 2-3). The EPMs are held in the name of Aldoga and Cape Alumina Proprietary Limited, both wholly owned subsidiaries of Metro Mining Limited. The tenements lie within the Aboriginal Freehold Land held by the Old Mapoon Aboriginal Corporation (OMAC) with whom the company has a Conduct and Compensation Agreement for exploration and is in the process of negotiating a Conduct and Compensation Agreement for mining. The underlying tenements are in good standing.

Aldoga lodged MLA 20676, MLA 20688 and MLA 20689 with the Department of Natural Resources and Mines (DNRM) on 19 October 2012.

MLA 20676 will include:
- Open cut BH1; and
- Internal access roads.

MLA 20688 will include:
- Open cut BH6 East;
- Workers camp; and
- Internal access roads.

MLA 20689 will include:
- Open cut BH6 West; and
- Internal access roads.

Aldoga lodged a further three MLAs, MLA 100051, MLA 100047 and MLA 100048, with DNRM on 10 July 2015 for infrastructure associated with the Project.

MLA 100051 will include:
- MIA and barge loading facility.

MLA 100047 will include
- Port haul road.

MLA 100048 will include:
- BH1 haul road.

Metro Mining will further require the granting by DNRM of two Mining Leases for Transportation (s.316 MR Act) to include two haul roads that cross ML 40082 that is currently held by Gulf Alumina.

The Metro Mining tenements are adjacent to mining leases held by Gulf Alumina (ML 40082 and ML 40069) and Rio Tinto Alcan (ML 7024 and ML 7031) and EPMs held by other companies (Figure 2-3).
The anticipated annual production rates are shown in Figure 2-4. The mine may be extended as a result of further exploration activities at the site and subsequent optimisation of the mine plan to reflect increased reserves.

![Figure 2-4 Estimated annual production rates](image)

### 2.2.5 Mining Sequence

Construction is planned to commence in April 2016, following the receipt of all necessary environmental approvals. The indicative mine development sequence is shown at Figure 2-5. The first shipment of bauxite is planned for October 2016.

Detailed design and construction is estimated to take seven months. The following works will be undertaken in the first year of construction and operation:

- **Removal of vegetation.** This will occur progressively ahead of operations to ensure that the disturbed areas are minimised prior to each wet season. Prior to clearing, any trees that are suitable for selective felling, to be reused as nesting or tree-hollow sites, will be marked and individually felled and stored. Once cleared, vegetation will be inspected by environmental staff to identify vegetation suitable to be placed directly onto rehabilitated areas to provide initial habitat and assist with soil erosion control purposes. Some vegetation may also be wood-chipped to provide base organic material for a trial composting process (See Section 6.11 - Waste). Vegetation that is not used in the rehabilitation or waste management processes will be windrowed and burned, with the burnt material incorporated into topsoil stockpiles.

- **Removal and storage of the topsoil.** Following clearing, topsoil will be collected where available and either used directly for rehabilitation purposes or placed into clearly marked topsoil stockpiles. This material will then be progressively replaced onto the post-mining rehabilitation landform. The mine plan is designed to maximise the amount of topsoil that can be placed directly, without stockpiling.

- **Removal of overburden.** Overburden thickness varies between 0.2 to 0.6 metres (m) over the majority of the deposit. Select areas of BH1 have overburden thickness of between 0.8 to 1.5 m and in some areas in BH6, the thickness varies between 0.6 to 1.0 m. The overburden is generally low in nitrogen, phosphorus and total organic carbon. Total iron concentrations were considered high which was evident on site due to the rich red soil colour. Soil salinity was considered low and pH was generally within the neutral range. The soils were typically not dispersive as the exchangeable sodium percentage (ESP) was below the limit of reporting (LOR) (<0.1%). For the initial operation, overburden material will be stored in temporary stockpiles, before being pushed back into the post-mined area. All overburden that is removed before mining will then be progressively deposited in the mined out areas.
- **Bauxite excavation.** Final equipment details will be determined by the contract mine operator; however, excavation of the bauxite is expected to utilise CAT992K front end loaders with 12 m³ bucket capacity. The excavated ore is hauled using "Pit Hauler" trucks having three trailers with a total capacity of 200 tonnes (t). No drilling or blasting is required and most of the ore will be free dug. Some ripping may be required in areas of cemented bauxite.

- **Sediment control in mining areas.** Sediment control requirements will be ongoing and integrated into mine planning. Sediment control will include measures to keep surface water flow out of the mining areas as well as control runoff from the areas. With mining operations carried out only in the dry season, the risk of significant water flow into or around the mining operations is minimised. Pits will be designed to ensure that suitable containment measures are in place at the start of the wet season.

- **Rehabilitation of mined out areas.** Mined areas will be progressively rehabilitated to meet agreed final land use criteria. Overburden material will be placed and shaped, before being covered with topsoil and any available composted material. Selected cleared vegetation may be placed back onto the topsoiled area to provide initial habitat and assist with soil erosion controls. It may also provide some direct seed placement. Where possible, locally sourced seed will then be spread across the rehabilitation area at rates that will be determined based on similar mining operations.

- **Final landform preparation.** Final land form is dictated by the bauxite floor and the amount of overburden replaced in the pit. In most areas this is expected to be stable with good drainage. Where necessary additional excavation / earth works will be carried out to achieve a suitable land profile or drainage outcome. These additional works will be minor and easily achieved using existing mining equipment.

- **Dust control.** Will be maintained using water trucks to minimise dust on the haul roads and in pit. Water trucks and sprays will be deployed in the stockpiling, conveying and industrial area as required.

- **Transport of product material will be by truck to the ROM stockpile.** Ore will be dumped and rehandled using front end loaders to screen, crush and stockpile, before going onto the product stockpile and conveyed onto barges.

- **Screen and crush.** Screening and crushing the bauxite before loading onto barges is required to eliminate oversize material and remove organic material. Organic material will be transported back to the mining area and either burned with the stripped vegetation or turned into the rehabilitated areas.

- **Stockpiling.** Ore will be stockpiled to a maximum height of 18 m using stackers with dozer push out if required. Two product stockpiles will be within a 120 m x 150 m area holding a maximum of approximately 100,000 t at any time.

- **Barge loading.** Barges, approximately 80 m x 20 m with a capacity of 2,500 t and 4,500 t with a draft up to 3.5 m, will be moored to piles in the river and loaded via a conveyor. The conveyor gantry from the barge to shore will be supported by piles. The total length of the conveyor will be approximately 550 m of which 150 m is over water.
- Figure 2-6 shows a conceptual design of the barge loading facility.

- **Barge transport.** Barges will be towed by tugs from the loading point to the transshipment location, approximately 12 km from the mouth of the Skardon River. Several temporary mooring buoys will be located in the river, near the mouth, and in the ocean, close to shore, immediately to the north of the mouth to assist barges in transit.

- **Transshipment.** OGVs of a 50,000 t (Handymax) or 70,000 t (Panamax) class will anchor between 12 km offshore from the Skardon River mouth in designated areas. These areas have been surveyed and are located away from any significant benthic habitats. Transshipment from barge to OGV will be carried out by bringing the barges alongside the OGV and using the ships’ grabs to pick up the ore and dump into the ships holds. Negligible amounts of dust and spillage will be generated during the transshipment process and, as bauxite is completely inert and the negligible amounts of material resulting from this process it is anticipated that impacts to the environment will be low.

The mine plan will be reviewed from time to time and may be subject to change. Changes may require progressive approval and will be identified in the existing Plan of Operations process.
FIGURE 2-5
MINE LEASE BOUNDARIES AND MINE DEVELOPMENT SEQUENCE

Legend
Mine Development Sequence
- Watercourse
- Haul Road
- Alternate Haul Road
- Barge Loading Area
- Camp Site
- Metro Mining Mine Lease Area

Data Source
MEC Mining, 2015;
QLD Government Open Source Data;
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

Design
1:55,000 Scale @ A3 - MDA

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Disclaimer
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Components
- BH6 West MLA boundary (ML 20689)
- BH6 East MLA boundary (ML 20688)
- BH1 MLA boundary (ML 20676)

Drum

- Watercourse
- Haul Road
- Alternate Haul Road
- Barge Loading Area
- Camp Site
- Metro Mining Mine Lease Area

Notes:
- Details Date 15/07/15
- Notes:

File Path:
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Map Details
- Scale @ A3 - 1:55,000
- Coordinate System: GCS GDA 1994 MGA Zone 54
- Note: This drawing is confidential and shall only be used for the purpose of this project.
BARGE LOADING FACILITY
CONCEPTUAL LONG SECTION

-- Diagram Content --

1. **SCALE:** 1:1,000
2. **APPARENT LINE OF BATHYMETRIC SURVEY**
3. **NO. 1 PROJECTS**
   - BES150115_Bauxite_Hill
   - GIS
   - DATA
   - MXD
   - TEMP
   - A3L_BES150115-001-TEMPL_v2.mxd

-- Notes --

1. **ALL DIMENSIONS ARE IN METRES (m) U.N.O.**
2. **ALL LEVELS ARE IN METRES (m) TO AHD U.N.O.**
3. **THE CONCEPT SHOWN IS INDICATIVE FOR DISCUSSION AND ENVIRONMENTAL APPROVAL PURPOSES ONLY. NO STRUCTURAL DESIGN HAS BEEN PERFORMED.**
4. **LAND PROFILE ESTIMATED FROM COTTRELL CAMERON & STEEN SURVEYS PTY LTD LIDAR SURVEY DRAWING NO. 10375-01 REVA.**
5. **TOPOGRAPHY AT THE PROPOSED SITE UNKNOWN.**
6. **BATHYMETRY CONTOURS SOURCE - ACOUSTIC IMAGING, DOC NO. AI2015-MM-04.**
7. **TIDAL PLANES BASED ON ACOUSTIC IMAGING SURVEY REPORT, DOC NO. AI2015-MM-04.**
8. **TIDAL AND FLOOD CURRENTS UNKNOWN.**
9. **DESIGN WATER LEVEL FOR STORM SURGE UNKNOWN. REQUIREMENT FOR BATTER SLOPE AND ABUTMENT EROSION PROTECTION TO BE CONFIRMED.**
10. **GEOTECHNICAL CONDITIONS ARE UNKNOWN.**
11. **10m PILE BENT SPACING SELECTED BASED ON CARPENTARIA CONTRACTOR’S GANTRY FOR OVER THE TOP PILE INSTALLATION.**
12. **CONVEYOR CONCEPT BASED ON REDISPAN MODULES ROLLED OUT FROM SHORE.**
13. **THE PROPOSED BARGE IS GENERIC, BASED ON 75m LENGTH, 25m BEAM, 4.5m MOULDED DEPTH, LIGHT DRAFT 0.7m AND MAXIMUM LADEN DRAFT 2.0m. BARGE WILL BE PART-FILLED AND REQUIRES WARPING TO SUIT A FIXED LOADER.**
2.2.6 Product Handling

Bauxite will be delivered ex pit to the ROM stockpile area by side tipping trucks and dumped on the stockpile pad. The bauxite is of direct shipping quality and as such no beneficiation is required. From the ROM, stockpile ore will be picked up by front end loaders and dumped into hoppers feeding the screening, crushing and stacking circuit.

The screens will be designed to remove organic matter (tree roots etc.) and separate larger lumps of cemented bauxite. Ore will be passed through a crusher to reduce the top size to minus 100 millimetre (mm). The crushed ore will then be stacked by stacking conveyors to one of three proposed stockpiles. Stockpile height will not exceed 18 m and total stockpile capacity will be approximately 100,000 t.

Screens, crusher and conveyors will be mobile with a through capacity between 800 tonnes per hour (t/hr) and 1200 t/hr. Power will be provided by direct drive diesel engines or using electric motors powered by diesel generators. Dust control will involve road tankers to dampen the stockpile pad and MIA and low volume water sprays at dust generating points and over the product stockpiles.

Bulldozers and front end loaders will be used to push bauxite from the ROM stockpile to the barge loading conveyor. The conveyor will have a belt width of nominally 1,500 mm and approximate operating speed of 4 metres per second (m/s), and will transfer product at approximately 1,500 t/hr from the stockpiles into the barge.

The Project will operate a small fleet of barges and tugs to carry the bauxite from the river berth to an OGV lying offshore. The fleet is anticipated to comprise of approximately six barges, three ocean going tugs and two assist tugs and one crew boat. The barge design is expected to be ‘dumb barges’ (without their own means of propulsion) and these will be either pushed or pulled by the tugs.

The vessels will all comply with applicable Australian Standards and will be registered as such. Refuelling of the tugs will take place either at the barge loading facility with fuel piped from the shore installation, in which case the mine’s fuel loading and unloading protocols will be followed, or the tugs will refuel at a commercial installation in Weipa.

Barge dimensions are approximately 80 m length, 20 m beam to a maximum of 90 m length, 30 m beam and draft up to 3.5 m depending on the payload. Barge loading will be carried out using a stationary conveyor transferring the ore from the product stockpiles to the barge.
2.3 Resource Base and Mine Life

2.3.1 Regional Geology

The Project is situated within the Jurassic – Cretaceous intracratonic Carpentaria Basin, which lies beneath the Gulf of Carpentaria, in offshore northern Australia, and extends onshore, into Queensland and the Northern Territory. The Carpentaria, Eromanga and Surat basins together form the Great Artesian Basin (GAB) (Figure 2-7). The Project lies within the Weipa sub-basin (Munson et al., 2013). In this region, the Carpentaria Basin is overlain by Cenozoic sediments of the Karumba Basin and Quaternary alluvial sediments.

Bauxite occurs in the upper part of a loose, pisolithic, laterite profile, which is up to 20 m in thickness (CSIRO, 2009). It is formed from weathering and leaching of shales and siltstones of the underlying formations.

Figure 2-7 Depositional basins with Great Artesian Basin (after Smerdon, 2012)
2.3.2 Stratigraphy

The stratigraphic units, present within the study area, are summarised in Table 2-2 and a map of surface geology of the study area is presented in Figure 2-8.

Table 2-2 Stratigraphy

<table>
<thead>
<tr>
<th>Period</th>
<th>Sub-Group / Formation</th>
<th>Dominant Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Surficial Beach Sand Deposits</td>
<td>Sands.</td>
</tr>
<tr>
<td></td>
<td>Valley Cut and Fill Deposits</td>
<td>Silts and sands of alluvium channel deposits (creek estuarine areas). Alluvium can be very kaolinitic as a result of re-working of source material from the pallid zone of the Rolling Downs Group or Bulimba Formation.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Bulimba Formation (Wyaaba Beds)</td>
<td>Variable lithology, ranging from claystone (often kaolinitic) to coarse grained unconsolidated sands, or cemented cobble conglomerate. Bauxite laterite develops at the top of the formation. Comprises localised sandy, permeable deposits of ancient stream channels.</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Rolling Downs Formation</td>
<td>Marine clays, fine grained clastics, mudstones and some sandstone lenses.</td>
</tr>
<tr>
<td></td>
<td>Gilbert River Formation</td>
<td>Sandstone interbedded with siltstone and conglomerate units.</td>
</tr>
</tbody>
</table>

Exploration holes were drilled to a maximum depth of 30 m with most holes being around 5 m depth. The lithological logs indicate that the general stratigraphic profile beneath the Project Site can be summarized as:

- Topsoil of 0 to 0.6 m;
- Bauxite 0.6 to 5 m;
- Ferricrete 5 to 6 m;
- Mottled silty clay (kaolin) 6 to 30 m; and
- Grey siltstone or sandstone > 30 m.

Overall, the underlying sequence consists of about 800 m of shales, siltstones and sandstones overlying granite and metamorphic basement rocks which form the ancient, stable rock platform of the continent.
FIGURE 2-8

SURFACE GEOLOGY

Legend
- Contour (mAHD)
- Watercourse
- Haul Road
- Alternate Haul Road
- Barge Loading Area
- Pit Extents
- Camp Site
- Metro Mining Mine Lease Area

DRG Ref: BES150115-023-R1_GEOL

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

DATA SOURCE
MEC Mining; Geology from DEEDI, 1994; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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DESIGNED: MD
CHECKED: -
APPROVED: - DATE: 15/07/15

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A typical stratigraphic profile of the Western Cape region is presented in Figure 2-9. At the Project site, the kaolinite clay locally reaches a thickness of up to 12 m (AGE, 2011).

**Figure 2-9 Typical stratigraphic profile of Western Cape region (after AGE 2011)**

### 2.3.3 Surficial Beach Sands

The Surficial Beach Sands have limited areal extent and thickness and are found on the beach ridges, overlying marine muds and clays.

### 2.3.4 Valley Fill Deposits

The Valley Fill Deposits are Quaternary alluvial sediments that occur within drainage valleys and estuarine areas that have been incised into the deeper formations. These deposits comprise of clays, silts and sands and can be very kaolinitic due to the source material derived from the pallid zone of the Rolling Downs Group or Bulimba Formation.

### 2.3.5 Bulimba Formation

The Cenozoic Bulimba Formation comprises of fluvial sediments (Radke *et al.*, 2012), derived mainly from the weathering of the Gilbert River Formation outcrop (CSIRO, 2009). Lithologies are variable, ranging from claystone (often kaolinitic) to coarse grained unconsolidated sands or cemented cobble conglomerate (SRK, 2014a).

The Bulimba Formation has undergone several episodes of lateritic weathering resulting in the formation of a pisolitic bauxite cap and kaolinite clay. It comprises of numerous vugs and fissures formed from volume changes associated with lateritic weathering. These macro pores, combined with the inter-granular pore space, produce relatively high permeability (Pettifer and Smart, 1976). The regolith profile typically comprises the bauxite (aluminium rich laterite) layer, which grades into ironstone (ferricrete) and kaolinite clay, and then into siltstone/claystone.

### 2.3.6 Rolling Downs Formation

The Rolling Downs Formation is of Mesozoic age and is mainly comprised of marine argillaceous clays, fine grained clastics, mudstones and some hydraulically unconnected sandstone lenses. In the study area, the upper part of the unit is laterised and has a strongly kaolinitic pallid zone.
There is some uncertainty as to whether the siltstone underlying the kaolinite clay layer represents the top of the Rolling Downs Formation or a transitional zone from the Bulimba Formation to the Rolling Downs Formation i.e. weathered zone. A groundwater exploration hole was drilled into the Rolling Downs Formation in 1994 at the Kaolin Dry Process Plant, approximately 2.7 km north of BH6 and 400 m from the Skardon River (SRK, 2014a). At this location the top of the Rolling Downs Formation was reported to be approximately 15 m below ground level (bgl), which is similar to the depth to the top of the siltstone encountered during drilling within BH1 and BH6. The siltstone was also noted to be highly weathered and it is therefore, assumed to represent the weathered upper part of the Rolling Downs Formation.

2.3.7 Gilbert River Formation

The Gilbert River Formation was formed in the Jurassic-Cretaceous period and comprises of fine to coarse-grained quartzose sandstone with pebble conglomerate and siltstone (CSIRO, 2009). It is the most extensive sandstone unit in the Carpentaria Basin and outcrops in the eastern portion of the Western Cape region, more than 30 km to the east of the Project. An indicative thickness of the Gilbert River Formation around Weipa is 140 m (McConachie et al., 1997).

2.3.8 Resource Summary

The most recent exploration data as outlined in the Metro Mining June 2015 announcement for the Australian Securities Exchange, show that the Australian Code for Reporting of Mineral Resources and Ore Reserves estimated resource is 41.8 million tonnes (Mt) of Proved and 6.4 Mt of Probable Marketable Ore Reserves. On average, the Proved Reserves contains 50.73% of total Al₂O₃ and 6.29% of reactive silica while the Probable Reserves on average contains 49.26% of total Al₂O₃ and 6.92% of reactive silica; all qualities are reported on a dry basis.

A breakdown of the reserves is shown in Table 2-3. The stated reserves represent the marketable product tonnes as this is a DSO, with no beneficiation and is saleable at ROM moistures.

Table 2-3 Mineral and ore reserve estimates

<table>
<thead>
<tr>
<th>Area</th>
<th>Category</th>
<th>DSO² Tonnes (Mt)¹</th>
<th>DSO Bauxite Qualities (Dry Basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Al₂O₃ (%)</td>
<td>THA³ (%)</td>
</tr>
<tr>
<td>BH1 and BH6</td>
<td>Measured Resource (Dry In-situ)</td>
<td>41.8</td>
<td>51.0</td>
</tr>
<tr>
<td>BH1 and BH6</td>
<td>Indicated Resource (Dry In-situ)</td>
<td>6.3</td>
<td>49.3</td>
</tr>
<tr>
<td>BH1 and BH6</td>
<td>Inferred Resource (Dry In-situ)</td>
<td>3.4</td>
<td>48.4</td>
</tr>
<tr>
<td></td>
<td>Total resource</td>
<td>51.6</td>
<td>50.6</td>
</tr>
<tr>
<td>BH1 and BH6</td>
<td>Proved Reserve⁵ (ROM @10% Moisture)</td>
<td>41.8</td>
<td>50.7</td>
</tr>
<tr>
<td>BH1 and BH6</td>
<td>Probable Reserve⁶ (ROM @10% Moisture)</td>
<td>6.4</td>
<td>49.3</td>
</tr>
<tr>
<td></td>
<td>Total Marketable Ore Reserves</td>
<td>48.2</td>
<td>50.2</td>
</tr>
</tbody>
</table>

1 For BH1 and BH6 the tonnages are calculated using the following default bulk densities determined from a program of sonic drilling; 1.6g/cm³ for BH1 and 2g/cm³ for BH6. Actual values are used where measurements have been taken
2 DSO is defined as bauxite that can be exported directly with minimal processing and beneficiation.
3 THA is trihydrate available alumina (gibbsite alumina + kaolinite alumina – low temperature desilication product (DSP) alumina) at 1500C.
4 RxSi is reactive silica at 150 degrees C.
5 Proved Reserve - the proved reserve is included in the BH1 and BH6 Measured resource
6 Probable Reserve - the probable reserve is included in the BH1 and BH6 Indicated resource
2.3.9 Ongoing Evaluation and Exploration Activities

Exploration by Metro Mining is ongoing within the Project area and will continue to be undertaken by Metro Mining throughout the mine life. The aim of the exploration program will be to better define the measured resource estimate for ongoing operational requirements of the mine. Exploration activities will be carried out according to the Project EMP and in consultation with key stakeholders, as appropriate.

2.4 Infrastructure Requirements

2.4.1 Mine Infrastructure

Infrastructure required for the life of the Project is shown in Figure 2-1. The following sections describe the infrastructure necessary to support the operation of the mine.

Where possible, Metro Mining will seek to develop and utilise shared infrastructure with Gulf Alumina in order to minimise potential construction and operational impacts. Discussions in this regard are continuing; however, due to the uncertainty of sharing infrastructure, Metro Mining is seeking approval for a standalone Project.

2.4.1.1 Mine Infrastructure Area

The MIA will comprise a level site of approximately 5.5 ha and will include:

- ROM dump site;
- Screening and crushing;
- Bauxite stockpiles;
- Load point for the barge loading conveyor;
- Earthmoving equipment hard stand;
- Administration offices;
- Workshops; and
- Fuel storage.

The MIA will include cut-off drains to prevent stormwater entering the site from the surrounding catchment and sediment control measures to control runoff water. The site will also include an isolated runoff control system around the workshops incorporating oil separators. As the mine will not be operating during the wet season sediment build up will be limited during this time and sediment control measures will be designed to manage all runoff without maintenance for the duration of the wet season.

2.4.1.2 Fuel Delivery and Storage

Fuel (diesel) consumption is estimated at approximately 20 kilolitres per day for the mining equipment, power generation and tugs. Onshore storage for up to 500,000 litres will be provided via a tank farm with self bunded containment. Fuel will be delivered via marine tankers and piped from the barge jetty.
All fuel tanks, bunding and transfer pipes will meet AS1940-2004: The Storage and Handling of Flammable and Combustible Liquids and AS1692-2006: Steel tanks for flammable and combustible liquids. Spill control measures will be in place according to AS1940-2004: The Storage and Handling of Flammable and Combustible Liquids.

2.4.1.3 Haul Roads

Haul road routes are generally within Metro Mining’s tenements. Haul roads outside Metro Mining’s tenements are also considered, where practicable, to decrease and avoid potential environmental impacts and construction and engineering costs. Haul roads will be constructed from BH6 to the MIA and barge loading facility, and from BH6 to BH1. Haul roads will be constructed using local materials taken from within the proposed haul road corridor or from the mining pits.

- The haul road design will be based on acceptable road design standards such as the Austroads Guide to Rural Road Design and the Queensland Road Planning and Design Manual. The basic design criteria adopted for the indicative design process is presented in Table 2-4 (see Figure 2-10 for indicative haul road design). Haul road design will includes suitable culverts and over flow structures to allow the free flow of water during the wet season, when the mine is not operating.

![Figure 2-10 Indicative haul road cross section](image-url)
Table 2-4 Indicative haul road design criteria

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical Cross Section</strong></td>
<td></td>
</tr>
<tr>
<td>Design vehicle</td>
<td>Multi-Train Haul Truck</td>
</tr>
<tr>
<td>Number of traffic lanes</td>
<td>2 lanes (one lane each travel direction) except across culverts where one way traffic is designated to minimise area of disturbance</td>
</tr>
<tr>
<td>Traffic lane width</td>
<td>4 m</td>
</tr>
<tr>
<td>Traffic lane crossfall</td>
<td>3%</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>2 m</td>
</tr>
<tr>
<td>Shoulder crossfall</td>
<td>4%</td>
</tr>
<tr>
<td>Cut batter slope</td>
<td>2H:1V</td>
</tr>
<tr>
<td>Fill batter slope</td>
<td>4H:1V</td>
</tr>
<tr>
<td><strong>Horizontal Alignment</strong></td>
<td></td>
</tr>
<tr>
<td>Design vehicle</td>
<td>Truck</td>
</tr>
<tr>
<td>Design Speed</td>
<td>90 kph</td>
</tr>
<tr>
<td>Minimum Curve Radius</td>
<td>250 m</td>
</tr>
<tr>
<td><strong>Vertical Alignment</strong></td>
<td></td>
</tr>
<tr>
<td>Design vehicle</td>
<td>Truck</td>
</tr>
<tr>
<td>Design Speed</td>
<td>90 km/h</td>
</tr>
<tr>
<td>Maximum Longitudinal Gradient</td>
<td>8%</td>
</tr>
<tr>
<td>Minimum K value for Crest Curves</td>
<td>40</td>
</tr>
<tr>
<td>Minimum K value for Sag Curves</td>
<td>35</td>
</tr>
</tbody>
</table>

Alternative haul road routes traversing adjoining mining leases held by Rio Tinto Alcan and Gulf Alumina are shown in Figure 2-11. Metro Mining has held discussions with both parties seeking their consent to locate alternate haul roads on their leases. As yet an agreement has not been reached and therefore, Metro Mining proposes to submit a mining lease for transportation under s316 of the MR Act. Should approval be successful the haul roads will be relocated to these alignments in order to minimise impacts to environmental values.
FIGURE 2-11

ALTERNATIVE HAUL ROAD ROUTES

---

**Legend**
- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Pit Extents
- Camp Site
- Metro Mining Mine Lease Area

**Notes:**
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- Copyright: CDM Smith
- Scale: 1:60,000
- DRG Ref: BES150115-025-R1_ALT_HR
2.4.2 Barges and Barge Loading Facility

2.4.2.1 Barge Loading Facility Infrastructure

The bauxite stockpiles are located within the MIA, approximately 550 m from the barge loading jetty. A single overland belt conveyor, with a belt width of 1,500 mm and approximate operating speed of 4 m/s, will transfer product bauxite at 1,500 t/hr from the stockpiles to the barges.

The overland conveyor will be contained in a gantry supported by pairs of vertical tubular steel piles generally spaced at 20 m centres and driven into the river bank and river floor progressively from the stockpiles to the barge loading berth. The gantry will be prefabricated in spans approximately 20 m long.

Discharge into the barges will be via a chute mounted at the end of the conveyor.

The barge loading berth requires three berthing dolphins with three additional dolphins provided for the barge waiting berth. It is envisaged that each dolphin will have a maximum of four tubular steel piles. Total length of the barge mooring including the second berth will be approximately 160 m.

To maintain safe barge berthing, loading and un-berthing processes, a minimum water depth of 4 m is being planned at the loading point.

The maximum drop height of the bauxite is 6 m.

The barge loading facility, including jetty and dolphins, will rest within the same mining lease for Infrastructure Purposes that contains the MIA (see Figure 2-3).

2.4.2.2 Barge Operations

Bauxite transportation will be via barge through the Skardon River. Each barge will carry between 2,500 t and 4,500 t depending on the tide at the time of loading. It is expected that transit at the river mouth will be limited for approximately seven hours a day during low tide. The Project feasibility has taken into consideration these restrictions and has designed the barge system such that bed-levelling or dredging is not necessary.

Sufficient numbers of barges will be placed in service to provide for the maximum requirement during the expected operating year. Barges will be loaded upon arrival at the barge loading facility at the rate of between 1,000 t/hr and 1,500 t/hr.

Tugboats will standby with the barges during loading. Barges will then be delivered to the transshipment location where they will be discharged to the awaiting carrier. The tug boats will pick up empty barges and return to the barge loading facility.

Metro Mining will monitor river depth and tidal stages at its loading location and at all critical locations between the loading facility and downstream to through the mouth of the Skardon River. Barges will only be loaded to drafts that will adequately clear the shallowest areas of the Skardon River. The tugboats will be of suitable design to clear the critical areas within the Skardon River at their lowest operating draft. As volume increases barges and tug boats will be added to the fleet to accommodate the increased tonnage. One or more mooring areas will be identified within the Skardon River to hold barges in between loading and during the wet season when the mine is not operational.
Vessels of between 50,000 to 70,000 t each will be self-loaded at the transshipment anchorage site. Vessels will be loaded in approximately four to six days, requiring 15 - 20 loaded barges to complete each cargo. Each barge will typically have a capacity of 2,500 t and 4,500 t and be towed by a tug of 2,000 horsepower (HP).

### 2.4.2.3 Barge Mooring

When not in use the barges will be moored in the Skardon River clear of other river traffic. Moorings will consist of a concrete block weighing between 5 t to 10 t placed on the river floor with a chain connected to a float.

The moorings will be designed to withstand cyclones (cyclone rated) and barges will be secured to these moorings during the wet season. Tugs will be redeployed during the wet season at sites outside the Skardon River.

### 2.4.3 Site Power and Water

#### 2.4.3.1 Site Power Generation

Power requirements will be sourced from onsite generators located within the MIA and the accommodation camp. The likely generator configuration is:

- Three generators (e.g. CAT generator) to provide 1 Megawatt (MW) for the operation of the MIA which will operate at 75% load; and
- One 500 (Kilowatt) kW CAT generator for the operation of the village, which will operate at 50% load.

Metro Mining is committed to minimising energy use throughout the Project life. A range of energy minimisation and energy efficiency strategies will be developed for both the construction and operational phases of the Project. These will be incorporated into detailed design and will be pursuant to the relevant legislation and policies such as the *Clean Energy Act 2011* (Cwlth) (CE Act) and the ClimateQ: Towards a Greener Queensland strategy. Further details on energy efficiency are provided in Section 6.9.

#### 2.4.3.2 Site Water Supply

A schematic of the proposed water management network for the Project is shown in Figure 2-12. The proposed water supply is via shallow and/or deep aquifer bores to meet a total annual demand of 200 ML. Assuming 275 days of operation per year and 20 hours of daily pumping time, a total yield of 10 litres per second (L/s) is required from the combined bores. Polyethylene storage tanks are proposed to buffer between supply from the bores and operational demand. The polyethylene tanks will include a peaking factor to accommodate temporary increases in water demand and to protect against irregularities in supply from the bores. A peaking factor of between one day and one week will equate to polyethylene tanks with a total storage of between 1 megalitre (ML) and 5 ML. The number of tanks required will be based on balancing the need to locate water storage near the water use versus trucking water to where it is used.
Fig 2-12 Proposed water management network

A summary of the potential breakdown of mine water demands which the water supply system must satisfy is shown in Table 2-5 and expanded on in Section 6.7 - Surface Water Resources. The majority of water use (150 ML/yr) is raw water for dust suppression of the dump station, haul roads and stockpiles, as well as for washdown of the crusher plant and conveyor system.

Table 2-5 Mine water demands

<table>
<thead>
<tr>
<th>Description</th>
<th>Annual Demand (ML)</th>
<th>Water Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations (crusher; truck fill for dust suppression)</td>
<td>150</td>
<td>Raw</td>
</tr>
<tr>
<td>Mine personnel (105 persons)</td>
<td>10</td>
<td>Potable</td>
</tr>
<tr>
<td>Fire Fighting (poly tank spare capacity)</td>
<td>5</td>
<td>Raw</td>
</tr>
<tr>
<td>Mine Infrastructure Area (Workshop / Washdown)</td>
<td>35</td>
<td>Raw / Potable*</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>-</td>
</tr>
</tbody>
</table>

*1 ML/yr potable supply to the MIA assuming 40 L/person/day

A potable water supply to the camp and MIA of approximately 11 ML/yr is required to meet the standard outlined in the National Health and Medical Research Council and Natural Resource Management Ministerial Council (NHMRC and NRMMC) (2011) National Water Quality Management Strategy, Australian Drinking Water Guidelines (ADWG). Field investigations and laboratory testing conducted indicate that the shallow aquifer water quality is suitable for potable use. Chemical dosing may be required to control pH levels and provide disinfection. Two potable
water tanks will be required; one at the mine camp and the other at the MIA. The main potable use tank will be located near the mine camp, as this is the main source of potable demand. A potable water pipeline or truck transport will be required to transport potable water to the storage tank located at the MIA.

A sewage treatment plant is proposed to be located near the accommodation camp. Wastewater produced from the MIA will be stored and periodically trucked and transported to the sewage treatment plant. Effluent and sludge waste streams will be appropriately treated and irrigated to surface or used as mulching media, respectively.

The water management network allows for potential reuse of water collected in sumps, ponds and slots. Allowance for reuse of water has not been incorporated into the demand analysis; however, such an allowance will reduce the amount of water abstracted from bores. The main function of the sumps, ponds and slots is to capture sediment laden runoff for sediment removal prior to release to the existing environment. Oil / water separators are proposed for vehicle wash and workshop areas prior to release or reuse of water.

Fire water supply will be provided through storage in polyethylene tanks at suitable locations around the mine lease. A total of 5 ML has provisionally been included for the purpose of this water resources assessment. It is anticipated that these stores be replenished post use and that the total volume is available for firefighting activities during operations.

2.4.4 Site Communications

The communications systems for the Project will comprise both voice and data systems that will be implemented in stages associated with early works, construction and operation. Prior to construction, adequate communications systems must be operational to support the health and safety for all personnel involved in the Project. Metro Mining proposes to utilise a combination of the existing commercial Telstra mobile Next G network together with the use of the public UHF radio network and satellite phones.

Radio procedures for emergency declaration will be in accordance with the standard operating procedures as instructed during generic and site specific induction processes.

Once the MIA and accommodation camp are in place, a permanent site radio VHF repeater station may be setup which will enhance voice communications over the Project area to meet the needs of both the construction and operational phases. Alternatively talks will continue with the relevant parties in regards to upgrading the existing services located in Mapoon.

2.4.5 Lighting

Artificial lighting will be designed, installed, operated and maintained in accordance with AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting, to minimise the amount of light spill associated with the Project. Controls stipulated in this standard include consideration of the location and orientation of lighting as well as the selection and maintenance of luminaries. Any further mitigation (e.g. shielding, further restricting the use of lighting) will be implemented on an as needed basis, through consultation with adjoining property users and statutory agencies. As the mine will be operating on a single 12 hour shift during the day, only minimal lighting will be required.
2.4.6 Site Waste Management

Metro Mining is committed to implementing waste minimisation and efficiency strategies. Metro Mining will ensure that construction and operation activities are in line with the waste management hierarchy outlined within the Environmental Protection (Waste Management) Policy 2000 which provides preferred principles of waste management based on:

- Avoid waste by optimising methods used within the construction, operation and decommissioning phases (most preferred);
- Reuse waste by identification of secondary sources that can utilise waste;
- Recycle waste by identification of facilities that can recycle the particular waste stream;
- Energy recovery from waste, e.g. creating energy from incineration; and
- Disposal of waste at an appropriate facility (least preferred).

The principles outlined above will form the basis of Metro Mining’s waste management strategy and be applicable to all waste streams which may be generated throughout the life of the Project. Detailed explanation of Metro Mining’s waste management procedures and strategies are presented in Section 6.11 - Waste.

2.4.6.1 Air Emissions

The predominant air emission from the Project will be in the form of dust from site preparation, product handling and transportation of product between the pit and the MIA. As outlined in Section 6.9, air quality is not predicted to exceed threshold criteria at any of the nearest sensitive receptors such as at Mapoon.

2.4.6.2 Excavated Waste

Waste material associated with the pit development and mining (including sub-soils and weathered rock) will be used for construction of the MIA and other infrastructure, where practicable. Topsoil will be retained nearby to the mine pits and reused as part of site rehabilitation (refer to Section 5.1 for further details on rehabilitation). These materials are relatively geochemically inert (i.e. testing showing relatively neutral pH) and have low acid forming potential (refer to Section 6.2 – Geology, Topography and Soils for geochemical properties). Intercepted product during the construction will be stockpiled if suitable at the MIA for future export.

The estimated excavated waste volumes for the first nine years of the Project development are shown in Table 2-6. Whilst referred to as waste, the excavated waste materials will be returned to the pit void as part of the Projects rehabilitation program. Therefore it is not expected that there will be any waste material stockpiles retained out-of-pit at the cessation of mining.
### Table 2-6 Waste material calculations for mine years 1 - 9

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Deposit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Ore</td>
<td>634,885</td>
<td>1,903,561</td>
<td>1,899,523</td>
<td>1,899,523</td>
<td>1,899,523</td>
<td>1,899,523</td>
<td>1,899,523</td>
<td>1,899,523</td>
<td>1,899,523</td>
</tr>
<tr>
<td>Average Distance Ore (m)</td>
<td>5,908</td>
<td>6,530</td>
<td>11,939</td>
<td>15,419</td>
<td>15,757</td>
<td>16,218</td>
<td>16,407</td>
<td>15,951</td>
<td>15,759</td>
</tr>
<tr>
<td>Total Waste Volume (bcm)</td>
<td>161,290</td>
<td>333,393</td>
<td>263,694</td>
<td>165,146</td>
<td>195,947</td>
<td>151,241</td>
<td>221,793</td>
<td>231,669</td>
<td>286,513</td>
</tr>
<tr>
<td>Average Distance Waste (m)</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
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<tr>
<td><strong>Deposit BH1</strong></td>
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<td>Total Ore</td>
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<td>1,185,517</td>
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<tr>
<td>Average Distance Ore (m)</td>
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<td>-</td>
<td>15,036</td>
<td>15,419</td>
<td>15,757</td>
<td>16,218</td>
<td>16,407</td>
<td>15,951</td>
<td>15,759</td>
</tr>
<tr>
<td>Total Waste Volume (bcm)</td>
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<td>-</td>
<td>207,002</td>
<td>165,146</td>
<td>195,947</td>
<td>151,241</td>
<td>221,793</td>
<td>231,669</td>
<td>286,513</td>
</tr>
<tr>
<td>Average Distance Waste (m)</td>
<td>-</td>
<td>-</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td><strong>Deposit BH6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Ore</td>
<td>634,885</td>
<td>1,903,561</td>
<td>714,005</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average Distance Ore (m)</td>
<td>5,908</td>
<td>6,530</td>
<td>6,681</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Waste Volume (bcm)</td>
<td>161,290</td>
<td>333,393</td>
<td>56,692</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average Distance Waste (m)</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### 2.4.6.3 Solid and Liquid Waste

The generation, recycling and disposal of wastes will be reduced through effective management and implementation of site specific recycling practices as outlined in Section 6.11 - Waste. As part of the waste management strategy, Metro Mining will develop and implement a Waste Management Plan that will provide the framework to implement good practice waste management practices in accordance with the Environmental Protection (Waste Management) Policy (Qld) 2000.

Mining activities will result in the generation of domestic, commercial and industrial type wastes.

Waste streams generated by the Project include:

- General waste suitable for disposal to offsite landfill;
- Putrescible wastes suitable for onsite composting;
- Reusable or recyclable materials such as wood, scrap metal, paper, cardboard, aluminium cans, glass and plastic bottles, paper, wood;
• Inert construction material suitable for disposal onsite to the waste trench; and
• Regulated waste such as tyres, solvents, lubricants, redundant chemicals and engine coolant.

Where possible waste will be recycled or reused and will be separated out into various skips according to its waste stream. In instances where the waste cannot be recycled, or disposed of in the inert waste trench, it will be removed offsite by appropriately licenced contractors and taken to landfill. For any regulated waste, an appropriately licensed waste contractor will be used to remove the waste from the Project site.

Licenced contractors will be engaged to manage waste removal, ensuring minimal waste disposal will occur on site. Full details of solid waste disposal are included in Section 6.11 - Waste.

2.4.7 Workforce Accommodation

The accommodation camp will have up to 100 rooms with 75% occupancy at any one time. The camp will provide accommodation needs for the workforce, any contractors required from time to time and any other visitors to the site (such as Metro Mining staff). Personnel will be shuttled between the accommodation camp and site at shift commencement and completion.

The construction of the accommodation camp is anticipated to occur over one month. The construction workforce is presently estimated at 75 people for the first month which will be maintained into the start of operations. This is because it is envisaged the mining contractor will have civil capabilities. During construction, it is anticipated that the workforce will reside within the limited existing camp facilities until the Project’s accommodation camp is operational. This method will reduce any demand on existing accommodation requirements within Weipa.

The accommodation camp will most likely be operated by a specialist camp supplier. The accommodation camp will include facilities such as:

• Single person accommodation units;
• Diesel generator to supply power;
• Potable water sources and sewage treatment plant;
• All catering and cleaning services;
• Dining room;
• Gymnasium and outdoor recreation areas;
• BBQ area;
• Designated outdoor smoking areas;
• Service point covering basic personal needs;
• An all-weather assembly point;
• First aid facilities; and
• Firefighting capability.
The accommodation camp will utilise diesel generators for power supply and will have its own sewage treatment plant. Waste water from the sewage treatment plant will be treated to a class suitable for irrigation and/or composting. The reuse of water is expected to minimise the need for disposal.

The accommodation camp will offer a high level of amenity, which will contribute to a healthy workforce. Ensuring adequate access to exercise and other recreational facilities, along with modern communication facilities, will also contribute to the health and social wellbeing of workers. The accommodation camp will be designed to take advantage of the natural features of the land (see Figure 2-13 and Figure 2-14). The accommodation camp has been located well away from the workings and MIA, in order to minimise vehicle and operational noise.
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DISCLAIMER

NOT TO SCALE

FIGURE 2-13

INDICATIVE ACCOMODATION CAMP DESIGN

This drawing is confidential and shall only be used for the purpose of this project.

DATA SOURCE

MEC Mining; AMEC Foster Wheeler, 2015;
QLD Government Open Source Data,
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

F:\1_PROJECTS\BES150115_Bauxite_Hill\GIS\DATA\MXD\TEMP\A3L_BES150115-001-TEMPL_v2.mxd

URL Ref: A3L_BES150115-001-TEMPL_v2
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map. Not to scale.
2.5 Workforce

The Project is expected to employ up to 105 employees and operate over a single 12 hours shift for approximately nine months of the year. The Project is still in its design stage and workforce requirements shown in Table 2-7 are indicative only.

Table 2-7 Indicative Project staffing numbers

<table>
<thead>
<tr>
<th>Staff</th>
<th>On shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td></td>
</tr>
<tr>
<td>Tradesman</td>
<td>3</td>
</tr>
<tr>
<td>Assistant Tradesman</td>
<td>2</td>
</tr>
<tr>
<td>Processing staff</td>
<td></td>
</tr>
<tr>
<td>Crushing and loading</td>
<td>4</td>
</tr>
<tr>
<td>Barging</td>
<td></td>
</tr>
<tr>
<td>Barging Operator</td>
<td>35</td>
</tr>
<tr>
<td>Load and Haul (Waste)</td>
<td></td>
</tr>
<tr>
<td>Load Operator</td>
<td>1</td>
</tr>
<tr>
<td>Truck Driver</td>
<td>2</td>
</tr>
<tr>
<td>Load and Haul (Ore)</td>
<td></td>
</tr>
<tr>
<td>Load Operator</td>
<td>2</td>
</tr>
<tr>
<td>Truck Driver</td>
<td>6</td>
</tr>
<tr>
<td>Ancillary Services</td>
<td></td>
</tr>
<tr>
<td>Grader Operator</td>
<td>1</td>
</tr>
<tr>
<td>Wash Truck Operator</td>
<td>1</td>
</tr>
<tr>
<td>Fuel Truck Operator</td>
<td>1</td>
</tr>
<tr>
<td>Dozer Operator</td>
<td>2</td>
</tr>
<tr>
<td>Total Site Labour</td>
<td>60</td>
</tr>
<tr>
<td>Operation Support</td>
<td></td>
</tr>
<tr>
<td>Mining Engineer</td>
<td>1</td>
</tr>
<tr>
<td>Mining Manager</td>
<td>1</td>
</tr>
<tr>
<td>Supervisor</td>
<td>2</td>
</tr>
<tr>
<td>Receptionist</td>
<td>1</td>
</tr>
<tr>
<td>Extras</td>
<td>5</td>
</tr>
<tr>
<td>Total Site Support</td>
<td>10</td>
</tr>
</tbody>
</table>

Planned Roster 2 on 1 off

Total Site Employees 105 (= 70/2x3)

2.5.1 Workforce Management

Metro Mining is continuing to develop workforce management plans and strategies and will continue to do so as Project planning and engagement with stakeholders progresses. The composition of the workforce and the source of workers will not be known until recruitment commences. No positions within the Project are to be specified as being resident or non-resident with all positions open to the ‘right’ candidate, wherever that person may reside.
The action plan for workforce management provides the flexibility for the changing labour markets as a result of other projects. In further developing and implementing the action plan, Metro Mining is committed to working with stakeholders to achieve the objectives of the plan.

2.5.1.1 Construction Phase

Recruitment and management of the workforce during the construction phase will largely be the responsibility of contractors and subcontractors appointed to undertake various components of the Project. Metro Mining will; however, include in the contract the requirement to meet any social or employment commitments that have been made. The contracting strategy for the construction phase is still being developed; however, contractors will be required to have recruitment and training programs in place, along with an employment policy. Contractors and subcontractors will be required to report on the following information which is regularly requested by the Office of Economic and Statistical Research (OESR) through the Queensland Treasury mining employment survey:

- Number of employees, contractors, subcontractors;
- Local government area of usual place of residence, plus postcode of usual place of residence;
- Name of contractor, subcontractor, etc. and number of personnel for each working on the Project;
- Number of workers involved in each of construction, operation and scheduled maintenance activities;
- Types of accommodation assistance provided to employees, contractors and subcontractors, if any (such as: subsidised housing, accommodation camp, temporary accommodation, commercial accommodation and other accommodation); and
- Number of workers in each type of accommodation.

All contractors engaged by the Project will be encouraged to utilise Australian and Queensland Government skills and training programs where possible, including the Australian Apprenticeship Program.
Section 3  Tenure and Tenements

3.1 Relevant Tenure and Tenements

Nearby tenure and tenements are identified in the Table 3-1, including those comprising the Bauxite Hills tenement held by Metro Mining subsidiaries. The mining lease tenements in the vicinity of the Project are shown at Figure 2-3.

Table 3-1 Nearby tenure and tenements

<table>
<thead>
<tr>
<th>ML Granted</th>
<th>Permit Number</th>
<th>Permit Name</th>
<th>Permit Status</th>
<th>Authorised Holder Name</th>
<th>Minerals</th>
<th>Shape Area Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML 6025</td>
<td>SKARDON RIVER NO. 1</td>
<td>Granted</td>
<td>GULF ALUMINA LIMITED</td>
<td>BX,CY,KAO</td>
<td>1,922</td>
<td></td>
</tr>
<tr>
<td>ML 7024</td>
<td>WEIPA</td>
<td>Granted</td>
<td>RTA WEIPA PTY LTD</td>
<td>BX,KAO</td>
<td>246,182.67</td>
<td></td>
</tr>
<tr>
<td>ML 7031</td>
<td>ALCAN WEIPA</td>
<td>Granted</td>
<td>ALCAN SOUTH PACIFIC PTY LTD</td>
<td>BX</td>
<td>138,900</td>
<td></td>
</tr>
<tr>
<td>ML 40069</td>
<td>SKARDON PIPELINE</td>
<td>Granted</td>
<td>GULF ALUMINA LIMITED</td>
<td>BX,KAO,SI</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>ML 40082</td>
<td>SKARDON BUFFER</td>
<td>Granted</td>
<td>GULF ALUMINA LIMITED</td>
<td>BX,KAO,SI</td>
<td>1,742.8863</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ML in Application</th>
<th>Permit Number</th>
<th>Permit Name</th>
<th>Permit Status</th>
<th>Authorised Holder Name</th>
<th>Minerals</th>
<th>Shape Area Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLA 20676</td>
<td>BAUXITE HILLS 1</td>
<td>Application</td>
<td>ALDOGA MINERALS PTY LIMITED</td>
<td>BX</td>
<td>2,317.9124</td>
<td></td>
</tr>
<tr>
<td>MLA 20688</td>
<td>BAUXITE HILLS 6 EAST (BH6 EAST)</td>
<td>Application</td>
<td>ALDOGA MINERALS PTY LIMITED</td>
<td>BX</td>
<td>530.8866</td>
<td></td>
</tr>
<tr>
<td>MLA 20689</td>
<td>BAUXITE HILLS 6 WEST (BH6 WEST)</td>
<td>Application</td>
<td>ALDOGA MINERALS PTY LIMITED</td>
<td>BX</td>
<td>2,052.3816</td>
<td></td>
</tr>
<tr>
<td>MLA 100047</td>
<td>Port Haul Road</td>
<td>Application</td>
<td>ALDOGA MINERALS PTY LIMITED</td>
<td>Infrastructure</td>
<td>45.23</td>
<td></td>
</tr>
<tr>
<td>MLA 100048</td>
<td>BH1 Haul Road</td>
<td>Application</td>
<td>ALDOGA MINERALS PTY LIMITED</td>
<td>Infrastructure</td>
<td>34.1</td>
<td></td>
</tr>
<tr>
<td>MLA 100051</td>
<td>Bauxite Hills Port</td>
<td>Application</td>
<td>ALDOGA MINERALS PTY LIMITED</td>
<td>Infrastructure</td>
<td>51.3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EPM Granted</th>
<th>Permit Number</th>
<th>Shape</th>
<th>Permit Status</th>
<th>Authorised Holder Name</th>
<th>Minerals</th>
<th>Subblock Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPM 4068</td>
<td>Polygon</td>
<td>Granted</td>
<td>GULF ALUMINA LIMITED</td>
<td>AMOC</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>EPM 15370</td>
<td>Polygon</td>
<td>Granted</td>
<td>ORESOME AUSTRALIA PTY. LTD.</td>
<td>AMOC</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>EPM 15376</td>
<td>Polygon</td>
<td>Granted</td>
<td>CAPE ALUMINA PTY LTD.</td>
<td>AMOC</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>EPM 16899</td>
<td>Polygon</td>
<td>Granted</td>
<td>CAPE ALUMINA PTY LTD.</td>
<td>AMOC</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>EPM 18384</td>
<td>Polygon</td>
<td>Granted</td>
<td>GULF ALUMINA LIMITED</td>
<td>AMOC</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>EPM 19001</td>
<td>Polygon</td>
<td>Granted</td>
<td>ORESOME AUSTRALIA PTY. LTD.</td>
<td>AMOC</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>EPM 19047</td>
<td>Polygon</td>
<td>Granted</td>
<td>ORESOME AUSTRALIA PTY. LTD.</td>
<td>AMOC</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>EPM 25147</td>
<td>Polygon</td>
<td>Granted</td>
<td>SUNRISE MINERALS PTY LTD</td>
<td>AMOC</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

Note: BX = Bauxite, KAO = Kaolin, SI = Silica, CY = Clay, AMOC = All Minerals Other than Coal

3.1.1 Native Title

The Ankamuthi People (QUD6158/98) and the Northern Cape York Group #1 (QUD157/11) have been identified as being the relevant Aboriginal parties associated with the Project area (see Figure 3-1). The Right to Negotiate process is well advanced with both Aboriginal parties. The requirements of the Cultural Heritage Management Plans (CHMPs) will be incorporated into this document.
Section 4  Approach to Environmental Assessment

This section outlines the environmental assessment approach in accordance with relevant legislation and guidelines.

4.1 Overview

The Project requires specific environmental approvals under the EP Act and potentially the EPBC Act. In addition, the Project will potentially require a number of other approvals, permits and licences for various components of the development. The general regulatory framework for the Project is provided in Table 4-1. The most significant legislation that applies to the environmental management of the operations is described within each potential area of impact in Section 6.

<table>
<thead>
<tr>
<th>Permit/Approval/Licence</th>
<th>Legislation</th>
<th>Authority</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Wide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Authority (EA)</td>
<td>EP Act</td>
<td>DEHP</td>
<td>Covers mining and associated activities as per operational and environmental requirements of an EA (mining activities).</td>
</tr>
<tr>
<td>Controlled Action Approval</td>
<td>EPBC Act</td>
<td>DotE</td>
<td>The Project was originally referred to DotE on 12 January 2012 and was declared a controlled action 10 February 2012. Draft EIA guidelines were issued for review 6 July 2012 and finalised 15 August 2012. The Project scope has changed significantly from the original referral and as such Metro Mining will seek to have the original referral withdrawn and a new referral will be submitted.</td>
</tr>
<tr>
<td>Mining Lease</td>
<td>MR Act</td>
<td>DNRM</td>
<td>Award of a mining lease following environmental approval.</td>
</tr>
<tr>
<td>Barge Loading Facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal of marine plants</td>
<td>SP Act 2009¹ and Fisheries Act 1994</td>
<td>DEEDI</td>
<td>Under s 76L, a permit is required for activities which result in the removal, damage or destruction of marine plants.</td>
</tr>
<tr>
<td>Approval for impacts in tidal areas</td>
<td>SP Act and potentially CPM Act 1995²</td>
<td>DEHP</td>
<td>No tidal works may be carried out in, on or above land under tidal water in the State of Queensland without a development approval in the form of a development permit.</td>
</tr>
<tr>
<td>Mine Operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licence to take water (surface water and/or groundwater) and approvals for related infrastructure</td>
<td>Water Act 2000</td>
<td>DEHP</td>
<td>The Water Act 2000 provides the framework to regulate the use of surface waters and groundwater through water planning instruments. Under the Water Act, a person (including a corporation) must not take, supply or interfere with water unless authorised under the act. An application to divert water from watercourses during construction and mine operational activities will be required for this Project.</td>
</tr>
<tr>
<td>Licence to take water from the Great Artesian Basin (GAB)</td>
<td>Water Act 2000</td>
<td>DNRM</td>
<td>Project needs to be declared ‘regionally significant’ by DNRM before an application for a water allocation can be lodged.</td>
</tr>
<tr>
<td>Transport Infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport corridor Mining Lease</td>
<td>MR Act</td>
<td>DNRM</td>
<td>Grant of a Mining Lease for transport purposes pursuant to s316 of the MR Act for access across Gulf Alumina (and Rio Tinto Alcan) tenements</td>
</tr>
</tbody>
</table>

¹ Sustainable Planning Act 2009; ² Coastal Protection and Management Act 1995

The environmental assessment has been prepared to assess EVs, potential impacts and propose appropriate management and mitigation strategies in relation to the activities to be undertaken for
the development of the mine. The approach taken was to assess the impacts in accordance with the DEHP guidelines which specify requirements for ERA applications with waste impacts and impacts to land, air, noise and water. For elements not covered by these guidelines, industry standards, guidelines and professional expertise and experience was used to undertake an assessment of the technical elements described in this report.

4.2 Overview of Key Approvals

The key approvals required for the Project include:

- Resource tenure in the form of six Mining Leases (MLA 20676, MLA 20689, MLA 20688, MLA 100051, MLA 100047 and MLA 100048) for minerals and infrastructure pursuant to the Queensland MR Act;

- Up to four Mining Leases for Transport (pursuant to s316 of the MR Act) may be required where agreements have been reached with other parties to develop haul roads across existing granted mining leases;

- Environmental approval in the form a resource EA pursuant to the Queensland Environmental Protection Act 1994 (EP Act); and

- Approval under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) to undertake the proposed action.

4.2.1 Mining Lease (MR Act)

Chapter 6 of the MR Act provides the legislative framework for exploration, development and mining tenure in the State. Compliance with the MR Act is administered by the Queensland DNRM. Granting of an ML, in conjunction with the issuing of an EA from DEHP entitles the holder to machine-mine specified minerals and carry out activities that are associated with, or support the mining activity. Such ancillary activities may include but not be limited to mineral processing, wastewater storage and treatment and machinery and equipment maintenance – provided these activities are undertaken within the ML boundary.

Three MLs for minerals are required for the Bauxite Hills Project, covering an area of 3,930 ha. The ML for Infrastructure (minerals) covering an area of 51.52 ha is required for the MIA and barge loading facilities and the four MLs for the haul roads cover an area of 90 ha in total. These areas have been selected to optimise the extraction of the bauxite resource to enable the safe conduct of operational activities, to allow advantageous positioning of the Project infrastructure and to minimize impacts to environmental values.

Prior to a mining lease being granted a proponent must apply and be granted an EA covering the activities which are proposed on the mining lease.

Under Part 3 Section 4A of the MR Act, development authorised under the MR Act is not subject to the provisions of the SP Act with the exception of development involving building work under the Building Act 1975 (Qld) and other assessable development under the SP Act, outside a mining lease.
4.2.2 Environmental Authority (EP Act)

4.2.2.1 Environmentally Relevant Activities

Section 107 of the EP Act defines a ‘resource activity’ as a ‘mining activity’. Section 110 of the EP Act further defines a ‘mining activity’ as an authorised activity for a mining tenement under the MR Act. Such authorised activities include that act of mining, processing and ancillary activities in support of a mining operation.

A resource or mining activity is also defined as a resource ERA. Schedule 2A of the Environmental Protection Regulation 2008 (EP Regulation) lists the resource ERAs. The proposed Project will involve the conduct of resource ERA 11 – Mining Bauxite.

Additional ERAs likely to be included in the single overall EA for the Project are:

- ERA 8 – Chemical Storage 3 - storing more than 500m³ of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c);
- ERA 16 2(c) - Extracting other than by dredging, in a year more than 1,000,000 t;
- ERA 33 – Crushing, milling, grinding or screening more than 5,000 t in a year;
- ERA 50 1(a) - Loading or unloading 100 t or more of minerals in a day or stockpiling 50,000 t or more of minerals within 5 km of the astronomical tide or 1 km of a watercourse;
- ERA 50 1(b) – Stockpiling 50,000 t or more of minerals or loading or unloading 100 t per day or more of minerals at another place;
- ERA 50 2 – Loading or unloading bulk materials or stockpiling 100 t per day or more of bulk materials in association with a port; and
- ERA 63 1(a)(i) – Sewage treatment for 100 to 1,500 equivalent persons with treated effluent discharges to an infiltration trench or irrigated.

4.2.2.2 Site-Specific EA

In Queensland, a mining proponent needs to apply for an EA to perform resource and prescribed ERAs. DEHP is responsible for administering the EP Act in granting and assessing compliance with EAs to provide for the regulation of environmental management in the mining industry.

The EA application process has different levels of assessment according to the level of potential environmental risk associated with the proposed project. To take into account the level of risk, there are three types of EAs that may be granted for a resource or mining activity. These include:

- Standard EA - if the ERA can meet the eligibility criteria and comply with the standard conditions;
- Variation EA - if the ERA can meet the eligibility criteria, but the Proponent wants to vary one or more of the standard conditions; or
- Site-Specific EA - if the ERA does not have eligibility criteria or cannot meet the eligibility criteria.

Schedule 3A of the EP Regulation prescribes the eligibility criteria for each mining activity that is authorised, or is to be authorised under an EA for a mining activity.
The proposed Project activities cannot comply with all of the eligibility criteria prescribed in Schedule 3A of the EP Regulation. Accordingly, a site-specific EA is required for the Project.

Once approved, the site-specific EA will prescribe conditions for the Project to ensure it is operated in accordance with the environmental protection objectives of the EP Act and subordinate legislation.

4.2.2.3 Environmental Impact Assessment

A site-specific EA application for resource activities require a decision to be made whether an Environmental Impact Statement (EIS) is required under the EP Act. If an activity has the potential to pose a significant risk to the receiving environment, the proponent may be required to submit an EIS. DEHP has published trigger criteria for mining projects that would usually be required to undertake an EIS under the EP Act.

Section 142 of the EP Act requires an EIS to be submitted for a site-specific EA application in a wild river high preservation area, a wild river special flood management area or under a nominated waterway in a wild river preservation area, unless:

- It is for specified works under the Wild Rivers Act 2005;
- The application relates to a coordinated project under the State Development and Public Works Organisation Act 1971 (SDPWO Act); or
- An EIS under the EP Act has already been submitted.

The Project is not located within a wild river high preservation area or in a wild river special flood management area and thus, an EIS is not required under section 142 of the EP Act.

Section 143 of the EP Act states that an EIS may be required for a site-specific EA application for a resource activity if:

- Section 142 does not apply;
- The application does not relate to a coordinated project under the SDPWO Act; or
- An EIS under the EP Act has not been submitted.

The criteria (EIS triggers) used to support DEHP’s decision-making under section 143 for greenfield projects are set out in Table 4-2. For this Project which has been designed to minimize impacts EVs through choosing lower impact mining methods, none of the EIS criteria are triggered and commentary is provided on the applicability of each criterion to the proposed Project in Table 4-2.
### 4.3 Approach to Impact Assessment

The Project is currently within the planning and design stage. The structure of each environmental assessment comprises of the following:

- **Regulatory Framework**: Identifies the regulatory provisions, including relevant acts, policies and guidelines, applicable to the environmental assessment;
- **Assessment Method**: Outlines the methods taken to form the below information including the use of baseline data, fieldworks, modelling and existing databases and reports;
- **Existing Environment**: Describes the existing environment prior to the commencement of the Project;
- **Potential Impacts**: Identifies the potential impacts that may result from the Project based on Project specifics;
- **Management and Mitigation Measures**: Proposes management and mitigation measures to reduce the likelihood and risk of potential impacts from occurring;
- **Qualitative Risk Assessment**: Analyses the initial risk, without mitigation and the residual risk, considering the proposed mitigation and management measures put forward in the assessment;
- **Summary**: Summarises the findings of the assessment; and
- **Commitments**: Addresses Metro Mining’s commitments to undertaking actions that will reduce potential impacts through a proactive rather than reactive approach to environmental management.

Relevant technical reports are provided in Volume 2 - Appendices.

### 4.4 DEHP Guidelines for Technical Assessment

The following technical guidelines have been considered and addressed in the preparation of this document:

- Application requirements for activities with impacts to air (EM960);
- Application requirements for activities with impacts to land (EM961);
- Application requirements for activities with noise impacts (EM962);
• Application requirements for activities with impacts to water (EM963); and
• Application requirements for activities with waste impacts (EM964).

4.5 Assessment Approach

The concept of the environment and its values is based on the broad definition in Section 8 of the EP Act. The term environment includes:

(a) “Ecosystems and their constituent parts, including people and communities; and

(b) All natural and physical resources; and

(c) The qualities and characteristics of locations, places and areas, however large or small, that contribute to their biological diversity and integrity, intrinsic or attributed scientific value or interest, amenity, harmony and sense of community; and

(d) The social, economic, aesthetic and cultural conditions that affect, or are affected by, things mentioned in paragraphs (a) to (c).”

Furthermore, Section 9 of the EP Act defines EVs as:

(a) “A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

(b) Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.”

This assessment considers the effects of the Project construction, operation and decommissioning activities on the identified EVs.

4.6 Determining Significant Impacts

For each potential impact of the Project, the assessment considers the following attributes of the impact using predefined criteria:

• The nature of the effect: direct or indirect, magnitude, extent, duration, timing, permanence and performance against policy standards; and

• The value of the affected environmental receptor: condition, size, number and sensitivity.

Using this information, the significance of impacts has been determined by the impact assessment process outlined below. To quantify the potential for an impact to cause harm, the assessment process was undertaken using the AS/NZS ISO 31000 – Risk Management criteria.

Definitions applicable to the impact assessment process described in this document are outlined in Table 4-3.
Table 4-3 Definitions for assessment of hazard and risk

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard</td>
<td>Something with the potential to cause environmental harm. This can include hazardous substances, plant and equipment, work processes or other aspects of the surrounding environment.</td>
</tr>
<tr>
<td>Likelihood</td>
<td>The chance or probability of an event resulting in an impact occurring.</td>
</tr>
<tr>
<td>Consequence</td>
<td>How much harm the impact could have, how many people it could affect and the duration of the harm.</td>
</tr>
<tr>
<td>Unmitigated Risk</td>
<td>The likelihood that a harmful consequence might result when exposed to the hazard without implementation of the proposed mitigation measures.</td>
</tr>
<tr>
<td>Residual Risk</td>
<td>The likelihood that a harmful consequence might result when exposed to the hazard with the effective implementation of the proposed mitigation measures.</td>
</tr>
</tbody>
</table>

4.6.1 Likelihood Assessment

A qualitative assessment of the possible event frequency was undertaken to assess the likelihood of an impact occurring, based on the ratings included in Table 4-4.

Table 4-4 Ratings for likelihood of occurrence

<table>
<thead>
<tr>
<th>Probability Rank</th>
<th>Probability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Almost certain</td>
<td>Will almost certainly occur. Has a 95% or greater chance of occurring within a 12-month period.</td>
</tr>
<tr>
<td>2</td>
<td>Likely</td>
<td>Probably will occur. Has a 70% to 95% chance of occurring within a 12-month period.</td>
</tr>
<tr>
<td>3</td>
<td>Possible</td>
<td>May possibly occur. Has a 30% to 70% chance of occurring within a 12-month period.</td>
</tr>
<tr>
<td>4</td>
<td>Unlikely</td>
<td>Could possibly occur. Has a 5% to 30% chance of occurring within a 12-month period.</td>
</tr>
<tr>
<td>5</td>
<td>Rare</td>
<td>Only likely to occur in exceptional circumstances. Has a 5% or less chance of occurring within a 12-month period.</td>
</tr>
</tbody>
</table>

4.6.2 Consequence Assessment

The potential level of consequence of an impact was assessed in accordance with the definitions shown in Table 4-5. Each outcome has been individually assessed where a hazardous incident may have multiple impacts.

Table 4-5 Consequence ratings

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Maximum Potential Consequence (Realistic)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Safety and Health of People</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Catastrophic</td>
<td>Extensive long-term harm with widespread impacts that are non-reversible in &lt;10 years. Significant degradation to EVs.</td>
</tr>
<tr>
<td>2</td>
<td>Major</td>
<td>Major long-term and widespread environmental harm that is reversible in 2 - 10 years. Major degradation to EVs.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>Moderate environmental harm that is contained onsite or minor widespread harm that is reversible in &lt;2 years. Moderate degradation to EVs.</td>
</tr>
<tr>
<td>4</td>
<td>Minor</td>
<td>Minor unplanned onsite environmental harm that does not extend offsite. Insignificant impacts to EVs.</td>
</tr>
<tr>
<td>5</td>
<td>Insignificant</td>
<td>Insignificant impacts that are contained onsite. No habitat disturbance.</td>
</tr>
</tbody>
</table>
4.6.3 Risk Matrix

The risk matrix adopted for the assessment is included in Table 4-6. The colour shading refers to the qualitative bands of risk (assessed) level.

For the purposes of this assessment, risk levels are defined as follows:

- **Extreme** – Works must not proceed until suitable mitigation measures have been adopted to minimise the risk;
- **High** – Works should not proceed without consideration of alternative options or additional controls to minimise the risk. A documented action plan is required;
- **Medium** – Acceptable with formal review. A documented action plan is required; and
- **Low** – Acceptable with review.

For the purpose of this assessment, risk levels above low have been considered significant.

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Almost Certain 1</td>
<td>Extreme</td>
</tr>
<tr>
<td>Likely 2</td>
<td>Extreme</td>
</tr>
<tr>
<td>Possible 3</td>
<td>Extreme</td>
</tr>
<tr>
<td>Unlikely 4</td>
<td>High</td>
</tr>
<tr>
<td>Rare 5</td>
<td>Medium</td>
</tr>
</tbody>
</table>

4.7 Environmental Management System

An environmental management system (EMS) for both the construction and operational phases of the Project will be developed based on the principles of the AS/NZS ISO 14001:2004 Environmental Management Systems. The EMS will establish the framework for environmental management of Project activities, and will include the following:

- The Project’s environmental policy statement;
- Roles and responsibilities;
- Identification of potential environmental impacts;
- Presentation of objectives and targets for the mitigation of potential environmental impacts;
- Implementation of plans and procedures to ensure objectives and targets are met;
- A reporting procedure – internal and external;
- Induction, training and awareness programs to ensure Project personnel are aware and capable of fulfilling the Project’s environmental responsibilities;
- An emergency and incident procedure; and
- Management review process to search for opportunities for continuous improvement.

The following sections outline the requirements relevant to the EMS and the proposed structure of the EMS.

### 4.7.1 Environmental Legal Requirements

A suite of State and Commonwealth legislation and policies are relevant to the Project. The EMS will implement the State and Commonwealth requirements in accordance with the relevant legislation, codes of practice, guidelines and standards and the EA conditions. The relevant legislation is provided in the Regulatory Framework subheading of each environmental assessment in Section 6. Adherence to the key legislation throughout construction and operational phases of the Project where relevant, is critical to the success of the EMS.

### 4.7.2 Roles and Responsibilities

Roles and responsibilities will be assigned to ensure effective environmental management. The key roles that are core to the successful implementation of the EMS will be listed according to Metro Mining’s organisational chart. Roles and responsibilities for the resourcing and management of the EMS will be developed prior to the commencement of construction.

### 4.7.3 Continual Improvement

Throughout the construction and operational phases of the Project, lessons learnt will be captured and used to ensure continuous improvement for environmental management. Lessons will be taken from internal and external audits of the Project EMP and other internal reporting e.g. site inspection reports.

### 4.7.4 Workforce Training

All staff, including contractors, will receive appropriate environmental training to ensure they are aware of their responsibilities and are competent to carry out their work in an environmentally acceptable manner. An induction will be mandatory for all personnel prior to commencement of any work and include environmental protection objectives, commitments and mitigation measures as detailed in the construction or operational EMP.

Ongoing environmental awareness training and communication will be a key aspect of the EMS. Ongoing instruction shall be provided via modular training packages and toolbox meetings.

### 4.7.5 Monitoring

Environmental monitoring will occur in accordance with the requirements of the EA and the EMS. Environmental monitoring as part of the EA will include the following where practical:

- Air quality (in response to complaints);
- Noise (in response to complaints);
- Water quality (surface and groundwater);
- Waste; and
- Erosion and rehabilitation.

An environmental monitoring plan will be developed prior to the commencement of construction works. It will include a list of all monitoring to be undertaken, methodology including recognised codes standards and guidelines, location of monitoring sites, parameters and frequency of each type of monitoring with reference to all monitoring procedures and records.

### 4.7.6 Environmental Auditing and Review

Audits will be undertaken regularly to ensure compliance with the EA, other regulatory requirements and performance standards, as appropriate. Audit reports will be used internally to improve environmental performance and to monitor regulatory compliance.

### 4.7.7 Emergency Response Plan

An Emergency Response Plan (ERP) will be developed in consultation with relevant Governments Departments to ensure that the potential consequence of emergency situations as identified in this report is minimised as far as possible, and will include management of the potential for environmental harm will be included in the Plan. Emergency situations that could arise during the construction and operation of the Project include:

- Release of dangerous goods;
- Traffic collisions;
- Flooding;
- Bushfire;
- On-site death or injury; and
- Contact details for relevant state emergency services;

The Project will have an on-site contact for state emergency services to contact in the event of an emergency situation. All Project personnel will receive basic training regarding the prevention, planning, response to and recovery from incident or emergency, which will be incorporated into the Project induction.

### 4.7.8 Non-Compliance

Non-compliances identified as part of the Project environmental monitoring, auditing and review processes will be investigated and appropriate corrective actions will be undertaken. Notification of the non-compliance to DEHP will also be undertaken in accordance with DEHP conditions, as appropriate.

### 4.7.9 Reporting

#### 4.7.9.1 External

Metro Mining will provide information on the Project’s environmental performance to external parties as required.

Reporting will be completed for the EA and other legislation. Examples of reporting are listed below:

- Annual Returns under the EP Act;
4.7.9.2 Internal

The EP Act (s320) requires that any person who becomes aware of any event or incident that may cause or has caused environmental harm to report the event or incident. The environmental incident response process will be communicated to all staff and all incidents to ensure incidents are reported and notified as necessary. Metro Mining may elect to notify authorities of incidents that are not breaches of statutory requirements.

Metro Mining’s Environmental Manager will coordinate internal reporting including monthly reports which will review environmental objectives and targets.

4.7.10 Management Review

In accordance with AS/NZS ISO 14001:2004 Environmental Management Systems – Requirements with guidance for use, Metro Mining management will review the EMS at planned intervals, to ensure its continuing suitability, adequacy and effectiveness.

The outputs from management reviews will include any decisions and actions related to possible changes to environmental policy, objectives, targets and other elements of the EMS.

4.7.11 Community and Stakeholder Consultation

Specific consultation about the proposed Project has already been undertaken between Metro Mining and key State and Commonwealth governments and key local stakeholders. Metro Mining will continue to actively engage all relevant Government agencies, stakeholders and other interested parties as required.
Section 5  Rehabilitation and Mine Closure

5.1 Rehabilitation

Overview

This section describes the options, strategic approaches and methods for progressive and final rehabilitation of the environment disturbed by the Project. Without effective rehabilitation, mining has the potential to permanently reduce the capacity of land and ecosystems to provide economic and ecological services, and be unsafe for future use. The incorporation of rehabilitation and decommissioning considerations within the Project description demonstrates Metro Mining’s commitment to integrating these stages of the Project into its EMS.

The Project is not expected to be decommissioned for approximately 27 years, or following depletion of the target bauxite resource. Progressive rehabilitation is proposed to be carried out as operations progress (rather than taking place as a large operation once mining is complete). Thus, staged treatments will be applied as soon as areas become available for such. Rehabilitation of the MIA; however, will take place once mining is completed and plant and structures decommissioned. The conceptual progressive rehabilitation process is shown at Figure 5-1.

Figure 5-1 Progressive rehabilitation (conceptual)

Areas requiring rehabilitation within the Project area will include:

- Open-cut pits;
- Mine Infrastructure Area (MIA) including:
  - Offices, car parks and internal service roads;
  - General workshop and stores;
  - Sewage treatment unit;
  - Heavy vehicle workshop, maintenance area and vehicle wash down bay;
  - Fuel farm and lubricant storage tanks;
  - Generator set area and telecommunications services; and
- General hardstand area.

- Water storages;
- Haul roads;
- Barge loadout conveyors and associated structures; and
- Accommodation facilities.

The post-mining rehabilitation outcome for all disturbed areas is to return the area to environmental and cultural land uses. Returning the area to these land uses is considered an achievable final land use and is consistent with the existing land use. To achieve this, the following rehabilitation objectives will apply over the life of the mine:

- Return the majority of disturbed land to a vegetation and habitat condition similar to the pre-existing condition where possible;
- Ensure that any land contamination as a consequence of the operation is appropriately managed to ensure no adverse impacts to post mine land use;
- Decommission, dismantle and remove site infrastructures that are not required by the post mine landowner;
- Ensure that constructed landforms are physically stable to the extent that they do not impact on surface water or groundwater quality; and
- The site shall not present a safety hazard to people, fauna or stock.

The review and audit of rehabilitation work undertaken during operations will be required as part of the Project’s EA. The Project’s Plan of Operations will set out the proposed program of actions to comply with EA conditions including a program to rehabilitate any disturbed land. This Plan will also provide for compliance measures obliged by any other legislation, for example, the MR Act.

The Plan of Operations will be approved by DEHP prior to any disturbance occurring on site and will be reviewed by a suitably qualified auditor. Approval by DEHP to renew the Plan of Operations will take place on a five year basis at most, but more likely annually. DEHP could suspend or cancel the EA in the event of any inadequacy or noncompliance of operations in meeting the approved Plan. In addition to this, the EA will require Metro Mining to provide Financial Assurance to DEHP prior to any activities taking place on site to cover any costs or expenses incurred in the highly unlikely event that the conditions of the EA are not met. This includes, for example, conditions relating to rehabilitation.

This section specifically identifies the following key aspects relating to the Project’s mine site rehabilitation:

- The control and management of mine waste;
- Proposed rehabilitation methods;
- The management of topsoil resources for use in rehabilitation of the site;
- Description of the planned progressive rehabilitation and re-vegetation of areas across the mine site;
• The integration with on-going and future rehabilitation activities across the wider mining area; and
• Rehabilitation monitoring and maintenance requirements which may apply.

The level of detail provided here is commensurate to the level of risk associated with each key closure issue and the time to closure. It sets out acceptable and realistic criteria for rehabilitation and closure that will allow the Project to meet the principles of ecologically sustainable development (ESD) without any unacceptable liability to the state.

Rehabilitation and Decommissioning Principles

As required by the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland series (Department of Minerals and Energy, 1995) and the Rehabilitation Requirements for Mining Projects (DEHP, 2014), Metro Mining will seek to achieve:

• A landform with the same or similar land use capabilities and/or suitability it had prior to the disturbance, unless other beneficial land uses are pre-determined and agreed with key stakeholders (i.e. post-mining landowners / managers, Traditional Owners and relevant regulators);
• Rehabilitation of mine wastes and disturbed land so that it is self-sustaining or to a condition where the maintenance requirements are safe and consistent with an agreed post-mining land use (i.e. environment land uses); and
• Maintenance of current and future water quality leaving existing waterways and aquifers with water quality and quantity levels that are not degraded and that are acceptable for existing and future users within or surrounding the site.

The Project’s closure objectives provide for a post-mining site that is physically safe to human and animals, geotechnically stable, non-polluting and capable of sustaining agreed land uses. These goals are consistent with the principles of ESD as required by the EP Act.

Ensuring Non-pollution

The overburden to be removed as part of the pit development will be set aside for rehabilitation or used as fill for above ground infrastructure works. Although some of this material will be temporarily stockpiled, overburden testing outlined in Section 6.2 – Geology, Topography and Soils shows the overburden material has a high pH and very low acid forming potential. Consequently, there is a very low risk of acid mine drainage or heavy metal mobilisation occurring.

As noted in Section 6.11 - Waste, a hazardous materials survey and contaminated land assessment will be undertaken prior to decommissioning of infrastructure to allow the effective management, disposal and removal of hazardous materials. Areas with the highest potential for environmental contamination such as the workshop, chemical and fuel storage and transfer area and the MIA will be assessed in accordance with the Contaminated Land Assessment Guideline (DEHP, 2014). Any identified contamination will be treated and contained on site using the Managing Contaminated Land under the SP Act (DEHP, 2014) as a guide.

Post-mining Objectives and Completion Criteria

The current land use in the Project area is predominantly for cultural activities carried out by Aboriginal parties, and is otherwise unoccupied land comprising native remnant vegetation. Recreational uses for camping and hunting also occur.
Metro Mining intends to manage its operations, decommissioning and rehabilitation to ensure that the land maintains similar EVs, using endemic native species where practicable.

After overburden and soil are returned to the mined areas within the pits the final landform will be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform will be similar. Where mining leaves batters on the edges of the pit, these will be recontoured to a maximum slope of 20% (1 in 5). The final landform will not have any out-of-pit dumps of excavated waste material or soil.

The rehabilitation of disturbed land at the mine site will be conducted so that:

- The final landform is stable and not subject to ongoing erosion which will result in the agreed post-mining landform not being achieved;
- Topography and surface drainage will be consistent with and complimentary to the overall landform;
- Suitable species of vegetation are established to achieve the nominated post-mine land uses;
- The potential for water and wind induced erosion is minimised, including the likelihood of environmental impacts being caused by the release of dust;
- The physical, chemical and biological properties of soil are appropriate to support the target land use;
- Natural vegetation in rehabilitated areas will have similar values and functions as surrounding natural ecosystems and habitats; and
- The water quality of any residual water bodies is suitable for the nominated use and does not have the potential to cause environmental harm.

Metro Mining will ensure that adequate funds are available to fulfil obligations and commitments for decommissioning and rehabilitation.

Rehabilitation and Decommissioning Closure Options

The rehabilitation and decommissioning strategy for the mine is presented by domain or landform (Table 5-1), as per DEHP's guideline - Rehabilitation requirements for mining resource activities. Action plans will be prepared for each domain, and these will be incorporated into the Project’s Plan of Operations.

Decommissioning options include:

- Leaving nominated and agreed infrastructure on site; or
- Completely removing all infrastructure (including slabs and footings).

The base case is that all infrastructure will be completely removed, unless otherwise agreed with the post-mining land owner and the Traditional Owners, and accepted by the relevant Government regulators as part of the final decommissioning plan.

Rehabilitation and Decommissioning Management Strategy

The Project’s EA and Plan of Operations will outline in detail the criteria and performance indicators that will demonstrate that the proposed decommissioning and rehabilitation strategies have been undertaken successfully and that the desired outcomes have been accomplished. Indicative
rehabilitation indicators and completion criteria are provided in Table 5-1. These outcomes represent Metro Mining’s commitments for the closure of the Project and have been written to be as clear and measurable as possible, and will form the basis for review and audit conditions as well as eventual lease relinquishment.

The outcomes and criteria will be reviewed and revised as necessary during the closure planning process, taking into consideration:

- The results of trials and investigations;
- Changes in mine planning; and
- Feedback from stakeholders.

### Table 5-1 Decommissioning and rehabilitation objectives and completion criteria by domain

<table>
<thead>
<tr>
<th>Domain</th>
<th>Outcome</th>
<th>Objective</th>
<th>Completion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All site components</td>
<td>Community and future generations are left with no residual liability for site rehabilitation or maintenance.</td>
<td>To ensure that progressive rehabilitation and site decommissioning leave the area safe, fit for purpose, and non-polluting.</td>
<td>Government acceptance of mine completion report which demonstrates achievement of all completion criteria.</td>
</tr>
<tr>
<td>Mine Pits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mine Pits</td>
<td>Access to the pit areas is restricted as necessary, subject to the landowner’s requirements for access and cultural purposes. Geotechnical stability has been confirmed. Habitat areas supporting native biodiversity.</td>
<td>Post mine land use is native bushland, where practical. Erosion rate is managed to levels that do not compromise post mine land use. Safety risk to people and fauna is managed.</td>
<td>Geotechnical stability has been achieved. Land is suitable for environmental and cultural land uses.</td>
</tr>
<tr>
<td>Mine Infrastructure Areas (MIA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration offices</td>
<td>All infrastructure removed(^1).</td>
<td>To leave the MIA in a condition fit for environmental land use.</td>
<td>Audit of domain against agreed final closure plan.</td>
</tr>
<tr>
<td>Sewage, water treatment plant</td>
<td>All infrastructure removed(^1); no pollution.</td>
<td>To leave the MIA in a condition fit for environmental land use.</td>
<td>Audit of domain against agreed final closure plan.</td>
</tr>
<tr>
<td>Workshops and fuel farm area</td>
<td>All infrastructure removed(^1); no pollution.</td>
<td>To leave the MIA in a condition fit for environmental land use.</td>
<td>Audit of domain against agreed final closure plan to confirm any contamination has been appropriated managed.</td>
</tr>
<tr>
<td>Conveyors and barge loading facilities</td>
<td>All infrastructure removed(^1).</td>
<td>To leave the site in a condition fit for environmental land use.</td>
<td>Audit of domain against agreed final closure plan.</td>
</tr>
<tr>
<td>Access tracks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) All infrastructure, except that specifically requested to remain following consultation with post-mining land owners / Traditional Owners, and with approval of the relevant regulator.
## Existing Environment

The majority of the Project site is dominated by Darwin stringybark woodland vegetation, with the remainder being a mix of Melaleuca and mangrove communities. Revegetation of Darwin stringybark communities after mining has proven to be successful at Gove and recently at Weipa, and as such is considered an achievable post-mining vegetation type. Given the general depression of the land surface following mining, there is however, some potential for a slight increase in the water holding capacity of the mined out areas resulting in an increase of the Melaleuca species, producing a similar ecosystem to that occurring along the edges of the bauxite plateaus.

## Post Mining Land use

The objective of the Project's rehabilitation program is aligned with the four general rehabilitation goals listed in the Queensland EPA Guideline 18: Rehabilitation requirements for mining projects, i.e. that the rehabilitated landform be:

- Safe to humans and wildlife;
- Non-polluting;
- Stable; and
- Able to sustain an agreed post-mining land use.

The rehabilitation operating philosophy is based on the following concepts:

- Design earthworks and revegetate to an accepted post mine land use;
- Minimise unnecessary land disturbance;
- Protect downstream water quality from sediment runoff;
- Protect downstream beneficial uses (surface water and groundwater); and
- On relinquishment of title, ensure that the agreed post-mine land use has been reached.

A final land use of native vegetation, maintaining as close as possible the existing EVs of the Project area, has been tentatively agreed with both the Traditional Owners and the land owners, and will be formalised in the Right to Negotiate process. Any significant change to the proposed final land use will be subject to relevant amendment and approval processes under the EA.
Metro Mining has made commitments to regularly consult with the land owners and the Traditional Owners about a range of mining issues, including rehabilitation progress and performance against success criteria to meet the agreed final land use. The community engagement process for the Project, and ongoing engagement commitments, are detailed in Section 7.

Local Indigenous people, including land owners and Traditional Owners, have indicated during consultation that seed collection and rehabilitation are two potential business opportunities they can foresee arising from the Project. Metro Mining will seek to involve and employ the local Indigenous communities in rehabilitation programs where practicable. Metro Mining is also supporting the development of Indigenous businesses in the Western Cape region as detailed in Section 7.

**Post Mining Landform**

Areas disturbed by mining activities and infrastructure would be rehabilitated to a stable landform with a self-sustaining vegetation cover. After overburden and soil are returned to mined-out pits, the final rehabilitated landform would be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform would be similar.

Where mining leaves batters on the edges of the pit, these would be recontoured to a maximum slope of 20% (1 in 5, or 11 degrees). The final landform would not have any out of pit dumps of excavated overburden or soil.

It is proposed the changes to topography due to mining would be relatively minor, as there would be no final out-of-pit dumps of overburden to raise elevations, and a lowering of the existing landform averaging approximately 3 m across the mining pits would occur, but would maintain a similar shape to the pre-existing landform, and would be of similar character to the existing lower areas surrounding the bauxite plateaus, meaning there would be no significant changes to the broad scale topography of the area.

Mining will involve clearing vegetation; however, vegetation would be retained within environmental buffers along waterways and significant swamp areas. Through the retention of vegetation buffers and proposed progressive rehabilitation with native species, no significant changes to the broad scale vegetation character of the Project area at the landscape scale are expected. Drainage will also be incorporated into the final rehabilitation plan to ensure a drainage design similar to the existing drainage patterns is reinstated.

As the Project is not using any beneficiation process, there is no requirement for a tailings storage facility. Any surface water drainage and roadworks would be revegetated after decommissioning.

The final landform at the completion of mining is shown at Figure 5-2. Final recontouring of the landform will be undertaken as part of the rehabilitation program. The recontouring and rehabilitation will be undertaken such that irregularities within the surface landform will be smoothed out and surface water drainage paths will be replaced.
**Undisturbed Land**

Land not impacted by mining activities will be retained as undisturbed native vegetation where this does not affect mining operations or present a health and safety risk. Land not impacted but made inaccessible by mining activities will be returned to its pre-mining use at the completion of mining.

**Topsoil Management**

The management of topsoil is one of the most critical components in terms of achieving successful rehabilitation. Topsoil management outlined below will apply across the Project mining areas. The dominant soil type of the Project area is Weipa (Wp) a Red Kandosol, which has a typical topsoil depth of 10 to 20 cm. These soils are weathered and low in nutrients, and support vegetation adapted to such conditions. The majority of seed readily able to germinate is present in the upper 5 cm of soil.

The onsite management of topsoil will include:

- Following clearing, topsoil will be stripped to an average 20 cm depth across all of the mining areas;
- Some understorey vegetation will purposefully be left following clearing and incorporated into the topsoil to retain the biological activity of the stored topsoil and provide propagules for regrowth which will stabilise the stockpiles during storage;
- Where topsoil is being stripped within an economic distance of a prepared rehabilitation area, topsoil will be directly placed on the rehabilitation area without stockpiling. Where this will not be feasible, topsoil stockpiles will be constructed;
- The height of topsoil stockpiles will be minimised where possible, and will be no greater than 2 m;
- Topsoil stockpiles will be left to self-revegetate. If after one or more wet season any weed species have established, appropriate controls will be undertaken; and
- Topsoil replacement on reshaped areas.

Topsoil will be stripped, and where possible, placed directly on available rehabilitation areas to avoid double handling and stockpiling. Topsoil will not be moved after any substantial rain to avoid compaction.

When direct placement is not feasible, topsoil will be stockpiled for later use in rehabilitation works. The topsoil stockpiles will be no greater than 2 m in height. If weeds become an issue, or if the stockpile is identified as needing to be stored for an extended time, they may need to be seeded with appropriate species, to limit erosion, and maintain a viable seed bank. Topsoil stockpiles would be located well away from any run-off areas.

The removal of topsoil and overburden during the mining process has the potential to change the nature of these materials and their subsequent interaction with the surrounding environment in a number of ways. Changes which may include the following:

- Soils and rock expand when loosened through excavation and are generally known to swell by approximately 30%. This is often referred to as a bulking factor. Therefore, the overburden material excavated and placed on the mine floor will swell to a volume approximately 1.3 times that of its in-situ or unmined volume. The post-mining material will also have a higher initial porosity than the original in-situ soil. This will; however, have little effect on the final landform;
Poorly maintained topsoil stockpiles can have lower nutrient status and organic matter content, and poorer structure compared to the original soil hosting vegetation communities; and

Poorly structured and dispersible soil materials may be prone to erosion, particularly on slopes.

Revegetation

Following mining, overburden will be replaced on the mined out floor using a loader. Depending on the level of compaction, it may be necessary to run a plough over the mine floor to a depth of 30 – 50 cm prior to replacing the overburden, to ensure the natural groundwater interactions are maintained. The overburden will then be replaced and re-contoured to ensure surface water drainage occurs similarly to the pre-existing drainage patterns.

Topsoil that has been collected from and stockpiled for that area will be placed over the overburden spread over the mined floor.

Direct seeding of local provenance species will be undertaken, with an aim to rehabilitate at a similar rate to that of mining, thereby minimising the area of land disturbed at any one time. There will be a delayed commencement of rehabilitation works at the beginning of mining until a suitable area for rehabilitation has had mining completed. This is estimated to take three years, in accordance with the proposed mine plan (Figure 2-5). Any delays to the mine plan could result in a delay in the commencement of rehabilitation.

The key species to be included in the rehabilitation seed mix will be determined from the findings of pre-mining vegetation surveys. Slight variations of the seed mix will be used depending on variations in vegetation, surface topography and soil type, and seed availability. Seeding of locally collected key species of trees and shrubs will enable the establishment of an ecosystem that will in time, resemble the surrounding unmined areas. Seeding of the placed topsoil will occur prior to the commencement of the wet season.

In addition to native seeds, one introduced grass species initially proposed as being sorghum (*Sorghum alatum*), varieties ‘Pearl’ or ‘Silk’, will be used. This introduced species will be used for rapid soil stabilisation. This variety is non-invasive and is usually out competed within five years by native grass species. Only certified weed ‘free’ sorghum seed will be used.

Hand seeding and planting of tubestock will take place if required to ensure establishment of specific species.

In summary, revegetation methods for all types of land will normally consist of:

- Timber clearing two - three years in advance of soil removal to allow soil and soil micro-organism recovery, and re-establishment of the soil seed bank;
- Topsoil removal at the appropriate depths;
- Overburden pushed over the adjacent mining panel;
- Ripping through the mine floor prior to overburden placement;
- Overburden recontoured to ensure the final topography is similar to the pre-mining surface;
- Direct placement of topsoil after removal;
- Native and sorghum seed mix application, using fertiliser as required; and
- Direct seeding and tubestock planting of selected species if required.

**Success Criteria**

Completion / success criteria are a set of objective standards against which rehabilitation progress can be assessed.

Mine closure and rehabilitation planning is a process that continues throughout the life of mine, and specific completion/success criteria will be developed in the early stages of the operation at the Project and reviewed during the life of the mine as advances in knowledge or techniques and changes in adjacent land use or stakeholder desires are presented.

Rehabilitation objectives and associated criteria, milestones and standards will need to be achievable using accepted mining industry leading practice rehabilitation operations and site specific monitoring and data collection. Completion/success criteria are invariably site specific, based on the biophysical parameters relevant to the mine location and end use goals. analogue sites will be assessed to ensure pre-mining ecological parameters are accurately captured and used to develop appropriate completion/success criteria. These are implemented in such a way as to ensure that closure aims are being achieved. Completion/success criteria would be thought of as ‘triggers’, where failure to meet a given criteria should prompt specific remedial steps.

A general list of components to be covered in rehabilitation completion/success criteria would include:

- Landform stability and performance;
- Biodiversity;
- Revegetation; and
- The monitoring and management of exotic species.

Indicators will be representative of key ecological processes related to stability and sustainability, as well as those that assess vegetation development, structure and diversity within important groups. In addition, these criteria will be site specific and closely related to the local climatic, specific ecosystem components, mining techniques and mining land use and include Traditional Owner requirements.

**Sediment Control and Erosion**

Limited soil testing has shown the soils of the Project site are not chemically predisposed to dispersion and are considered to have a low erosion potential. Erosion control in rehabilitation planning is an essential component to achieving site stability, particularly on rehabilitated landforms that have steep or long slopes. Erosion control is usually achieved through a combination of vegetation establishment and surface drainage control.

Management strategies for the mitigation of soil erosion include:

- At any one time, only the minimum area of land would be cleared in order to maintain the safe operation of the Project;
- Land that has been assigned for clearance will be surveyed, marked out and signed off by an appropriate person prior to clearing in order to ensure no additional areas are inadvertently disturbed;
All available disturbed areas of the Project will be rehabilitated progressively;

The mine rehabilitation programme would aim to return the land to the agreed final land use;

Sediment traps, drainage bunds and drains will be constructed if necessary to manage sediment and surface water run-off;

Water leaving sediment controls will be monitored on a regular basis to ensure they are meeting design standards; and

Topsoil will be stripped to the nominated depth and stockpiled in piles no more than 2 m high. Seeding topsoil stockpiles may be required if the topsoil is to be stockpiled for an extended period.

The initial introduction of sorghum in the seed mix will enable effective soil surface stabilisation and cools the otherwise bare soil surface in the early stages of rehabilitation.

Assuming the depth of bauxite at the plateau edge is equal to or greater than 0.5 m, the Project plans to mine to the edge of the bauxite plateau, thereby retaining the original topography of the land and maintaining natural drainage patterns across the Project area. This will reduce the impacts of potential water ponding, sediment run-off and/or erosion.

The proposed access/haul road construction design will have sufficient surface drainage to prevent run-off eroding the road surfaces or adjacent areas.

The erosion control measures to be implemented throughout the life of the Project are summarised in Table 5-2.

**Table 5-2 Erosion controls for mining activities**

<table>
<thead>
<tr>
<th>Area</th>
<th>Control Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleared Land</td>
<td>▪ Restrict clearing to areas essential for the works;</td>
</tr>
<tr>
<td></td>
<td>▪ Windrow vegetation debris along the contour;</td>
</tr>
<tr>
<td></td>
<td>▪ Minimise length of time soil is exposed;</td>
</tr>
<tr>
<td></td>
<td>▪ Minimise soil stockpiling;</td>
</tr>
<tr>
<td></td>
<td>▪ Divert run-off from undisturbed areas away from the works; and</td>
</tr>
<tr>
<td></td>
<td>▪ Direct run-off from cleared areas to sediment control, if not contained.</td>
</tr>
<tr>
<td>Exposed soils (after stripping of topsoil)</td>
<td>▪ Minimise length of time subsoil is exposed;</td>
</tr>
<tr>
<td></td>
<td>▪ Direct run-off from exposed areas to sediment control, if not contained.</td>
</tr>
<tr>
<td>Rehabilitated areas</td>
<td>▪ Progressive rehabilitation during operations;</td>
</tr>
<tr>
<td></td>
<td>▪ Apply fast growing, recessive pastoral grass seed to ensure soil stabilisation prior to the establishment of native species;</td>
</tr>
<tr>
<td></td>
<td>▪ Apply seed and fertiliser as necessary to ensure rapid re-establishment of native species;</td>
</tr>
<tr>
<td></td>
<td>▪ Direct run-off from rehabilitated areas to sediment controls, if not contained; and</td>
</tr>
<tr>
<td></td>
<td>▪ Re-contour the land similar to the pre-mining state to ensure natural drainage patterns are maintained.</td>
</tr>
<tr>
<td>Sediment dams / drains and other water management structures</td>
<td>▪ Rehabilitate any dam or drain not required post-mining by:</td>
</tr>
<tr>
<td></td>
<td>- regrading embankments</td>
</tr>
<tr>
<td></td>
<td>- replacing topsoil</td>
</tr>
<tr>
<td></td>
<td>- seeding</td>
</tr>
</tbody>
</table>
Monitoring and Maintenance

Rehabilitation maintenance may be necessary, in some form, after seeding. Rehabilitation maintenance assists in the establishment and growth of key species and ultimately the success of rehabilitated areas ensuring areas achieve a stable, self-sustaining post-mining ecosystem similar to that existing pre-mining. The major forms of rehabilitation maintenance that may be required in rehabilitated areas at the Project include rehabilitation infill, fire management and weed and pest animal control.

Rehabilitation infill will occur if rehabilitated areas have not established successfully, are impacted by natural disaster (e.g. cyclones or fire), or do not meet the developed rehabilitation completion/success criteria. Using interim criteria, initial establishment will be monitored at approximately six and 18 months after seeding. The findings of these monitoring assessments will indicate whether infill is necessary. Typically, poor plant establishment is the result of poor soil, or incorrect soil management. Infill techniques will be designed specifically for each area identified depending on the cause of poor establishment. Infill techniques could involve placing fresh topsoil and re-seeding, re-contouring and re-seeding, or additional tubestock planting in targeted sites within the rehabilitated area.

Fire management is an essential component of rehabilitation maintenance in northern Australia. Fires can be detrimental to rehabilitation, particularly in young (<10 years old) rehabilitation, if appropriate management practices are not implemented. Fire will be actively prevented from entering rehabilitated areas until they are old enough to be resilient to fire. Fire breaks will be required around rehabilitated areas bordering native vegetation and public roads and access. Fire breaks, constructed using a dozer and/or grader, will be approximately 10 m wide and free of fallen trees and woody debris. This will prevent fires from outside of the mining area burning the rehabilitated areas. Annual back burning may be required to ensure fires do not enter the rehabilitated areas. Public access to the mine area will be prevented to minimise the chances of accidental, and intentional, fires burning the rehabilitation. Once rehabilitated areas are determined to be resilient to fire, the introduction of fire will be required.

A Fire Management Plan is being developed in conjunction with the Mapoon Land and Sea Rangers, to ensure the Project’s fire management is complementary with the surrounding land management processes.

A detailed weed and feral pest management plan will also be developed with the input of the Mapoon Land and Sea Rangers. This will guide the responsible management and control of declared weeds to minimise the impact of the operation on the surrounding environment, and ensure pest animals are controlled in an environmentally responsible manner. All off-road vehicles and earthworks machinery entering the mine site from external areas will be inspected and cleaned thoroughly on arrival. If weeds are recorded within the mine lease, early herbicide treatment will be initiated to eradicate or prevent the spread of weeds. In areas where weeds are located, soil movement, including grader work, will be avoided and access will be restricted. Stockpiled soils can become infested with weeds over time, therefore long-term stockpiling will be avoided where possible. To prevent weed infestations, stockpiles will be hand seeded with native species if they are likely to be maintained for an extended time.

The aim of rehabilitation monitoring is to determine whether the key species have established and whether the rehabilitated areas are likely to develop into an ecosystem similar to pre-mining or require upgrade work.

Every rehabilitated area will be assessed six and 18 months after seeding. The six month assessment will focus on the establishment of key canopy species (e.g. Darwin stringybark) while the 18 month
assessment will focus on both the density and composition of all species including trees, shrubs and groundcover.

Long term monitoring sites will also be established to record the progression of species composition over time, and the establishment of an ecosystem that approaches the values and success criteria of the pre-existing landscape. Analogue sites away from the mining area will also be established at this time. It is proposed monitoring of the long-term sites will be undertaken approximately every five years.

Before lease relinquishment all rehabilitation will be monitored to ensure it meets parameters defined in the completion/success criteria.

**Lease Relinquishment**

For lease relinquishment to occur, Metro Mining will be required to demonstrate that ecological completion/success criteria and standards have been met. Approval from the regulators will be required to achieve sign-off against completion/success criteria and ultimately lease relinquishment. A site inspection and consultation process involving the regulators, land owners, Traditional Owners, and other relevant stakeholders will be required.

While Metro Mining would be looking at progressive lease relinquishment, the reality of maintaining access to areas for ongoing operational requirements, and the length of time to establish mature ecosystems that can be confirmed as meeting all relevant success criteria, means that no lease relinquishment would be envisaged within the first 10 years of the mining operations. Any future plans for relinquishment would be included in the Plan of Operations.

### 5.1.1 Commitments

In relation to Project rehabilitation Metro Mining's commitments are provided in Table 5-3.

**Table 5-3 Commitments – rehabilitation**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Where practicable, minimise the area of disturbance during construction and operations.</td>
</tr>
<tr>
<td>R2</td>
<td>Ensure that an appropriate and sustainable end land use for disturbed land is established post closure.</td>
</tr>
<tr>
<td>R3</td>
<td>In consultation with Aboriginal parties and affected persons implement an approved work plan for rehabilitation.</td>
</tr>
<tr>
<td>R4</td>
<td>Develop and implement a Fire Management Plan ensuring rehabilitation is protected from fire until it has become fire-tolerant. The introduction of fire frequency and intensity on the Project site will need to be managed.</td>
</tr>
<tr>
<td>R5</td>
<td>Undertake monitoring for all rehabilitation areas to ensure establishment has been successful and development is likely to meet completion/success criteria. Monitoring will also ensure any early failures can be addressed in the early stages of ecosystem development.</td>
</tr>
<tr>
<td>R6</td>
<td>Develop and implement a Weed and Pest Management Plan ensuring weeds and pest animals are appropriately controlled and/or eradicated at the Project site.</td>
</tr>
</tbody>
</table>
5.2 Decommissioning

Decommissioning will occur prior to mine closure and will involve the removal of mine infrastructure and services, and the remediation of all environmentally disturbed areas. A decommissioning plan will be developed to ensure closure goals will be met.

Closure planning will include consultation with key stakeholders to provide input into the decommissioning and post-closure planning process to ensure that the focus on environmental and social issues are maintained during and after the decommissioning process.

Overview

Metro Mining's decommissioning philosophy, similar to the rehabilitation philosophy, is based on the following concepts:

- Remove infrastructure (unless requested to be left as is) and revegetate to a predetermined post-mine land use;
- Minimise unnecessary land disturbance;
- Compacted areas will be ripped, re-contoured, topsoiled (where required) and revegetated;
- Minimise erosion and its potential off lease effects;
- Protect downstream water quality from contaminated runoff; and
- On relinquishment, ensure that the agreed post-mine land use has been reached.

Decommissioning Program

The decommissioning program will be developed outlining the key concepts and requirements to successfully decommission and rehabilitate the site. The programme will be integrated with closure planning and identify actions critical to closure.

Topsoil and Overburden Stockpiles

There will be no remaining overburden stockpiles as all available topsoil will be utilised in the final rehabilitation process.

Mine and Port Infrastructure

The infrastructure to be left on-site following mine closure will depend on the requirements of Metro Mining, the Traditional Owners and the landowner requests. It is currently envisaged; however, that all buildings, offices, plant equipment, workshops, raw water tanks, power plant, conveyors, sewage treatment plant, fuel storage tanks, stockpiles and associated facilities will be decommissioned and removed from site.

Compacted areas will be ripped, re-contoured, topsoiled (where required) and reseeded.

Water Supply Bores and Storages

Water supply bores and / or storages will be permanent, unless removal is specifically requested by the landowner, and therefore will not require decommissioning. Bores or storages required to be removed will be decommissioned in accordance with the appropriate guidelines at the time.
Drainage

Permanent drainage contours and structures will remain to ensure drainage is controlled, unless removal is specifically requested by the landowner, and therefore will not require decommissioning.

Creek / Gully Diversions

It is not anticipated that creek or gully diversions will be required for the Project.

Access/Haul Roads

Should roads not be required by the landowner, they will be rehabilitated to blend in with the surrounding landforms. Compacted areas will be ripped, topsoiled and reseeded.

Mine Village

All mine village infrastructure to be left on-site following mine closure will depend on landowner and potentially Traditional Owner requests. It is currently envisaged; however, that all buildings and associated facilities will be decommissioned and removed from site. After the infrastructure has been removed the land will be rehabilitated to blend in with the surrounding landscape, with disturbed areas ripped, topsoiled and seeded as required.

Waste Disposal

All waste material generated during the decommissioning process will be disposed of appropriately and recycled were possible.

Waste oil will be sent off-site by licensed contractors complying with Queensland waste tracking legislation and disposed of appropriately.

Any hydrocarbon contaminated soil identified within the infrastructure and operational areas will be disposed of at an approved facility or bio-remediated on-site.
Section 6  Environment and Management

This section outlines the assessment methodology, regulatory framework, existing environment, potential impacts and proposed mitigation measures for the various environmental aspects of the Project.

6.1 Climate

The Project lies within the Australian Monsoon Zone and has a Climate Classification of Equatorial – Tropical Savannah using the Bureau of Meteorology’s (BoM) modified Koppen classification system (BoM, 2014).

The area typically experiences warm wet summers and warm dry winters. The summer wet season is relatively short, lasting from approximately December to March, and occurs with the change in the prevailing south-east trade winds to the north-west monsoons. Approximately 95% of the region's rainfall occurs between November and April.

A significant influence on the year-to-year weather variability is exerted by the El Nino Southern Oscillation (ENSO) phenomenon, an eastern Pacific system of atmospheric and oceanic interactions which affects the weather worldwide and can result in large variations in the timing and amount of wet season rainfall on Cape York.

Meteorological data for the Project has been acquired from two long-term BoM weather stations, a temporary weather station located at Pisolite Hills (approximately 23 km south from the Project) and a recently installed weather station for the Project located at the Skardon River airstrip. Two additional pluviometers have been installed by the bordering SRP, with information provided as part of a shared-data agreement.

The location of all meteorological data collection points are shown in Table 6-1.

Table 6-1 Relevant weather station data

<table>
<thead>
<tr>
<th>Weather Station</th>
<th>Commenced Operation</th>
<th>Status of Operation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Mapoon</td>
<td>1893</td>
<td>Closed in 2000</td>
<td>Nearest BoM long-term weather station. No longer in Operation</td>
</tr>
<tr>
<td>Weipa Eastern Ave and Weipa Airport</td>
<td>1914</td>
<td>In operation</td>
<td>Weipa Airport data has been added to Weipa Eastern Ave data, where Weipa Eastern Ave data is unavailable</td>
</tr>
<tr>
<td>Pisolite Hills</td>
<td>2008</td>
<td>Removed in 2014</td>
<td>Nearest privately owned weather station</td>
</tr>
<tr>
<td>Bauxite Hills</td>
<td>2014</td>
<td>In operation</td>
<td>Onsite weather station</td>
</tr>
<tr>
<td>Pluviometer 1 and 2</td>
<td>2014</td>
<td>In operation</td>
<td>Skardon Bauxite Mine rain gauges</td>
</tr>
</tbody>
</table>

The data obtained from these weather stations has been used collectively to describe the historical climatic patterns within the vicinity of the Project. Historical data is presented as an indicative guide to future climatic trends, cycles and extremes.

6.1.1 Temperature

Temperature data for Old Mapoon, Weipa and the Pisolite Hills project area are presented in (Table 6-2). The local monthly mean minimum and maximum temperatures indicate that the hottest months of the year for the Project are typically October, November and December, ranging from 34 to 36.1 degrees Celsius (°C). The coolest months of the year across all weather stations are July and August, with monthly mean minimum temperatures ranging from 17.5°C to 18.9°C.
Table 6-2 Monthly mean maximum and minimum temperatures

<table>
<thead>
<tr>
<th>Month</th>
<th>Old Mapoon</th>
<th>Weipa Eastern Ave</th>
<th>Pisolite Hills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Minimum Temperature (°C)</td>
<td>Mean Maximum Temperature (°C)</td>
<td>Mean Minimum Temperature (°C)</td>
</tr>
<tr>
<td>January</td>
<td>22.5</td>
<td>32.7</td>
<td>24</td>
</tr>
<tr>
<td>February</td>
<td>22.5</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>March</td>
<td>22.2</td>
<td>33</td>
<td>23.6</td>
</tr>
<tr>
<td>April</td>
<td>21.9</td>
<td>32.8</td>
<td>22.5</td>
</tr>
<tr>
<td>May</td>
<td>20.5</td>
<td>31.4</td>
<td>21.3</td>
</tr>
<tr>
<td>June</td>
<td>18.8</td>
<td>30.4</td>
<td>19.5</td>
</tr>
<tr>
<td>July</td>
<td>18.1</td>
<td>30.3</td>
<td>18.9</td>
</tr>
<tr>
<td>August</td>
<td>18.1</td>
<td>30.6</td>
<td>18.8</td>
</tr>
<tr>
<td>September</td>
<td>19.2</td>
<td>32.4</td>
<td>20</td>
</tr>
<tr>
<td>October</td>
<td>20.7</td>
<td>34</td>
<td>21.4</td>
</tr>
<tr>
<td>November</td>
<td>21.7</td>
<td>35</td>
<td>23.2</td>
</tr>
<tr>
<td>December</td>
<td>22.5</td>
<td>34.7</td>
<td>23.9</td>
</tr>
</tbody>
</table>

Note: data for Pisolite Hills were obtained via the Project weather station between December 2008 and January 2013.

6.1.2 Rainfall

Rainfall data for Old Mapoon, Weipa and the Pisolite Hills project area are presented in Table 6-3. The mean annual rainfall at the broader Project area ranges between 1,640 mm at Old Mapoon to 1,768.8 mm at Weipa. December to March is generally accepted as the monsoon period, with rainfall during this time accounting for over 80% of the Project's total yearly rainfall. The Project can typically experience 90 days of precipitation per annum. The driest period is between June and August where mean rain fall is less than 2 mm for these months.

Table 6-3 Monthly mean rainfall

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Old Mapoon</td>
</tr>
<tr>
<td>January</td>
<td>421.1</td>
</tr>
<tr>
<td>February</td>
<td>411.2</td>
</tr>
<tr>
<td>March</td>
<td>308.4</td>
</tr>
<tr>
<td>April</td>
<td>94.8</td>
</tr>
<tr>
<td>May</td>
<td>18.7</td>
</tr>
<tr>
<td>June</td>
<td>4.2</td>
</tr>
<tr>
<td>July</td>
<td>2.7</td>
</tr>
<tr>
<td>August</td>
<td>1.1</td>
</tr>
<tr>
<td>September</td>
<td>4.0</td>
</tr>
<tr>
<td>October</td>
<td>11.1</td>
</tr>
<tr>
<td>November</td>
<td>63.8</td>
</tr>
<tr>
<td>December</td>
<td>228.9</td>
</tr>
<tr>
<td>Total</td>
<td>1,640.0</td>
</tr>
</tbody>
</table>

Note: data for Pisolite Hills were obtained via the Project weather station between December 2008 and January 2013.
6.1.3 Relative Humidity

Relative humidity data for Weipa and the Pisolite Hills project area are presented in Table 6-4. Relative humidity at broader project area typically peaks in February before reducing each month until September / October. Relative humidity at 9am is consistently reported higher than that at 3pm. No humidity data is available for the Old Mapoon weather station.

### Table 6-4 Monthly mean relative humidity

<table>
<thead>
<tr>
<th>Month</th>
<th>Weipa Eastern Ave</th>
<th>Pisolite Hills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relative Humidity at 9am (%)</td>
<td>Relative Humidity at 3pm (%)</td>
</tr>
<tr>
<td>January</td>
<td>85</td>
<td>75</td>
</tr>
<tr>
<td>February</td>
<td>87</td>
<td>78</td>
</tr>
<tr>
<td>March</td>
<td>84</td>
<td>73</td>
</tr>
<tr>
<td>April</td>
<td>80</td>
<td>62</td>
</tr>
<tr>
<td>May</td>
<td>78</td>
<td>57</td>
</tr>
<tr>
<td>June</td>
<td>77</td>
<td>53</td>
</tr>
<tr>
<td>July</td>
<td>76</td>
<td>51</td>
</tr>
<tr>
<td>August</td>
<td>73</td>
<td>46</td>
</tr>
<tr>
<td>September</td>
<td>68</td>
<td>44</td>
</tr>
<tr>
<td>October</td>
<td>60</td>
<td>46</td>
</tr>
<tr>
<td>November</td>
<td>70</td>
<td>53</td>
</tr>
<tr>
<td>December</td>
<td>78</td>
<td>65</td>
</tr>
<tr>
<td>Annual</td>
<td>77</td>
<td>59</td>
</tr>
</tbody>
</table>

Note: data for Pisolite Hills were obtained via the Project weather station between December 2008 and January 2013 and recorded only minimum and maximum values.

6.1.4 Wind

Wind data for the Weipa Eastern Ave weather station is presented at Table 6-5.

### Table 6-5 Monthly mean wind speed

<table>
<thead>
<tr>
<th>Month</th>
<th>Weipa Eastern Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Wind Speed at 9am (km/h)</td>
</tr>
<tr>
<td>January</td>
<td>4.4</td>
</tr>
<tr>
<td>February</td>
<td>3.9</td>
</tr>
<tr>
<td>March</td>
<td>5.2</td>
</tr>
<tr>
<td>April</td>
<td>7.6</td>
</tr>
<tr>
<td>May</td>
<td>8.6</td>
</tr>
<tr>
<td>June</td>
<td>8.3</td>
</tr>
<tr>
<td>July</td>
<td>8.1</td>
</tr>
<tr>
<td>August</td>
<td>8.4</td>
</tr>
<tr>
<td>September</td>
<td>9.8</td>
</tr>
<tr>
<td>October</td>
<td>9.1</td>
</tr>
<tr>
<td>November</td>
<td>6.4</td>
</tr>
<tr>
<td>December</td>
<td>4.5</td>
</tr>
<tr>
<td>Annual</td>
<td>7</td>
</tr>
</tbody>
</table>

Weipa recorded its windiest month in September. The calmest month has been recorded as January at 9 am. Measured monthly mean wind speeds range from 4.4 to 11.8 km per hour (km/h). No wind data are available for Old Mapoon or Pisolite Hills.
Wind roses demonstrate the annual mean wind direction at Weipa Eastern Ave weather station is predominantly from the southeast (Figure 6-1). Seasonally, winds tend from northwest to southeast and rarely blow from the north or south direction.

High winds occurring as a result of cyclones can cause structural damage and present a safety risk from flying debris. Rehabilitation is at risk of damage from high winds, including defoliation and windthrow of trees. Species adapted to the local climate will be utilised in rehabilitation to maximise the ability of revegetated areas to withstand these types of storms and regenerate quickly.

All plant and infrastructure facilities will be designed and constructed to the relevant Australian Standards to reduce the risk of structural damage caused by high wind speeds.
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**DISCLAIMER**
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**DATA SOURCE**
MEC Mining; 1sSRTM v1.0 Geoscience Australia 2011; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

**FiguRe 6-1**
SEASONAL WIND DIRECTIONS

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1:150,000 Scale @ A3 -
6.2 Geology, Topography and Soils

6.2.1 Regulatory Framework

The key legislation and guidelines relevant to the assessment and management of geology, topography and soils includes the following:

- *Land Act 1994* (Land Act);
- *Land Protection (Pest and Stock Route Management) Act 2002* (Land Protection Act); and
- DEHP Guideline – Application requirements for activities with impacts to land (EM961).

The *Regional Planning Interest Act 2014* (RPI Act) was considered; however, the Project is not located within any areas defined as of regional interest therefore an approval under this legislation is not required.

**Land Act 1994**

The *Land Act* addresses the management of land for the benefit of the people of Queensland by having regard to the following principles:

- Sustainable resource use and development;
- Land evaluation based on the appraisal of land capability and the balancing of different economic, environmental, cultural and social opportunities;
- Values of the land, development, community purpose, protection of environmentally and culturally valuable and sensitive areas and features; and
- Consultation with community groups, industry associations and authorities and administration.

**Land Protection (Pest and Stock Route Management) Act 2002**

The objectives of the *Land Protection Act* are to consolidate, amend and provide laws for the management, control, prohibition, and regulation of the introduction, spread and keeping of certain plants and animals declared under the Act.

Pest species declared in the *Land Protection Act* that have been identified onsite will be managed under the Act.

**DEHP Guideline – Application requirements for activities with impacts to land (EM961)**

The *Application requirements for activities with impacts to land (EM961)* is the land related guideline for ERAs under the EP Act. The guidelines require three key areas to be addressed:

- Identify the EVs of the site, including any significant flora and fauna associated with the land (Section 6.2.3);
- Identify the possible impacts due to the proposed activity (Section 6.2.4) and all associated risks to the EVs (Section 6.2.6); and
- Identify the strategies to mitigate the identified risks to the EVs (Section 6.2.5).

This section will address, as a minimum, the aforementioned requirements in the following sections.
6.2.2 Assessment Method

An assessment of the geology, topography and soils was undertaken by:

- Examining available baseline data and mapping in the region;
- Reviewing available report for works conducted locally or regionally to the Project area;
- Review of the Environmental Management Register (EMR) and the Contaminated Land Register (CLR); and
- Assessing Project specific information from desktop and field studies.

6.2.3 Existing Environment

6.2.3.1 Geology

The Project bauxite deposits are located within the Carpentaria Basin, a sub-basin of the GAB. The bauxite occurs on plateaus as the upper part of a Quaternary / Tertiary loose, pisolitic, laterite profile that is up to about 15 m thick. Quaternary alluvial deposits of silt, clay and minor sand occur in the valleys associated with the rivers. The alluvial deposits are derived from Palaeozoic basement rocks that sub crop in the Eastern Highlands.

The bauxite is formed from weathering and leaching of shales and siltstones of the underlying Tertiary / Cretaceous Bulimba Formation and Lower Cretaceous Rolling Downs Group. This has resulted in a “classic” lateritic profile; an upper bauxite layer which is up to 5 m thick, grades over a narrow interval into ferricretes which in turn grade into mottled and silty clays, including kaolinite, with some sandy clay layers. The clays in turn grade into the parent rock at depth, being generally dark grey Cretaceous shales and siltstones.

Table 6-6 Stratigraphy of study area

<table>
<thead>
<tr>
<th>Period</th>
<th>Sub-Group/Formation</th>
<th>Dominant Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Surficial Beach Sand Deposits</td>
<td>Sands.</td>
</tr>
<tr>
<td></td>
<td>Valley Cut and Fill Deposits</td>
<td>Silts and sands of alluvium channel deposits (creek estuarine areas). Alluvium can be very kaolinitic as a result of re-working of source material from the pallid zone of the Rolling Downs Group or Bulimba Formation.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Bulimba Formation (Wyaaba Beds)</td>
<td>Variable lithology, ranging from claystone (often kaolinitic) to coarse grained unconsolidated sands, or cemented cobble conglomerate. Bauxite laterite develops at the top of the formation. Comprises localised sandy, permeable deposits of ancient stream channels.</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Rolling Downs Formation</td>
<td>Marine clays, fine grained clastics, mudstones and some sandstone lenses.</td>
</tr>
<tr>
<td></td>
<td>Gilbert River Formation</td>
<td>Sandstone interbedded with siltstone and conglomerate units.</td>
</tr>
</tbody>
</table>

Exploration holes were drilled to a maximum depth of 30 m with most holes being around 5 m depth. The lithological logs indicate that the general stratigraphic profile beneath the Project Site can be summarized as:

- Topsoil of 0 to 0.6 m;
- Bauxite 0.6 to 5 m;
- Ferricrete 5 to 6 m;
- Mottled silty clay (kaolin) 6 to 30 m; and
- Grey siltstone or sandstone > 30 m.

Overall, the underlying sequence consists of about 800 m of shales, siltstones and sandstones overlying granite and metamorphic basement rocks which form the ancient, stable rock platform of the continent.

A typical stratigraphic profile of the Western Cape region is shown at Figure 2-9. At the Project site, the kaolinite clay locally reaches a thickness of up to 12 m (AGE, 2011).

### 6.2.3.2 Topography

The Project mining is located on bauxite plateaus that surround the Skardon River. Mine pit areas are proposed across an elevation range of approximately 6 metres Australian Height Datum (mAHD) to 16 mAHD. The plateaus are non-undulating and exhibit moderate slopes of approximately 0.6% (BH1 MLA) and 0.3% (BH6 West MLA). Steeper slopes are encountered along the fringes of the Skardon River.

The BH1 MLA boundary is surrounded to the north and south by tidal zones of the Skardon River and main tributary, respectively. To the east, a ridge rises between these major drainage lines and is characterised by tributary gully formations that feed the main channels.

The BH6 West MLA is divided by a ridgeline running parallel to the main tributary of the Skardon River. The western boundary is characterised by a series of swamps, coastal dunes and low lying coastal zones that are tidally influenced. The eastern boundary rises up a ridge that forms the divide between the Skardon River and Namaleta Creek catchments. Figure 6-2 is a visual representation of the topography of the study area.

Vegetation types in the study area include medium to tall Eucalypt woodland, grassland, mangrove communities surrounding the Skardon River estuary and open Melaleuca wetlands around creeks. Further descriptions of vegetation character are presented in Section 6.6 - Terrestrial Ecology.

### 6.2.3.3 Soils

Broad scale soil mapping on Cape York Peninsula was first undertaken as a part of the compilation of the Atlas of Australian Soils (Isbell et al., 1968). In 1992, the Cape York Peninsula Land Use Strategy (CYPLUS) was developed to assist government make sustainable land use and planning decisions regarding Cape York Peninsula. CYPLUS included a soil survey and agricultural land suitability assessment (Biggs and Philip, 1995). This assessment used site and chemical analysis data from previous soil surveys as well as profile descriptions and chemical analyses from a new field survey to produce detailed soil descriptions and a soil map at a scale of 1:500,000.

The soil types mapped for the Project area and soil sample locations are shown in Figure 6-3. Analytical results of the soil samples are included in Appendix A.
The drawing is confidential and shall only be used for the purpose of this project.

DISCLAIMER
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DATA SOURCE
M&G Mining
QLD Government Open Source Data
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

Legend
- Barge Mooring Location Elevation (mAHD)
  - Contour
    - -1.1 - 0.0
    - 0.1 - 5.0
  - Watercourse
    - 5.1 - 10.0
  - Barge Loading Area
    - 10.1 - 15.0
  - Pit Extents
    - 15.1 - 20.0
  - Haul Road
    - 20.1 - 25.0
  - Alternate Haul Road
    - 25.1 - 30.0
  - Mine Lease Area
    - 30.1 - 35.0
  - Camp Lease Area
    - 35.1 - 40.0

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CDM Smith
cdmsmith.com

DESIGNER
15/07/15

checklist
- CHECKED
- DATE

F:\1_PROJECTS\BES150115_Bauxite_Hill\GIS\DATA\MXD\FINAL\ERA\BES150115-007-R1_TOPO.mxd
FIGURE 6-3

SOIL TYPES AND SAMPLE LOCATIONS

Legend
- Soil Sampling Location
- Watercourse
- Pit Extents
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Camp Site
- Metro Mining Mine Lease Area

Mapped soils of the Cape York Peninsula (1995)

Bt-Deep Gradational or Uniform red massive soil with ferruginous nodules formed on remnant surfaces.
Bv-Deep Gradational mottled yellow soil formed on siltstone, mudstone or claystone
Cv-Deep to very deep coloured Uniform sands formed in beach ridges on terraces and beach ridge plains.
Cv-Deep Uniform or Gradational red massive soils on alluvial plains within the Rolling Downs Group.
Gv-Deep uniform bleached sand over coffee rock formed on drainage depressions and footslope on northern sandstones
Hm-Deep gradational bleached yellow massive soils formed on sandstones
Mn-Very deep uniform frequently cracking saline grey clays formed on marine plains
Mp-Deep duplex or gradational soils with a dark loamy surface over a mottled grey clay formed in swamps
Sd-Recent estuarine deposits under mangroves
Ss-Very deep uniform coastal sands deposited on laterite and other surfaces
Wp-Deep gradational or uniform red massive soil with aluminous concretions

DATA SOURCE
MEC Mining;
QLD Government Open Source Data;
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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METRO MINING LIMITED

DRG Ref: BES150115-006-01_SOIL
Table 6-7 Soil types mapped in the Project area

<table>
<thead>
<tr>
<th>Legend</th>
<th>Dominant Soil</th>
<th>Concept</th>
<th>Great Soil Group</th>
<th>Aust. Soil Class</th>
<th>Landform</th>
<th>Assoc. Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wp</td>
<td>Weipa</td>
<td>Deep</td>
<td>Red Earth</td>
<td>Red Kandosol</td>
<td>Plains</td>
<td>Ad, Mp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>gradational or uniform red massive soils with aluminous concretions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bv</td>
<td>Batavia</td>
<td>Deep</td>
<td>Yellow Podzolic</td>
<td>Yellow Dermosol</td>
<td>Hillslopes, plains</td>
<td>MI, Ld, Pn, Sp, Br, Hk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gradational mottled yellow soils with nodules (F,N,M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sd</td>
<td>Skardon</td>
<td>Recent</td>
<td>No suitable group</td>
<td>Intertidal Hydrosol</td>
<td>Tidal flats, estuarine</td>
<td>Go, Mn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>estuarine deposits under mangrove</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cv</td>
<td>Caravan</td>
<td>Deep to very deep coloured uniform sands formed in beach ridges on chenier and beach ridge plains</td>
<td>Siliceous sands</td>
<td>Othic Tenosol</td>
<td>Coastal margin associated with younger sand dune deposits and beach ridges. Very minor distribution</td>
<td>Mn</td>
</tr>
<tr>
<td>Mp</td>
<td>Mapoon</td>
<td>Deep duplex or Gradational soils with dark loamy surface over mottled grey clay</td>
<td>Humic gley</td>
<td>Redoxic Hydrosol</td>
<td>Swamps, drainage depressions</td>
<td>Wp, Ad, Kd, Ab</td>
</tr>
</tbody>
</table>

1. Australian Soil Classification (Isbell, 2002).
2. Great Soil Group (Stace et al., 1968).

Biggs and Philip (1995) also identified and described seven soil landscapes on the Cape York Peninsula based on distinctions in physiography and geology as well as elements of vegetation and current land use. These soil landscapes are useful for providing an overview of the soils and explaining their position in the landscape.

Soil Descriptions

The following descriptions of the soil types found at site are taken from Biggs and Philip (1995).

Soils of the Rolling Downs Group and Laterised Bulimba Formation

The soils of this group are divided into two distinct sub-groups, the first of which consists of highly weathered soils found on an older (and higher) surface while the second consists of younger less weathered soils found on the underlying sediments. There is a continuum between many of the soils, particularly those in subgroup (b). The nature of all soils reflect both the nature of their parent material and the climatic conditions under which they were formed. Segregations of pedogenic origin are a key feature, with iron and aluminium compounds more prevalent in the better drained
more weathered soils (subgroup a) and manganese dominant segregations more prevalent in the less weathered, less permeable or less well-drained soils (subgroup b).

(a) Sedentary soils on deeply weathered plateaus and remnants

These soils are located in the uppermost part of the Rolling Downs Landscape on highly weathered sandstone surfaces such as the Aurukun surface. The soils are all deep or very deep Kandosols with high concentrations of segregations in the subsoil and often the surface horizons.

**Weipa (Wp)** is the dominant bauxitic soil of the Aurukun Surface. A Red Kandosol, it contains aluminous concretions throughout, but may also contain some ferruginous concretions. As indicated, it exists in conjunction with Andoom. Surface colour varies, probably reflecting differing levels of organic matter influence. With depth, colour grades towards red or red-brown. Textures vary little throughout the profile, and Uniform medium texture profiles are not uncommon.

Weipa is the dominant soil type at the site. Mine infrastructure, mining areas and haul roads would generally be located on higher elevated areas dominated by this soil.

(b) Sedentary soils on level plains to undulating rises on weathered rock

The soils of this sub-group exist in an erosional landscape, in comparison to the relict landscape of the previous subgroup. The fine grained and argillaceous sediment of the Rolling Downs Group give rise to high clay content soils that exist in an apparent weathering sequence from Picaninny to Lydia.

**Batavia (Bv)** is a Yellow or Brown Dermosol that is commonly Bleached-Ferric, Ferric or Mottled. A hard setting, medium textured, and commonly mottled dark or grey A1 overlies an occasionally conspicuously bleached A2 with similar textures. The A3 horizon tends towards yellow-brown or yellow with an increase in texture. The B1 horizon displays similar characteristics to the A3, but sub-angular blocky or polyhedral structure becomes evident. The B2 horizons extend to an average of 0.95 m and are yellow-brown or yellow, with clay content increasing with depth. A maximum of medium heavy clay is reached in the B22. Below the B2 lies a red mottled grey or pale medium heavy to heavy clay B3 that frequently possesses lenticular structure.

The contrast between the B2 and B3 horizons is quite obvious in the field. Field pH decreases in the B3. It is suggested that the B3 represents a pallid zone in what is essentially a lateritic profile. Ferruginous to manganiferous nodules are present throughout the soil in percentages ranging from <2 to >50. Vegetation on this soil can vary but is usually a form of Darwin stringybark (*Eucalyptus tetrodonta*) or *E. leptophleba* woodland. The presence of species such as the broad leaved tea tree (*Melaleuca viridiflora*) and quinine bush (*Petalostigma banksia*) in the understorey appears to be a function of drainage and content of segregations. Batavia is one of the most common soils on the Peninsula and is extensively distributed wherever Rolling Down Group sediments are exposed. The two most commonly associated soils are Myall and Lydia, although it frequently adjoins ridges of Bertie and Scorpion.

Batavia is mapped to occur at the northern and southern edges of BH1 and at a drainage line located between BH6 east and BH1. The areas within BH1 will not be developed, whereas the haul road connecting BH6 east and BH1 will cross the draining line where the Batavia soils are located.

**Soils of the drainage lines and swamps**

Two types of swamps have been described on the Peninsula.

**Mapoon (Mp)** is vegetated by various *Melaleuca* spp. including large *M. leucodendron* of up to 25 m in height in the north, and shorter willow bottlebrush (*M. saligna*) and *M. Clarksonii* in the southwest.
The soil is typically found on the Aurukun and Kendall Surfaces; however, small swamps with Mapoon type soil are found in the alluvial country of the central and southwest of the Peninsula. Mapoon shows more evidence of organic matter accumulation than Hesket and may be classified as a Humose or Melanic Orthic Redoxic Hydrosol. The morphology of Mapoon typically consists of an organic-influenced medium textured surface overlying an occasionally bleached, grey medium textured horizon. Below this are mottled grey or pale clay B horizons that are usually structured. Horizons of a variable nature are commonly found below the B2. Field pH of the profile ranges from very strongly acid to slightly acid.

Mapoon soils are mapped to occur in the south west section of BH6 West. A second area is mapped outside but immediately adjacent to the BH6 West MLA area. No development is proposed to occur within the mining lease containing this soil type.

Soils of the coastal margin

The soils of the coastal areas are divided into two categories that are principally related to texture and mode of formation.

(a) Beach ridge and dune deposits

The soils within this category are all dominated by the sand fraction and have been deposited by wind and/or wave action. Windblown dune deposits are essentially a feature of the east coast and are quite extensive in areas, e.g. Cape Flattery. Beach ridge deposits of varying ages are found on both coasts but are a major feature of the west coast, particularly the central and south-west. In areas the beach ridges have been reworked by coastal movement and only narrow strips remain. Smart (1976a, 1976b) provides a detailed discussion of the nature of the south-western beach ridges while Pye (1982) discusses the east coast dune deposits.

Caravan (Cv) is an Orthic Tenosol found extensively along the west coast of the Peninsula. Colour within the profile varies considerably, with yellow-brown or grey common. It consists of an A1 showing some evidence of organic matter accumulation, over a paler A2. Below the A2 are B2 horizons displaying distinct to prominent mottling. Following the B2, two scenarios are possible. Some of the remnant deposits of Caravan lie directly on marine clays, and this is evident as a D horizon. Other deeper deposits of Caravan frequently have a 2A2e and then mottled pale 2B horizons. It is likely that the B2 and 2B2 horizons reflect wet season and dry season water table fluctuations. Shells may be a feature in any horizon. Vegetation on Caravan varies from open woodlands to heath or herb lands.

Caravan is mapped as present within the Project in small locations at the western edge of BH6 West. No development is proposed in these locations.

(b) Estuarine and near coastal plains

Extensive estuarine and near coastal plains are found on the central- and south-western coasts, and also in the vicinity of Princess Charlotte Bay on the east coast. These plains typically consist of large areas of Vertosols and salt pans interspersed by beach ridges. The plains are often incised by rivers and variable amounts of localised alluvial influence exist.

Skardon (Sd) is the Intertidal Hydrosol found in mangroves along the Peninsula coastline. The only site recorded was difficult to dig and describe due to a water table just below the surface. It was arenaceous in nature but it is likely that Skardon varies considerably. Sites described by Smith and Biggs (unpubl.) in mangroves of the Cairns area were typically argillaceous. Skardon and the associated mangroves are found in narrow strips intermittently along the coast, with major occurrences in the Lockhart River and Escape River areas.
Skardon is mapped to occur in narrow strips along tidal fridges associated with mangroves. These soils are mapped to occur on the mangrove fringes of the Skardon River. The bauxite loading conveyor will be located fringing mangroves where these soils are present.

**Soil Chemical and Physical Properties**

The soils in the mining areas are considered to be chemically and physically poor, typical of those associated with the woodlands of the bauxite plateau. A preliminary soil chemistry and fertility assessment was undertaken for the Project in March 2015 to determine baseline conditions of the site prior to disturbance. Three boreholes were constructed to a maximum depth of 0.6m below surface and two representative samples from the topsoil and subsoil were tested for baseline fertility, erosion potential, exchangeable cations and total metals.

The results indicate the sites soils a generally low in nitrogen, phosphorus and total organic carbon which may lead to impeded growth of vegetation during rehabilitation. Total iron concentrations were considered high which was evident on site due to the rich red soil colour. Soil salinity was considered low and pH was generally within the neutral range. The soils were typically not dispersive as the ESP was below the LOR (<0.1%) and the Emerson crumb test confirmed the structure of the soil.

Laboratory analysis was also undertaken by Rio Tinto Alcan for the SoE Project EIS on the Weipa soil type; the dominant soil type within the Project area. Results of laboratory analyses of samples taken from the Weipa soil type indicate the soil is slightly to moderately acid with a pH range generally of 5.7 to 6.5. Field pH assessments of Weipa soil profiles ranged from slightly acidic in the A horizon (pH 6.0 to 7.0) becoming more neutral at depth (pH 6.5 to 7.0). Laboratory analysis of one sample was strongly acidic (pH 4.9 to 5.4); however, field pH assessments of other Weipa soil profiles were less acidic and within expected ranges (pH 6.0 to 7.0).

Laboratory Electrical Conductivity (EC) analysis on the Weipa soil type indicate this soil types has low salinity (EC < 0.5 deciSiemens). Low chloride levels throughout the soil profiles for these soil types indicate good drainage. Soil profiles sampled and analysed were generally non-sodic (ESP<6) although two samples were slightly sodic (ESP =6), and exchangeable sodium and cation exchange capacity (CEC) concentrations are very low. The low CEC concentrations make ESP results less meaningful in these soils.

Observations and results derived from the Rio Tinto Alcan analysis are consistent with those of Biggs and Philip (1995). Weipa soils generally have low levels of calcium, magnesium and potassium, which limit their suitability for a range of crops and improved pasture plants. The low CECs are associated with low clay contents (<35%) and the predominance of kaolin (which has a low CEC), common in lateritic landscapes. There is a consistent trend of higher CEC values in the surface than in the rest of the profile, which is linked to higher organic carbon in the surface. Levels of all cations are higher in the surface and decline consistently with depth.

The Weipa soil type is extremely infertile with low levels of Colwell extractable phosphorus (<1mg/kg) and very low exchangeable potassium (<0.35mg/kg). The average calcium/magnesium (Ca/Mg) ratio in the top 30cm is 1.6, and at 50-60cm depth the average Ca/Mg ratio is 0.95. These ratios are within the range considered desirable for good plant growth. At depths below 70cm the Ca/Mg ratio is on average 0.8, indicating an imbalance that could result in calcium deficiency and poor root growth if that layer was exposed at the surface during rehabilitation. Nutrients such as nitrogen, calcium and potassium are concentrated in the surface 10cm of soil, due to nutrient recycling in the litter layer. This layer represents the main nutrient storage capacity for tropical soils, and therefore would need to be preserved to facilitate rehabilitation following mining.
Soils in the lower lying areas of the Project, that will not be mined, are of marine origin and contain iron sulphides that on exposure to air and water react to produce acid i.e. Acid Sulfate Soils (ASS).

The Australian Soil Resource Information System (ASRIS), developed by CSIRO, provides predictive ASS mapping across Australia. From the ASRIS mapping, the mangrove and riparian habitats are identified as areas with the greatest potential to generate ASS. The potential to generate ASS decreases away from the Skardon River and associated tributaries, with low potential within the woodlands and grasslands.

The presence of ASS becomes an environmental issue when construction activities involve the disturbance, excavation and relocation of these soils, or dewatering of these soils. The sulfuric acid leachate that is generated when these soils are disturbed or dewatered can potentially result in the acidification of surrounding soils and water, and the secondary contamination of soils and water through the release of heavy metals.

Preliminary ASS data was collected on 3 September 2014, from indicative locations along the Skardon River (refer to SS04 and SS05 in Figure 6-3). The objective of this ASS investigation was to determine the presence or absence of ASS within the proposed construction area to be disturbed.

The following ASS guidelines, ASS maps, documents and associated data were considered as a part of this review:

- Acid Sulfate Soils Mapping - 1:100,000 scale - Acid Sulfate Soils of Far North Queensland (16th April 2015);
- ASS drilling borelogs maximum depth of six metres (03/09/2014);
- ASS laboratory results (SGS Reference CE111659 -03/09/2014); and
- Borehole BH6 E1 and E2 locations (Google Earth .kmz file).

A review of the preliminary ASS laboratory results and bore logs constructed to a maximum depth of six metres indicated the presence of Actual ASS (Titratable Actual Acidity >0.02% sulfur) in a number of samples from surface level to 0.5 metres below surface level within the area of investigation, as shown in Table 6-8.

**Table 6-8 Preliminary ASS summary**

<table>
<thead>
<tr>
<th>Hole ID</th>
<th>Easting</th>
<th>Southing</th>
<th>Depth (m)</th>
<th>Lithology</th>
<th>pH (KCl)</th>
<th>Chromium Suite Net Acidity (%w/w S)</th>
<th>Calculated Liming Rate (kg CaCO3/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH6-E1-2</td>
<td>616877</td>
<td>8699740</td>
<td>0.00 - 0.25</td>
<td>Grey brown/red soil with organic matter</td>
<td>5.00</td>
<td>0.03</td>
<td>1.5</td>
</tr>
<tr>
<td>BH6-E1-3</td>
<td>616857</td>
<td>8699726</td>
<td>0.00 - 0.25</td>
<td>Grey brown/red soil</td>
<td>4.9</td>
<td>0.04</td>
<td>1.9</td>
</tr>
<tr>
<td>BH6-E2</td>
<td>617330</td>
<td>8698300</td>
<td>0.00 - 0.25</td>
<td>Dark brown to brown clay with fine roots</td>
<td>5.1</td>
<td>0.04</td>
<td>1.8</td>
</tr>
<tr>
<td>BH6-E2</td>
<td>617330</td>
<td>8698300</td>
<td>0.25 – 0.5</td>
<td>Brown to reddish orange clay with minor organic matter</td>
<td>4.9</td>
<td>0.04</td>
<td>1.8</td>
</tr>
<tr>
<td>BH6-E2-2</td>
<td>617308</td>
<td>8698288</td>
<td>0.00 - 0.25</td>
<td>Brown soil with organic matter</td>
<td>4.7</td>
<td>0.07</td>
<td>3.1</td>
</tr>
</tbody>
</table>
The key activities which may disturb ASS are vegetation clearing, earthworks (e.g. haul road culverts, drainage and sediment controls) and construction of the barge loading facility. For construction purposes, soils that occur on the lower-lying Melaleuca and mangrove ecosystems along the Skardon River and tributaries should be treated as potential ASS. Once final design and construct plans have been approved, and prior to disturbance by construction activities, Metro Mining shall delineate ASS within the proposed disturbance area in accordance with the QASSITM Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland (1998). Once the quantity and quality of ASS have been delineated, identified ASS shall be managed in accordance with Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines (Dear et al., 2014).

6.2.3.4 Land Use Suitability

The suitability of the soils of Cape York Peninsula were assessed by Biggs and Philip (1995) for a number of land uses using the methods described by the former Department of Primary Industries (DPI) (1990). Interpreting land suitability using these methods was used previously in the Planning Guidelines: The Identification of Good Quality Agricultural Land (DPI and DHLGP 1993). The following five land uses were directly assessed by Biggs and Philip (1995):

- Peanut cropping;
- Sorghum and maize cropping;
- High input pastures;
- Medium input pastures; and
- Low input pastures.

These land uses were chosen because they are currently practiced at certain locations on the Cape York Peninsula.

The suitability of each of the soil types present on the Cape York Peninsula was assessed for each of the above land uses that Biggs and Philip (1995). Land suitability of the Cape York Peninsula was mapped at a scale of 1:700,000 and was based on the suitability of the dominant soil type of each map unit, and the dominant soil types were based on soil survey data from air photo interpretation and ground observations. Biggs and Philip (1995) mapped most of the Cape York Peninsula north of Aurukun as "land suitable for low intensity grazing of native pastures."

A land suitability assessment for a range of soil types was also undertaken by Rio Tinto Alcan, including for the Weipa soil type that is dominant across the Project area. The outcome of the land suitability assessment found that the Weipa soil type is not considered to be good quality agricultural land or suitable for improved pasture land uses. The Weipa soil type does, however, have some use for low intensity grazing of native pastures. Land suitable for low intensity grazing of native pastures represents native pasture grazing land with a very low fertility status; however, it is often associated with areas suitable for pastoral development and is a useful component of the total grazing system. Soils associated with estuarine areas (Skardon soil type), near coastal plains (Caravan) and soils associated with drainage lines (Batavia) and swamps (Mapoon) within the Project area are not suitable for any improved pasture or native pasture grazing land uses. The finding of the Rio Tinto Alcan SoE EIS – land suitability assessment was consistent with the Biggs and Philips (1995) assessment.
6.2.3.5 Contaminated Land

A search of the DEHP EMR and CLR was undertaken to determine whether a notifiable activity had been undertaken within the Project area. Land that has been used for a notifiable activity, of which the DEHP has been advised, is recorded on the EMR. The EMR provides information on historic and current land uses, including whether the land has been, or is currently used for a notifiable activity, or has been contaminated by hazardous material.

The CLR includes land that has been proven (through investigation) to be contaminated, and is causing or has the potential to cause serious environmental harm. Therefore, land will only be recorded on the CLR when an investigation shows it is contaminated and action must be undertaken to remediate or manage the land. There are no land parcels within the Project area that are listed on the CLR.

The search of the register indicated Lot 11 of SP 204113, Lot 12 of SP 204113 and Lot 13 of SP 204113 are listed on the EMR for Chemical Storage, Landfill, Petroleum Product or Oil Storage (see Appendix B). The EMR listing is likely to be associated with the historical mining activities undertaken by others in the broader area.

As this site is not listed on the CLR a site based management plan is not required.

6.2.4 Potential Impacts

Construction works and mining will involve clearing and earthworks for internal access roads / haul roads, equipment and materials laydown areas, excavation for water management systems, site preparatory works and establishment of buildings and workshops, and construction of the barge loading facility. The construction activities will include earthworks for excavation, re-profiling, regrading, stockpiling, and drainage and water storage structures.

During operation, major activities will relate to the extraction of bauxite, the management of erosion and sedimentation, including diverting clean water away from work areas, and collection of dirty water in sediment ponds and the implementation of progressive rehabilitation.

6.2.5 Management and Mitigation Measures

The following management measures will be put in place to mitigate potential impacts on geology, soils and landforms:

- To minimise impacts of excavation on topography and surrounding landscapes, Metro Mining will implement the following:
  - maintain appropriate slope profiles over the site, whilst allowing for natural drainage
  - maintain average slope gradients at 4% or less (the erosion potential of longer slopes will need to be considered)
  - minimise slopes gradients adjacent to creeks

- The main land disturbance areas in the mine area will be as a result of open cut excavations, construction of dams, mine infrastructure and haul roads. Mitigation measures to limit the impacts of land disturbance include:
  - the topsoil in these areas would be recovered and maintained to ensure useable soils are retained
- all topsoil would be stripped and stored separately from subsoils
- where the ROM plan allows, the topsoils will be stripped and placed directly onto rehabilitation areas or stored for the minimum time possible to make maximum use of seed stocks
- stockpiling of topsoils will be minimised or avoided where possible. Where topsoils are stockpiled, the height of stockpiles will not exceed 2 m

- An Erosion and Sediment Control Plan (ESCP) will be prepared to address the potential issues arising from the field investigations. Erosion in active construction or development areas cannot be eliminated; however, impacts can be controlled and minimised through the following management actions:
  - limiting the area of disturbance and progressively clearing areas immediately before construction
  - strip and stockpile topsoil prior to construction
  - divert surface water runoff around construction areas
  - minimise the period that exposed soil is left open during construction
  - place sediment traps and silt fences to minimize off-site impacts
  - maintain a site monitoring program to assess erosion control measures

- Further assessments for ASS will be carried out during design and prior to construction commencing. If ASS are identified an ASS Management Plan for specific construction works will be developed;
- Areas of identified dispersive soils will be closely monitored to assess the efficacy of the erosion control measures;
- Where land is disturbed progressive land rehabilitation will occur as use of those areas ceases and areas suitable for rehabilitation become available;
- Post disturbance regrading will be undertaken to produce slopes that are suitable for the proposed land use; and
- A drainage design that addresses runoff volumes and erosion minimisation will be put in place.

While no contaminated sites have been identified and there has been no known development within the site, measures that could be employed to manage any land contamination issues at the Project site include:
- Where site contamination is present and remedial measures are required a Contaminated Site Management Plan or Remediation Action Plans (RAP) will be prepared in line with possible construction techniques that will minimise excavations for site preparation;
- Where site contamination must be excavated, the work will be completed under a RAP and validated to assess the effectiveness of the remediation. A validation report will be prepared suitable for submission to DEHP to assess the effectiveness of the remediation, the proposed management measures (if any) and allow a site suitability statement to be issued for the lot by DEHP;
- No contaminated soils will be removed from a lot without a disposal permit issued by DEHP;
- Remedial measures will include (in order of preference) risk assessment, on-site containment, on-site treatment and / or off-site treatment or disposal; and
- Sediment ponds will be appropriately designed and constructed on-site during the construction phase with the objective of continued use through to the operation phase. To assist with maintaining acceptable water quality, sediment controls will be put in place prior to clearing activities and for the operational phase they will be designed as part of the site Water Management System and in accordance with the operational environmental management planning.

### 6.2.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential geology, topography and soil impacts is summarised in Table 6-9. An analysis of initial risk, without mitigation, was considered for each technical element. The residual risk considers the mitigation and management measures developed for geology, topography and soils, and put forward in this assessment.

**Table 6-9 Qualitative risk assessment - geography, topography and soils**

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Erosion and sediment mobilisation                      | Minor               | Likely             | Medium       | ▪ Implement site ESCP  
▪ Soil survey  
▪ Topsoil management plan                               | Low                |
| Erosion mobilising sediment into nearby watercourses   | Moderate            | Possible           | Medium       | ▪ Implement site ESCP  
▪ Soil survey  
▪ Topsoil management plan  
▪ Water monitoring                                       | Low                |
| Loss of topsoil integrity from improper removal or storage | Minor               | Possible           | Medium       | ▪ Implement site ESCP  
▪ Identification and use of material placement areas  
▪ Topsoil management in accordance with International Erosion Control Association (IECA) 2008 | Low                |
| Impacts to soil from potential contaminants (e.g. refuelling, spills and leaks) | Moderate            | Unlikely           | Medium       | ▪ Storage in bunds/hardstands  
▪ Refuelling undertaking in appropriately designed areas | Low                |
| Localised hydraulic alterations. (i.e. the impact from diverting surface water flows into areas surrounding the Project) | Insignificant       | Almost certain     | Low          | ▪ Implement site ESCP  
▪ Water management system  
▪ Design to maximise cut and fill  
▪ Reuse of cut material                          | Low                |
6.2.7 Summary

The land assessment presented above demonstrates that the construction and operation of the Project will result in changes to topography in the areas mined for bauxite. The Project will not result in significant long-term impacts to soil characteristics in the locations outside of the mined areas. Topsoil Management Plans and ESCP will be implemented throughout the life of the Project to ensure surface and subsoils are managed and minimise erosion and sedimentation. The Project design footprint has also been minimised as far as practicable, such that 1,668.99 ha will be disturbed as a worst case scenario. Should Metro Mining obtain approval to develop the off-lease haul roads the disturbance area will be reduced to 1,636.75 ha. These measures ensure that the Project will ultimately have minimal impacts on the landscape.

The Project will be operated in a way that protects the EVs of land. Project activities will be managed to prevent adverse effects on EVs due to unplanned releases. The application of water will be managed to prevent adverse effects on the composition or structure of soils and subsoils and in particular to prevent drying of soils that will be used as part of rehabilitation activities and also to prevent dust lift off from stockpiles. In addition, disturbed areas will be rehabilitated to meet the EP Regulation guideline criteria, as outlined in Section 5.1.

6.2.8 Commitments

Metro Mining's commitments for geology, topography and soils management are provided in Table 6-10.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTS1</td>
<td>ESCPs will be developed and put in place prior to the commencement of construction works for all areas of the Project that may cause erosion and/or have sediment runoff from product material.</td>
</tr>
<tr>
<td>GTS2</td>
<td>Topsoil management measures will be documented, monitored and maintained with a reconciliation of top soil excavation and rehabilitation maintained. Excess topsoil will be used in Project areas with topsoil deficits.</td>
</tr>
<tr>
<td>GTS3</td>
<td>Prior to construction carry out soil sampling at waterways where haul road crossings are to occur, to better identify erosion risk and put in place appropriate management measures.</td>
</tr>
<tr>
<td>GTS4</td>
<td>Minimising the land required for the mine development to the extent practicable.</td>
</tr>
<tr>
<td>GTS5</td>
<td>Undertake progressive rehabilitation to reinstate similar drainage patterns to pre-mining.</td>
</tr>
</tbody>
</table>

6.3 Landscape and Visual Amenity

This section describes the existing environment values of the land area that may be affected by the Project. Management and mitigation measures to address potential impacts to the existing land are outlined in this section.

6.3.1 Regulatory Framework

There is no direct legislation governing impacts to visual amenity.

6.3.2 Assessment Method

When undertaking a visual impact assessment it is generally recognised that there is a limit to the human field of vision, which result from human physiological limitations and landscape structure. The key factors in determining visual impact are therefore based on:

- The human perception of views and parameters of vision;
- The natural topography and topographical change; and
- The natural vegetation that has the potential to screen views.

Scientific studies undertaken by Costella (1995) and Ball et al. (2005) identify the relationship between the potential landscape change and the proportion of area the development occupies (i.e. how much can be seen) within the horizontal and vertical visual catchments. Figure 6-4 has been developed based on this research to assist in rating the visual impact at sensitive receptor sites, taking into account the effects of topography and vegetation.

![Effect of topography and vegetation on views](image)

**Figure 6-4 Effect of topography and vegetation on views**

In addition to the direct visual impact the duration in which people view the landscape is a crucial factor in analysing the sensitivity to change. For example, variations in the landscape are more noticeable from lookouts and permanent viewing points when compared to a view whilst travelling along a road. As such, the relative duration spent at each viewing location has a significant influence the sensitivity of change to the landscape.

The specific objectives of the landscape and visual amenity assessment are to identify and assess:

- Landscape and visual amenity baseline conditions;
- Sensitive receptors and potential impacts;
- The visual significance of the Project on existing landscape character and amenity; and
- A range of management and mitigation measures to limit visual and character effects from the Project.

Due to the remote location of the Project, and the limited viewing locations (or access to the general public) a detailed landscape and visual impact assessment has not been prepared; however, an assessment has been undertaken as per the following:

- Desktop review of existing environment and location of sensitive receptors at the Mapoon Township and the Skardon River mouth;
- Topographic and sensitive receptor analysis; and
- Basic qualitative review of likely impacts.

When calculating the viewshed a nominal 5 m elevation was applied. This approach was adopted to provide a conservative calculation to over-estimate potential impacts to visual amenity.

6.3.3 Existing Environment

6.3.3.1 Land Use

The land use within the Project area is currently limited to exploration activities associated with mining and cultural and recreational uses. In addition to the Project, Gulf Alumina are proposing to develop a separate mine within the immediate Project area. Current land uses within and adjacent to the Project area are shown on Figure 6-5.

Previously the dominant use of the lands within the Project area were for cultural purposes and mining and processing of Kaolin (i.e. the Skardon Kaolin Project). Whilst there are currently no rural properties within the immediate vicinity of the Project there may have been limited cattle grazing and associated activities within the broader area during the early to mid-1900s.

Exploration activities, including drilling and associated access track development, have taken place throughout the Project area and activities such as drilling, ore sampling and other exploration activities are continuing.

The use of the Project area by Traditional Owners and management of access to the Project area by Traditional Owners are discussed in Section 6.12. Areas of cultural and recreational importance that have been identified by the Traditional Owners include Bigfoot Swamp, Lunette Swamp and middens identified near the existing Port of Skardon River.

Recreational activities within the Project area are generally associated with traversing the Project area to access camping areas at the mouth of the Skardon River (see Plate 6-1). Existing vehicles tracks are used infrequently for recreational 4WD activities and hunting. The branch of the Skardon River that dissects the Project area is used for recreational fishing and boating activities.

Plate 6-1: Camping at the mouth of Skardon River
While overall there has been very little direct disturbance and the terrestrial environment is generally in good condition, some areas have been affected by camping, frequent controlled and uncontrolled fires, and damage from feral pigs. The effect of the current fire regime on the Darwin stringybark ecosystem has been the development of a homogeneous vegetation structure that varies little throughout the Project area.

6.3.3.2 Landscape Character

The Project area maintains a number of distinct landscape characteristics, given its location on wooded bauxite plateaus that graduate to swamp and mangroves through to the Skardon River.

Creeks and drainage lines on the Project are generally narrow and meander through wetlands at the base of higher plateaus. Most are ephemeral, with high flows during the wet season that will slow down or cease altogether during the dry.

Melaleuca woodlands, wide grassy flanks beside narrow creeks and low-lying swamps are all features of the Project site.

There are also two specific swamp areas, Bigfoot and Lunette that occur within close proximity to the mining areas.

The landscape and visual assessment classified five distinct landscape characteristics in the locality surrounding the Project:

- Tall Eucalypt woodland;
- Open Melaleuca wetlands;
- Mangrove community;
- Skardon River; and
- Current Skardon River jetty and associated facilities.

Tall Eucalypt Woodland

Tall Eucalypt woodland on upper escarpment and plateaus is the primary landscape character type across the majority of the Project. This landscape character type is found from the lower foothills / slopes of the escarpment at approximately 10 mAHD and up to plateaus from approximately 22 mAHD. This woodland is characterised by vegetation 20 - 30 m in height, and exhibits moderate density. It has moderate to high visual / vegetation screening potential (see Plate 6-2).
Open Melaleuca Wetlands

This community is located from low-lying flat plains at 3.0 mAHD, to the lower plains at the foot of the escarpment up to 9.0 mAHD at the proposed accommodation area. It is also located throughout the site on depositional plains and seasonally inundated swamps. It is comprised of Melaleuca with Eucalypt emergent, in the order of 10-15 m in height. Despite the presence of taller vegetation, this landscape character type offers only moderate screening as it is open and is located on areas of lower relief (see Plate 6-3).
Mangrove Community

A mangrove community is located along the Skardon River and on intertidal areas adjacent to the river. It has an average height of 10-15 m. It is a dense, closed forest community dominated by large-leaved orange mangrove and long-styled stilt mangrove in the outer mangrove regions, and yellow mangrove and northern grey mangrove in intertidal areas. Given the height and density of this community, it provides very effective vegetation screening from the water looking inland (Plate 6-4).

Plate 6-4: Project mangrove community

Skardon River

The Skardon River is generally fringed by mangrove vegetation. At the mouth of the river it widens and allows views across the small harbour. Currently the waters are used by locals for fishing and transport. A typical view of the open waters landscape type at the mouth of the river is depicted in Plate 6-5.

Plate 6-5: Mouth of the Skardon River
Current Skardon MIA

While the majority of the land surrounding the Project is undeveloped, the existing Skardon Mine does change the immediate landscape character. The current infrastructure includes the existing Skardon Port, a well maintained haul road that runs from the Skardon River airstrip to the Port area (approximately 14 km), the Skardon River airstrip, the remains of the Skardon Kaolin Project accommodation camp, remnant kaolin pits, including one that Namaleta Creek runs through, and the remains of the wet and dry kaolin processing plants that are being decommissioned and removed from site. The existing Port of Skardon infrastructure is depicted in Plate 6-6.

![Plate 6-6: Existing Port of Skardon infrastructure](image)

6.3.3.3 Visual Amenity

There are limited sensitive receptors within a 40 km radius of the Project. The town of Mapoon is the most populated sensitive receptor and is located approximately 35 km from the MIA and 16 km from the mining lease boundary (see Figure 6-6). Given the distance, and the intervening forests and mangroves, infrastructure from the Project is not expected to be visible from Mapoon.

The most significant vantage point for visual amenity impacts will be from the Skardon River itself, given the location of the product stockpiles beside the river and the construction of the barge loading facility and its extension part-way into the river. As there is limited vehicle access into the area, any access to the Skardon River is most likely achieved by boat from Mapoon, Weipa and/or possibly Bamaga, by Traditional Owners and for recreational fishing.

It should be noted that the size of the Project infrastructure that will be visible from the river will be similar to that already existing at the Port of Skardon. This level of visible intrusion has been readily accepted by the existing users of the area, meaning a similar level of impact for the Project is unlikely to cause any significant concern.
6.3.4 Potential Impacts

6.3.4.1 Visual Amenity

**Land Activities**

Visual impact relates to changes in views experienced in the landscape. Visual assessment identifies the extent of the impact to the sensitivity of the viewpoints. The following main criteria are generally applied to assess the visual impact.

- **Distance** - The greater the distance the less detail is observable and the more difficult it is to distinguish the development from the surrounding area;

- **Elevation** - Lower elevation of a proposed development has a lower impact due to the surrounding features and backdrop;

- **Size** - The smaller the development the less impact;

- **Context** - The degree to which the development is in character with the surrounding landscape;

- **Activity** - The more movement of vehicles and activities, the more visible the development; and

- **Change** - The degree and rapidity of change associated with the development.

A high level assessment of the Project against the visual impact criteria is provided in Table 6-11.

### Table 6-11 Visual impact assessment

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Potential Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>The nearest sensitive receptors are at Mapoon, approximately 16 km away (direct line of site).</td>
<td>Low</td>
</tr>
<tr>
<td>Elevation</td>
<td>The Project site is at a similar elevation to the surrounding environment. In particular it is not at an elevation that makes it particularly visible from a distance.</td>
<td>Low</td>
</tr>
<tr>
<td>Size</td>
<td>The Project is a small – medium size operation, producing a maximum rate of 1.95 Mtpa, utilising basic earthmoving techniques and with no chemical processing required. In comparison to the existing Weipa bauxite mine, this is a small operation.</td>
<td>Low</td>
</tr>
<tr>
<td>Context</td>
<td>The majority of the surrounding environment is undeveloped; however, the previous Skardon Kaolin Project and Skardon River Bauxite Project means the development is not totally out of context.</td>
<td>Medium</td>
</tr>
<tr>
<td>Activity</td>
<td>The relatively small size of the mining operations and the lack of road access means that transport movements will be limited to barge and planes. Plane movements are estimated to average three in-bound flights a week, while barge movements will only be visible from the Skardon River. With a maximum production rate of 1.95 Mtpa, basic mining techniques and no beneficiation, the activities from the mine are classified as low.</td>
<td>Low</td>
</tr>
<tr>
<td>Change</td>
<td>As this is a relatively small and simple operation, the changes that do occur are likely to occur quickly. It is, however, considered the degree of change is relatively small.</td>
<td>Medium</td>
</tr>
</tbody>
</table>

The visual amenity values and potential impacts associated with the Project are relatively low, given that the dense and / or tall woodlands and mangroves within the vicinity of the mine tend to limit the local viewshed.

Given the limited access, distance from the closest sensitive receptors, acceptance of the existing Port of Skardon infrastructure and the relatively small size of the mining operations, no significant visual amenity impact is predicted from the mining operations.

Viewshed analysis from the township of Mapoon and the mouth of the Skardon River are shown at Figure 6-7 to Figure 6-9.
DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
MEC Mining; 1sSRTM v1.0 Geoscience Australia 2011; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric Geosensor PRODUCT SUITE V2.1.1

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FIGURE 6-7
VIEWSHED ANALYSIS AT 5m ELEVATION FROM SENSITIVE RECEPTOR R44 IN MAPOON

VIEWSHED ANALYSIS
Not Visible
Visible

Legend
Observer Location
Sensitive receptor
Watercourse
Camp Site
Barge Loading Area
Haul Road
Alternate Haul Road
Pit Extents
Mine Lease Area

Mapoon
Residential Houses
Accommodation Village
ML 20671 BAUXITE HILLS 3
ML 20688 BAUXITE HILLS 6 EAST
ML 20689 BAUXITE HILLS 6 WEST
DUCIE RIVER
NAMALETA CREEK
PAWSON CREEK
PARGON CREEK
DULHYNTY RIVER
SKARDON RIVER
METROVILLA RIVER
MAMAETA CREEK
NAMALETA CREEK
PAPON CREEK
PAWSON CREEK
Transshipment Activities

The Project will involve the transshipment of bauxite from barges to OGVs moored approximately 12 km offshore of the Skardon River mouth. To establish the visible horizon limit from the observation points at Mapoon and the Skardon River mouth the following approach was adopted. Numerically, the radius of the Earth varies a little with latitude and direction; but a typical value is 6,378 km, which makes the distance to the geometric horizon 3.57 km times the square root of the height of the eye in meters (see Young, 2015). For example, an observer standing on the ground with an average eye-level height of 1.70 m, the horizon is at a distance of 4.7 km.

To establish the viewshed to sea from Mapoon Township and the Skardon River mouth, and then be consistent with the land activities viewshed, a nominal 5 m elevation was applied to the above formula. This approach established that at a 5 m elevation, the observer would be able to view the horizon out to sea to approximately 8 km. This limit is well inside the location of the transshipment activities which is located approximately 12 km offshore of the mouth of the Skardon River (Figure 6-10).

It is therefore unlikely that the daytime ship loading activities occurring approximately 12 km from the mouth of the Skardon River will be observable from sensitive receptors located at Mapoon. It is, however, possible that observers may see mast lighting at night whilst moored or transit lighting whilst underway.

People camping at the Skardon River mouth camp area and those undertaking recreational activities on the Skardon River will be able to observe tug and barge operations transiting to the transshipment mooring points of the Skardon River mouth. It is unlikely that daytime transshipment activities will be visible from these locations; however, night time mast or transit lighting may possibly be able to be seen from camp sites at the Skardon River mouth.

6.3.5  Management and Mitigation Measures

No significant landscape or visual impacts are expected for identified sensitive receptors as a result of the Project. Nonetheless, a range of measures will be employed to reduce potential or direct views of the Project from the Skardon River.

6.3.5.1  General Landscape and Visual Impact Management

The following landscape and visual impact management measures will be employed for the Project:

- Vegetation between the Project area and the Skardon River will be retained where possible as an environmental buffer. This will assist in limiting potential views from the river;

- Landscaping will be established where useful to minimise the visual impacts of the Project; and

- Use of material and paint colours for on-site infrastructure that naturally blend with the surrounding landscape, with the exception of colouring and materials required to adhere to safety measures.
DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

GCS GDA 1994 Zone 54

Figure 6-10
VISUAL TO SEA FROM MAPOON TOWNSHIP AND THE SKARDON RIVER

DATA SOURCE
QLD Government Open Data Source
Australian Government Bureau of Meteorology

CLIENT

DATE
Details
MD
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This drawing is confidential and shall only be used for the purpose of this project.

MD
15/07/15
23/02/15

R

Legend

Observer Location
Town
Shipping Route
Major watercourse
Minor watercourse
Pit Extents
Transhipment option
Observer Location 5km Buffer
Barge Loading Area
Haul Road
Alternate Haul Road
Mine Lease Boundary
6.3.5.2 Lighting Impact Management – Land Based

Permanent lighting will be required at the MIA, barge loading conveyor and workers accommodation. The following lighting impact management measures will be employed for the Project:

- Lighting will be limited to only that which is essential during both construction and operational periods;
- Lighting design will include light shrouding techniques (i.e. be well shielded, full cut-off and downward directed type fixtures);
- Luminaries will be mounted low in the vertical plane and use the lowest intensity for the safe completion of tasks;
- Lighting will be arranged so as to avoid direct light spill or unnecessary sky glow over the Project area. The type and location of some emergency and safety lighting will; however, be determined by existing construction and safety regulations;
- Intense lights, or clusters of light, will be avoided where practicable;
- To ensure lighting management measures are complied with, periodic visual inspections, audits and corrective management of light sources will be undertaken;
- Automated control systems will be investigated to switch off or reduce lighting where practicable, including the use of timers and motion detectors; and
- Ground-level path lighting will be used where practicable.

6.3.5.3 Lighting Impact Management – Sea Based

To reduce the extent of lighting spill at to sea during night time activities, ships lighting will be kept to the minimum required by shipping laws.

6.3.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential landscape and visual amenity impacts is summarised in Table 6-12. An analysis of initial risk, without mitigation, was considered for landscape and visual amenity. The residual risk considers the mitigation and management measures developed for this element and put forward in this assessment.

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>View of Project from Mapoon</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Limit vegetation clearance where possible</td>
<td>Low</td>
</tr>
<tr>
<td>View of Project from Skardon River mouth</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Limit vegetation clearance where possible</td>
<td>Low</td>
</tr>
</tbody>
</table>
### 6.3.7 Summary

The assessment found that no visual impacts are expected at the Mapoon township or the mouth of the Skardon River. There is potential impact to boat users that infrequently use the south arm of the Skardon River; however, this is expected to be limited to the MIA, barge loading conveyor and mooring infrastructure. With lighting required on the barge loading conveyor and associated barge mooring infrastructure there will be some visual impacts from lighting at night. This impact is expected to be minimal given the infrequent use of the river, particularly at night. Vegetation buffers and other mitigation measures are proposed where practicable to mitigate the potential visual impact to river users.

It is unlikely that daytime activities at sea will be observable from Mapoon or the Skardon River mouth. There may, be some lighting visible from ships at mooring or underway at night; however, this will be managed by not undertaking night time ship loading activities and limiting lighting to the minimum required under current shipping laws.

### 6.3.8 Commitments

Metro Mining’s commitments for landscape and visual amenity management are provided in Table 6-13.

**Table 6-13 Commitments – landscape and visual amenity**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVA1</td>
<td>Minimising the land required for the mine pit development to the extent practicable.</td>
</tr>
<tr>
<td>LVA2</td>
<td>Rehabilitation will return the land to an environment that will be conducive to the community and will return the aesthetics, where practicable.</td>
</tr>
</tbody>
</table>

### 6.4 Marine Ecology

This section summarises the key marine habitats, species of significance and sediment and water quality characteristics of the proposed Project area. This includes identifying potential impacts and key environmental receptors during both the construction and operational phases. Additionally, management and mitigation measures are proposed to reduce potential impacts on the marine environment. The technical marine ecology report, prepared by Ports and Coastal Environment (PaCE), can be found in Appendix C – Marine Ecology Technical Report and should be read in conjunction with this report.
6.4.1 Regulatory Framework

The key legislative framework relevant to the assessment and management of marine ecology includes the following:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Coastal Protection and Management Act 1995* (CPM Act);
- *Quarantine Act 1908* (Quarantine Act); and

*Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act provides a framework to protect and manage nationally and internationally important flora, fauna and ecological communities (among other things) as defined under the act as MNES. Under the EPBC Act the DotE has jurisdiction over actions that are likely to have a significant impact on MNES.

*Coastal Protection and Management Act 1995*

The CPM Act provides for the protection, conservation, rehabilitation and management of the coast, including its resources and biological diversity. The CPM Act acknowledges the goal, core objectives and guiding principles of the National Strategy for Ecologically Sustainable Development in the use of the coastal zone.

An approval for tidal works will be required under the CPM Act. Works associated with the proposed barge-loading facilities may include construction within tidal areas and the disposal of excavated material within tidal areas. This will also include constructing the loading berth located outside the Skardon River in the Gulf of Carpentaria.

*Quarantine Act 1908*

The Quarantine Act is the primary legislation relating to quarantine and biosecurity regulation in Australia. The objective of the Quarantine Act is to ensure the long term protection of Australia landscape, marine, agricultural and terrestrial environment through the exclusion of pests and disease.

*Fisheries Act 1994*

The main purpose of the Fisheries Act is to provide for the use, conservation and enhancement of the fish resources and habitats as a way to apply and promote the principles of ESD. It regulates the taking and possession of specific fish, removal of marine vegetation, the control of development in areas of fish habitat and listed noxious fish species.

An approval is likely to be required to remove mangroves for the construction of the barge loading facility under this Act.

6.4.2 Assessment Method

The assessment method for benthic habitats incorporated project specific surveys by PaCE, a review of relevant literature and the findings of other benthic surveys conducted within the study area. The surveys undertaken by PaCE included 116 locations (2014 - 48 locations and 2015 – 68 locations),
in order to better understand the benthic habitats from upstream adjacent to the proposed barge developments to the Skardon River Entrance. Habitats within the proposed transshipment locations and several bathymetric “high spots” were also surveyed offshore.

Sites were distributed with regards to available bathymetric information (e.g. rocky reef, shoals), available footprint layouts, and so to provide coverage of the general operational areas. Video data was analysed and percentage cover recorded within key classes including seagrass, total live cover, macroalgae, macroinvertebrates, coral and bare substrate cover.

### 6.4.2.1 Marine Development Footprint

To accurately assess the potential impacts to the marine environment the proposed marine development footprint and activities were identified.

Construction of the barge loading facility will be undertaken under a combination of land and vessel based methods. The construction through the mangroves is proposed to be based on a conveyor system and piling rather than infill and causeway development methods. The abutments connecting the conveyor alignment to the upland stockpile and barge loading facility will include a section of bank stability revetments to protect the infrastructure during seasonal flooding and tidal elevations. A trestle based conveyor will connect the stockpile with the barge loader and quay line. This will include gantry based structures and a series of dolphins for securing the barges and moving them fore and aft during loading.

Key elements of the Project in regards to the marine environment include the:

- Barge loading facility;
- Marine operations and barge route;
- Cyclone moorings; and
- Offshore transshipment area.

Dredging or bed levelling is not proposed to access the Skardon River. No changes to bed morphology is expected from the proposed operations.

### Barge Loading Facility

Three options have been identified for locating the barge loading facility. Option 1 is situated approximately 1700 m upstream of the existing ramp on the Skardon River, Option 2 is approximately 300 m upstream of the existing ramp and Option 3 1000 m upstream of the existing barge ramp. Option 3 has been selected as the preferred option given bathymetry constraints at the other locations.

### Marine Operations and Barge Route

The bauxite stockpiles are located within the MIA, approximately 550 m from the preferred barge loading facility. A single overland belt conveyor, with a belt width of 1,500 mm and approximate operating speed of 4 m/s, will transfer product bauxite at 1,500 t/hr from the stockpiles to the barges. Details of the barging of bauxite from Skardon Port to the offshore transshipment location is provided in Section 2.4.2.
Cyclone Moorings

Currently six mooring sites have been identified within the Skardon River to hold barges in between loading and during the wet season when the mine is not operational. When not in transit with bauxite, loading or unloading, the barges will be moored in the Skardon River clear of other river traffic. Moorings will consist of a concrete block weighing between 5 t to 10 t placed on the river floor with a chain connected to a float on the surface. The moorings are sufficient to withstand cyclones (cyclone rated) and barges will be secured to these moorings during the wet season. Tugs will be redeployed during the wet season at sites outside the Skardon River.

Offshore Transshipment Area

Sufficient water depth is required for OGVs at all stages of the tide, plus an allowance for under keel clearance when loading bulk carriers with bauxite. Additional allowance may be required for swell, and prevailing sea state. In addition to the required clearances regarding vessel draft, the location of the proposed transshipment areas and anchorages has been reviewed using a constraints based assessment. The criteria applied to the site selection processes included:

- Water depths greater than 10 m;
- A buffer of 1000 m from potential/known reefs and shoals;
- A buffer of 1000 m from marine protected areas; and
- Minimization of the barge travel distance to account for operational costs (a distance of 15 km or under has been applied for preferred distances, and 20 km as an economic boundary).

The proposed transshipment anchorage locations have been inspected as part of benthic investigations using drop video and side scan sonar techniques to screen the locations for habitat value. These sites fit the initial criteria outlined within the constraints screening. Bulk carriers will anchor within the identified area and load bauxite via deck based cranes.

No structures (e.g. moorings or pontoons) are proposed for construction at the OGV anchorage area located approximately 12 km offshore of the mouth of the Skardon River.

6.4.3 Existing Environment

The Gulf of Carpentaria is a large and relatively shallow body of water which is enclosed on three sides by the Australian mainland and bounded on the north by the Arafura Sea. The Gulf of Carpentaria can be subject to seasonal fluctuations in sea level (up to 0.5 m) as a result of trade winds (e.g. during the monsoon) and forcing from the Arafura Sea (Wolanski, 1993). These seasonal sea level fluctuations can result in large areas only being inundated by tides in the summer months (during the monsoon), as a result these areas cannot support mangrove or freshwater vegetation and therefore form salt flats.

Ryan et al. (2003), describes Skardon River as a tidal creek as it has a low freshwater input with low-gradient and seaward-sloping coastal flats. These systems are primarily influenced by tidal currents and as a result they comprise of straight, sinuous or dendritic tidal channels that taper and shoal to landward. The mudflats which surround the creeks tend to be high relative to the tidal planes, with seawater being mainly confined to the tidal channels except during high tide on spring tides. Tidal creeks are usually highly turbid due to the strong tidal currents generated by the macro-tidal ranges allowing fine sediments to remain in suspension during spring tides. The tidal action results in the transport of sediment into the estuary, where the sheltered conditions eventually
allow the coarser sediment fractions to settle. The currents within the creek will be influenced by the channel depth and orientation along with the difference in tidal range through the creek.

Due to the narrow entrance of the Skardon River (approximately 300 m) combined with the complex and relatively shallow bathymetry of the ebb tidal delta and the offshore channel, swell waves are not expected to propagate inside the Skardon River. The area upstream of the entrance will therefore only be influenced by locally generated wind waves. Due to the configuration of the Skardon River, with the channel width ranging from 1 km close to the entrance to 350 m at the proposed barge loading facility and the dominant wind directions, not aligning with the estuaries main axis, the locally generated wind waves will be small and very short period. Based on this, along with the dominance of tidal currents within the river, wind generated waves in the estuary are not considered to be a significant process.

The bathymetry of the main channel in Skardon River along with areas of indicative bed forms are shown in Figure 6-11 and the results of the 2012 bathymetry survey are included as Appendix D. The highest tidal current speeds in an estuary tend to occur close to the entrance. Due to the configuration of the Skardon River, the peak speeds are expected to occur at the constriction of the entrance where a flatbed occurs. The flat bed indicates that the flow velocity exceeds the speed at which ripples and mega ripples form, with peak current speeds potentially exceeding one metre per second (m/s). Offshore of the entrance mega ripples and sand waves occur in the main channel where current speeds remain high due to the constrained channel focusing the flow.
FIGURE 6-11

BATHYMETRY OF SKARDON RIVER
(SEPTEMBER 2009)

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

DATA SOURCE
Acoustic Imaging; MEC Mining; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

LEGEND

Bathymetry (m)

- 0.1 - 1
- 6.9 - 6
- 9.9 - 7
- 11.9 - 1
- 2.9 - 2
- 8.9 - 8
- 9.9 - 9
- 10.9 - 10
- 11.2 - 11
- 4.9 - 4

Watercourse
Metro Mining Mine Lease Area
Barge Loading Area
Haul Road
Alternate Haul Road
Pit Extents

DRG Ref: BES150115-027-R1_BATHYM_SR

DESIGNED: MD
DRAWN: MD
APPROVED: MD
DATE: 16/07/15

Notes:

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Draft

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Client Notes:

Bathymetry (m)

- 0.1 - 1
- 6.9 - 6
- 9.9 - 7
- 11.9 - 1
- 2.9 - 2
- 8.9 - 8
- 9.9 - 9
- 10.9 - 10
- 11.2 - 11
- 4.9 - 4

Watercourse
Metro Mining Mine Lease Area
Barge Loading Area
Haul Road
Alternate Haul Road
Pit Extents
Acid Sulfate Soils

The river based sediment sampling confirms elevated PASS concentration within the upper estuary and adjacent to the proposed barge facilities. Sediments within the proposed conveyor alignments and barge loading areas have the potential to create acid drainage problems should these be exposed to oxidising conditions. Given the proposed piling construction methods the risk is; however, considered low. The Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines (Dear et al., 2002) identify piles as a low impact construction method for ASS impacted areas. The Queensland guidelines reference AS2159-1995 – Piling Design and Installation (Standards Australia, 1995) for guidance on the use of piles in soils that contain pyrite or are saline. The guidelines also advise research on concrete performance in sulfate-rich environments.

The presence of minor ASS and PASS within the immediate on shore locations indicates that shoreline construction, excavations and construction of any associated revetments may need to more broadly consider ASS and PASS distribution during the detailed design of the infrastructure.

Observed Marine Vegetation

The Skardon River and adjacent inshore and off-shore areas encompass several marine habitats, including; saltmarsh, mangroves, seagrass, rocky reef, oyster reef, coral reef and broad areas of intertidal and sub tidal soft substrates that are either bare or variably colonized by macroinvertebrates and macroalgal communities. Table 6-14 identifies the specific vegetation types that have been observed in mangrove, samphire marine grass and sedgeland communities during previous studies.

Table 6-14 Vegetation of the Skardon River (adapted from Roelofs et al., 2002)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangroves</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhizophora stylosa</em></td>
<td>Red mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Rhizophora apiculata</em></td>
<td>Tall-stilted mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Ceriops tagal</em></td>
<td>Yellow mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Bruguiera gymnorrhiza</em></td>
<td>Large-leaved orange mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Bruguiera parviflora</em></td>
<td>Small-leaved orange mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Sonneratia sp.</em></td>
<td>Mangrove apple</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Avicennia marina</em></td>
<td>Grey mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Xylocarpus granatum</em></td>
<td>Cannonball mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Xylocarpus moluccensis</em></td>
<td>Cedar mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Excoecaria agallocha</em></td>
<td>Blind-your-eye mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Osbornia octodonta</em></td>
<td>Myrtle mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Aegialitis annulata</em></td>
<td>Club mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Lumnitzera racemosa</em></td>
<td>Black mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Nypa fruticans</em></td>
<td>Mangrove palm</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Heritiera littoralis</em></td>
<td>Looking-glass mangrove</td>
<td></td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Acrostichum speciosum</em></td>
<td>Mangrove fern</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Aegiceras corniculatum</em></td>
<td>River mangrove</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td><em>Hibiscus tiliaceus</em></td>
<td>Native Hibiscus</td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995; Perry 1995</td>
</tr>
<tr>
<td>Samphires</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Halosarcia spp.</em></td>
<td>Pigface</td>
<td>✓</td>
<td>✓</td>
<td>Cited in Perry 1995</td>
</tr>
<tr>
<td><em>Fimbristylis spp.</em></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Danaher 1995</td>
</tr>
</tbody>
</table>
6.4.3.1 Coastal Habitats

Saltmarsh

Defined clearly from aerial imagery, saltpan and fringing saltmarsh habitats are present throughout the Skardon River system. These habitats exist as a fringe between the dominant open woodland and Melaleuca vegetation and mangrove habitats (Plate 6-7) and are characterised by periodic inundation leading to hypersaline soils, becoming bare saltpans in some instances. Plants displaying adaptations to these harsh conditions include samphires (*Halosarcia* sp.), and several marine grasses (*Sporobolus* sp., *Fimbristylus* sp., *Tecticornia* sp.). The mangroves bordering these habitats, at their landward extents, typically include *Excoecaria* sp. and *Avicenna* sp.

Where the interaction of freshwater allows a reduction in soil salinity, and slight elevations preclude saline inundation, sedges and grassland swamps may also develop (Perry 1995). Species recorded from these habitats include the sedge *Eleocharis* sp., marine couch (*Xerochloa* sp.) and *Fimbristylus* sp., and emergent trees and shrubs including *Melaleuca* sp. and *Grevillea* sp. (Perry, 1995).

The location of the proposed barge loading facility does not cross mapped saltmarsh habitats or saltpans. A listing of saltmarsh species encountered during surveys by Roleofs et al. (2003), including the regional ecosystem (RE) code is presented within Table 6-15.
Table 6-15 Regional ecosystems within the Skardon River - marine vegetation

<table>
<thead>
<tr>
<th>RE Code</th>
<th>Community Description</th>
<th>Status*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.1a</td>
<td>Long-styled Stilt Mangrove (<em>Rhizophora stylosa</em>) +/- Large-leaved Orange Mangrove (<em>Bruguiera gymnorhiza</em>) closed forest as outer mangroves</td>
<td>EPBC Act: NA</td>
</tr>
<tr>
<td>3.1.3</td>
<td>Yellow Mangrove +/- Northern Grey Mangrove low closed forest on intertidal areas</td>
<td>EPBC Act: NA</td>
</tr>
<tr>
<td>3.1.6</td>
<td>Sparse herb land or bare salt pans associated with salt plains and saline flats, including saltmarsh</td>
<td>EPBC Act: NA</td>
</tr>
</tbody>
</table>

*Status:
EPBC Act: CE = Critically Endangered, E = Endangered, V = Vulnerable, NA = not applicable
VMA: E = Endangered, OC = Of Concern, LC = Least Concern

Mangroves

Mangrove communities of Cape York are considered one of the world’s most species rich, supporting over 30 mangrove species that are unique to the region. Mangroves are also known to support more than 75% of all Australia’s commercially and recreationally important fish and crustacean species during some phase of their lifecycle (Abrahams *et al.*, 1995; Duke, 2006; Quinn, 1992). They provide a structurally complex habitat that can provide protection for juveniles and a source of carbon that may be exported by the tide to other areas and food webs in the region (Manson *et al.*, 2005; Meynecke *et al.*, 2008).

A community of fringing mangrove habitat exists along the shores of the Skardon River, extending from just inside the mouth to the upper estuary/freshwater interface (Plate 6-8). The long-styled stilt mangrove (*Rhizophora stylosa*) dominates the mangrove community fringing the waterways of the Skardon River. Roelofs *et al.* (2002) also surveyed the tall-stilted mangrove (*Rhizophora apiculata*), yellow mangrove (*Ceriops tagal*), large-leaved orange mangrove (*Bruguiera gymnorhiza*), small-leaved orange mangrove (*Bruguiera parviflora*), mangrove apple (*Sonneratia* sp.), grey mangrove (*Avicennia marina*), cannonball mangrove (*Xylocarpus granatum*), cedar mangrove (*Xylocarpus moluccensis*) and blind-your-eye mangrove (*Excoecaria agallocha*). A listing of species encountered during a number of surveys is presented within Table 6-14.

Northern grey mangrove (*Avicennia marina* ssp. *eucalyptifolia*) and yellow mangrove communities are commonly established behind the mangrove fringe, nearest the saltpan/saltmarsh. The grey mangrove species are also present along the leading edge of the mangrove community adjacent to low gradient mudflats. Patches of mangrove apple were also identified by Roelofs *et al.* (2002) being previously mapped as gaps in the mangrove fringe by Danaher (1995). PaCE noted the presence of mangrove apple within the vicinity of the proposed barge loading footprint. Stunted examples of this species were recorded by Roelofs *et al.* (2002) and observed by PaCE (2014, 2015). This stunted form has not been previously recorded in the region by Danaher (1995), and Sheppard *et al.* (2000, 2001, 2002). From field observations, these communities appear stunted based on the presence of shallow ironstone rock in some instances.
The mangrove vegetation of the Skardon River is in good condition, with little evidence of disturbance and a well distributed range of life stages from juveniles to flowering adults. Historical clearing of a thin mangrove fringe has been undertaken at the nearby existing Skardon River barge ramp. Isolated minor impacts from feral pigs and cattle was also been observed over the saltpan, saltmarsh and landward fringe of the mangrove community within the study area. The mangroves identified from the Skardon River reflect the findings of previous similar surveys (Danaher, 1995; Perry 1995) and are typical of the Cape York Peninsula (Bunt et al., 1982).

**Wetlands**

The mangroves and adjacent saltmarsh / saltpans are considered to form part of the Skardon River – Cotterell River Aggregation (Figure 6-12). This wetland is listed under the Directory of Important Wetlands in Australia (DIWA).

No Ramsar listed wetlands are mapped within or adjacent to the Project area.
6.4.3.2 Benthic Habitats

Seagrass

Several surveys for the distribution and abundance of seagrass and associated benthic habitats have been undertaken within the Skardon River since 1986 (Table 6-16). The present known distribution of seagrass habitats within the Skardon River is presented within Figure 6-13.

Table 6-16 Benthic habitat surveys undertaken from the Skardon River (1986-2015)

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coles et al.</td>
<td>1986</td>
<td>Entrance</td>
</tr>
<tr>
<td>Roelofs et al.</td>
<td>2003</td>
<td>Whole river dry season</td>
</tr>
<tr>
<td>Roelofs et al.</td>
<td>2003</td>
<td>Whole river wet season</td>
</tr>
<tr>
<td>Rasheed et al.</td>
<td>2007</td>
<td>Whole river</td>
</tr>
<tr>
<td>Chartrand and Thomas (2010)</td>
<td>2010</td>
<td>Entrance</td>
</tr>
<tr>
<td>PaCE</td>
<td>2014</td>
<td>Metro Mining barge loading facility</td>
</tr>
<tr>
<td>PaCE</td>
<td>2015</td>
<td>Downstream of the barge loading facility to the entrance</td>
</tr>
</tbody>
</table>

Initial surveys by Coles et al. (1986) identified two isolated patches of seagrass near the Skardon River estuary entrance. Further baseline investigations were undertaken during 2002 (wet season) and 2003 (dry season) (Roelofs et al., 2004). Seagrasses were recorded within a tributary to the main river channel during both these events [narrowleaf seagrass (*Halodule uninervis*)]. Another species, paddle grass (*Halophila dciptiens*), was reported only during the dry season (2003) survey. This included three small meadows located within 500 m of the existing barge ramp at the then kaolin processing area. Subsequent surveys were undertaken in 2006 adjacent to the barge ramp facility (Rasheed et al., 2007). These surveys extended the distribution of seagrass nearer to the existing barge loading facility, adding another small meadow which fringed the mangrove banks upstream to the extent of the port limits. Distribution of narrowleaf seagrass was also extended, reporting a low density meadow adjacent to the barge loading facility.

Rasheed et al. (2007) described that seagrass distribution during 2006 (approximately 9.1 ha) was double that of the previous surveys in 2003 (approximately 4.4 ha). The variability in the distribution of these meadows is not unusual (Rasheed et al., 2007). Paddle grass is a colonising species that can rapidly form meadows in the right conditions (i.e. lower rainfall, and greater benthic irradiance) (Rasheed et al., 2006).

During 2010, a detailed survey encompassing the then proposed barge access area was undertaken through the river entrance (Chartrand and Thomas, 2010). A narrowleaf seagrass meadow recorded earlier by Coles et al. (1986) was identified during this survey covering an area of approximately 1 ± 0.3 ha. Although a total of 230 seagrass habitat characterisation sites were surveyed within the river entrance and surrounds, no additional seagrass communities were identified (Figure 6-14) (Chartrand and Thomas, 2010). The majority of the survey locations within the entrance reported open substrate, sand or sand and shell.
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

GCS GDA 1994 MGA Zone 54

DATA SOURCE
MCC Mining
QLD Government Open Source Data
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

This drawing is confidential and shall only be used for the purpose of this project.

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FIGURE 6-13
SKARDON RIVER SEAGRASS HABITATS

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During the 2014 surveys, nine small paddle grass meadows were located in thin (<5 to 10 m) patchy bands adjacent to the mangrove banks upstream of the existing barge loading facility (PaCE, 2014). These extended up to and immediately beyond the proposed barge loading facility. The bed forms of the area were dominated by silty sands rather than silts and clays. Typical marine muds were located on the intertidal banks and within the fringing mangroves.

Deeper locations, central to the channel, did not appear to provide suitable conditions for seagrass colonisation. This follows the findings of previous investigations in the area (Rasheed et al., 2007) where seagrasses occurred nearest to the river banks where light conditions remain favourable. The proposed jetty is located within a deeper area of the river to optimise operations, but also to avoid potential seagrass meadows. The alignment of the conveyor infrastructure may potentially cross seagrass habitat.

The seagrass meadows encountered during the surveys of areas upstream and the proposed jetty location and downstream in the vicinity of the existing SRP jetty averaged 19.9 % cover ± 19.8%, ranging between 0.5 and 57.8 % cover. Review of video footage identified relatively strong currents mobilising organic debris and sand through these meadows and associated benthic communities.

**6.4.3.3 Other Benthic Habitats**

Nearshore rocky reef habitat containing significant coral and soft coral cover has been identified approximately 5 to 7 km southwest of the entrance to the Skardon River. These habitats provide substantial resources for turtles and other marine species of conservation significance. The extent of this habitat has not been fully defined. Given its shallow depths and risk of grounding, operational
activities are not proposed within this near shore zone. It is anticipated that impacts to this habitat will be negligible; however, care should be taken to minimise interaction during vessel transit.

**Sub Tidal Habitats**

The majority of sub tidal benthic habitats within the Skardon River estuary are dominated by open bare substrates of silt, silty/sand, sand and rock (approximately 77%). Only a very limited live benthic cover has been recorded within the Skardon River. Of the live cover recorded, macroalgae was dominant (17%). Macroinvertebrates were greatest within rocky shoals and rubble fields which provide stable substrate for colonisation. These habitats include a range of macroinvertebrates dominated by sponges and ascidians, and brown macroalgae. Several intertidal areas of oyster rock/reef have been identified adjacent to mangrove banks.

The proposed anchorage areas were surveyed using video techniques. Benthic habitat within the preferred anchorage area was dominated by bare coarse shell and sandy substrates (96%). A sparse cover (of sea whips, sponges, gorgonian fans, ascidians and hard corals (*Turbinaria* spp.) were identified within the northern most anchorage. These biota appear to have created a scattered low profile sponge, soft coral and minor hard coral reef (profile <0.5 m), observed from two of the five survey locations. In addition to the benthic video locations, side scan sonar transects identified a single patch of benthic structure within the footprint of around 0.5 ha (potentially rock or mixed reef as identified in the video imagery).

The benthic habitats within the remaining anchorage areas presented reduced benthic cover compared to the preferred option. This included scattered macroalgae and macroinvertebrates such as sea whips, sponges, ascidians and mobile epifauna, including feather stars and starfish. Side scan transects identified a small patch of potential rocky reef (0.15 ha) which was not observed within the video locations.

**Intertidal Habitats**

Intertidal habitats surrounding the entrance to the Skardon River are dominated by sand beaches, exposed to prevailing wind and waves from the Gulf of Carpentaria. As the shoreline progresses into the estuary and river system, silty sands and muds begin to dominate the intertidal substrate. This is accompanied by an increasing mangrove habitat, and decline in exposed sandy shores, ironstone banks and *Casuarina* sp. habitat. The distribution of intertidal mud and sand banks at the entrance and inner estuary system is quite extensive; however, as the river progresses upstream the width of the primary waterway narrows. The edge of the banks become steeper, particularly on the outer bank curves, favoring the establishment of mangroves such as the *Rhizophora* sp. Further upstream within the small tributaries, the channels may dry completely or almost completely at low tide. These intertidal habitats are predominately bare mud and silty/sand with the presence of some isolated patches of filamentous algae and oyster beds having been recorded (Roleof *et al.*, 2002 and PaCE, 2015).

**Reef Habitats**

Two additional offshore locations were surveyed using underwater video and side scan transects. These were selected based on elevations mapped within the existing bathymetry charts for the study area. Both locations contained rock/reef substrate as identified from side scan sonar transects. The nearest of these locations to the Skardon River mouth (approximately 5 to 7 km southwest) presented a high cover of hard corals (37%), associated soft corals and benthic macroinvertebrates (6%). Biota was encrusting over an underlying rocky reef, interspersed by coarse sand patches, shell and soft corals, ascidians and other non-encrusting biota. The extent of the rocky reef habitat at this location was estimated by reviewing side scan sonar imagery. The
complex extended over 600 m in length and 300 m in width resulting in approximately 18 ha of potential rocky reef habitat. The edges of the feature were not fully identified and there is potential for this habitat area to be greater than this estimate. While the Project activities will not operate within or near this feature, care should be taken to ensure that supply vessels and general shipping accessing the Project remain clear of this habitat.

The percentage cover associated with the Skardon River, the three anchorage options and the reef patch, described above, is provided in Table 6-17.

### Table 6-17 Percentage cover from the Skardon River, anchorages options and a nearshore reef patch

<table>
<thead>
<tr>
<th>Area</th>
<th>Bare substrate</th>
<th>Live cover</th>
<th>Macroalgae</th>
<th>Hard Coral</th>
<th>Macro invertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>77.4</td>
<td>22.6</td>
<td>17.4</td>
<td>0.00</td>
<td>0.8</td>
</tr>
<tr>
<td>Anchorages (Total)</td>
<td>96.4</td>
<td>2.5</td>
<td>0.1</td>
<td>0.31</td>
<td>2.0</td>
</tr>
<tr>
<td>Option 1</td>
<td>95.3</td>
<td>4.7</td>
<td>0.2</td>
<td>1.00</td>
<td>3.3</td>
</tr>
<tr>
<td>Option 2</td>
<td>99.1</td>
<td>0.9</td>
<td>0.1</td>
<td>0.00</td>
<td>0.8</td>
</tr>
<tr>
<td>Option 3</td>
<td>97.6</td>
<td>2.4</td>
<td>0.0</td>
<td>0.00</td>
<td>2.4</td>
</tr>
<tr>
<td>Reef patch</td>
<td>55.5</td>
<td>44.5</td>
<td>0.9</td>
<td>37.00</td>
<td>6.6</td>
</tr>
</tbody>
</table>

### 6.4.3.4 Conservation Significant Species

The EPBC Act Protected Matters search aims to include species which are likely to occur in a geographic region, based on known ranges and habitat preferences. Inclusion in the report does not necessarily mean that the animal or plant will occur at a specific location. Consideration of site specific information is important for augmenting the results of the protected matters search and verifying that an animal or plant does occur at a specific locality, or has a high likelihood of occurring based on habitat attributes. Additionally, site specific information may identify that a species of conservation significance not included in the EPBC Act Protected Matters search may occur or is highly likely to occur based on habitat attributes.

The marine species that are known to occur or highly likely to occur at or adjacent to the proposed Project location are listed at Table 6-18. The listing status under the EPBC Act, the NC Act and the IUCN are included.

A number of marine species identified in the EPBC Act Protected Matters search, were considered to not occur, or highly unlikely to occur at or adjacent to the Project. These species along with a brief justification as to why they were not considered further is included in Appendix C of the PaCE marine ecology report (see Appendix C to this report).

### Table 6-18 Conservation status listed species that are known to occur or highly likely to occur

<table>
<thead>
<tr>
<th>Species</th>
<th>EPBC Act Listing</th>
<th>Listing under the NC Act</th>
<th>IUCN Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Reptiles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flatback turtle (<em>Natator depressus</em>)</td>
<td>Vulnerable, migratory marine species, listed marine species</td>
<td>Vulnerable</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Loggerhead turtle (<em>Caretta caretta</em>)</td>
<td>Endangered, migratory marine species, listed marine species</td>
<td>Endangered</td>
<td>Endangered</td>
</tr>
<tr>
<td>Green turtle (<em>Chelonia mydas</em>)</td>
<td>Vulnerable, migratory marine species, listed marine species</td>
<td>Vulnerable</td>
<td>Endangered</td>
</tr>
<tr>
<td>Olive Ridley turtle (<em>Lepidochelys olivacea</em>)</td>
<td>Endangered, migratory marine species, listed marine species</td>
<td>Endangered</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>Hawksbill turtle (<em>Eretmochelys imbricate</em>)</td>
<td>Vulnerable, migratory marine species, listed marine species</td>
<td>Vulnerable</td>
<td>Endangered</td>
</tr>
<tr>
<td>Species</td>
<td>EPBC Act Listing</td>
<td>Listing under the NC Act</td>
<td>IUCN Status</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------------------------------------------------------</td>
<td>--------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Estuarine crocodile (<em>Crocodylus porosus</em>)</td>
<td>Migratory marine species, listed marine species</td>
<td>Not listed</td>
<td>Least concern</td>
</tr>
<tr>
<td>Sea snakes (19 species)</td>
<td>Listed marine species</td>
<td>Not listed</td>
<td>Not assessed, least concern or data deficient</td>
</tr>
<tr>
<td>Mammals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dugong (<em>Dugong dugon</em>)</td>
<td>Migratory marine species, listed marine species</td>
<td>Vulnerable</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>Indo Pacific humpback dolphin (<em>Sousa sahulensis</em>)</td>
<td>Migratory marine species, whales and other cetaceans</td>
<td>Near threatened</td>
<td>Near threatened</td>
</tr>
<tr>
<td>Australian snubfin dolphin (<em>Orcaella heinsohni</em>)</td>
<td>Migratory marine species, whales and other cetaceans</td>
<td>Near threatened</td>
<td>Near threatened</td>
</tr>
<tr>
<td>Bryde’s whale (<em>Balaenoptera edeni</em>)</td>
<td>Migratory marine species, whales and other cetaceans</td>
<td>Not listed</td>
<td>Data deficient</td>
</tr>
<tr>
<td>Spotted dolphin (<em>Stenella attenuate</em>)</td>
<td>Whales and other cetaceans</td>
<td>Not listed</td>
<td>Least concern</td>
</tr>
<tr>
<td>Bottlenose dolphin (<em>Tursiops truncatus s. st.</em>)</td>
<td>Whales and other cetaceans</td>
<td>Not listed</td>
<td>Least concern</td>
</tr>
<tr>
<td>Fish and Sharks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speartooth shark (<em>Glyphis glyphis</em>)</td>
<td>Critically endangered</td>
<td>Not listed</td>
<td>Endangered</td>
</tr>
<tr>
<td>Dwarf sawfish (<em>Pristis clavata</em>)</td>
<td>Vulnerable</td>
<td>Not listed</td>
<td>Endangered</td>
</tr>
<tr>
<td>Longtooth sawfish (<em>Pristis pristis</em>)</td>
<td>Vulnerable</td>
<td>Not listed</td>
<td>Critically endangered</td>
</tr>
<tr>
<td>Green sawfish (<em>Pristis zijsron</em>)</td>
<td>Vulnerable</td>
<td>Not listed</td>
<td>Critically endangered</td>
</tr>
<tr>
<td>Pipefishes (33 species)</td>
<td>Listed marine species</td>
<td>Not listed</td>
<td>Not assessed, least concern or data deficient</td>
</tr>
</tbody>
</table>

(*) The taxonomy of the Bottlenose Dolphin remains has not been determined.

**Marine Reptiles**

**Turtles**

Marine turtles nest on beaches throughout the western Cape York region; however, the Project will not impact upon turtle nesting habitat. The barge loading facility within the Skardon River is situated within a mangrove fringed estuary environment, with a suitable nesting habitat situated at the mouth approximately 10 km downstream. Coastal beaches in the Mapoon and Skardon area provide suitable and regionally important nesting habitat, with beaches north and south of the Skardon River entrance demonstrating nesting activity (RPS, 2014; Dr Riku Koskela pers comm)

Flatback turtles are the most common nesting species in the proposed development area and the species nests only in Australia. Flatback turtles in the study area nest all year round; however, peak in May through to September. Along the part of Western Cape York that has been surveyed, the beach between Port Musgrave and the Skardon River has the greatest prevalence of nesting.

The beaches adjacent to the Project area, including all of western Cape York, are not important nesting locations for loggerhead turtles, although the waters are used for feeding.

The green turtle is unlikely to be found as no extensive beds of seagrass occur at and adjacent to the proposed barge loading facility location. Paddle grass may be found as thin meadows of low density
fringing the adjacent mangrove communities within the immediate subtidal zone; however, this is not sufficient to support the green turtle even for a short period of time.

Hawksbill turtles are known to nest along western Cape York beaches, although the high density nesting locations are in Torres Strait (Long (Sassie) Island, Hawkesbury Island and Dayman Island) and islands in the northern Great Barrier Reef (e.g. Boyd Island and Milman Island) (Limpus, 2009).

Olive Ridley turtles nest year round, although most nesting occurs during the dry season, from April to November. Low-density nesting occurs along the north western coast of Cape York Peninsula between Weipa and Bamaga (Limpus et al., 1983).

**Estuarine Crocodiles**

The estuarine crocodile inhabits coastal and inland waterways from Gladstone to Cape York and through the Gulf of Carpentaria to the Queensland/Northern Territory border (Read et al, 2004) with the majority of the population occurring in tidally influenced areas (Fukuda et al., 2007). The habitat of the estuarine crocodile includes marine habitats such as mangroves, but they also commonly occur in freshwater habitats such as rivers, lakes and swamps.

The Port Musgrave area, and in particular, the Wenlock River, is recognised as containing significant habitat for the estuarine crocodiles with one of the largest breeding populations in Queensland (Abrahams et al., 1995; Read et al., 2004; DEHP, 2013).

**Sea Snakes**

The sea snake fauna has been assessed in detail in the Weipa area, and the dominant sea snake species is the spine-bellied sea snake (*Lapemis hardwicki*) comprising approximately 90% of the sea snake fauna (Redfield et al., 1978). Other species recorded in the Weipa area include:

- Perot's sea snake (*Acalyptophis peronii*);
- Reef shallows sea snake (*Aipysurus duboisii*);
- Olive sea snake (*Aipysurus laevis*);
- Stokes' sea snake (*Astrotia stokesii*);
- Common sea snake (*Enhydrina schistose*);
- Elegant sea snake (*Hydrophis elegans*); and
- Reef sea snake (*Hydrophis ornatus*).

The aforementioned species have been recorded from multiple locations elsewhere in the Gulf of Carpentaria (Redfield et al., 1978). There are no specific studies that have examined the sea snake fauna specifically at the sites of the proposed development.

**Marine Mammals**

**Dugongs**

Dugongs are abundant at many locations in the Gulf of Carpentaria and are usually associated with seagrass beds. A major proportion of dugongs in the Gulf of Carpentaria occur in the region of the Wellesley Islands, the Sir Edward Pellew Group, and Blue Mud Bay (Saalfield and Marsh, 2004). Of the estimated 27,602 (± 3,110) dugongs in the Gulf of Carpentaria, only 15% occurred in the waters
of the Queensland coast, reflecting the much greater area of seagrass along the Northern Territory coast (Saalfield and Marsh, 2004).

Dugongs are known to occur in low densities in Port Musgrave (Saalfield and Marsh, 2004) and are closely associated with the areas of seagrass beds in the area. Incidental observations while undertaking seagrass mapping identified the presence of dugong feeding trails in the seagrass beds which is further evidence of dugong foraging in Port Musgrave (WorleyParson, 2010). Seagrass surveys have been undertaken within the Skardon River since the late 1980s. Over this period a single sighting for dugong has been recorded upstream within the Skardon River adjacent to the now decommissioned kaolin facility and barge ramp (Roelofs et al., 2002).

The Project is not at or adjacent to seagrass habitat that constitutes important dugong habitat. The main feeding locations for dugong in the Gulf of Carpentaria are known and are remote from the Project location.

**Whales and Dolphins**

No whales or dolphins (cetaceans), that are listed by the state or Commonwealth as threatened species are likely to occur at or adjacent to the proposed Project location. All cetacean species are however, given specific protection under the EPBC Act as listed “whales and other cetaceans” and in a number of instances, migratory marine species. This assessment identified that five species of cetaceans are highly likely to occur at or adjacent to the Project location: Indo-Pacific humpback dolphin, Australian snubfin dolphin, spotted dolphin, bottlenose dolphin, and Bryde’s whale.

The EPBC Act database search also identified the potential for killer whales to be present within the study area. It has recently been reported that killer whales have been observed south of Weipa (August, 2014) (Cairns Post, Accessed March 29, 2015). It is likely that killer whales transit the western shores of Cape York, and may pass through the waters offshore of the Skardon River.

Six incidental dolphin sightings have been recorded between Mapoon (Cullen Point) and the lower estuary system of the Skardon River during various studies undertaken by PaCE.

**Fish and Sharks**

A number of shark and sawfish species are the focus of contemporary conservation efforts, and sawfishes and northern river sharks (Glyphis spp.) are a specific focus in northern Australia. The waters of the Gulf of Carpentaria contain a number of threatened shark species. Australia is considered to possibly be the last country where viable populations of sawfishes potentially remain and as such populations are of global significance (Phillips et al., 2011). The northern river sharks are endemic to Australia and parts of Papua New Guinea.

The speartooth or Bizant River shark have been recorded from the lower reaches (salinity between 0.8 and 28 ppt) of the Wenlock and Ducie Rivers and Port Musgrave as well as the Bizant River, and a number of river systems in the Northern Territory (Peverell et al., 2006). From a limited amount of tagging work, speartooth sharks are considered to move up and down an estuary system with the tide and repeatedly use the same available habitat (Pillans et al., 2010). Given the habitat preference of the species it possibly occurs in the Skardon River.

The dwarf sawfish occurs on sand and mudflats and upstream estuarine habitats, including in inundated mangrove habitats that the species access at high tides (Peverell, 2005; Stevens et al., 2008). Given the habitat preference of the species it is highly likely to occur in the Skardon River and may also occur at and adjacent to the proposed barge loading facility.
The largetooth sawfish utilises both marine and freshwater habitats, but does not generally extend into coastal habitat such as the flats at the mouth of rivers, and appears to have a preference for waters of low salinity (Thorburn et al., 2004). Given the habitat preference of the species it is highly likely to occur in the Skardon River and may occur at and adjacent to the barge loading facility. Given the salinity during the dry season is ambient seawater (35 ppt) and the species appears to have a preference for lower salinity water, the area around the barge loading facility is; however, unlikely to constitute as a critical habitat, at least during the dry season.

The green sawfish is considered to be widely distributed throughout the Gulf of Carpentaria; however, it has a preference for sand and mud flats outside of river mouths (Peverell, 2005). It frequently utilises very shallow water (< 1 m) and an individual animal commonly uses the same small patch of habitat repeatedly (Peverell and Pillans, 2004 and Stevens et al., 2008). Given the current information on the habitat preference of the green sawfish, it is unlikely to be present at or adjacent to the barge loading facility. Individuals may occur at the Skardon River entrance shoals and at the transshipping location on the basis that adults are known to extend into deeper waters in the vicinity of river mouths.

**Pipefishes**

The Gulf of Carpentaria also supports rich pipefish populations. The distribution and abundance of pipefishes in the Gulf of Carpentaria is poorly known, but it is known that the species group forms a component of by-catch in the Northern Prawn Fishery. The Project is unlikely to result in any significant impacts to pipefishes.

### 6.4.3.5 Fisheries

A range of recreational and commercial fisheries activities occur within the Skardon River and the adjacent foreshore areas. Prawning may also occur offshore pending the wet season flows from the adjacent Ducie and Wenlock River Catchments; however, the peak trawling activities within the western Cape region occur further south, adjacent to Weipa.

The commercially important species found in the study area include; barramundi (*Lates calcarifer*), blue threadfin salmon (*Eleutheronema teradactylum*), king threadfin salmon (*Polydactylus macrochir*), blacktip shark complex (*Carcharhinus limbatus/tilstoni*) and juvenile grey mackerel (*Scomberomorus semifasciatus*). Species of recreational importance such as giant queenfish (*Scomberoides commersonnianus*) and barramundi were identified and these stocks currently support commercial charter operations.

### 6.4.4 Potential Impacts

The assessment of potential impacts has taken into consideration the duration of construction activities occurring during the dry season and the Project design which does not require dredging for export barges and supply vessels. The potential impacts of the Project’s construction and operational activities to the marine habitats, marine species and fisheries are provided below.

### 6.4.4.1 Marine Habitats

The potential impacts to marine habitats include:

- Direct impacts to habitats;
- Increased sedimentation and Total Suspended Solids (TSS);
- Degradation or modification of benthic habitats;
Disturbance of PASS; and

Decreased water quality.

**Direct Impacts to Habitats**

Construction of the proposed barge loading infrastructure will require the disturbance of fringing mangrove and potential minor saltmarsh vegetation communities adjoining the adjacent melaleuca and eucalyptus woodlands of the plateau. The footprint considered includes the proposed abutments and revetments at the upper tidal limits, conveyor trestle and quay line from which bauxite loading will be undertaken.

The proposed infrastructure would seek a corridor of 40m in width and approximately 550 m in length through the mangroves to connect this infrastructure to the stockpile area on the adjacent bauxite plateau. This alignment would result in the disturbance of approximately 2.2 ha of mangrove vegetation and <0.04 ha of potential saltmarsh vegetation. These works represent a minor local impact on mangroves (4% of mangroves within the immediate project area [500 m radius]), minor change in mangroves over 1,000m radius (1.5%) and negligible (<0.07%) change on a ‘river wide’ basis (refer to Table 3-10 of Appendix C).

The barges may induce altered current patterns and may lead to localised erosion of underlying soft sediments within the berth pocket, by way of increased current velocities during flood and ebb tidal flows and during maneuver of the barges and tugs via prop wash. The absence of the need for deepening or widening the berth pocket, or access route for the barge operation means overall hydrodynamic function will remain as per the existing predevelopment case. Ongoing operations have the capacity to alter bank stability and erosion factors. Given the potential for cumulative impacts from other proposed operations, and the proposed operational life of 27 years, further investigation into vessel wake and wave erosion will be considered as part of the detailed design work prior to construction.

The barging of the bauxite from Skardon Port to the offshore transshipment location will result in the generation of vessel wake waves within the Skardon River. As mangroves are present along the majority of the banks of the Skardon River any vessel wake waves are expected to be attenuated by the established mangrove vegetation and will therefore not result in significant erosion of the river bank.

Dust impacts to mangrove and saltmarsh vegetation is considered a risk during operations. The proposed bauxite products will not be washed; rather the product will be dry screened and stockpiled at the MIA awaiting export.

**Increased Sedimentation and TSS Solids**

Mangrove and bank environments may possess greater silt and clay fractions as materials deposit along these shorelines. These environments; however, will not be open to significant perturbations beyond the initial construction period as tidal fluctuations and strong river currents will mitigate much of this impact over a short timeframe.

Operation of barges and supply vessels may generate prop wash as sediments are mobilized from the bottom in shallower waters. Prop wash generates increased turbidity and sediment mobilisation surrounding the immediate location of vessel operation. The influence of prop wash is greatest at the lower end of the tidal range. Given the localised and repetitive nature of the proposed operations at the barge loading facility, after a period of operation, the influence of prop wash may decrease as
fine sediments in the areas are mobilised, leaving coarser fractions or the exposure of underlying firm substrates (in this instance underling clays and ironstone).

Minor changes in current velocities may also be expected surrounding the mooring blocks for cyclone moorings. Localised mobilisation of soft sediments may be expected within the immediate vicinity of these features.

**Degradation or Modification of Benthic Habitats**

The benthic assemblages have developed their distribution according to physical substrates, current dynamics and a complex relationship of prevailing water quality regimes and benthic light availability. Although the significant variability in ambient conditions may infer a high resilience to water quality changes, it should be noted that the respite between periods of impact becomes increasingly important the further conditions wane from optimal for long-term survival/growth. While it is important to consider that provision of respite during construction programs may be of particular importance to benthic communities where impacts exceed natural durations, given the relatively short construction period for this Project, no respite periods are currently proposed.

The transshipment location contains low density benthic communities. Surveys have concluded a dominance of bare substrates, with live cover being in the order of 1-3%. Localised physical disturbance from anchoring can be expected.

**Disturbance of PASS**

Review of available ASS data indicates a potential for acid generation along the conveyor alignment. The adopted method of construction over the mangrove habitats is considered a suitable approach to disturbance minimisation as outlined within the Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines (Dear et al., 2002).

**Decreased Water Quality**

Key impacts to long-term water quality during operation will include, potential dust emissions during the loading process, barge and vessel movements, potential spills and chemical release.

Spills and accidents resulting in the release of chemicals to the waterways, or directly to mangrove systems are not considered of substantial risk. This is based on limited volumes and standard approaches to use and management. The greatest risk of impact from chemical release may arise from accidental discharge of diesel and other fuels to the environment during transfer of fuel to onshore storage tanks either via pipeline or operational failures, or via the pump-out of sewerage systems from barges and service vessels. Standards and operational controls are considered to substantially limit the likelihood of such impacts.

**6.4.4.2 Marine Species**

The potential impacts to marine species include:

- Increased underwater noise and vibrations;
- Direct fauna strike;
- Increased lighting;
- Increased shading; and
• Introduction of pest species into the marine environment.

**Increased Underwater Noise and Vibrations**

Underwater noise and vibrations generated, mainly, through construction but also during operational activities can result in hearing damage, the temporary or permanent displacement of species from their habitat and cause interruptions of species’ behaviours.

**Direct Fauna Strike**

During the construction and operational stages of the Project, physical interaction with marine species will be primarily based upon movement of barges, supply barges, and miscellaneous small vessel activity supporting the Project (survey, monitoring and maintenance etc.). Increased shipping in the Skardon River may result in mortality and/or injury as a result of vessel strike.

**Increased Lighting**

Artificial light spill from the barge loading facility and transshipment site can result in the modification to species behaviours. Given the absence of dredging, excavation and distance between the turtle nesting beaches and proposed barge loading facility, within the upper reaches of the Skardon River, disturbance is considered negligible.

**Increased Shading**

Habits immediately adjacent to the barge loading facility may be influenced, to a minor degree, by shading. This may result in the decline in seagrass condition (if species are present) where light availability is restricted. Extended declines in light availability may result in stunted growth or decreased biomass of the meadow, or lead to death where light conditions are no longer suitable for growth.

**Introduction of Pest Species into the Marine Environment**

The risk of introduction of marine pests by the Project is likely to be minimal given that ships will remain offshore, and will not enter the estuarine and inshore waters of the Skardon River, where a range of additional habitat refuges exist. Following the processes described by Hodet *et al.* (2001), introduction of marine pests could; however, still potentially occur via translocation of species introduced to other ports within Australia i.e. translocations from ports servicing the needs of Metro Mining.

6.4.4.3 **Fisheries**

The commercial and recreational fisheries resources of the study area may be affected in two ways:

• Displacement of fishing effort; and

• An increase of recreational fishing pressure from improved road access.

The spatial distribution of the commercial fishery (western beach shoreline north and south of the Skardon River entrance) and some limited commercial fishing effort inside the estuary is predominantly outside areas directly impacted by the Project. Furthermore, the commercial fishing effort in the inshore net and crab fisheries of the area is small relative to the rest of the Gulf of Carpentaria and has been declining over the last decade; therefore despite the minor displacement, a major impact due to the development is not anticipated. Impact upon fisheries resources is considered minor.
The proposed vessel anchorages and transshipment locations offshore of the Skardon River are located inshore of an identified minor prawn catch area. The most profitable prawning grounds are located further south adjacent to Weipa. Impact upon prawn fisheries from the Project is considered minor.

The Project will not create a significant loss of intertidal or subtidal habitat and the passage of fish within and between freshwater, estuarine and marine systems will not be influenced by barriers, or if barriers in the form of creek crossings are required, appropriate fish passages will be incorporated. Further, as dredging is not proposed the impacts upon fisheries habitats are considered minor.

6.4.5 **Management and Mitigation Measures**

The proposed mitigation and management processes outlined within this document will be provided within the Project EMP. This document gathers the proposed mitigation, monitoring and management measures required to minimise environmental impacts during the construction and operational phases of the Project.

The content of the EMP will incorporate the following:

- Vessel operations;
- Underwater noise and vibration;
- Marine habitats;
- Introduced marine pests;
- Water quality;
- Sediment quality;
- Stormwater management;
- Dust management;
- ASS management;
- Spill response; and
- Education and inductions.

These measures provide response to the impacting processes outlined within the assessment.

In addition to the Project EMP, Significant Species Management Plans will be prepared such as the example shown at Figure 6-15 for marine turtles.
Significant Species Management Plan

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**Relevance for Bauxite Hills Project**

The Project does not impact directly upon turtle nesting habitat, however it does potentially have a limited impact to marine turtles. Disturbance to preferred foraging and nesting habitat is negligible given the absence of dredging or excavation, and the potential impacts attributable to lighting are not considered a significant issue given the distance between the nesting beaches and proposed barge facility options within the upper reaches of the Skardon River. Increased vessel movements within the Skardon River and adjacent coastal regions present the greatest potential for interaction (PACE, 2015).

**Description and Characteristics**

**Nesting** Marine turtles nest on beaches throughout the Western Cape York region, with coastal beaches in the Mapoon and Skardon area demonstrating nesting activity. Marine turtles are long-lived and late maturing with maturity reached at between 30 and 50 years of age. Female marine turtles may lay several clutches of eggs per year, but may not nest every year. A feature of their nesting behaviour is site fidelity to a nesting beach - that is returning to the same beach to lay eggs. Nesting generally occurs between the high water mark and the foredune.

**Light** Once hatched, lighting cues are identified as critical for hatchlings to move from the beach to the ocean – a behaviour known as sea-finding. Where there are no man-made light sources hatchlings move from away from the dark silhouetted shoreline towards the brighter ocean horizon. Brightness in this context however, is a term that encompasses wavelength and intensity. Marine turtles do not perceive light in the same way that humans do. Generally, marine turtles respond to short wavelength light (blue/green/ultraviolet) but only weakly respond to light that we see well (red light).

**Flatback Turtles** have a preference for shallow, soft-bottomed sea bed habitats away from reefs. The Flatback turtle is
carnivorous and mostly feeds on invertebrates including sea cucumbers and soft corals. Flatback turtles are the commonest nesting species in the Project area and the species nests only in Australia. The most significant nesting site in the north-eastern Gulf of Carpentaria is Crab Island, which is approximately 27 km south-west of Bamaga. Flatback turtles in the area of the Project nest all year round with a peak in May through to September. Egg predation by feral pigs is identified as a significant impact on nesting success, and entanglement in marine debris (e.g. discarded fishing nets) a significant impact on adults and hatchlings.

**Loggerhead Turtle** In Australia, the Loggerhead turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia. While nesting is concentrated in southern Queensland, foraging areas are more widely distributed. The prey of loggerhead turtles is extremely diverse and principally of gastropod and molluscs but they also consume other invertebrates eg jellyfish, sea cucumbers, and also fish. Feeding extends from nearshore waters to depths of 55 metres. The beaches adjacent to the proposed Project area are not important locations for loggerhead turtles although the waters are used for feeding.

**Green Turtle** The important nesting locations for the Gulf of Carpentaria Green turtle stock are the Weipa Islands, eastern Arnhem Land, Groote Eylandt and the Sir Edward Pellew Islands. Western Cape York is not an important nesting location. Adult Green turtles eat mainly seagrass and algae, although they will occasionally eat other items such as jellyfish and sponges. No extensive beds of seagrass occur at and adjacent to the Project although thin meadows of low density may occur fringing the adjacent mangrove communities within the immediate sub tidal zone. Algae and other macrophytes are also present. The biomass of seagrass and algae is unlikely to be suitable to support Green turtles, even for a short period of time.

**Olive Ridley Turtles** have a worldwide tropical distribution, including northern Australia. Low-density nesting occurs along the north-western coast of Cape York Peninsula between Weipa and Bamaga. Olive Ridley turtle populations on western Cape York are at significant risk from the foraging activities of feral pigs, as almost the entire Olive Ridley nesting population for Queensland occurs in the area of intense egg predation by feral pigs. Olive Ridley turtles nest year round, although most nesting occurs during the dry season, from April to November. Immature and adult Olive Ridley turtles are carnivorous, feeding principally on gastropod molluscs and small crabs, with foraging occurring from nearshore areas to the continental shelf.

**Hawksbill Turtles** are generally associated with reef habitats. They feed principally on various species of sponge, but they may also feed on algae, soft corals and macro-algae such as jellyfish and comb-jellies. Hawksbill turtles are known to nest along western Cape York beaches, although the high density nesting locations are in Torres Strait and islands in the northern Great Barrier Reef.

**Management Strategies**

**Feral Pig Controls**
- Implement Feral Pig Controls as part of the Weed and Pest Management Plan, in conjunction with Mapoon Land and Sea Rangers and neighbouring land owners

**Boat Speed and Access**
- Barge and tug movements will be restricted to dedicated zones to avoid sensitive habitats, and at speeds identified for safe vessel operation and minimising risk of fauna strike. See Figure 1 attached.

**Barge Loading and Transshipping Lighting**
- Lighting will meet safety standards, but where possible incorporating design for limiting turtle impacts eg light shrouding, preference for long wavelength lights (560-700 nm), avoiding light clusters etc.

**Marine Construction Works**
- Soft start procedure for any pile driving works
- Operate during daylight hours only
- Marine observer to inspect a 500m radius and give ‘all clear’ for turtles, dugongs, dolphins or other marine megafauna prior to commencement of construction works

**Marine Monitoring**
- Marine monitoring will include water quality and other criteria (refer Bauxite Hills EMP and EA), such as marine fauna observations, reports of any fauna strikes or near misses, seagrass etc.

**Environmental Offset Commitments** (refer to Bauxite Hills Environmental Offset Strategy)
- Support Mapoon Land and Sea Rangers annual turtle camp
- Provide direct financial contribution to the Western Cape Turtle Threat Abatement Alliance

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6.4.5.1 Marine Habitats

Direct Impacts to Habitats

The process of selecting the proposed locations for anchoring has considered avoidance of potentially significant habitats and adjacent environmental management areas. Management measures to protect marine habitats include the following:

- Monitor marine works during construction and conduct a pre development water quality program to establish time series monitoring locations within habitats;
- Conduct clearance surveys within the finalised development footprint;
- Establish a marine vessel operations plan for construction and operational activities. The plan will identify restricted access areas and minimise the interaction between vessel operations and potential seagrass and other benthic habitat communities;
- Dust suppression measures within the stockpile area and barge loading processes;
- Implement a seagrass monitoring program that will survey seagrass abundance, distribution and species composition each spring/summer (October/November) for several years;
- Port and vessel operations have the potential to generate shoreline erosion due to vessel wake. Despite being of low risk of erosion, the timeframe of operations (27 years) and potential for additional project developments to occur in the river (Gulf Alumina), investment into a vessel wake and bank erosion study will be considered; and
- Maintain existing native riparian vegetation around the barge loading facility, where possible. This is especially important for mangrove vegetation as it will help to prevent bank erosion due to locally generated wind waves and vessel wake waves from the barges.

Increased Sedimentation and TSS Solids

Monitoring of sediments within the proposed barge loading facility footprint, barge route and OGV anchorage should be undertaken intermittently, as part of operational management processes.

Degradation or Modification of Benthic Habitats

To mitigate and appropriately manage potential impacts to benthic habitats the following measures will be taken:

- The transshipment location has been surveyed using side scan sonar to avoid potential rocky reef structures. This will allow avoidance of higher value benthic habitat by anchoring processes;
- Ensure bulk fuel handling standards of operations are met as a minimum and spill response and management procedures are implemented;
- Dust management will occur at the barge loading facility; and
- Stormwater management measures will be implemented at the stockpile facility.
Disturbance of PASS

Following finalisation of design parameters, the requirement for an ASS Management Plan will be determined.

Decreased Water Quality

The affects upon water quality during construction and operation of the proposed development are considered of minor impact. Risks associated with the spillage of chemicals are considered low, with the handling of hydrocarbons at the jetty and during vessel operations possibly the largest risk factor. In the event of a spill, response plans (oils, diesel and chemicals etc.) will be enacted to control any such incidents. The format of these plans will follow that outlined by the Australian Maritime Safety Authority (AMSA), Maritime Safety Queensland (MSQ) or the nominated Port operations management organisation. The absence of any dedicated discharges, ongoing polluting processes from chemical release and demonstrated broad ambient fluctuations generally limits water quality threats from the Project.

6.4.5.2 Marine Species

Increased Underwater Noise and Vibrations

Soft starts are recommended during construction and refer to the increasing of pile energy gradually over a period of time as this will gradually and temporally deter the marine mammals. Trained marine megafauna observers should be on-board the pile driver to identify any cetaceans (or other megafauna) present in the area of construction, and pile driving activities should not start if an animal is identified within 100 m of the pile driver when operating.

Direct Fauna Strike

Marine operations will be conducted in compliance with the vessel access and speed limit plan (ranging from 4-8 knots) provided within the Project EMP. Vessel movements will be restricted to dedicated zones and at speeds suited to safe vessel operation. This will minimize interaction with marine species and adjacent habitats.

Increased Lighting

Measures to reduce the impacts of lighting need to remain considerate of occupational safety and navigation requirements thus the following measures will be taken:

- Only essential lighting will be included in development;
- Lighting design will consider techniques that limit turtle impacts and include light shrouding where necessary (i.e. be well shielded, full cut-off and downward directed type fixtures);
- Luminaries will be mounted low in the vertical plane and use the lowest intensity for the task;
- Intense lights or clusters of lights will be avoided wherever possible;
- An automated control system will be implemented to reduce or switch off un-necessary lighting;
- White lights that emit ultraviolet light will be avoided, strong blue or green spectral elements will also be limited;
- Install timers and motion detectors wherever possible;
- Periodic inspections, audits and corrective management of light sources will be undertaken; and
- Inductions for staff and contractors will include relevant information on marine turtles.

**Increased Shading**

Given that shading is expected to only impact the small area of habitat immediately adjacent to the barge loading facility specific management and mitigation measures have not been proposed.

**Introduction of Pest Species into the Marine Environment**

Ships servicing the Project operations will be required to manage ballast waters in line with the existing management strategy. The Department of Agriculture (DoA) manages ballast water taken up overseas with the intention of discharge within an Australian port. The DoA ensures that foreign ballast water has been managed in accordance with the Australian Ballast Water Management Requirements before permitting its discharge inside Australia's territorial sea (12 nm limit generally applies).

The former Department of Agriculture and Fisheries released guidance into the design, operation and reporting of marine pest monitoring within Australia via the Australian marine pest monitoring guidelines and Australian pest monitoring manual. These documents will be used to establish a practical monitoring, management and reporting program for introduced marine pests.

**6.4.5.3 Fisheries**

A no-take policy will be implemented at all operational facilities to mitigate localised increases in recreational fishing pressure by employees and a 200 m exclusion zone will be effective around the barge loading facility. While it is recognised that increases in fishing pressure from visitors to the region will occur over time, management of these pressures is presently facilitated by size limits, bag limits, limitation of fishing gear and closures.

Vessel operations will remain within designated zones to minimise disturbance of fisheries activities.

**6.4.6 Qualitative Risk Assessment**

A qualitative risk assessment of potential impacts to the marine flora and fauna are summarised in Table 6-19. An analysis of initial risk, without mitigation, was considered in relation to the marine environment. The residual risk considers the mitigation and management measures developed for this element and put forward in this assessment.
<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Physical interaction with fauna species during construction and operations      | Minor               | Possible           | Medium       | ▪ Exclusion of fishing at Metro Mining controlled premises  
▪ Vessel exclusion zones over shallow water  
▪ Undertake vessel movements as slow as practicable  
▪ Fauna management plan implemented  
▪ Noise abatement                                                                  | Low             |
| (Spear tooth shark, Sawfish, Dugong, Dolphin, Turtle, wader birds etc.)          |                     |                    |              |                                                                                                 |               |
| Vessel movements – bow wave impacts                                             | Minor               | Unlikely           | Low          | ▪ Minimise vessel speed to as low as practicable  
▪ Remain within the deep water navigation channels during transit                    | Low             |
| Marine pests introduction                                                       | Moderate            | Unlikely           | Medium       | ▪ Marine Pest Management Plan prepared  
▪ Construction vessels and equipment (barges etc.) inspected prior to operations at Skardon River  
▪ Standard requirements for visiting international vessels followed as per AQIS requirements (i.e. Ballast Water Management) | Low             |
| Acid sulfate soil disturbance                                                   | Minor               | Unlikely           | Low          | ▪ ASS and PASS disturbance minimised during operations  
▪ Management and treatment plans developed if ASS or PASS is to be disturbed       | Low             |
| Prop wash increases in ambient turbidity and damage to benthos                  | Insignificant       | Possible           | Low          | ▪ Vessel operations to control vessel movement to minimise prop wash  
▪ Limit passage over or immediately adjacent to seagrass habitats  
▪ Utilise defined shipping routes and follow proposed vessel access plan            | Low             |
<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine habitat disturbance</td>
<td>Minor</td>
<td>Likely</td>
<td>Medium</td>
<td>• Conduct detailed clearance surveys when construction footprint is finalised</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Implement appropriate monitoring programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Minimise required clearing and limit access over seagrass habitats</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Minimise adjacent seagrass damage during construction by managing the buffer around the development</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Restrict access to saltmarsh and mangrove habitats</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Fauna spotter used during construction</td>
<td></td>
</tr>
<tr>
<td>Bulk carrier anchorage damage to benthic communities</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>• Detailed preclearance survey to ensure higher density habitats are avoided</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Shipping schedules planned to minimise vessel time at anchor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Vessel to remain within the designated area to avoid impact spread</td>
<td></td>
</tr>
<tr>
<td>Oil/fuel spills and chemical releases</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>• Hydrocarbon and spill management plan established according to the Australian Maritime Safety Authority (AMSA) and Port Authority requirements</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Staff trained in spill notification and cleanup kits available</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Australian standards in the handling and storage of hydrocarbons followed</td>
<td></td>
</tr>
<tr>
<td>Dust generation during barge loading</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>• Loading systems to minimise dust generation where possible</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Losses during transshipment recorded and reported</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Monitoring of sediments undertaken</td>
<td></td>
</tr>
<tr>
<td>Stormwater management and sediment control at loading area</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>• Stormwater management plan prepared</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Site management and sediment control structures in-place according to management plan</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Discharge monitoring and reporting in accordance with the plan</td>
<td></td>
</tr>
<tr>
<td>Potential Impacts</td>
<td>Initial Consequence</td>
<td>Initial Likelihood</td>
<td>Initial Risk</td>
<td>Management and Mitigation Measures</td>
<td>Residual Risk</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Changed behaviours as a result of marine noise and vibration during construction</td>
<td>Major</td>
<td>Unlikely</td>
<td>High</td>
<td>• Fauna spotters and vessels to coax mega fauna away prior to start-up of piling operations.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Soft startup of piling operations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Unnecessary ship movements avoided</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Vessel speeds reduced as low as practicable</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Shallow water habitats avoided and vessel management plan implemented</td>
<td></td>
</tr>
<tr>
<td>Changed behaviours as a result of marine noise and vibration during operation</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>• Vessel speeds reduced as low as practicable within estuary</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Unnecessary ship movements avoided</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Shallow water habitats avoided and vessel management plan implemented</td>
<td></td>
</tr>
</tbody>
</table>

### 6.4.7 Summary

Available information relevant to the marine ecology of the study area and field studies has been used to develop an understanding of the marine environment. From this baseline knowledge, potential impacts were identified and mitigation and management measures proposed.

It is anticipated that with the appropriate mitigation and management measures the risk of the potential impacts occurring will be low. The construction and operational activities associated with the Project are unlikely to significantly impact the marine environment, given that no dredging or bed levelling is required.

Metro Mining will implement an EMP that will mitigate, manage and monitor the potential impacts described in this assessment. This document will be regularly updated to reflect the current status of the Project.

### 6.4.8 Commitments

Metro Mining’s commitments for marine ecology management are provided in Table 6-20.

<table>
<thead>
<tr>
<th>Table 6-20 Commitments – marine ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
</tr>
<tr>
<td>ME1</td>
</tr>
<tr>
<td>ME2</td>
</tr>
</tbody>
</table>
6.5 Freshwater Ecology

This section summarises the freshwater aquatic ecological features of the region, assesses the potential impacts and provides management strategies. The technical freshwater ecology report, prepared by Amec Foster Wheeler Environment and Infrastructure (Amec Foster Wheeler), can be found in Appendix E and should be read in conjunction with this section.

6.5.1 Regulatory Framework

This section provides an outline of the statutory framework relevant to the identification and management of aquatic ecological values within the Project area.

6.5.1.1 International agreements

International conventions relevant to aquatic ecological values of the Project area include the Ramsar Convention on Wetlands.

The Ramsar Conventions broad aims are to halt the worldwide loss and decline of wetlands and to conserve, through wise use and management, remaining wetlands. The convention encourages the designation of sites containing representative, rate or unique wetlands, or wetlands that are important for conserving biological diversity. Once designated these sites are added to the Convention’s List of Wetlands of International Importance and become known as Ramsar sites.

6.5.1.2 Commonwealth

The EPBC Act provides a framework to protect and manage nationally and internationally important flora, fauna and ecological communities (among other things) as defined under the act as MNES. Under the EPBC Act the DotE has jurisdiction over actions that are likely to have a significant impact on MNES.

The EPBC Act Policy Statement 1.1 - Significant Impact Guidelines, define a significant impact as an impact which is important, notable or of consequence, having regard to its context or intensity. The likelihood of an action having a significant impact depends upon the intensity, duration, magnitude and geographic extent of the impacts.

6.5.1.3 State

State legislation relevant to aquatic ecological values of the Project area include:

- Environmental Protection Act 1994 (EP Act); and

Environmental Protection Act 1994

The EP Act has a broad objective of achieving sustainable development within Queensland. The subordinate EP Regulation defines Category A and Category B environmentally sensitive areas (ESAs). Category A ESAs include national parks, marine parks, the Great Barrier Reef region and the wet tropics area. Category B ESAs include some classes of protected areas, endangered Regional Ecosystem (RE) types, declared fish habitat areas and some areas subject to international conventions.
Nature Conservation Act 1992

The NC Act and subordinate legislation provide for the protection and conservation of nature, including the declaration and management of protected areas, the protection of wildlife and habitat, and the sustainable use of native wildlife areas.

The Nature Conservation (Wildlife) Regulation 2006 (Qld) provides a list of plants and animals that are listed as extinct, endangered, vulnerable, near threatened (EVNT), least concern, and international or prohibited.

The Nature Conservation (Protected Areas Management) Regulation 2006 (Qld) identifies protected areas, including forest reserves, resource reserves, conservation parks, national parks and nature refuges.

The NC Act includes provisions for permits relevant the interference of protected fauna; however, no permits are required for taking protected plants in the Project area pursuant to Section 41(b) of the NC Act, as clearing will occur in the course of an activity under a mining lease. Impacts on plants and animals listed under the Nature Conservation (Wildlife) Regulation 2006 (Qld) including EVNT species are considered in the following sections.

6.5.2 Assessment Method

The description of aquatic ecological values presented in this section is based on studies completed in the Project area in the late dry season of 2014 and early wet season of 2015. The following sections provide a description of desktop and field assessments completed in the Project area.

6.5.2.1 Desktop Assessment

A review of literature pertaining to the aquatic values of and adjacent to, the Project area was undertaken. Commonwealth and state database searches were defined by the coordinates -11.86668 latitude, 142.04155 longitude and included a 25 km buffer.

6.5.2.2 Survey Timing

Aquatic ecology surveys were undertaken between 4 and 11 November 2014, corresponding to the late dry season. Follow-up surveys were undertaken between 31 January and 6 February 2015, corresponding to the early wet season. The timing of dry season surveys was considered ideal for assessing the persistence of water in the aquatic ecosystems across the Project area and the communities they supported. Wet season surveys were undertaken following a period of heavy rainfall. The timing of the wet season surveys was dictated by likelihood of reduced access to the sites and increased safety risks associated with higher likelihood of estuarine crocodile dispersal across the Project area later in the wet season. The decision for this timing was made in consultation with DEHP.

6.5.2.3 Site Selection

A desktop review of available relevant literature and investigation of aerial photography and topographic maps suggested that little freshwater habitat would be present across much of the Project area during the late dry season. In addition, the majority of aquatic habitats in close proximity to the Project are classed as marine/estuarine and are therefore not assessed in this scope of works. Based on this review, three sites were selected for this survey period; two within wetland systems and one on an ephemeral stream (Figure 6-16). It should be noted; however, that the
paucity of suitable freshwater aquatic ecosystems within the Project area results in limited survey findings.

During the wet season sampling was restricted due to the potential for estuarine crocodiles to be present in the area (i.e. unable to enter the water physically). Even when no crocodiles or evidence of crocodiles (e.g. slides) were observed, the fringes of the pools were generally vegetated with native couch or water chestnut (*Eleocharis dulcis*), which may have obscured observations. In addition, the pools present at sites AQ01 and AQ02 during the dry seasons had attracted feral pigs, cattle and wetland birds, all of which are preyed upon by crocodiles. As personal health and safety was the highest priority, the restriction on access to some wetland habitats during these surveys was supported by Metro Mining.

### 6.5.2.4 Survey Techniques

Key aquatic ecological indicators assessed at each survey site are provided in Table 6-21.

**Table 6-21 Aquatic ecology assessment indicators**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic habitat</td>
<td>Rapid assessment techniques were used to provide a description of habitat type and quality at each site. Field assessment protocols were consistent with Queensland AusRivAS (2000) for this component, as these represent a commonly used standard and will be required for the interpretation of macroinvertebrate and fish results.</td>
</tr>
<tr>
<td>Aquatic and riparian flora</td>
<td>Qualitative surveys of aquatic and riparian flora were done for each site reach. Aquatic flora were identified in the field, and as required collected and submitted to the Queensland Herbarium to validate identification of suspected near threatened species, under the NC Act.</td>
</tr>
<tr>
<td>Water quality</td>
<td>In situ physico-chemical water quality data (temperature, pH, conductivity, dissolved oxygen and turbidity) was recorded to assist with the interpretation of ecological data.</td>
</tr>
<tr>
<td>Macroinvertebrates</td>
<td>Field macroinvertebrate surveys were undertaken following AusRivAS protocols. Following these conventions, a composite macroinvertebrate sample was collected at each site using a standard 250µm mesh dipnet. Samples were “live picked” on site to strict protocols and the animals collected preserved in 70% alcohol. Macroinvertebrates were identified to family taxonomic level (where applicable) and enumerated. Data analysis included: abundance, taxonomic richness, community composition, plecopteran, ephemeropteran and trichopteran (PET) and tolerant taxa, and SIGNAL 2.</td>
</tr>
<tr>
<td>Macrourcrustaceans</td>
<td>Macrourcrustaceans were surveyed using the macroinvertebrate sampling techniques as well as with fish sampling techniques. Visual inspections were also made for macrourcrustaceans remains and burrows.</td>
</tr>
<tr>
<td>Fish</td>
<td>Cast netting, box trapping and active dip netting were the primary fish survey techniques used in the end-of-dry season surveys. All native fish caught were identified and measured.</td>
</tr>
<tr>
<td>Turtles and other aquatic vertebrates</td>
<td>Aquatic turtle surveys were undertaken at sites with suitable habitat using baited cathedral traps. Targeted sampling of other aquatic vertebrates was not undertaken although any incidental sightings or signs (scats, tracks and other traces) were recorded.</td>
</tr>
</tbody>
</table>

The availability of standing water during the dry season limited the sampling methods able to be employed. A summary of methods employed at each site during the late dry and early wet season surveys is provided in Table 3 of Appendix E and site descriptions are provided in Table 4 of Appendix E.
FIGURE 6-16
AQUATIC ECOLOGY SITES

Legend
- Aquatic Survey Site
- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Pit Extents
- Camp Site
- Metro Mining Mine Lease Area
- Directory of Important Wetlands
- Ground-truthed RE
  - Of Concern
  - Of Least Concern
- Water

DATA SOURCE
- MEC Mining; AMEC Foster Wheeler, 2015;
- QLD Government Open Source Data;
- Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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

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GCS GDA 1994 MGA Zone 54
Scale @ A3 - 1:60,000

DESIGNER
1:60,000 Scale @ A3  -

CLIENT

MD

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Details

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CRG Ref: BES150115-036-R1_AG_ECOL
6.5.2.5 Species Assessment

The likelihood of occurrence for individual species was determined based on a review of previous records, a review of known habitat preferences, and an assessment of habitat availability and the presence of microhabitat features within the Project area. This included known associations for each species, known records and distribution ranges. Species were assigned to one of the following categories:

- **Known to occur**: includes species/communities previously recorded from the Project area;
- **Likely to occur**: includes species/communities previously recorded in proximity to the Project area, and which have suitable habitat features available on site which to support the species;
- **May occur**: includes species/communities where suitable habitats or associations are present in the Project area but where there are no known records in the area; and
- **Unlikely to occur**: includes species/communities for which the Project area offers limited or no potential habitat, is outside their known range and/or is without broader habitat requirements.

6.5.3 Existing Environment

6.5.3.1 Aquatic Ecological Values

The diversity of aquatic flora and fauna within the Project area is heavily influenced by the region’s climatic conditions. Extended dry periods followed by monsoonal rains and flash flooding limits the availability of aquatic habitat, therefore restricting species diversity and abundance. While from a regional perspective, the permanent water bodies of the Skardon River catchment, and the Skardon River-Cotterell River Aggregation, offer significant diverse habitat, the Project area is largely devoid of permanent standing water.

The riparian vegetation at all sites was dominated by Melaleuca over storey with predominantly grass understorey. There was proportionally more bare ground at site AQ03 than the other sites. The woody debris was largely dominated by detritus although there were logs and branches at all sites that would provide some structural woody habitat during the wet season.

**Aquatic Macroinvertebrates**

During the late dry season surveys, aquatic ecological communities were restricted due to limited presence of standing water. At AQ01 visual observations identified the presence of adult boatmen (family Notonectidae) and predaceous diving beetles (family Dytiscidae). Both these macroinvertebrate groups are tolerant of highly disturbed aquatic ecosystems (Chessman, 2003). Five consecutive cast net (fine) throws failed to capture any larger macroinvertebrates.

Despite appearing to be shallow the remnant pool at site AQ02 was not considered suitable to sample by entering the water due to the potential presence of estuarine crocodiles. Visual observations failed to detect any aquatic macroinvertebrate, fish or turtle activity. Two species of adult dragonflies (*Neurothemis stigmatizans* and *Nannodiplax rubra*) from the family Libellulidae were observed at the site.

While there was no standing water at site AQ03, visual observations at the site revealed burrows in banks that may have been created by yabbies’ (*Cherax* spp.) or freshwater crab (*Austrothelphusa* spp.). It is likely that any yabbies or freshwater crabs at the site would have been buried deep in the stream substrate at the time of the late dry season surveys.
During the wet season surveys, 24 families/taxa of macroinvertebrates, and three families/taxa of microcrustacean were recorded either within, or immediately adjacent to the Project area (Table 8 of Appendix E).

The highest diversity and abundance of aquatic fauna was recorded at AQ02, suggesting that of the sites surveyed, it may have been inundated the longest. A total of 74 macroinvertebrate individuals were recorded from 16 family/taxa groups. In addition, two family/taxa of microcrustaceans (cladocera and copepod) were recorded.

The second highest diversity and abundance of aquatic fauna was recorded at the other wetland site, AQ01. Here, 40 macroinvertebrate individuals from 10 different family/taxa groups were identified. Three family/taxa of microcrustaceans (cladocera, copepod and ostracoda) were also recorded at AQ01.

The lowest diversity was recorded at the stream site, AQ03, where 28 individuals were recorded from six macroinvertebrate family/taxa. This suggests that this site had only recently been inundated, meaning that colonisation was later than at the other aquatic sites.

The macroinvertebrate communities recorded in wet season surveys are considered typical of those found in ephemeral systems across Cape York following recent inundation. Re-colonisation by species will have occurred through four main mechanisms:

- Drought resistant eggs;
- Parasitism;
- Aerial colonisation; and
- Aestivation.

Fertilised eggs of the three taxonomic groups of microcrustaceans (cladocera, copepoda and ostracoda) are capable or persisting in dry substrate conditions for extended periods of time, continuing development only after being inundated by water for extended periods. Nemotodes and water mites are capable of dispersing rapidly and widely by parasitism of a wide range of aquatic and terrestrial fauna hosts. Several macroinvertebrate groups are also able to persist in dry environments by burying into the substrate, some such as crabs and crayfish are able to aestivate (reduce metabolism until a state of torpor is induced). Groups recorded at the Project site that aestivate include segmented worms, springtails, crabs and crayfish.

Many insects have terrestrial, typically aerial, adult stages and an aquatic larval stage. Adults of these species are quick to lay eggs in newly formed aquatic habitat. This would include families of beetles, true flies, true bugs, damselflies, dragonflies, and caddis flies.

Following an extended period of inundation of the ephemeral streams and swamps, the number of colonising species is likely to increase through aerial colonisation. Due to the seasonal nature of the watercourses the family composition of aquatic invertebrate fauna across northern Australia is relatively uniform at the river basin scale (Cook et al., 2010).

Many of the macroinvertebrates recorded during the surveys are likely to be widespread across the region and tolerant of a range of water quality conditions. Two genus of malacostraca in western Cape York are currently poorly understood and therefore may be susceptible to significant changes in the environments around them. These are crayfish (Cherax spp.) and freshwater crabs (Austrothelphusa spp.). The crayfish in western Cape York (family Parastacidae) are morphologically similar to the orange-fingered yabby (Cherax depressus), but are thought to
represent a different species complex (Robert McCormack pers. comm.). Genetic and morphological studies are currently in progress to clarify the taxonomic status and geographical ranges. A single crayfish specimen was recorded at site AQ02.

**Aquatic Invertebrates**

There was little suitable habitat for aquatic vertebrates at AQ01 and AQ02, and no standing water at site AQ03 during the dry season surveys. At AQ01 and AQ02 water had retreated to small stagnant pools. At AQ01 five throws of a cast net did not capture any fish or larger macroinvertebrate specimens, and no fish or turtles were observed. Similarly no fish or turtles were observed at site AQ02. While there was no standing water at AQ03, anecdotal evidence suggests that senescing pools were present as recently as a month prior to the surveys, and that they contained fish at that time (Graeme Sullivan pers. comm).

The early wet season surveys were conducted following a number of significant rainfall events that had resulted in creek flows and there was substantially more water at all sites compared to the dry season surveys; however, it was not a heavy wet season and conditions may not have been optimal for all species. No vertebrate species were recorded in cathedral traps, box nets, active dip netting or by visual observations at AQ01 or AQ02 in the wet season surveys. Neither were any fish or turtles collected in the cathedral traps at site AQ03. Box traps captured eight specimens of empire gudgeon (*Hypseleotris compressa*), with a further six specimens observed in the water column. A school of 12 checkered rainbowfish (*Melanotaenia splendida ssp. inornata*) were observed in one pool with a fine mesh cast net used to capture two individuals and verify the species identification.

**Species of Scientific Significance**

Freshwater crabs contain many undescribed species (Peter Davie, pers. comm), several of which are recorded only from Cape York Peninsula. Several specimens of a small freshwater crab were recorded at sites AQ01 and AQ03, with another specimen collected in a non-targeted assessment downstream from AQ03. Adults of the species did not appear to exceed a carapace width of about 2 cm and the coloration appears to be comparable with a species that has recently been described south of Weipa in similar habitat. The species is currently being described by the Queensland Museum and was identified during surveys for the SoE Project (Rio Tinto Alcan, 2011), found in the Winda Winda Creek catchment (from three separate sites). This species appears to be closely associated with bauxite deposits, suggesting that it may be excluded from other types of aquatic habitats due to specific water chemistry requirements (Ross Smith pers. comm). A voucher specimen was provided to the Queensland Museum, with its identification yet to be confirmed.

**Nationally Significant Wetlands - Skardon River-Cotterell River Aggregation**

While no nationally significant wetlands exist within the mining footprint, some very small sections of the Skardon River-Cotterell River Aggregation are within the infrastructure footprint, and adjacent to the mining lease areas. The Skardon River–Cotterell River Aggregation consists of the estuaries and wetlands of five small rivers within the Skardon River catchment. The mining lease areas of the Project adjoin the Skardon River. The inclusion of this aggregation as a nationally important wetland is based on it being:

- A good example of a wetland type occurring within a biogeographic region in Australia;
- A wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- A wetland that is important as a habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail; and
- A wetland that supports a diversity of native flora and fauna or communities which are considered endangered or vulnerable at a national level.

**Nationally Significant Wetlands – Port Musgrave Aggregation**

The only other nationally significant wetland is the Port Musgrave Aggregation which sits well to the south of the Project area. The Port Musgrave Aggregation consists of the enclosed bay, estuaries and wetlands of the Wenlock and Ducie Rivers, and contains one of the largest known breeding populations of estuarine crocodiles in Queensland.

**6.5.3.2 Threatened Species/Communities**

Of the species listed with a conservation status (refer to Table 5 of Appendix E), the largetooth sawfish is the only one that may be present in the broader Skardon River aquatic environment; however, there is insufficient freshwater habitat across or adjacent the Project area to support juveniles of the species (Peverell, 2005).

The estuarine crocodile and freshwater crocodile (*Crocodylus johnsonii*) were the only fauna species of state significance likely to occur within or adjacent the Project area. Suitable habitat for these species is present throughout the estuarine and marine habitats within and adjacent the Project area, and also within the ephemeral freshwater streams and swamps within and adjacent the Project area. These species are analysed in detail within Appendix E.

The only true freshwater species listed in the BoT was waterhole yabby (*Cherax cartalacoolah*). The waterhole yabbie has been recorded on the east coast of Cape York; however, is unlikely to be present within the Project area due to lack of suitable year-long habitat.

One flora species, *Lycopodiella limosa*, listed as near threatened under the NC Act, has previously been recorded 50 km to the east of BH1 (WorleyParsons, 2011). The species has not; however, been previously recorded within the Project area.

Two species of aquatic macrophytes (plants) were listed in the BoT (although not of critical or high conservation importance); *Aponogeton cuneatus* and *A. queenslandicus*. *A. cuneatus* is found in permanent creeks and rivers, often in shaded areas (Jacobs *et al.*, 2006), and as such is not considered likely to occur on or adjacent the Project area. *A. queenslandicus* grows in temporary freshwater bodies but is unlikely to be present as all known records occur further south than the Project area (Stephens and Dowling, 2002).

The Aquatic Conservation Assessment (DEHP, 2012a) for the riverine and non-riverine wetlands of the Cape York catchments identified 26 freshwater fish and two freshwater crustaceans as priority species. The majority of these species are not found in close proximity to the Project area, or would be unlikely to persist in the aquatic habitat available therein. There may; however, be suitable habitat within the Project area for redclaw crayfish (*C. quadricarinatus*), which is listed as a priority species in Cape York catchments due to declining abundance related to fishing pressure.

Wetlands across the Project area are part of the Skardon River-Cotterell River Aggregation which is listed under the DIWA.
6.5.4 Potential Impacts

6.5.4.1 Direct Impacts

The mining footprints of BH1 and BH6 do not overlap aquatic habitats of the Project area. The two designated haul roads and barge loading facility do overlap aquatic habitat associated with the Skardon River (Figure 6-16). These areas are largely ephemeral drainage channels and swampy ecosystems (e.g. RE 3.3.49 and RE 3.3.9).

Impacts on Surface Water

Potential impacts to surface waters arising from the Project with the potential to impact aquatic values of the Project area include, water quality and alteration of surface water inflows to the swamps and wetland associated with the Skardon River.

During mining, minor drainage channels supplying water to the Skardon River and associated swamps and wetlands may be disrupted, potentially altering flows to these watercourses. Surface water flows from areas associated with the Project may carry pollutants including, sediments, hydrocarbons and other chemicals. These would negatively impact water quality of aquatic environs, and lead to significant impacts of aquatic values.

Similarly any contamination of groundwater due to Project activities may impact surface waters through groundwater baseflows to these environments.

Erosion and Sediment Runoff

Land clearing will occur during the construction and operation phases of the Project as a result of clearing of mining areas, and construction of ancillary infrastructure (e.g. haul roads, barge loading facility etc.). Clearing of remnant vegetation would be required across the mining footprint, comprising 1,668.99 ha (worst case scenario). The effects of land clearing relevant to the aquatic ecological values of the Project area may include:

- Increased erosion of soils and runoff to adjacent environs;
- Loss of land stabilisation and riparian filtration functions; and
- Loss of habitat, loss of connectivity between habitat areas and associated diminished fauna movement.

Dust

Dust generation has the potential to enter aquatic habitats, impacting water quality, and reducing photosynthesis of aquatic plants and riparian vegetation. Project activities likely to generate dust include mining, waste rock stockpiling, vehicle movements, stockpiling (e.g. topsoil, spoil, product bauxite), and bauxite transport.

Noise

Increased noise from operation of machinery and vehicle traffic has the potential to disturb aquatic fauna and impact on feeding and breeding behaviour where it occurs in close proximity to aquatic sites. In general, increased activity levels are likely to result in reduced fauna activity around work areas. As the majority of activities that generate increased noise do not occur in close proximity to significant aquatic ecology values, it is expected that potential impacts will be minimal.
6.5.4.2 Indirect Impacts

As with most ecosystems associated with variable and perennial inundation, aquatic ecology values are likely to be tolerant of significant changes in abiotic conditions. Species colonising these areas can generally tolerate a range of conditions. It is therefore unlikely that changes to hydrology of the swamp that are predicted to occur during mining activities will significantly alter overall aquatic flora diversity. If the size of standing water during the dry season significantly increases in area, and does not dry out over a period of years, it is possible that there will be mortality of Melaleuca trees as a result of anaerobic soil conditions. This impact is; however, likely to be compensated by an increase in Melaleuca trees around the expanded boundary of the wetland area. Currently, Bigfoot Swamp has an area absent of any tree species directly surrounding the area of standing water during the dry season. The size of this area may increase over time during mining operations; however, following a return to current hydrological conditions, it is likely that Melaleuca trees will recolonise these areas.

Aquatic fauna diversity may increase over time if the size and depth of standing water increases during the dry season and could lead to a temporary shift in aquatic fauna to species that require permanent water to persist. Given the ecologically short mining-life timeframe of 27 years, it is unlikely that significant changes will occur in this time. Post mining, it is predicted that hydrological conditions would largely return to existing conditions and therefore a return to baseline aquatic flora and fauna assemblages over time.

6.5.5 Management and Mitigation Measures

The proposed mitigation and management processes outlined within this document will be provided within the Project EMP. This document gathers the proposed management and mitigation measures required to minimise environmental impacts during the construction and operational phases of the Project. In addition to the Project EMP, Significant Species Management Plans will be prepared for significant freshwater flora and fauna such as the example shown at Figure 6-15 for marine turtles.

6.5.5.1 Direct Impacts

The Project alignment was created to incorporate both an efficient design whilst positioning infrastructure where possible to minimise environmental harm. The MLA boundary of 20689 was reduced during the design phase to offer additional protection to Bigfoot Swamp, a large alluvial swamp system comprising a broad drainage depression to the west of the BH6 mining footprint. Reducing the extent of the MLA boundary ensures the buffer between this habitat and the mine footprint will be maintained, with a commitment that the buffer will be maintained to at least 200 m.

Buffer zones around watercourses will be in accordance with relevant guidelines, and comprise:

- 50 m for stream order 1 or 2 watercourses;
- 100 m for stream order 3 or 4 watercourses; and
- 200 m for stream order 5 or greater watercourses.
Impacts on Surface Water

Management of potential impacts to water quality within aquatic environs may include:

- Preparation of a site erosion and sediment management plan which incorporates rehabilitation monitoring and trials;
- Implementing suitable spill containment around hydrocarbon, chemicals and other harmful substance stores; and
- Implementing a site-specific water quality monitoring program.

Erosion and Sediment Runoff

Clearing of vegetation would occur in stages as mining progresses. General mitigation measures to be implemented to reduce the impacts of vegetation clearance and habitat loss on aquatic values include:

- Maintain a buffer around riparian vegetation;
- Preparation of a site erosion and sediment management plan which incorporates rehabilitation monitoring and trials; and
- Monitoring of rehabilitation success to be conducted at locations representative of the range of conditions on the rehabilitating areas. Reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness.

Dust

Refer to Section 6.9.5 for management and mitigation measures related to air quality including dust suppression and avoidance measures.

Noise

Refer to Section 6.10.5 for further details on proposed noise attenuation measures.

6.5.5.2 Indirect Impacts

Given the unpredictable nature of potential impacts to Bigfoot Swamp, a Receiving Environment Monitoring Program (REMP) will be developed with consideration of DEHP’s Receiving environment monitoring program guideline - For use with Environmental Relevant Activities under the EP Act. The REMP will include annual monitoring of Bigfoot Swamp. Where significant changes in the swamp are observed, suitable mitigation measures will be developed and undertaken if necessary.

Noise and light generated by the Project are unlikely to be sufficient to have a significant impact on aquatic values and therefore downstream impacts related to noise and light are considered unlikely.

6.5.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential freshwater ecological impacts is summarised in Table 6-22. An analysis of initial risk, without mitigation, was considered for freshwater ecology. The residual risk considers the mitigation and management measures developed for this element and put forward in this assessment.
Table 6-22 Qualitative risk assessment - freshwater ecology

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Reduced water quality and surface water inflows to the swamps and wetland associated with the Skardon River | Moderate | Unlikely | Medium | ▪ Prepare an ESCP  
▪ Implement suitable spill containment around hydrocarbons, chemicals and other harmful substance stores  
▪ Implement a site-specific water quality monitoring program | Low |
| Erosion and sediment runoff | Moderate | Unlikely | Medium | ▪ Maintain a buffer around riparian vegetation in accordance with relevant guidelines  
▪ Prepare an ESCP which incorporates rehabilitation monitoring and trials | Low |
| Smothering aquatic plants and impacting water quality due to increased dust | Minor | Unlikely | Low | ▪ Refer to Section 6.9.5 for dust management and mitigation measures | Low |
| Altered aquatic feeding and breeding behaviours as a result of nearby noise | Minor | Unlikely | Low | ▪ Refer to Section 6.10.5 | Low |
| Change in water levels and impacts downstream as a result of Project activities | Minor | Unlikely | Low | ▪ Develop a REMP  
▪ Monitor Bigfoot Swamp annually | Low |

6.5.7 Summary

Key habitat for aquatic fauna identified through the assessment include permanent water sources associated with riparian corridors and wetlands of the Skardon River-Cotterell River Aggregation - in particular Bigfoot Swamp to the north and west of the Project area presented perennial wetland conditions.

Land clearance and habitat loss associated with the establishment of the mine areas and supporting infrastructure will have a minor impact on riparian vegetation associated with Skardon River and Skardon River-Cotterell River Aggregation. Bigfoot Swamp will be potentially impacted by an increase of groundwater flows during mining operations, followed by a possible very slight decrease of groundwater flows following mining operations. During mining activities the size and depth of water in Bigfoot Swamp is likely to increase, returning to close to baseline conditions at the completion of mining.

Potential impacts on aquatic values should be mitigated through future Project design and will include:

▪ Minimising encroachment on the Skardon River and associated wetlands and floodplains to avoid impacts on riparian vegetation communities and important fauna habitats associated with the Skardon River;
Measures to limit vegetation loss and impacts on connectivity where the mining footprint and infrastructure corridors occur between wetland habitats; and

Development of a REMP in alignment with DEHP’s Receiving Environment Monitoring Program guideline - For use with Environmental Relevant Activities under the EP Act that includes annual monitoring of Bigfoot Swamp. Where significant changes in the swamp are observed, suitable mitigation measures can be developed and undertaken if necessary.

The Project area supports a relatively low diversity of aquatic flora and fauna species, largely due to the ephemeral nature of the watercourses within the Project area. No threatened aquatic species were recorded during the surveys. No threatened species are predicted as likely to occur within the Project area.

6.5.8 Commitments

Metro Mining’s commitments for freshwater ecology management are provided in Table 6-23.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE1</td>
<td>Develop and implement an Erosion and Sediment Control Plan prior to the commencement of construction.</td>
</tr>
<tr>
<td>FE2</td>
<td>Develop a Receiving Environment Monitoring Program.</td>
</tr>
<tr>
<td>FE3</td>
<td>Develop and implement a dynamic Surface Water Quality Monitoring Program for the life of the Project.</td>
</tr>
</tbody>
</table>

6.6 Terrestrial Ecology

This section identifies and describes the existing terrestrial flora and fauna values within and surrounding the Project area. Potential impacts on terrestrial ecological values are identified, management measures have been identified and a qualitative impact assessment has been undertaken. The full terrestrial ecology assessment, conducted by Amec Foster Wheeler, is provided in Appendix F and should be read in conjunction with this section.

6.6.1 Regulatory Framework

This section provides an overview of the statutory framework relevant to the identification and management of terrestrial ecological values within the Project area.

6.6.1.1 International Agreements

International conventions relevant to the terrestrial ecology values of the Project area include:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA);
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and
- Ramsar Convention on Wetlands.

The three migratory bird agreements - JAMBA, CAMBA, and ROKAMBA - list bird species that migrate between Australia and the other parties to the convention - Japan, China and the Republic of Korea respectively. These agreements impose obligations on signatory's to regulate for the protection of the listed migratory bird species. Under Australia's commitment and in accordance
with Section 20 and 20A of the EPBC Act, it is an offence to carry out an action that will, or is likely to have a significant impact on a migratory bird species, without prior approval from the Commonwealth.

The Ramsar Conventions broad aims are to halt the worldwide loss and decline of wetlands and to conserve, through wise use and management, remaining wetlands. The convention encourages the designation of sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity. Once designated, these sites are added to the Convention’s List of Wetlands of International Importance and become known as Ramsar sites.

### 6.6.1.2 Commonwealth

Commonwealth legislation and policy relevant to the terrestrial ecology values of the Project area include:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Significant Impact Guidelines Version 1.1, 2013; and

**Environment Protection and Biodiversity Conservation Act 1999**

The EPBC Act provides a framework to protect and manage nationally and internationally important flora, fauna and ecological communities (among other things) as defined under the act as MNES. Under the EPBC Act the DotE has jurisdiction over actions that are likely to have a significant impact on MNES.

**EPBC Act Environmental Offsets Policy 2012**

The EPBC Offsets Policy outlines the position of the Commonwealth Government with respect to the use of environmental offsets under the EPBC Act.

Offsets will only apply to projects that are determined a controlled action, and that have a ‘significant’ impact on a MNES (as defined in the *Significant Impact Guidelines Version 1.1, 2013*). Offsets are required to compensate for any residual, significant impact to a MNES such as vegetation clearing. The policy sets out principles for the provision of offsets to compensate for impacts on MNES.

This information provided in this section sets out the MNES that are known to occur, or likely to occur, within the Project area and how impacts on MNES can be avoided or minimised, and any proposed mitigation strategies.

### 6.6.1.3 State

State legislation relevant to the terrestrial ecology values of the Project area include:

- *Environmental Protection Act 1994* (EP Act);
- *Nature Conservation Act 1992* (NC Act);
- *Vegetation Management Act 1999* (VM Act);
- *Land Protection (Pest and Stock Route Management) Act 2002*; and
**Environmental Protection Act 1994**

The EP Act has a broad objective of achieving sustainable development within Queensland. The subordinate EP Regulation defines Category A and Category B ESAs. Category A ESAs include national parks, marine parks, the Great Barrier Reef region and the wet tropics area. Category B ESAs include some classes of protected areas, endangered RE types, declared fish habitat areas and areas subject to international conventions.

**Nature Conservation Act 1992**

The NC Act and subordinate legislation provide for the protection and conservation of nature, including the declaration and management of protected areas, the protection of wildlife and habitat, and the sustainable use of native wildlife areas.

The Nature Conservation (Wildlife) Regulation 2006, along with the Nature Conservation (Wildlife Management) Regulation 2006, provide lists of plants and animals that are listed as extinct, endangered, vulnerable, near threatened, special least concern, least concern, and international or prohibited.

The Nature Conservation (Protected Areas Management) Regulation 2006 identifies protected areas, including forest reserves, resource reserves, conservation parks, national parks and nature refuges.

The NC Act includes provisions for permits relevant to the interference of protected fauna and breeding places; it also requires permits to be obtained for unavoidable clearing of protected plants. Impacts on plants and animals listed under the Nature Conservation (Wildlife) Regulation 2006, including EVNT species, are considered within this section.

**Vegetation Management Act 1999**

The VM Act establishes Queensland’s vegetation management framework and classifies remnant vegetation in Queensland as endangered, of concern, or least concern REs. REs are vegetation communities that are consistently associated with a combination of geology, land-form and soil in a bioregion. Descriptions of an RE from the Regional Ecosystem Description Database and classifications assigned under the VM Act have been used as the basis for assessment of remnant vegetation communities in the Project area. It should be noted; however, that mining activities approved by the grant of an EA under the EP Act prior to 2014 are exempt from vegetation clearing regulations under the VM Act and SP Act.

**Land Protection (Pest and Stock Route Management) Act 2002**

The Land Protection Act provides for the declaration of Class 1, Class 2 or Class 3 pest plant and animal species. Under Section 77 of the Land Protection Act, a landowner must take reasonable steps to keep land under their control free of Class 1 and Class 2 pests. The definition of landowner under the Land Protection Act includes the lessee for a mining lease granted under the MR Act.

Under the Land Protection Act it is an offence to introduce, keep or supply a declared pest, feed a declared pest animal, or take a declared pest for commercial use. It is also an offence to:

- Supply anything containing reproductive material of a Class 1 or Class 2 pest prescribed under the Land Protection (Pest and Stock Route Management) Regulation 2003.

- Transport a vehicle or thing containing soil or other organic material, which contains the reproductive material of a declared pest plant.
Environmental Offset Act 2014

A new offset framework was introduced in Queensland in July 2014. This includes the following policies:

- **Environmental Offsets Act 2014 (EO Act)** – this is the primary legislation that establishes a head of power for the State to impose offset conditions and rules around how offsets will be required and delivered. It outlines offsets will be required to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter. Key definitions are established and it also provides for the making of an Environmental Offsets Policy;

- **Environmental Offsets Regulation 2014 (EO Regulation)** – the regulation defines those prescribed environmental matters that may require an offset and are referred to as “Matters of State Environmental Significance” (MSES), defines activities that may be required to provide an offset including resource activities under the EP Act, requirements of an Offset Delivery Plan, provisions for advance offsets etc.; and

- **Environmental Offsets Policy 2014 (EO Policy)** – the policy is where the operational detail and guidance can be found as to how offsets will be assessed and need to be delivered. The policy includes information on relationship between Commonwealth and State offsets, criteria that offsets must meet, offset delivery options and staging of offsets.

The Queensland Offset Framework establishes an ‘avoid, mitigate, offset’ hierarchy for development. Where it is demonstrated that impacts cannot be avoided or mitigated, and there is a ‘significant’ residual impact to a prescribed environmental matter, then an offset is required.

6.6.2 Assessment Method

The description of terrestrial ecological flora and fauna values are based on desktop assessments and ecological studies completed in the Project area in the late dry season of 2014 and early wet season of 2015. The following sections provide a description of the desktop and field assessments.

6.6.2.1 Desktop Assessment

A review of literature pertaining to the terrestrial flora and fauna values of, and adjacent to the Project area, was undertaken. Commonwealth and state database searches were defined by the coordinates -11.86668 latitude, 142.04155 longitude (based on a 25 km search radius centred on the Project area). The desktop assessment was complemented by on-site field assessments. Terrestrial ecology surveys were undertaken between 4 and 11 November 2014, corresponding to the late dry season. Follow-up surveys were undertaken between 31 January and 6 February 2015, corresponding to the early wet season.

6.6.2.2 Vegetation and Terrestrial Flora Assessment

Field surveys were conducted over six days in November 2014, and six days in January/February 2015. The primary objective of these surveys was to identify and describe vegetation communities and terrestrial flora values, and ground-verify DEHP RE mapping for the Project area. Surveys were carried out in accordance with the Queensland Herbarium’s Methodology for the Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 3.2 (Neldner et al., 2012).

Key terrestrial vegetation and flora indicators assessed during each survey are provided in Table 6-24.
Table 6-24 Terrestrial vegetation and flora indicators assessed

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site condition</td>
<td>- Native species richness</td>
</tr>
<tr>
<td></td>
<td>- Non-native plant cover</td>
</tr>
<tr>
<td></td>
<td>- Course woody debris</td>
</tr>
<tr>
<td></td>
<td>- Native perennial grass cover and organic litter</td>
</tr>
<tr>
<td></td>
<td>- Tree species richness, tree canopy height, recruitment of woody perennial</td>
</tr>
<tr>
<td></td>
<td>species, and abundance of large trees</td>
</tr>
<tr>
<td></td>
<td>- Tree canopy cover and shrub canopy cover</td>
</tr>
<tr>
<td>Site context</td>
<td>- Habitat connectedness</td>
</tr>
<tr>
<td></td>
<td>- Habitat context</td>
</tr>
<tr>
<td></td>
<td>- Distance from permanent water</td>
</tr>
<tr>
<td></td>
<td>- Ecological corridor context</td>
</tr>
<tr>
<td>Habitat quality</td>
<td>- Trees with hollows</td>
</tr>
<tr>
<td></td>
<td>- Foraging quality</td>
</tr>
<tr>
<td></td>
<td>- Shrubby understory</td>
</tr>
<tr>
<td></td>
<td>- Rocky outcrops</td>
</tr>
<tr>
<td></td>
<td>- Stone/shale</td>
</tr>
<tr>
<td></td>
<td>- Tussock grass/spinifex</td>
</tr>
<tr>
<td></td>
<td>- Litter and logs</td>
</tr>
<tr>
<td></td>
<td>- Threatening processes (e.g. industry, grazing stock, urban, pollution)</td>
</tr>
<tr>
<td></td>
<td>- Species mobility</td>
</tr>
<tr>
<td></td>
<td>- Aquatic/riparian habitat</td>
</tr>
</tbody>
</table>

A total of 86 sites across the Project area were assessed during the late dry season surveys, comprising three secondary and 83 quaternary sites. A total of 42 sites were assessed during the early wet season surveys, comprising five secondary, 29 quaternary and eight BioCondition sites. The location of terrestrial vegetation and flora sites assessed during the surveys is illustrated in Figure 6-17, and a summary of survey effort is provided in Table 6-25.

Table 6-25 Summary of flora survey sites and survey effort

<table>
<thead>
<tr>
<th>Site type</th>
<th>No. of sites</th>
<th>Information collected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry</td>
<td>Wet</td>
</tr>
<tr>
<td>Secondary</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Quaternary</td>
<td>83</td>
<td>29</td>
</tr>
<tr>
<td>BioCondition</td>
<td>-</td>
<td>8</td>
</tr>
</tbody>
</table>

RE mapping was revised and more accurately defines the spatial extent of REs in the Project area and forms the basis of the impact assessment component in Section 6.6.4. It is important to note that the infrastructure footprint for the Project was not finalised until after the field surveys. As such, not all areas of the footprint were ground-verified in terms of REs and vegetation communities. The REs ground-truthed during the vegetation surveys are shown in Figure 6-18.

BioCondition assessment involves a rapid assessment of vegetation condition at the property scale for different REs. It is a site-based, quantitative procedure that typically provides a score from ‘functional’ through to ‘dysfunctional’ condition from a biodiversity perspective (Eyre et al., 2011). The score is based on a comparison between measured site-specific attributes, and benchmark values for each of those attributes, specific to a particular RE. No bioregion specific BioCondition benchmark data was available and therefore scoring was not possible. The BioCondition assessment process was; however, used to quantitatively assess key vegetative attributes.
6.6.2.3 Terrestrial Fauna Assessment

Terrestrial fauna surveys, during the late dry season (November 2014) and the early wet season (January/February 2015), were designed to target threatened species known, or likely to occur, within the Project area, as identified through a desktop literature review, targeted searches of relevant databases, and presence of habitats known to support likely threatened species.

Survey site selection

Survey sites were selected based largely on RE mapping, habitat diversity and landforms. Eight trapping sites were selected to provide adequate spatial coverage across the representative REs and Project area. A further five observation sites were selected outside of the dominant REs, based on presence of preferred habitats for targeted fauna species. The location, dominant vegetation community, and RE associated with each fauna survey site are provided in Table 3 of Appendix F. The fauna survey sites are shown in Figure 6-19.
FIGURE 6-19
TERRESTRIAL FAUNA SURVEY SITES

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This drawing is confidential and shall only be used for the purpose of this project.

APPROVED

DRAWN

CHECKED

DESIGNED

MD

CHECKED

OPENED

DATE

Details

Date

Notes

F:\1_PROJECTS\BES150115_Bauxite_Hill\GIS\DATA\MXD\FINAL\ERA\BES150115-030-R1_FAUNA_SURVEY_SITES.mxd

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

GCS GDA 1994 MGA Zone 54

DATA SOURCE
MEC Mining;
QLD Government Open Source Data;
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

DESIGNER

CLIENT

1:60,000 Scale @ A3 - 1:60,000

Legend

Watercourse
Barge Loading Area
Haul Road
Alternate Haul Road
Pit Extents
Camp Site
Metro Mining Mine Lease Area

Fauna Survey Site
Opportunistic Fauna Observation Site
Palm cockatoo
6.6.2.4 Species Assessment

General

The likelihood of occurrence of individual species was determined based on a review of previous records, known habitat preferences, the specific wet and dry season field surveys, and an assessment of habitat availability and the presence of microhabitat features within the Project area. This included known RE associations for each species, known records and distribution ranges. Species were assigned to one of the following categories:

- **Known to occur**: includes species/communities previously recorded in the Project area or directly adjacent to the Project area;
- **Likely to occur**: includes species/communities previously recorded in proximity to the Project area and suitable habitat features are available in the Project area which support the species;
- **May occur**: includes species/communities where suitable habitats are present in the Project area, and where the known distribution of the species overlaps the Project area, but where there are no known records in the area; and
- **Unlikely to occur**: includes species/communities for which the Project area offers limited or no potential habitat, is outside their known range and/or is without broader habitat requirements.

Impacts on potential habitat for flora and fauna species were assessed based on RE associations for individual species derived from known habitat associations and published literature. RE associations provide an indication of the presence of suitable habitat but do not account for the actual distribution of suitable microhabitat (e.g. logs, leaf litter etc.) or niche habitat (e.g. suitable nesting sites) within each RE. The areas are therefore likely to represent an overestimate of actual habitat availability for most species.

Bat Call Analysis

Variability in the calls produced from a single species means that there are a number of species present in Cape York Peninsula that have overlapping calls. Whether calls can be identified to a specific species depends on the quality of the call pass. If the quality of the call pass is poor, bat fauna may be identified to a species complex. The likelihood of a species complex being attributed to one species or another will depend on the call quality, number of clear pulses, and the call files immediately before/after. For example, a call pass may be identified as hoary wattled bat (*Chalinolobus nigrogriseus*) and northern broad-nosed bat (*Scotorepens sanborni*) complex; however, if the call immediately preceding this (within a second or two) was clearly a hoary wattled bat, then the species is more likely to be hoary wattled bat. Four categories were used for the call analysis, including:

- **Present**: There are numerous call passes with clear call pulses which can be confidently identified to the species. This means that the species was present on the survey site;
- **Likely**: There are several call passes which may be attributed to this species; however, they have been identified as a species complex. It is possible that these calls may have been produced by another species. It is likely that the species is present on the survey site;
- **Possible**: There are one or more call passes which may be attributed to this species; however, they have been identified as a species complex; and
- **Not Detected.** There were no call passes which were attributed to this species. This species was not detected in the call data; however, this does not mean the species is absent from the survey site.

### 6.6.3 Existing Environment

The Project area is located on Province 7 (Weipa Plateau) of the Cape York Peninsula Bioregion and occupies part of the Skardon River catchment draining westward into the Gulf of Carpentaria. The broader Cape York region is remote and largely undisturbed, with some areas of high biodiversity value, nationally and regionally significant ecosystems, numerous important cultural heritage sites, and significant Indigenous cultural values attached to the natural landscape (DIP, 2014). The Project area has a limited diversity of geological features, and as such the array of habitat types is limited. The current mine footprints (BH1 and BH6) comprise three REs of which there is one Of Concern RE (3.3.12), and are elevated compared to the surrounding terrain (see Table 6-26 and Table 6-27 for the REs associated with Project infrastructure). Areas in the north and west of BH1, and far north, west and east of BH6, slope down towards tributaries of the Skardon River catchment.

**Table 6-26 Approximate area of vegetation clearing due to Project activities (haul roads outside Metro Mining’s mining lease) – Option 1**

<table>
<thead>
<tr>
<th>Project component</th>
<th>RE</th>
<th>VM / BD Status</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1 East – Pit Extraction Area</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>758.91</td>
</tr>
<tr>
<td>BH6 South – Pit Extraction Area</td>
<td>3.3.12</td>
<td>OC / OC</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>3.3.14</td>
<td>LC / NC</td>
<td>9.13</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>312.76</td>
</tr>
<tr>
<td>BH6 West – Pit Extraction Area</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>480.72</td>
</tr>
<tr>
<td>Associated Infrastructures (e.g. stockpiles)</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>6.84</td>
</tr>
<tr>
<td>Camp Accommodation</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>11.29</td>
</tr>
<tr>
<td>Jetty/Barge Loading Facility</td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>0.28</td>
</tr>
<tr>
<td>Northern Haul Road</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>40.23</td>
</tr>
<tr>
<td>Southern Haul Road</td>
<td>3.1.1</td>
<td>LC / NC</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>3.3.12</td>
<td>OC / OC</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>3.3.22</td>
<td>LC / NC</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>3.3.49b/3.3.9</td>
<td>LC / NC</td>
<td>8.51</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>32.95</td>
</tr>
<tr>
<td>Western Haul Road</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>3.01</td>
</tr>
<tr>
<td>Total clearing per RE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1.1</td>
<td>LC / NC</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>2.97</td>
</tr>
<tr>
<td></td>
<td>3.3.12</td>
<td>OC / OC</td>
<td>0.382</td>
</tr>
<tr>
<td></td>
<td>3.3.14</td>
<td>LC / NC</td>
<td>9.13</td>
</tr>
<tr>
<td></td>
<td>3.3.22</td>
<td>LC / NC</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>3.3.49b/3.3.9</td>
<td>LC / NC</td>
<td>8.51</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>1643.98</td>
</tr>
<tr>
<td>Combined RE Clearing Area</td>
<td></td>
<td></td>
<td>1,668.99</td>
</tr>
</tbody>
</table>
### Table 6-27 Approximate area of vegetation clearing due to Project activities (all infrastructure within Metro Mining’s mining lease) – Option 2

<table>
<thead>
<tr>
<th>Project component</th>
<th>RE</th>
<th>VM / BD Status</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1 East – Pit Extraction Area</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>758.91</td>
</tr>
<tr>
<td>BH6 South – Pit Extraction Area</td>
<td>3.3.12</td>
<td>OC / OC</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>3.3.14</td>
<td>LC / NC</td>
<td>9.13</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>312.76</td>
</tr>
<tr>
<td>BH6 West – Pit Extraction Area</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>480.72</td>
</tr>
<tr>
<td>Associated Infrastructures (e.g stockpiles)</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>6.84</td>
</tr>
<tr>
<td>Camp Accommodation</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>11.29</td>
</tr>
<tr>
<td>Jetty/Barge Loading Facility</td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>0.28</td>
</tr>
<tr>
<td>Northern Haul Road</td>
<td>3.1.1</td>
<td>LC / NC</td>
<td>3.85</td>
</tr>
<tr>
<td></td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>16.29</td>
</tr>
<tr>
<td>Southern Haul Road</td>
<td>3.1.1</td>
<td>LC / NC</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>5.49</td>
</tr>
<tr>
<td></td>
<td>3.1.6</td>
<td>LC / NC</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>3.3.12</td>
<td>OC / OC</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>3.3.22</td>
<td>LC / NC</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>3.3.49b/3.3.9</td>
<td>LC / NC</td>
<td>5.57</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>15.55</td>
</tr>
<tr>
<td>Western Haul Road</td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>3.01</td>
</tr>
<tr>
<td>Total clearing per RE</td>
<td>3.1.1</td>
<td>LC / NC</td>
<td>5.16</td>
</tr>
<tr>
<td></td>
<td>3.1.1a/3.1.3</td>
<td>LC / NC</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>3.1.6</td>
<td>LC / NC</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>3.3.12</td>
<td>OC / OC</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>3.3.14</td>
<td>LC / NC</td>
<td>9.13</td>
</tr>
<tr>
<td></td>
<td>3.3.22</td>
<td>LC / NC</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>3.3.49b/3.3.9</td>
<td>LC / NC</td>
<td>5.57</td>
</tr>
<tr>
<td></td>
<td>3.5.2</td>
<td>LC / NC</td>
<td>1606.69</td>
</tr>
<tr>
<td>Combined RE Clearing Area</td>
<td></td>
<td></td>
<td>1636.75</td>
</tr>
</tbody>
</table>

#### 6.6.3.1 Habitat Connectivity

Habitat connectivity within the Project area is linked to riparian corridors associated with the Skardon River and contiguous areas of terrestrial vegetation across the mining lease areas. The Skardon River-Cotterell River Aggregation, to the north of the Project area, is listed under the DIWA and a riparian corridor of regional significance under the Cape York Biodiversity Planning Assessment (BPA) (DEHP, 2012b). Contiguous tracts of remnant vegetation to the south of the Project area have links to the Port Musgrave Aggregation. The Port Musgrave Aggregation is also listed under the DIWA, comprises the Ducie and Wenlock Rivers and Namaleta Creek, and is both a regional and state significant riparian corridor.

#### 6.6.3.2 Other Values

ESAs are those classed as having national, state, regional or local biodiversity significance. Areas recognised as being sensitive in respect to flora and fauna were identified based on spatial data, desktop searches and observations made during the field surveys, as summarised in Table 6-28.
Areas of high ecological significance that occur within the Project area

<table>
<thead>
<tr>
<th>Significant Biodiversity Values</th>
<th>Description of Value in Project Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmentally Sensitive Areas (ESAs)</td>
<td>No Category A ESAs occur in the Project area. Category B ESAs occur in MLA 20688 and MLA 20676, comprising areas of marine plant communities.</td>
</tr>
<tr>
<td>Protected area estates</td>
<td>No protected area estates are located in the Project area.</td>
</tr>
<tr>
<td>Threatened Ecological Communities (TECs)</td>
<td>No TECs occur in the Project area.</td>
</tr>
<tr>
<td>Endangered and of concern REs</td>
<td>No endangered REs occur in the Project area. Two of concern REs occur in the Project area.</td>
</tr>
<tr>
<td>High Value Regrowth representative of Endangered REs</td>
<td>No high value regrowth vegetation is present in the Project area.</td>
</tr>
<tr>
<td>REs of ‘low’ or ‘medium’ representation in Protected Areas</td>
<td>No REs of low or medium representation in Protected Areas are present in the Project area.</td>
</tr>
<tr>
<td>DEHP Mapped Essential Habitat Areas</td>
<td>The Project area does not contain any DEHP mapped essential habitat.</td>
</tr>
<tr>
<td>Habitat for Threatened Flora and Fauna</td>
<td>Areas providing potential habitat for threatened or near threatened flora and fauna species were identified in the Project area. These areas have been discussed.</td>
</tr>
<tr>
<td>Drainage Features and Riparian Vegetation</td>
<td>The Skardon River and its tributaries is the only river system in the Project area, and includes the Skardon River-Cotterell River Aggregation. These areas can provide important habitat for a range of species and riparian vegetation in wetland areas, and along drainage features and can facilitate fauna movement across a landscape.</td>
</tr>
<tr>
<td>Wetlands</td>
<td>No Ramsar Wetlands occur in, or immediately downstream of the Project area. Some wetlands listed in the DIWA occur within the Project area. Wetlands (estuarine, palustrine, lacustrine and riverine) are mapped within, and were observed within, the Project area. These areas were found to provide important habitat for a range of wetland birds including those listed as migratory under the EPBC Act.</td>
</tr>
<tr>
<td>Connectivity to Wildlife Corridors</td>
<td>The BPA expert panel report identifies riparian corridors of regional significance associated with the Skardon River to the north of the Project area. A large area of contiguous vegetation is located to the south of the Project area with connectivity to the state and regionally significant riparian corridors associated with the Port Musgrave Aggregation.</td>
</tr>
</tbody>
</table>

### 6.6.3.3 Threatened Species/Communities

#### Regional Ecosystem Mapping

Sixteen current DEHP certified mapped REs occur in the Project area as show in Table 6-29.

<table>
<thead>
<tr>
<th>RE</th>
<th>Description</th>
<th>EPBC Act Status</th>
<th>VMA Status</th>
<th>Biodiversity Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.1a</td>
<td>Closed forest of <em>Rhizophora stylosa</em> ± <em>Bruguiera gymnorhiza</em>. Occurs as outer mangroves</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.1.3</td>
<td><em>Ceriops tagal</em> ± <em>Avicennia marina</em> low closed forest. Extensive on intertidal areas</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.1.6</td>
<td>Sparse herbland or bare salt pans. Associated with salt plains and saline flats</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.3.9</td>
<td><em>Lophostemon suaveolens</em> open forest. Occurs on streamlines, swamps and alluvial terraces</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.3.12</td>
<td><em>Melaleuca quinquenervia</em> open forest. Associated with scattered coastal swamps</td>
<td>-</td>
<td>OC</td>
<td>OC</td>
</tr>
<tr>
<td>RE</td>
<td>Description</td>
<td>EPBC Act Status</td>
<td>VMA Status</td>
<td>Biodiversity Status</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>3.3.14a</td>
<td><em>Melaleuca saligna</em> ± <em>M. viridiflora</em>, <em>Lophostemon suaveolens</em> woodland on drainage swamps</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.3.22a</td>
<td><em>Corymbia clarksoniana</em> or <em>C. novoguineensis</em> woodland on alluvial plains</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.3.49b</td>
<td><em>Melaleuca viridiflora</em> low open woodland on low plains</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.3.60a</td>
<td><em>Themeda arguens</em>, <em>Dichanthium sericeum</em> closed tussock grassland on marine plains</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.3.64</td>
<td><em>Baloskion tetraphyllum</em> subsp. <em>meiostachyum</em> open sedgeland in drainage swamps in dunefields</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.5.2</td>
<td><em>Eucalyptus tetrodonta</em>, <em>Corymbia nesophila</em> tall woodland on deeply weathered plateaus and remnants</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.5.10</td>
<td><em>Eucalyptus tetrodonta</em>, <em>Corymbia nesophila</em> woodland on sandy gently undulating rises and low hills</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.5.11</td>
<td><em>Eucalyptus tetrodonta</em>, <em>Corymbia nesophila</em> woodland on lower slopes of plains and rises</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.5.14</td>
<td><em>Melaleuca viridiflora</em> ± <em>Acacia spp.</em> ± <em>Asteromyrtus symphyocarpa</em> low woodland on scattered coastal sand plains</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.5.22c</td>
<td><em>Corymbia clarksoniana</em> &amp; <em>Erythrophleum chlorostachys</em> &amp; <em>Corymbia spp.</em> &amp; <em>Eucalyptus spp.</em> woodland on plains</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
<tr>
<td>3.7.3</td>
<td><em>Eucalyptus cullenii</em> ± <em>E. tetrodonta</em> woodland on erosional escarpments and plains</td>
<td>-</td>
<td>LC</td>
<td>NC</td>
</tr>
</tbody>
</table>

Bio = Biodiversity status; NC = no concern at present; LC = least concern

**Commonwealth EPBC Act Protected Matters**

MNES fauna species identified as potentially occurring within a 25 km radius of the approximate centre of the Project area included 11 threatened species and 24 migratory species, and three marine species. MNES flora species identified as potentially occurring within a 25 km radius of the approximate centre of the Project area included 10 threatened species.

**Queensland Wildlife Online Database**

The results of the database search indicated that 18 EVNT fauna species potentially occur with a 25 km radius of the approximate centre of the Project area. The results of the database search indicated that 19 EVNT flora species potentially occur with a 25 km radius of the approximate centre of the Project area. Results are summarised in Table 8 of Appendix F.

**Back on Track Regional Significant Species**

The ‘Back on Track’ (BoT) species prioritisation framework lists species of critical or high conservation status, within a particular area, irrespective of their EPBC Act or NC Act listings. This conservation status is based on the occurrence, significance and threats to individual species on a regional scale.

The BoT species prioritisation framework database search identified 20 fauna species and 11 flora species of critical or high conservation status as potentially occurring with the Cape York Natural Resource Management region.

The results of all relevant database searches are provided in Table 8 of Appendix F.
Environmental Context

The vegetation of the Project area is a complex mosaic of open forest, woodland, and extensive swamplands, gallery forests on perennial streams and rivers, closed forest and mangroves. The lateritic surface (i.e., laterites are soil types rich in iron and aluminium, formed in hot and wet tropical areas) of the Weipa Plateau is characterized by Eucalypt and Corymbia woodlands with the deep aluminous laterites of the Weipa area supporting the best development of Darwin stringybark, Melville Island bloodwood (*Corymbia nesophila*) and Cooktown ironwood (*Erythrophloeum chlorostachys*) dominant tall woodland and open forest on Cape York Peninsula. Areas of shallow silty soils with impeded drainage characteristics are scattered across the lateritic surface, supporting low woodland communities with dominant Eucalyptus, Corymbia and Melaleuca species. Shallow drainage depressions provide a seasonal wetland habitat and are dominated by woodlands and open forests with characteristic Melaleuca, Lophostemon, Xanthostemon and Asteromyrtus. These swamp forests display a complex variety of vegetation communities on their margins, compositionally zoned in response to local variations in the persistence of water through the dry season.

The coastal environment of the Mapoon Plain adjoins the Project area to the east. The plain features an extensive system of coastal sand dunes, and a complex of grasslands and herblands, Casuarina dominated woodlands and shrublands, vine thickets, Melaleuca open forests and woodlands and Corymbia woodlands. Poorly drained swales provide seasonal wetland habitats dominated by Melaleuca species, and mangrove communities occur along estuarine areas associated with the Skardon River and Nameleta Creek.

Habitat Assessments

The majority of the Project area was found to support remnant least concern RE 3.5.2 Darwin stringybark and Melville Island bloodwood tall woodland on deeply weathered plateaus and remnants which is consistent with current RE mapping. The structural and floristic description of RE 3.5.2 is:

“*Eucalyptus tetrodonta* (Darwin stringybark) predominates forming a distinct but discontinuous canopy (22-32 m tall) with *Corymbia nesophila* (Melville Island bloodwood) present as a sub-dominant to co-dominant canopy species. Large *Erythrophloeum chlorostachys* (Cooktown ironwood) trees may also be present. These occur just below the canopy. A very sparse to sparse sub canopy layer (8-25 m tall) is dominated by *Eucalyptus ssp.* and *Grevillea glauca* (bushman’s clothes peg). Scattered low trees (4-8 m tall) are sometimes present. Wattles and *Eucalyptus ssp.* dominate the sparse to very sparse shrub layer (0.5-2 m tall). The ground layer is usually sparse to medium density and dominated by grasses, including *Sarga plumosum* (plume sorghum), *Heteropogon triticeus* (giant speargrass), *Alloteropsis semialata* (cockatoo grass) and *Eulalia mackinlayi* (silky browntop). Occurs on deeply weathered plateaus and remnants.”

EPBC Act Values – TECs

An online search of the EPBC Act, relevant databases, and field surveys did not locate the presence of TECs within or adjacent to the Project area (Attachment 7 of Appendix F).

Regional Ecosystems

DEHP certified RE mapping was verified in the field to confirm the extent and description of vegetation communities in the Project area. Thirteen REs were recorded in the Project area during the surveys, and are presented in the ground-verified RE mapping (Figure 6-18) and summarised in
Table 9 of Appendix F. These REs were used as the basis for the assessment of terrestrial flora values of the Project area.

Eight of the sixteen DEHP certified REs mapped for the Project area were recorded during the field survey. Five REs not previously mapped for the Project area were also recorded and are included in the ground-verified RE mapping (Figure 6-18).

The field surveys confirmed that the predominant vegetation of the Project area comprises least concern RE 3.5.2 with characteristic tall grassy woodland of Darwin stringybark and Melville Island bloodwood with Cooktown ironwood. Woodlands of tropical bloodwood (C. novoguineensis) and nonda (Parinari nonda), typically occur on plateau margins. Broad swampy drainage systems occupy the western parts of MLA 20689, and the margins of the estuaries within MLA 20676 feature seasonal wetlands and forested swamps consistent with REs 3.3.12, 3.3.14, 3.3.22, and 3.3.42. Vegetation of these areas includes woodlands and low open forests of a number of paperbark species (Melaleuca viridiflora, M. saligna, M. quinquenervia, M. leucadendra) in association with swamp box (Lophostemon suaveolens) and tropical bloodwood. Limited areas of sedgeland and grassland occur on the margins of swamps which hold water to the end of the dry season (RE 3.3.65). Estuarine sediments associated with the Skardon River system occupy the peripheries of the leases. These support mangrove shrublands and forests (RE 3.1.1 and 3.1.3) as well as extensive salt pans (RE 3.3.6) with fringing grasslands of saltwater couch (Sporobolus virginicus). Mangrove habitats are generally adjoined by paperbark woodlands on narrow alluvial flats.

Two of concern REs were confirmed being; open forests of coastal paperbark (Melaleuca quinquenervia) (RE 3.3.12) that occurs in a narrow band running north to south on MLA 20676 and MLA 20689. This RE is likely to be impacted as a result of proposed haul road options. Tall shrubland of concern RE 3.3.51 comprising saltwater paperbark (Melaleuca acacioides) and hakea (Hakea pedunculata), occur along the landward margins of mangrove shrublands and forests in MLA 20676, but not within the mining or infrastructure footprint.

No endangered REs were confirmed within the Project area, and are not in the revised ground-verified RE mapping.

**Of Concern REs**

Of the 13 ground-verified of concern REs recorded in the Project area, two are scheduled as of concern VM Act and Biodiversity Status (Table 6-30). RE 3.3.51 does not overlap the mine or infrastructure footprints; however, RE 3.3.12 overlaps approximately 0.382 ha in Option 1 and approximately 0.7 ha in Option 2 of the infrastructure footprint.

<table>
<thead>
<tr>
<th>RE</th>
<th>Summary Description</th>
<th>Local Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.12</td>
<td>Coastal paperback open forest.  Associated with scattered coastal swamps</td>
<td>Woodland and open forest with coastal paperback. Associated with broad drainage depressions and margins of alluvial plains</td>
</tr>
<tr>
<td>3.3.51</td>
<td>Saltwater paperback +/- Hakea tall shrubland on marine plains</td>
<td>A restricted RE found on MLA 20676 where it manifests in linear communities fringing the outer margins of estuarine deposits and mangroves. Provides habitat for D. johannis/bigibbum</td>
</tr>
</tbody>
</table>
No Concern at Present/Least Concern REs

The ground-verified RE mapping recorded 11 ‘no concern at present’ REs occurring in the Project area.

Flora Species

A total of 227 flora species were recorded in the Project area. Of these, 197 were recorded during late dry season surveys and an additional 29 during early wet season surveys. Seventy-eight families were represented, dominated by Poaceae (29), Myrtaceae (25), Cyperaceae (17), Apocynaceae (8), and Proteaceae (8).

Threatened Flora Species

Desktop assessments identified two MNES and four EVNT threatened flora species as likely to occur in the broader Project area. No threatened flora species were confirmed during the 2014/15 dry and wet season surveys.

Orchid species were identified during surveys outside proposed clearing areas. The observed specimens were likely to be the fragrant tea tree orchid (*Dendrobium trilamellatum*); however, this species shares similar habitat and has similar habits to the vulnerable flora species the brown antelope orchid (*Dendrobium johannis*). These orchids were found in riparian and wetland habitats outside of proposed impact areas, their locations are illustrated within Figure 6-17. No suitable flowering material was present at the time of survey and species level identification was not possible. It should also be noted that conditions were sub-optimal for detection of the near threatened (NC Act) *Heterachne baileyi* during both survey periods. This species is likely to be present within the broader Project area in fringing wetland habitats. Surveys also failed to detect the presence of the vulnerable (NC Act) Australian arenga palm (*Arenga australasicum*).

The preferred habitat and likelihood of occurrence of threatened flora species potentially occurring in the Project area is provided in Table 11 of Appendix F. The assessment of likelihood of occurrence is based on both the application of the likelihood of occurrence definitions presented in Section 6.6.2.4 and uses desktop assessment and field survey results. No flora species of scientific significance were recorded in the Project area during the surveys.

Flora of Bioregional Significance

The application of a range of generic criteria may be applied to define or classify non-threatened bio-regionally significant flora species. These include regional endemicity, isolated distribution, disjunction, limits of geographical range, or special scientific, cultural and commercial interest. Analysis of Queensland Herbarium data and field recordings indicates that several regionally significant species may occur in, or in close proximity, to the Project area. None were recorded during the field surveys.

Special Least Concern Flora Species

Special least concern restricted plants are horticultural species that are not considered sufficiently rare to be classified as threatened species; however, may be subject to harvest and trade to an extent that if unregulated would pose a threat to the species. As such, to ensure that populations of these species do not become threatened, their removal is regulated under the NC Act. Special least concern species recorded during the surveys included:

- Chielanthes /Lip ferns (*Cheilanthes* sp.);
- Bush lily (*Crinum uniflorum*);
- *Drosera lanata*;
- Sundew (*Drosera* sp.);
- Bladderword (*Utricularia* sp.);
- Wallum fringe (*Nymphoides exiliflora*);
- Blue lily (*Nymphaea violacea*);
- Tea tree orchid (*Dendrobium canaliculatum*);
- Fragrant tea tree orchid (*Dendrobium trilamellatum*);
- Bottlebrush orchid (*Dendrobium smillieae*);
- *Dendrobium califorme*;
- Elegant hyacinth-orchid (*Dipodium elegantulum*);
- Tropical hyacinth-orchid (*Dipodium stenochilum*); and
- Trigger plant (*Stylidium* sp.).

### Culturally Significant Flora

Culturally significant flora species are those used historically or presently by Indigenous people for food, medicine and materials. Species recorded within the Project area that may be considered culturally significant as a food resources (e.g. seeds, leaves and berries) for Indigenous people include, wattles (*Acacia* spp.), wild orange (*Capparis canescens*), and kurrajong (*Brachychiton populneus*). Flora species with medicinal properties that may be considered culturally significant include wattles, soap tree (*Alphitonia excelsa*), native quinine (*Petalostigma pubescens*), flax lilies (*Dianella* spp.), cockatoo apple (*Planchonia careya*), and kurrajong. Several potentially culturally significant sites were also recorded during the surveys, as detailed in Table 6-31 and illustrated in Figure 6-18.

#### Table 6-31 Trees of potential cultural significance

<table>
<thead>
<tr>
<th>Ref No.</th>
<th>Description</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scar tree - stringy bark</td>
<td>611048</td>
<td>8690708</td>
</tr>
<tr>
<td>2</td>
<td>Sugar bag tree - old scar on dead ironwood approximately 20cm dbh.</td>
<td>611238</td>
<td>8690540</td>
</tr>
<tr>
<td>3</td>
<td>Old ironwood stump 1.6m with obvious axe cut at top of stump</td>
<td>613822</td>
<td>8695212</td>
</tr>
<tr>
<td>4</td>
<td>Ironwood stump 1.6m axe cut</td>
<td>616074</td>
<td>8698016</td>
</tr>
<tr>
<td>5</td>
<td>Old scar tree</td>
<td>611401</td>
<td>8690435</td>
</tr>
<tr>
<td>6</td>
<td>Midden site on edge of gully in salt pan country of low tea tree</td>
<td>620866</td>
<td>8696753</td>
</tr>
</tbody>
</table>

### Introduced Flora

Surveys undertaken at the already disturbed sites of Skardon landing and the previous Skardon Kaolin Project recorded robust populations of introduced flora including mint weed (*Hyptis suaveolens*) and stylo (*Stylosanthes hamata*). Surveys found no major weed issues in the undisturbed bushland or existing access roads and tracks; however, there remains potential that intact habitats could be degraded by exotic species occurring in the more developed areas of Weipa.
6.6.3.4 Terrestrial Fauna Values

The limited diversity of flora species and vegetation communities, and relatively uniform landform topography and substrate in the Project area supports a low diversity of fauna species. During the surveys, 98 vertebrate species were recorded comprising 8 amphibian species, 18 reptile species, 64 bird species and 8 mammal species.

6.6.3.5 Terrestrial Fauna Assemblages

Birds

One bird species palm cockatoo (*Probosciger aterrimus*), listed as near threatened under the NC Act was recorded during the surveys. The palm cockatoos were recorded infrequently throughout the Project area. No bird species listed as critically endangered, endangered or vulnerable under the EPBC Act were identified during the field survey; however, three species listed as migratory marine, four listed as marine, and three listed as migratory were recorded. Four bird species listed as being of bioregional significance under the BPA for Cape York were recorded during the surveys, including:

- Black-backed butcherbird (*Cracticus mentalis*);
- Palm cockatoo;
- Radjah shelduck (*Tadorna radjah*); and
- Whimbrel (*Numenius phaeopus*).

Bats

Based on the desktop review, 15 listed bat species were likely to be present, four possibly present, and six unlikely to be present within the broader Project area (refer to Table 13 of Appendix F).

While the results of the desktop review provide an indication of species likely to be present due to previous records; information on bats recorded from the area was limited and therefore may not be a true representation of the bat fauna of the Project area. Fauna surveys conducted during the late dry and early wet seasons, increased the knowledge of bat species potentially present within the Project area with 3,079 passes captured for analysis.

Call analysis identified a total of 345 call passes from the AnaBat data set recorded during the late dry season surveys. Analysis of calls identified two species present [northern freetail bat (*Chaerephon jobensis*) and hoary wattled bat], four likely to be present, and five possible occurring species within the Project area. Only one of these species overlap with the list identified through the desktop assessment.

Call analysis identified a total of 2,835 call passes from the AnaBat data set recorded during the early wet season surveys. Some of these contained multiple bat passes, while a few were unrecognisable calls (e.g. recording interference, overlapping calls). Analysis of call passes identified one species present (hoary wattled bat), seven likely to be present, and seven possible within the Project area. Of these, four overlap with the list identified through the desktop assessment. Species likely to be present based on the desktop review, and those detected from the call pass files are summarised in Table 13 of Appendix F. During the course of surveys, no threatened microbat species were observed through trapping exercises.

Passive acoustic monitoring has identified the possible and likely presence of three different *Saccolaimus* species. This genus is difficult to determine to species level through passive acoustic
analysis given the propensity for calls of individuals from multiple *Saccolaimus* species to overlap on one recording.

Of these species, the bare-rumped sheathtail bat (*Saccolaimus nudicluniatus*) is listed as critically endangered under the EPBC Act and Endangered under the NC Act. This species was noted as possibly occurring at one fauna survey site (TR05) through passive acoustic call analysis; however, two other common *Saccolaimus* species [yellow-bellied sheath-tail bat (*S. flaviventris*) and Papuan sheath-tailed bat (*S. mixtus*)] were considered likely to be present at this site. This being said, no species reference calls have been positively obtained for this species and these results are not considered conclusive for identification. It is noted, no confirmed records of this species have been obtained from the Western Cape York Peninsular (see Appendix F which includes acoustic call data from field surveys). Current knowledge of this species’ known range is poor with minimal records of this species which are restricted to the eastern coastal areas of the Cape York Peninsular between Bowen and Cooktown (DotE, 2015). Historic records also exist from the Alligator River in the Northern Territory (DotE, 2015). The bare-rumped sheathtail bat has been previously recorded in Darwin stringybark woodland (Murphy, 2002) similar to that supported on site. Although not known from the northwest of Cape York microbat experts suggest this species may potentially occur across the coastal areas across the northwest of Cape York, although Churchill (2008) does not have this species distribution over western Cape York.

Surveys undertaken in 2012 by RPS for proposed Gulf Alumina development did not detect this species. The subsequent reporting does suggest this species may be present within the region; however, it is more likely other *Saccolaimus* sp. such as the yellow-bellied sheath-tail bat or the Papuan sheath-tailed bat are likely to be common across the site. As this species may occur within the region, mitigation measures should be implemented to avoid or minimise any potential impacts to the species.

**Macropods**

The agile wallaby (*Macropus agilis*) was the only macropod recorded in the Project area during the surveys.

**Terrestrial Mammals**

Three terrestrial mammal species were recorded in the Project area during the surveys. These included dingos (*Canus lupus/dingo*), feral cats (*Felis catus*), and feral pigs (*Sus scrofa*). It is likely wild dogs (*Canus lupus familiaris*) are also present within the region.

It is likely these species are in some capacity impacting the densities of native fauna and flora species present within the Project area and broader region. Pigs are likely to have impacts to native fauna through competition for herbivorous resources, the spreading of weeds and also creating erosional and water quality issues, particularly within habitats such as Big Foot Swamp and mangrove habitats. Feral cats cause direct predation pressure on small native fauna within the region, and can respond in large numbers to fluctuations in prey abundance placing pressure on native faunal assemblages. Although considered a pest under the Land Protection Act, the presence of dingo and wild dogs has been shown to reduce the levels of mesopredators (such as feral cats and foxes) and as such retaining these higher level predators within the systems can keep mesopredator populations in check.
Arboreal Mammals

Four arboreal mammals were recorded during the surveys, all during the late dry season surveys. These included, sugar glider (*Petaurus breviceps*), black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*), and common brushtail possum (*Trichosurus vulpecula*).

Reptiles

Eighteen reptile species were recorded during the surveys, 17 during late dry season surveys, and nine (some previously recorded) during early wet season surveys. Of those recorded during the early wet season, only one species was not detected in the late dry season surveys - sand goanna (*Varanus gouldii*). One species, Eborac Island gecko (*Nactus eboracensis*) is listed as a priority species under the BPA for Cape York.

Amphibians

Nine amphibian species were recorded during the surveys, four during the late dry and five during the early wet season. Only one species was recorded during both surveys, cane toad (*Rhinella marinus*). One species, six-toothed rainbow-skink (*Carlia sexdentata*) is listed of bioregional significance under the BPA for Cape York.

Migratory and Marine Fauna Species

A total of ten migratory bird species were recorded across the site (three migratory marine, four marine and three migratory birds). Most records being in proximity to fringing wetland areas. A further four species are likely to occur or may occur in the Project area. After periods of significant rain many areas would retain water. These areas would expect to provide temporary wetland habitats for migratory species. These species and their likelihood of occurrence within the Project area are summarised in Table 14 of Appendix F.

Fauna of Bioregional Significance

Seven species of bio-regional significance were recorded during the surveys. These are:

- slender frog (*Austrochaperina gracilipes*);
- Six-toothed rainbow-skink;
- Mistletoe bird (*Dicaeum hirundinaceum*);
- Dollarbird (*Eurystomus orientalis*);
- Varied triller (*Lalage leucomela*);
- Eborac Island gecko; and
- Great bowerbird (*Ptilonorhynchus nuchalis*).}

Fauna of Cultural Significance

Culturally significant fauna listed under the NC Act include least concern bird species which are listed under JAMBA, CAMBA and ROKAMBA and the koala (*Phascolarctos cinereus*), echidna (*Tachyglossus aculeatus*) and the platypus (*Ornithorhynchus anatinus*). The only species of cultural significance recorded during surveys were a number of migratory avian species listed under
international agreements. It is likely the echidna occurs within the Project area, evidence of this species was noted in the RPS 2012 surveys.

**Introduced Fauna**

Four introduced pest fauna species were recorded during the surveys and it is likely that an additional one other pest species (identified through the desktop search) occurs with the Project area. All of the observed introduced species were Class 2 pests. These species are detailed in Table 15 of Appendix F.

Feral pest species such as the dog/dingo, feral cat, feral pig and cane toad would be expected to occur throughout the Project area and broader region.

The observation of cane toads in the area is of importance given that this region is also potential habitat for northern quoll (*Dasyurus hallucatus*) which feed on the cane toad. Despite no quolls being found within the Project area, it is relevant to note that ingestion of a cane toad by animals can result in death and as a result the cane toad is recognised as a key threatening process for species in the area.

**Threatened Fauna**

One threatened fauna species listed under the NC Act was recorded from the Project area during fauna surveys, being near threatened palm cockatoo. A further two threatened fauna species are considered likely to occur in the Project area, being black-necked stork and beach stone-curlew. These species and their likelihood of occurrence within the Project area are summarised in Table 14 of Appendix F.

**6.6.4 Potential Impacts**

**6.6.4.1 Direct Impacts**

**Land Clearing**

Land clearing would occur during the construction and operation phases of the Project as a result of clearing of mining areas, and areas for ancillary infrastructure (e.g. haul roads (both options), barge loading facility). Clearing of remnant vegetation will be required across both the mining and infrastructure footprints and approximate areas are summarised in Table 17 of Appendix F (Option 1) and Table 18 of Appendix F (Option 2). Of the REs to be cleared, one is listed of concern (RE 3.3.12), while the remainder are listed as least concern. The area to be cleared does not include any TECs. Clearing of vegetation would occur in stages as mining progresses.

The effects of land clearing may include:

- Loss of vegetation communities or individual threatened species;
- Reduced species abundance and biodiversity;
- Loss of habitat, loss of connectivity between habitat areas and associated diminished fauna movement; and
- Loss of land stabilisation and riparian filtration functions.
**Habitat Loss**

Clearing of vegetation would result in loss of habitat for terrestrial flora and fauna species. Habitat loss has been limited to the mine and minor infrastructure areas. Residual impacts on habitat within the Project footprint would be expected to arise as a result of:

- Encroachment on riparian vegetation associated with Skardon River and Skardon River-Cotterell River Aggregation by Project activities; and
- Removal of habitat, such as tree hollows and coarse woody debris, from within mine and infrastructure footprints.

**Habitat Fragmentation**

Connectivity across the broader Project area has been considered in terms of habitat connections and broader corridors with regional linkages beyond the boundaries of the Project area. Within the Project area connectivity is linked to riparian corridors associated with the Skardon River and contiguous areas of terrestrial vegetation in BH1 and BH6.

The primary areas of impact on connectivity within the Project area as a result of the Project, include:

- Loss of connectivity within the band of terrestrial vegetation in MLA 20676 associated with the establishment of the BH1 mine area. This would result in areas to the west of the pit footprint becoming isolated from large, contiguous tracts of vegetation to the east of the Project area;
- Loss of connectivity between riparian corridors and wetland areas in the south of MLA 20676, and between MLA 20676 and riparian and wetland habitats to the west; and
- Reduced connectivity of riparian corridors along the lower Skardon River associated with the construction mine areas and haul roads (both options). Fauna movement along this corridor and access for less mobile species to aquatic habitats would be restricted. The haul road (both options) also increases the potential for interaction between vehicles and fauna, which would be mitigated by imposing slower speed limits at the crossing point.

**Edge Effects**

A key impact associated with the clearing of vegetation and construction of infrastructure and mine area is the creation of smaller patches of vegetation, with a greater edge-to-surface-area ratio. Impacts associated with this increase in edge area are known as ‘edge effects’ and include increased exposure to weed invasion, light and wind penetration (which can alter microclimate features). Plant communities may become susceptible to disease and an overall decrease in health; over time community structure and composition may change as a result. The quality of associated fauna habitats may deteriorate as a result and some species are known to avoid disturbed habitats.

The impacts of edge effects are difficult to quantify as these effects occur gradually over time. Therefore, direct impacts such as vegetation loss and fragmentation are used to determine impacts.

**Impacts on Surface Water**

Potential impacts to surface waters arising from the Project with the potential to impact aquatic values of the Project area include, water quality and alteration of surface water inflows to the swamps and wetland associated with the Skardon River.
During mining, minor drainage channels supplying water to the Skardon River and associated swamps and wetlands would be disrupted, potentially altering flows to these watercourses. Surface water flows from areas associated with the Project may carry pollutants including, sediments, hydrocarbons and other chemicals. These would negatively impact water quality of aquatic environs, and lead to significant impacts of aquatic values.

Similarly any contamination of groundwater due to Project activities may impact surface waters through groundwater baseflows to these environments.

**Impacts to Groundwater**

Groundwater resources are present within the Project area and have been assessed in Section 6.8. An assessment of the groundwater resources in the Project area has been completed and potential impacts to groundwater discussed. One potential area of impact is due to clearing of vegetation required and lowering of the ground surface during mining this has the potential to temporarily increase recharge rates. Numerical groundwater modelling predicts that groundwater discharge rates to Bigfoot Swamp and Skardon River (including the tributaries and estuary) may increase during mining. The quality of recharge water is expected to remain unaffected and relatively small additional volumes of groundwater discharged to the Skardon River are not expected to adversely affect aquatic or riparian ecosystem function. Additional volumes of groundwater discharged to Bigfoot Swamp have the potential to increase the pool levels during times of inundation. The potential for increased pool levels to affect wetland ecosystems will depend on their resilience and resistance to variations in pool levels, and the extent to which increased discharge raises pool levels outside the natural range.

**Dust**

Dust generation has the potential to smother plants, reducing photosynthesis and resulting in decreased vegetation condition or the death of vegetation. Project activities likely to generate dust include mining, waste rock stockpiling, vehicle movements, stockpiling (e.g. topsoil, spoil, product bauxite), and bauxite transport (e.g. haul trucks, etc.). A deposition rate of 500 mg/m²/day is considered sufficient to have a detrimental effect on plant health.

Dust impacts are typically assessed for sensitive receptors (e.g. places of residence) within close proximity to dust generating activities. While not directly linked to terrestrial flora and fauna values, the results of dust deposition assessments should be reviewed to assess the likely extent of impact of dust generating activities within the Project area.

**Noise**

Increased noise from operation of machinery and vehicle traffic has the potential to disturb terrestrial fauna species and impact on feeding and breeding behaviour. In general, increased activity levels are likely to result in reduced fauna activity around work areas.

**Light**

Key sources of light generation in the Project area will be the mine areas and associated infrastructure areas, and haul roads. Headlights and flashing lights associated with vehicle movements will also contribute. Combined, these sources would also be expected to result in ‘sky glow’ or the general lightening of the night sky.
Light spill has the potential to impact on nocturnal terrestrial fauna species by disrupting feeding behaviour and reducing effective ranges. It can also impact on the breeding behaviour of some species. Conversely, increased light will attract insects which may be beneficial for some species.

**Traffic**

The traffic generation associated with the Project has the potential to impact terrestrial flora and fauna in the following ways:

- Mortality resulting from vehicle collision;
- Dust generation, which has the potential to smother roadside plants thereby affecting vegetation condition and reducing available habitat and food resources; and
- Noise disturbance which can disrupt fauna behaviour.

Direct fauna mortality associated with vehicle movement on haul roads and access roads has the potential to impact on a number of fauna species. Reptile species which may use road verges as habitat are susceptible to collision as they are less mobile than other species.

**Increased Fire Risk**

The Project has the potential to increase fire risk associated with the operation of vehicles, and activities undertaken by site personnel (e.g. welding, cigarette butts). Uncontrolled fires have the potential to alter ecosystem characteristics and directly and indirectly impact on ecological values in the Project area.

**Weeds**

The Project area lies in close proximity to extensive disturbance associated with the abandoned Skardon Kaolin Project. There are; however, extensive areas of woodland that are free from disturbance, with the exception of riparian zones and swamps which have impacts associated with feral pigs and cattle. Although existing weed issues are subsequently minor, there is considerable potential that presently intact habitats will be degraded by exotic species.

**Pest Fauna**

Feral animals declared as pets under the Land Protection Act represent a threat to primary industries and natural resources and responsibility for control rests with landholders. The following pest animals were recorded from the Project area:

- Dog/dingos;
- Wild dogs;
- Feral cats;
- Feral pigs; and
- Cane toads.

Impacts of these species are likely to include the following:

- Predation on native species;
- Competition for food resources, which may decrease abundance of prey for native predator species;
- Habitat changes due to destruction of plants; changed floristic composition; reduced regeneration of plants; alteration of soil structure; increased invasion and spread of weeds;
- Increased access for non-native predator species;
- Toxicity to native species;
- Reduced water quality and availability; and
- Spread of exotic invertebrates and creation of habitats suitable for disease.

### 6.6.4.2 Indirect Impacts

This section identifies the impacts that are associated with changes in surface water and groundwater levels as a result of clearing. The response of the terrestrial ecosystem to predicted changes in the size and depth of inundation is difficult to predict. As with most ecosystems associated with variable and perennial inundation, terrestrial ecology values are likely to be tolerant of significant changes in available habitats. Species utilising these areas can generally tolerate a range of conditions; however, there will be a variable reduction in available habitats due to longer and higher inundation levels within the surrounding areas of Big Foot Swamp. This may potentially alter vegetation communities and their extent subject to toleration of longer period of and deeper levels of inundation. It is, however, unlikely that changes to hydrology of the swamp that are predicted to occur during mining activities will significantly alter overall terrestrial flora diversity. If the size of standing water during the dry season significantly increases in area, and does not dry out over a period of years, it is possible that there will be mortality of Melaleuca trees as a result of anaerobic soil conditions. Currently Bigfoot Swamp has an area absent of any tree species directly surrounding the area of standing water during the dry season. The size of this area may increase over time during mining operations; however, following a return to current hydrological conditions, it is likely that Melaleuca trees will recolonise these areas.

### 6.6.4.3 Impacts on Threatened Terrestrial Flora Values

No endangered REs were recorded in the Project area and therefore impacts to these are not considered. Two of concern REs were recorded in the Project area (e.g. mining lease areas and infrastructure footprints). Of these, RE 3.3.51 does not overlap the mine or infrastructure footprints, and therefore significant impacts to this RE are not anticipated. However, RE 3.3.12 overlaps the infrastructure footprint of some haul roads and extraction pits, with approximately 0.38 ha expected to be cleared through Option 1, and approximately 0.7 ha expected to be cleared through Option 2. The area of disturbance would be minimised to the greatest extent possible through reducing the haul road width if possible or adjustments to their location where possible. Additional impacts to remaining vegetation communities would be minimised where practicable.

No nationally significant EPBC Act listed flora species were recorded within the disturbance footprints of the mine areas during the surveys. It is, however, considered *Dendrobium bigibbum* and the brown antelope orchid both listed as vulnerable are likely to occur in the broader Project area due to the presence of suitable habitat. Potential records of the brown antelope orchid were encountered within wetland habitats proximate to the Project area; however, individuals were not in flower and not able to be positively identified. It is more likely these individuals were fragrant tea tree orchid based on form and habit. These species have been recently split by the Queensland Herbarium (pers comms, David Fell 2015). All orchid species were detected in Melaleuca swamps.
adjacent to proposed mining operations and are unlikely to be impacted by the proposed mining operations. As both listed orchid species share similar habitats within the region, both have been considered as potentially impacted. Impacts to these species have been assessed through a Significant Impact Assessment found within the Biodiversity Offsets Strategy prepared by Amec Foster Wheeler (2015). No TECs were recorded in the Project area and therefore impacts to these were not considered.

No state significant flora species were recorded in the surveys. It is considered the near threatened grass species *Heterachne baileyi* is likely to occur within the broader project area and has been historically identified by other studies in the region. This species is likely to be restricted to riparian and wetland areas and unlikely to be impacted the proposed mining activities.

Riparian and watercourse vegetation occurs within the Project area but not within the mine footprint. Two watercourses (stream order 2) will be crossed by development of internal roads and haul roads (both options) resulting in an estimated 9.04 ha (Option 1) and 6.42 ha (Option 2) of remnant vegetation being impacted.

### 6.6.4.4 Impacts on Threatened Terrestrial Fauna Values

Impacts to threatened terrestrial fauna would result from land clearing, habitat loss and fragmentation. The potential occurrence of threatened fauna species, habitat associations and impacts are summarised in Table 19 of Appendix F.

Essential habitat for most of the migratory and marine avian species known to occur, or likely to occur within the Project area includes coastal, wetland, riverine and riparian habitats. It is predicted approximately 22 ha (Option 1) and 30 ha (Option 2) of these moister habitats will be impacted by the proposed development layout through clearing for infrastructure. Impacts to these species were not considered significant. The Project will result in minor impacts to suitable habitat for a number of migratory species, mainly associated with jetty and haul road components which intersect riparian and mangrove habitats. These habitats are highly common and extensive throughout the region and the Project is unlikely to substantially modify, destroy or isolate areas of important habitat for migratory species. The area of disturbance would be minimised to the greatest extent possible.

Impacts to migratory avifauna which utilise drier habitats such as the rainbow bee-eater or dollar bird were not considered significant either given the extent and quality of habitat supported within the wider region and their ability to adapt to impacts (e.g. persist in urban and cleared environments).

### Potential Offset Requirements

Biodiversity offsets would be required for the Project to compensate for any significant, residual impacts to MNES and biodiversity values listed as MSES. Offsets for the Project are required to be assessed and delivered under the EPBC Offsets Policy and EO Act. To fully address the Projects offset requirements a Biodiversity Offsets Strategy Report has been prepared by Amec Foster Wheeler (2015) (refer to Appendix G). This report evaluates both MNES and MSES offset requirements, including a Significant Impact Assessment for MNES and MSES under the applicable guidelines to determine the extent of offsets required. Offset delivery options are then considered (e.g. direct offsets, financial contributions, in-direct offsets) as applicable under relevant policies and timing of offset delivery.

For further details on this assessment refer to the Biodiversity Offsets Strategy Report (Appendix F) (Amec Foster Wheeler, 2015).
6.6.5 Management and Mitigation Measures

The proposed management and mitigation processes outlined within this document will be provided within the Project EMP. In addition to the Project EMP, Significant Species Management Plans will be prepared for significant terrestrial flora and fauna such as the example shown at Figure 6-15 for marine turtles.

6.6.5.1 Direct Impacts

Land Clearing

General mitigation measures to be implemented to reduce the impacts of vegetation clearance and habitat loss include:

- Clear delineation of areas of native vegetation requiring removal to equipment operators and supervisors before any clearance to ensure disturbance is minimised;
- Maintenance of retained areas of existing vegetation to assist in providing a source of seed for mine rehabilitation works;
- Preparation of a site rehabilitation management plan which incorporates rehabilitation monitoring and trials;
- Where practicable, minimise the total area of disturbance at any particular time and implement progressive rehabilitation;
- Use of native species for rehabilitation wherever possible; and
- Monitoring of rehabilitation success to be conducted at locations representative of the range of conditions on the rehabilitating areas. Reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness.

Habitat Loss

Impacts on habitat and associated fauna would be minimised by:

- Minimising vegetation clearance along drainage features in order to maintain bank stability, habitat connectivity and movement corridors for terrestrial fauna species and a habitat refuge for fauna seeking shelter and water including the use of alternate citing for haul roads;
- No clearing of riparian vegetation, or if riparian clearing is required, minimising this to the greatest extent possible and implementing appropriate management and/or mitigation measures;
- Having a qualified spotter-catcher available when clearing in habitat areas; and
- Progressive rehabilitation of mined areas to incorporate the provision of nest hollows and microhabitat features such as trees and logs.

Habitat Fragmentation

These site-scale impacts on connectivity are not considered to have a significant impact on regional-scale connectivity or the value of state-significant biodiversity corridors to the south.
**Edge Effects**

Rehabilitation of disturbed areas and the provision of buffers around undisturbed areas of remnant vegetation will help to minimise edge effects. Similarly, adopting other measures described throughout this assessment will help to lessen the impact of edge effects over the life of the Project.

**Impacts on Surface Water**

Management of potential impacts to water quality within aquatic environs may include:

- Preparation of a site erosion and sediment management plan which incorporates rehabilitation monitoring and trials;
- Implementing suitable spill containment around hydrocarbon, chemicals and other harmful substance stores; and
- Implementing a site-specific water quality monitoring program.

Refer to Section 6.7.5 for additional management and mitigation measures associated with potential impacts to surface water.

**Impacts to Groundwater**

Refer to Section 6.8.5 for management and mitigation measures associated with potential groundwater impacts.

**Dust**

Refer to Section 6.9.5 for management and mitigation measures related to air quality including dust suppression and avoidance measures.

**Noise**

Activities that generate increased noise should be restricted to daylight hours to minimise impacts on the breeding and feeding behaviour of nocturnal animals. Refer to Section 6.10.5 for further details on proposed noise attenuation measures.

**Light**

Lighting will be required for the construction and operational activities associated with the Project. The following lighting impact management measures will be employed for the Project:

- Lighting will be limited to only that which is essential during both construction and operational periods;
- The current mine plan is based on a single daytime 12-hour shift for mining, therefore land-based lighting at night time will be minimal;
- Ground-level path lighting will be used, where practicable; and
- Intense lights, or cluster of light, will be avoided, where practicable.
Traffic

The highest risk of direct fauna mortality is likely to be associated with vehicles travelling along the haul road to the barge loading facility. This risk is heightened where the corridor is in close proximity to riparian corridors and wetlands associated with the Skardon River. Reduced speeds should be implemented to minimise the risk of vehicle collision with fauna. Provision of lighting also reduces the risk of startling animals crossing the road at night.

Where possible, native fauna injured during construction and operational phases of the Project would be taken to a vet or wildlife carer. In the event of injuries to domestic fauna or livestock, personnel would call for veterinary assistance and notify the appropriate landholder. Given the remote nature of the mining operations, veterinary assistance may not be available, in which case a site procedure for humane euthanasia of critically injured fauna will be developed.

Increased Fire Risk

Appropriate management systems should be put in place to prevent accidental ignition of fires. Vegetation retained on site should be managed for fuel load and appropriate fire regimes should be put in place to maintain biodiversity values while minimising the risk of bushfire. Fire regimes and management measures will be documented in a site-specific Fire Management Plan that will be developed in coordination with the Mapoon Land and Sea Rangers, and any neighbouring management plans.

Weeds

Weed management measures to be implemented in the Project area should include:

- Wash down facilities to be constructed at access points for vehicles arriving and departing from the Project site. These facilities are to be bunded and located away from drainage lines to minimise the risk of weed spread;
- Vehicles entering the Project site and leaving properties known to contain declared weeds will be thoroughly washed down before entering clean areas; ensuring that wheels, wheel arches and the undercarriage are free of mud and plant material;
- Radiators, grills and vehicle interiors will be cleaned of accumulated seed and plant material;
- Vehicles to keep to roads or compacted surfaces (preventative) and reduce vehicle movements in wetted soil where avoidance is not possible;
- Identified weeds of management concern, including declared and environmental weeds, to be controlled in accordance with local best practice management as described in the Pest Fact sheets published by the Department of Agriculture and Fisheries;
- Treated areas will be monitored to assess the success of declared weed eradication;
- Weed management to be included in the site induction program for the Project to promote awareness of weed management issues; and
- A site-specific Weed and Pest Management Plan is to be developed for the Project in coordination with the Mapoon Land and Sea Ranges current weed and pest management practices.
Pest Fauna

The following general mitigation measures are proposed for the management of pest animal species:

- Appropriate disposal and management of wastes on site; and
- A site-specific Weed and Pest Management Plan is to be developed for the Project in coordination with the Mapoon Land and Sea Ranges current weed and pest management practices.

6.6.5.2 Management of Indirect Impacts

Given the unpredictable nature of potential impacts to Bigfoot Swamp, a REMP will be developed with consideration of DEHP’s Receiving Environment Monitoring Program Guideline - For use with Environmental Relevant Activities under the EP Act (2014). The REMP will include annual monitoring of Bigfoot Swamp. Where significant changes in the swamp are observed, suitable mitigation measures will be developed and undertaken if necessary.

6.6.5.3 Management of Impacts on Threatened Terrestrial Flora Values

The area of direct disturbance to riparian vegetation will be minimised to the greatest extent possible. Buffer zones to watercourses (Figure 6-20) will be in accordance with the defined distances as stipulated under the EO Policy for the Cape York Peninsula Bioregion and comprise:

- 25 m for stream order 1 or 2 watercourses;
- 50 m for stream order 3 or 4 watercourses; and
- 100 m for stream order 5 or greater watercourses.

Impacts on remnant watercourse vegetation would be avoided or minimised through:

- Reducing the width of haul roads/internal roads where they cross watercourses;
- Maintaining adequate buffers from the Skardon River riparian corridor, and providing appropriate scour and erosion protection to maintain the integrity of vegetation and ecological function;
- Maintaining adequate buffer distances from watercourses not directly impacted by mining; and
- Acceptance of Option 1 haul road alignments.
6.6.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential terrestrial ecological impacts is summarised in Table 6-32. An analysis of initial risk, without mitigation, was considered for terrestrial ecology. The residual risk considers the mitigation and management measures developed for this element and put forward in this assessment.

Table 6-32 Qualitative risk assessment - terrestrial ecology

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land clearance and habitat loss</td>
<td>Moderate</td>
<td>Almost Certain</td>
<td>Extreme</td>
<td>▪ Minimise vegetation clearance along drainage features ▪ Provide exclusion fencing between the Skardon River riparian zone and the edge of the mining footprint ▪ Have a qualified spotter-catcher available during clearing activities ▪ Rehabilitation to incorporate the provision of nest hollows and microhabitat features</td>
<td>Medium</td>
</tr>
<tr>
<td>Habitat fragmentation</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Avoid state-significant biodiversity corridors to the south ▪ Ensure construction and operational activities occur within the designated areas</td>
<td>Low</td>
</tr>
<tr>
<td>Impacts on surface water</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Implement suitable spill containment around hydrocarbons, chemical and other harmful substances stores ▪ Implement a site specific water quality monitoring program ▪ Prepare an ESCP ▪ Refer to Section 6.7.5</td>
<td>Low</td>
</tr>
<tr>
<td>Impacts on groundwater</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Dust suppression ▪ Seal roads, where practicable ▪ Refer to Section 6.8.5</td>
<td>Low</td>
</tr>
<tr>
<td>Smothering plants due to increased dust</td>
<td>Minor</td>
<td>Likely</td>
<td>Medium</td>
<td>▪ Refer to Section 6.9.5</td>
<td>Low</td>
</tr>
<tr>
<td>Change in feeding and breeding behaviours of nocturnal fauna as a result of increased noise</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Activities that generate significant noise will be restricted to daylight hours ▪ Refer to Section 6.10.5</td>
<td>Low</td>
</tr>
<tr>
<td>Disrupted feeding behaviours and turtle nesting due to light spill</td>
<td>Moderate</td>
<td>Unlikely</td>
<td>Medium</td>
<td>▪ Lighting will be limited to only that which is essential ▪ Ground-level path lighting will be used, where practicable ▪ Intense lights, or cluster of light, will be avoided, where practicable</td>
<td>Low</td>
</tr>
</tbody>
</table>
### Potential Impacts

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality from vehicle collisions</td>
<td>Major</td>
<td>Unlikely</td>
<td>High</td>
<td>▪ Implement speed limits&lt;br&gt;▪ Avoid riparian corridors and wetlands</td>
<td>Low</td>
</tr>
<tr>
<td>Altered ecosystems as a result of fires</td>
<td>Moderate</td>
<td>Unlikely</td>
<td>Medium</td>
<td>▪ Retain vegetation on site for fuel load and conduct appropriate fire regimes&lt;br&gt;Develop and implement a site specific Fire Management Plan</td>
<td>Low</td>
</tr>
<tr>
<td>Introduction and spread of weeds and introduction of pests</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Develop and implement a site specific Weed and Pest Management Plan&lt;br&gt;Monitor management measures&lt;br&gt;Appropriate disposal and management of wastes</td>
<td>Low</td>
</tr>
</tbody>
</table>

### 6.6.7 Summary

The Project area supports a relatively low diversity of vegetation communities and terrestrial flora and fauna species. As a worst case scenario the Project will clear approximately 1,650 ha of remnant vegetation, based on Option 2. Clearing is dominated by least concern RE 3.5.2 (approximately 98% of all clearing). While two of concern REs were mapped in the Project area, only one RE 3.3.12 will be impacted by the Project with the largest impact being 0.7 ha. There may be opportunities to reduce this impact through adopting the alternate haul road location assuming approval from other parties is obtained and/or refining the location of haul roads within Metro Mining’s MLA.

Other key areas of remnant and riparian vegetation associated with the Skardon River, and Skardon River-Cotterell River Aggregation occur in the Project area, but not within the mining footprints. Remnant vegetation in the Project area has linkages to recognised regional and state-significant biodiversity corridors but does not itself form part of these corridors. Intact landscape-scale linkages will remain around the Project area. No TECs occur in the Project area.

One threatened fauna species (palm cockatoo) was recorded during surveys and several other fauna and flora are known to occur in the area or have been recorded in previous studies.

Key habitat resources for fauna identified through the assessment include permanent water sources associated with riparian corridors and wetlands of the Skardon River-Cotterell River Aggregation, and large tracts of contiguous remnant vegetation to the south and east of the Project area. In particular wetland areas to the north and west of the Project area (including Big Foot Swamp) were observed to support a relatively high diversity of fauna species, when compared to the dominant Darwin stringybark community. Consequently these wetland areas may provide particular niche habitats for significant species.

The broader Project area is also known to support several threatened flora species or their suitable habitat including the near threatened grasses *Heterachne baileyi*, *Lepturus geminatus*, *Eremochloa ciliaris*, and potential to support the vulnerable epiphytic orchids brown antelope orchid and *Dendrobium bigibbum* (see Table 11 of Appendix F). Further flora surveys during flowering are required to confirm and quantify the abundance and distribution of these threatened species.
The Project will result in no removal of permanent water sources but will result in minor areas of riparian habitat being removed and up to 14 ha (worst case scenario) of mangrove and intertidal areas being lost to accommodate haul roads and the proposed barge loading facility on the Skardon River.

To fully address the Project’s offset requirements a Biodiversity Offsets Strategy Report has been prepared by Amec Foster Wheeler (2015) and is included as Appendix G. This report aims to detail the Project’s estimated extent of significant, residual impacts to MNES and MSES.

### 6.6.8 Commitments

Metro Mining’s commitments for terrestrial ecology management are provided in Table 6-33.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE1</td>
<td>Develop and implement an offsets strategy that compensates for unavoidable clearing as per the Biodiversity Offsets Strategy Report.</td>
</tr>
<tr>
<td>TE2</td>
<td>Develop and implement a Fire Management Plan.</td>
</tr>
<tr>
<td>TE3</td>
<td>Develop and implement a Weed and Pest Management Plan.</td>
</tr>
<tr>
<td>TE4</td>
<td>Develop and implement an Erosion and Sediment Control Plan.</td>
</tr>
<tr>
<td>TE5</td>
<td>Fauna spotters to be used prior to clearing activities.</td>
</tr>
<tr>
<td>TE6</td>
<td>Develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to EVs.</td>
</tr>
<tr>
<td>TE7</td>
<td>Clearing will be minimised to the extent needed for operational requirements.</td>
</tr>
<tr>
<td>TE8</td>
<td>Progressive rehabilitation will be undertaken throughout the mine life to minimise the area of land under disturbance.</td>
</tr>
</tbody>
</table>

### 6.7 Surface Water Resources

This section summarises baseline conditions to the Project site and determines potential Project impacts relating to surface water quality, water resources, and catchment hydrology and flood hydraulics (refer to Appendix H for the technical report) which should be read in conjunction with this section. The impact assessment contained herein has been conducted in accordance with the regulatory framework and is measured against EVs and performance objectives for surface water resources that may potentially be affected by the proposed Project. This section also outlines proposed mitigation measures to manage any potential impacts.

#### 6.7.1 Regulatory Framework

Currently in Queensland, water resources and water quality are assessed and managed under a number of state, national and international regulatory instruments and guidelines. The following are relevant to the Project:

- *Water Act 2000* (Water Act);
- *Environmental Protection Act 1994* (EP Act);
- Environmental Protection (Water) Policy 2009 [EPP(Water)];
- Water Resource (Great Artesian Basin) Plan 2006 (GAB WRP);
- DEHP Queensland Water Quality Guidelines (QWQG) 2009;
Australian and New Zealand Environment and Conservation Council and Agriculture and Resources Management Council of Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC and ARMCANZ guidelines);

- DEHP Guidelines - Application requirements for activities with impacts to water (EM963); and

**Water Act 2000**

The Water Act provides a structured system for the planning, protection, allocation and use of Queensland's surface waters and groundwater. Under section 808 of the Water Act, a person must not take, supply or interfere with water unless authorised. Authorisation under the Water Act for the taking of water from overland flow, a watercourse, lake or spring comes via a water entitlement and a development application. The Water Act also governs the safety and surveillance of dams.

The majority of water management activities that are conducted on the Project will be covered by the Water Act.

**Environmental Protection Act 1994**

The EP Act provides the key legislative framework for environmental management and protection in Queensland. The object of the EP Act is to: “Protect Queensland’s environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends” (Section 3). The EP Regulation addresses Queensland wetland mapping.

The EP Act has a range of subordinate legislation which assists in achieving its object including the EPP (Water).

**Environmental Protection (Water) Policy 2009**

The EPP (Water) provides the basis for the effective administration and enforcement of the EP Act. The EPP (Water) seeks to protect Queensland waters while allowing for ESD. Queensland waters are defined as including rivers, streams, wetlands, lakes, aquifers, estuaries and coastal areas. The purpose of the EPP (Water) is to:

- Identify EVs for the defined water; and
- Determine water quality guidelines and water quality objectives (WQOs) to enhance or protect the identified EVs.

Specific geographical areas have been designated in Schedule 1 of the EPP (Water) as having EVs to be enhanced or protected. A review of the EPP (Water) indicates that EVs and WQOs have not yet been defined for the Ducie River drainage sub-basin. Those EVs most likely relevant to the Project include:

- Biological integrity or aquatic ecosystems;
- Secondary recreation use;
- Aesthetic purposes;
- Drinking water; and
- Cultural and spiritual values.
The EPP (Water) specifies the relevant guidelines to be used in the assessment of surface water quality. The hierarchy of guidelines for assessment associated with water quality are:

- Site specific guidelines such as those listed in Schedule 1 of EPP (Water);
- QWQG; and
- ANZECC and ARMCANZ guidelines.

This Project is located in the Gulf Rivers Region outlined in the QWQG. As mentioned in the QWQG, no specific WQO have yet been established for the Cape York Region. Therefore, in accordance with the QWQG, the national ANZECC and ARMCANZ guidelines for fresh water have been used for comparative purposes when assessing existing local and regional surface water quality.

In cases where baseline water quality values exceed the ANZECC and ARMCANZ default trigger values, the ANZECC and ARMCANZ guidelines recommend deriving local trigger values provided sufficient data exist to do so. The plausibility of deriving local water quality trigger values using all available data is discussed below.

The mean, median, 80th percentile and 20th percentiles were calculated for parameters where sufficient data exists. For statistical calculation of percentiles, a minimum of four data points is required. Although percentiles can be calculated with fewer data points, accuracy increases with increasing sample numbers. As outlined in the QWQG, percentiles should be calculated with around five data points, but preferably with 15-20 data points, as percentile values level off with higher sample sizes. Deriving percentiles from small sample sizes leads to percentile estimates that lie inside (i.e. below) the true percentile values (i.e. more stringent values). All data are presented by surface water category: fresh water/springs and estuarine/marine.

**Water Resource (Great Artesian Basin) Plan 2006**

The objectives of the GAB WRP are to define the availability of water and provide a framework for sustainable management of water within the Queensland component of the GAB. The GAB WRP regulates mining extractions and addresses connectivity through the protection of flows to springs and surface water flows sourced from the GAB.

**DEHP Guidelines - Application requirements for activities with impacts to water (EM963)**

The Application requirements for activities with impacts to water (EM963) is the water related guideline for ERAs under the EP Act. The guideline requires three key areas to be addressed:

- Identify the EVs of the receiving environment (Section 6.7.3);
- Identify the possible impacts due to the proposed activity (Section 6.7.4) and all associated risks to the EVs (Section 6.7.6); and
- Identify the strategies to mitigate the identified risks to the EVs (Section 6.7.5).

This section will address, as a minimum, the aforementioned requirements in the following sections.

**International Erosion Control Association Guidelines 2008**

The IECA guidelines form the industry best practice and are recommended for use in the DEHP Application requirements for activities with impacts to water (EM963). These guidelines provide a framework for conducting erosion and sediment control measures. IECA may specify appropriate erosion control measures for a given slope and soil type during construction activities.
6.7.1.1 Environmental Objectives and Performance Outcomes

In accordance with the EP Act (Section 125), generally there are three key areas to be identified and addressed through the ERA application process regarding water:

- Identify the EVs of the receiving environment;
- Identify the possible impacts due to the proposed activity and all associated risks to the EVs; and
- Identify the strategies to mitigate the identified risks to the EVs.

For EA applications that have the potential to impact on waters, the application must describe how the following environmental objective and performance outcomes for the ERA will be achieved. Under the EP Regulation (Schedule 5, part 3, table 1) and the Guideline for Application Requirements for Activities with Impacts to Water (Section 2), the environmental objective and performance outcomes for water are:

**Environmental Objective (Water)**

The activity will be operated in a way that protects EVs of waters.

**Performance Outcome**

There is no actual or potential discharge to waters of contaminants that may cause an adverse effect on an EV from the operation of the activity.

All of the following:

- The storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;
- Contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;
- The activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an EV will not leave the site without prior treatment;
- Any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland; and
- The activity will be managed so that adverse effects on EVs are prevented or minimised.

**Environmental Objective (wetlands)**

The activity will be operated in a way that protects the EVs of wetlands.

**Performance Outcome**

- There will be no potential or actual adverse effect on a wetland as part of carrying out the activity; and
- The activity will be managed in a way that prevents or minimises adverse effects on wetlands.
6.7.2 Assessment Method

6.7.2.1 Baseline Assessment

The assessment method to determine the potential impacts on surface water and hydrology has been based on the following:

- A review of regulatory framework;
- Water sampling and laboratory testing from 16 locations;
- A flood frequency analysis, to determine the likely flow in the Skardon River for a given Average Recurrence Interval (ARI);
- Hydrologic modelling using the RORB software package to establish the relationship between rainfall and runoff, calibrated against the flood frequency analysis;
- Water balance modelling, in which Boughton’s Australian Water Balance Model (AWBM) was incorporated into the GoldSim modelling environment to determine the water budget for the Skardon River catchment; and
- Flood assessment of the Skardon River and tributaries using 2D modelling software to predict flood characteristics, such as inundation extent, flood depth and flow velocities for ARI events up to an including the Probable Maximum Flood (PMF).

6.7.2.2 Water Quality

The existing water quality for the Project area was examined from a range of data sources as outlined below. These data are discussed and compared in the following sections and in relation to local data, data from the broader region and the ANZECC and ARMCANZ guidelines.

- DNRM gauge station data from the Dulhunty River station;
- Publically available data from nearby projects, namely Rio Tinto Alcan’s SoE EIS (Volume 3, Section 16, 2012) Project located approximately 110 km to the south of this Project and the previously planned Metro Mining Pisolite Hills Project approximately 50 km to the south of this Project (data collection spanned 2008-2013);
- Water quality data from the immediately adjacent Gulf Alumina SRP for which an EIS is currently being undertaken; and
- Specific water quality monitoring undertaken for this Project. Samples taken represent both freshwater and estuarine/marine water as outlined below.

6.7.2.3 Historical Water Quality

DNRM is required to obtain and publicly provide information and data on the quantity and quality of water in Queensland for the purposes of water planning under the Water Act. The Queensland Government has undertaken water monitoring at various gauging stations throughout the state since the 1960s. These data can be used to provide an indication of the baseline water quality in a region over several years or decades.

A review of DNRM stream gauge information indicate that data from one stream gauge location in close proximity to the Project is available for the Dulhunty River which is located approximately 38 km to the east in the Ducie Basin (Table 6-34). These data have been used to describe the longer term historical water quality surrounding the Project area.
Not all sampling parameters were recorded during all sampling events (i.e. water quality data have not been continuously recorded) with the number of data points ranging from 81 for water temperature to 5 for Manganese. Results for the Dulhunty River water quality monitoring are shown in Table 6-35.

Table 6-35 Dulhunty River gauge site water quality data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>n</th>
<th>Mean</th>
<th>Median</th>
<th>80th percentile</th>
<th>20th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Electrical Conductivity @ 25°C (µS/cm)</td>
<td>20-250a</td>
<td>57</td>
<td>39.919</td>
<td>35.000</td>
<td>42.000</td>
<td>34.000</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>2-15b</td>
<td>45</td>
<td>2.889</td>
<td>2.000</td>
<td>3.000</td>
<td>1.200</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>81</td>
<td>25.978</td>
<td>25.900</td>
<td>28.000</td>
<td>24.000</td>
<td></td>
</tr>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>47</td>
<td>26.851</td>
<td>27.000</td>
<td>30.400</td>
<td>22.600</td>
<td></td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>40</td>
<td>8.700</td>
<td>5.000</td>
<td>10.000</td>
<td>4.000</td>
<td></td>
</tr>
<tr>
<td>Field pH</td>
<td>6-8c</td>
<td>46</td>
<td>6.228</td>
<td>6.250</td>
<td>6.600</td>
<td>5.700</td>
</tr>
<tr>
<td>Field Dissolved Oxygen (mg/L)</td>
<td>43</td>
<td>7.412</td>
<td>7.500</td>
<td>8.000</td>
<td>6.700</td>
<td></td>
</tr>
<tr>
<td>Total Alkalinity as CaCO3 (mg/L)</td>
<td>45</td>
<td>4.533</td>
<td>4.000</td>
<td>6.000</td>
<td>2.000</td>
<td></td>
</tr>
<tr>
<td>Bicarbonate (mg/L)</td>
<td>43</td>
<td>5.828</td>
<td>4.900</td>
<td>7.920</td>
<td>3.560</td>
<td></td>
</tr>
<tr>
<td>Hardness as CaCO3 (mg/L)</td>
<td>40</td>
<td>3.100</td>
<td>3.000</td>
<td>4.000</td>
<td>2.000</td>
<td></td>
</tr>
<tr>
<td>Total Dissolved Ions (mg/L)</td>
<td>47</td>
<td>22.253</td>
<td>21.400</td>
<td>27.080</td>
<td>17.920</td>
<td></td>
</tr>
<tr>
<td>Soluble Calcium (mg/L)</td>
<td>39</td>
<td>0.300</td>
<td>0.200</td>
<td>0.400</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td>47</td>
<td>9.121</td>
<td>8.600</td>
<td>12.000</td>
<td>7.060</td>
<td></td>
</tr>
<tr>
<td>Soluble Magnesium (mg/L)</td>
<td>44</td>
<td>0.598</td>
<td>0.600</td>
<td>0.800</td>
<td>0.400</td>
<td></td>
</tr>
<tr>
<td>Nitrate (mg/L)</td>
<td>8</td>
<td>0.400</td>
<td>0.500</td>
<td>0.500</td>
<td>0.180</td>
<td></td>
</tr>
<tr>
<td>Potassium (mg/L)</td>
<td>38</td>
<td>0.545</td>
<td>0.300</td>
<td>0.620</td>
<td>0.200</td>
<td></td>
</tr>
<tr>
<td>Sodium (mg/L)</td>
<td>47</td>
<td>5.640</td>
<td>5.300</td>
<td>6.040</td>
<td>4.760</td>
<td></td>
</tr>
<tr>
<td>Sulphate (mg/L)</td>
<td>19</td>
<td>2.189</td>
<td>2.000</td>
<td>4.000</td>
<td>0.600</td>
<td></td>
</tr>
<tr>
<td>Soluble Aluminium (mg/L)</td>
<td>0.0008d</td>
<td>12</td>
<td>0.044</td>
<td>0.035</td>
<td>0.082</td>
<td>0.016</td>
</tr>
<tr>
<td>Boron (mg/L)</td>
<td>0.0014 e</td>
<td>9</td>
<td>0.029</td>
<td>0.030</td>
<td>0.050</td>
<td>0.010</td>
</tr>
<tr>
<td>Copper (mg/L)</td>
<td>0.3f</td>
<td>32</td>
<td>0.074</td>
<td>0.050</td>
<td>0.088</td>
<td>0.030</td>
</tr>
<tr>
<td>Flouride (mg/L)</td>
<td>1.9g</td>
<td>5</td>
<td>0.010</td>
<td>0.010</td>
<td>0.010</td>
<td>0.010</td>
</tr>
<tr>
<td>Soluble Iron (mg/L)</td>
<td>1.9h</td>
<td>42</td>
<td>8.48</td>
<td>8.50</td>
<td>10.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Manganese (mg/L)</td>
<td>0.008i</td>
<td>9</td>
<td>0.014</td>
<td>0.010</td>
<td>0.020</td>
<td>0.010</td>
</tr>
</tbody>
</table>

* ANZECC and ARMCANZ default trigger values (95%) for Tropical Australian Lowland Rivers
* ANZECC and ARMCANZ low reliability levels for pH<6.5
* ANZECC and ARMCANZ high reliability levels 2 Sample number
6.7.2.4  Adjacent Projects

Publically available data outlined in the SoE EIS (Volume 3, Section 16) was also examined. This project is located approximately 100 km to the south near Weipa and provides a regional overview of water quality. Water quality samples from this project were taken from a range of habitats including freshwater and estuarine/marine areas (Table 6-36 and Table 6-37, respectively).
### Table 6-36 Freshwater stream water quality from the nearby SoE Project (SoE EIS, 2012) and the Pisolite Hills Project

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>South of Embley data</th>
<th>Pisolite Hills data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n(^1)</td>
<td>Mean</td>
</tr>
<tr>
<td>Electrical Conductivity (µS/cm)</td>
<td>20-250(^a)</td>
<td>56</td>
<td>26</td>
</tr>
<tr>
<td>pH</td>
<td>6-8(^a)</td>
<td>44</td>
<td>5.3</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>2-15(^a)</td>
<td>58</td>
<td>19</td>
</tr>
<tr>
<td>Dissolved Oxygen (%)</td>
<td>85-120(^a)</td>
<td>17</td>
<td>78.2</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td>58</td>
<td>28.2</td>
</tr>
<tr>
<td>Calcium (mg/L)</td>
<td></td>
<td>56</td>
<td>0.1</td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td></td>
<td>56</td>
<td>0.4</td>
</tr>
<tr>
<td>Hardness (mg CaCO3/L)</td>
<td></td>
<td>56</td>
<td>1.9</td>
</tr>
<tr>
<td>Silicon (µg/L)</td>
<td></td>
<td>18</td>
<td>592</td>
</tr>
<tr>
<td>Potassium (mg/L)</td>
<td></td>
<td>56</td>
<td>0.09</td>
</tr>
<tr>
<td>Sodium (mg/L)</td>
<td></td>
<td>56</td>
<td>3.0</td>
</tr>
<tr>
<td>Chlorine (mg/L)</td>
<td></td>
<td>56</td>
<td>6.0</td>
</tr>
<tr>
<td>Total phosphorous (mg/L)</td>
<td>0.01(^a)</td>
<td>27</td>
<td>0.03</td>
</tr>
<tr>
<td>Ammonia (mg/L)</td>
<td>0.01(^a)</td>
<td>48</td>
<td>0.02</td>
</tr>
<tr>
<td>Total nitrogen (mg/L)</td>
<td>0.2-0.3(^a)</td>
<td>49</td>
<td>0.10</td>
</tr>
<tr>
<td>Total dissolved solids (mg/L)</td>
<td></td>
<td>56</td>
<td>21.0</td>
</tr>
<tr>
<td>Sulfate (mg/L)</td>
<td></td>
<td>56</td>
<td>1.0</td>
</tr>
<tr>
<td>Aluminium(^2) (µg/L)</td>
<td>0.8(^b)</td>
<td>57</td>
<td>40.0</td>
</tr>
<tr>
<td>Aluminium(^3) (µg/L)</td>
<td>0.8(^b)</td>
<td>57</td>
<td>169</td>
</tr>
<tr>
<td>Iron(^2) (µg/L)</td>
<td>300(^b)</td>
<td>57</td>
<td>46.0</td>
</tr>
<tr>
<td>Iron(^3) (µg/L)</td>
<td>300(^b)</td>
<td>57</td>
<td>276</td>
</tr>
<tr>
<td>Chromium(^2) (µg/L)</td>
<td>1(^ac)</td>
<td>57</td>
<td>0.06</td>
</tr>
<tr>
<td>Chromium(^3) (µg/L)</td>
<td>1(^ac)</td>
<td>57</td>
<td>0.09</td>
</tr>
<tr>
<td>Parameter</td>
<td>WQO</td>
<td>South of Embley data</td>
<td>Pisolite Hills data</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>-----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td><strong>Manganese</strong>² (µg/L)</td>
<td>1900\text{a}</td>
<td>57</td>
<td>3.9</td>
</tr>
<tr>
<td><strong>Manganese</strong>³ (µg/L)</td>
<td>80\text{a}</td>
<td>57</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>Nickel</strong>² (µg/L)</td>
<td>11\text{ac}</td>
<td>57</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Nickel</strong>³ (µg/L)</td>
<td>11\text{ac}</td>
<td>57</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Copper</strong>² (µg/L)</td>
<td>1.4\text{ac}</td>
<td>57</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Copper</strong>³ (µg/L)</td>
<td>1.4\text{ac}</td>
<td>57</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Zinc</strong>² (µg/L)</td>
<td>8\text{ac}</td>
<td>57</td>
<td>0.61</td>
</tr>
<tr>
<td><strong>Zinc</strong>³ (µg/L)</td>
<td>8\text{ac}</td>
<td>57</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Arsenic</strong>² (µg/L)</td>
<td>13\text{ac}</td>
<td>57</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Arsenic</strong>³ (µg/L)</td>
<td>13\text{ac}</td>
<td>57</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Cadmium</strong>² (µg/L)</td>
<td>0.2\text{ac}</td>
<td>56</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>Cadmium</strong>³ (µg/L)</td>
<td>0.2\text{ac}</td>
<td>56</td>
<td>0.005</td>
</tr>
<tr>
<td><strong>Lead</strong>² (µg/L)</td>
<td>3.4\text{ac}</td>
<td>56</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Lead</strong>³ (µg/L)</td>
<td>3.4\text{ac}</td>
<td>56</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Mercury</strong>² (µg/L)</td>
<td>0.6\text{ac}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Mercury</strong>³ (µg/L)</td>
<td>0.6\text{ac}</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

\text{a} ANZECC and ARMCANZ default trigger values
\text{b} ANZECC and ARMCANZ low reliability levels for pH<6.5
\text{c} ANZECC and ARMCANZ high reliability levels
\text{d} Assume Cr(VI)

\text{1} Sample number
\text{2} Dissolved
\text{3} Total
Table 6-37 Estuarine/marine water quality (SoE EIS, 2012 sites WP8, 10A, 10B and 21)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>n(^1)</th>
<th>Mean</th>
<th>Median</th>
<th>80(^{th}) percentile</th>
<th>20(^{th}) percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Conductivity (µS/cm)</td>
<td>11</td>
<td>16600</td>
<td>2100</td>
<td>45300</td>
<td>430</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7-8.5(^a)</td>
<td>11</td>
<td>6.3</td>
<td>6.3</td>
<td>6.7</td>
<td>5.7</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>1-20(^a)</td>
<td>12</td>
<td>2.7</td>
<td>2.6</td>
<td>3.3</td>
<td>1.54</td>
</tr>
<tr>
<td>Dissolved Oxygen (%)</td>
<td>80-120(^a)</td>
<td>5</td>
<td>66</td>
<td>60</td>
<td>79</td>
<td>56</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>11</td>
<td>28.6</td>
<td>28.6</td>
<td>31.0</td>
<td>26.4</td>
<td></td>
</tr>
<tr>
<td>Calcium (mg/L)</td>
<td>12</td>
<td>119</td>
<td>14.6</td>
<td>328</td>
<td>2.08</td>
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</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>12</td>
<td>376</td>
<td>49</td>
<td>1050</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>Hardness (mg CaCO3/L)</td>
<td>10</td>
<td>2156</td>
<td>238</td>
<td>6049</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Silicon (µg/L)</td>
<td>6</td>
<td>1300</td>
<td>1150</td>
<td>2000</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Potassium (mg/L)</td>
<td>12</td>
<td>112</td>
<td>14.6</td>
<td>299</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Sodium (mg/L)</td>
<td>12</td>
<td>3379</td>
<td>420</td>
<td>9502</td>
<td>64.6</td>
<td></td>
</tr>
<tr>
<td>Chlorine (mg/L)</td>
<td>12</td>
<td>5151</td>
<td>1100</td>
<td>12940</td>
<td>142</td>
<td></td>
</tr>
<tr>
<td>Total phosphorous (mg/L)</td>
<td>0.02(^a)</td>
<td>7</td>
<td>0.05</td>
<td>0.03</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Ammonia (mg/L)</td>
<td>0.015(^a)</td>
<td>11</td>
<td>0.008</td>
<td>0.003</td>
<td>0.013</td>
<td>0.003</td>
</tr>
<tr>
<td>Total nitrogen (mg/L)</td>
<td>0.25(^a)</td>
<td>9</td>
<td>0.22</td>
<td>0.17</td>
<td>0.22</td>
<td>0.14</td>
</tr>
<tr>
<td>Total organic compounds (mg/L)</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total dissolved solids (mg/L)</td>
<td>12</td>
<td>9495</td>
<td>2250</td>
<td>23000</td>
<td>332</td>
<td></td>
</tr>
<tr>
<td>Aluminium(^1) (µg/L)</td>
<td>0.5(^b)</td>
<td>13</td>
<td>4.8</td>
<td>4</td>
<td>7.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Aluminium(^3) (µg/L)</td>
<td>0.5(^b)</td>
<td>13</td>
<td>110</td>
<td>56</td>
<td>147</td>
<td>27</td>
</tr>
<tr>
<td>Iron(^1) (µg/L)</td>
<td>300(^b)</td>
<td>13</td>
<td>24</td>
<td>13</td>
<td>31</td>
<td>3.8</td>
</tr>
<tr>
<td>Iron(^3) (µg/L)</td>
<td>300(^b)</td>
<td>13</td>
<td>267</td>
<td>218</td>
<td>409</td>
<td>174</td>
</tr>
<tr>
<td>Chromium(^1) (µg/L)</td>
<td>4.4 (^c)</td>
<td>11</td>
<td>0.05</td>
<td>0.02</td>
<td>0.09</td>
<td>0.02</td>
</tr>
<tr>
<td>Chromium(^3) (µg/L)</td>
<td>4.4 (^c)</td>
<td>12</td>
<td>0.18</td>
<td>0.11</td>
<td>0.05</td>
<td>0.21</td>
</tr>
<tr>
<td>Manganese(^1) (µg/L)</td>
<td>80(^b)</td>
<td>11</td>
<td>3.3</td>
<td>2.5</td>
<td>4.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Manganese(^3) (µg/L)</td>
<td>80(^b)</td>
<td>11</td>
<td>3.4</td>
<td>2.8</td>
<td>4.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Nickel(^1) (µg/L)</td>
<td>70(^c)</td>
<td>11</td>
<td>0.11</td>
<td>0.05</td>
<td>0.16</td>
<td>0.02</td>
</tr>
<tr>
<td>Nickel(^3) (µg/L)</td>
<td>70(^c)</td>
<td>12</td>
<td>0.14</td>
<td>0.09</td>
<td>0.23</td>
<td>0.03</td>
</tr>
<tr>
<td>Copper(^1) (µg/L)</td>
<td>1.3(^c)</td>
<td>11</td>
<td>0.06</td>
<td>0.01</td>
<td>0.11</td>
<td>0.005</td>
</tr>
<tr>
<td>Copper(^3) (µg/L)</td>
<td>1.3(^c)</td>
<td>12</td>
<td>0.09</td>
<td>0.08</td>
<td>0.15</td>
<td>0.01</td>
</tr>
<tr>
<td>Zinc(^1) (µg/L)</td>
<td>15(^c)</td>
<td>11</td>
<td>0.72</td>
<td>0.5</td>
<td>0.65</td>
<td>0.04</td>
</tr>
<tr>
<td>Zinc(^3) (µg/L)</td>
<td>15(^c)</td>
<td>12</td>
<td>0.40</td>
<td>0.33</td>
<td>0.66</td>
<td>0.06</td>
</tr>
<tr>
<td>Arsenic(^1) (µg/L)</td>
<td>4.5(^b)</td>
<td>11</td>
<td>0.17</td>
<td>0.12</td>
<td>0.26</td>
<td>0.03</td>
</tr>
<tr>
<td>Arsenic(^3) (µg/L)</td>
<td>4.5(^b)</td>
<td>11</td>
<td>0.25</td>
<td>0.19</td>
<td>0.42</td>
<td>0.06</td>
</tr>
<tr>
<td>Cadmium(^2) (µg/L)</td>
<td>5.5(^c)</td>
<td>10</td>
<td>0.01</td>
<td>0.004</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td>Cadmium(^3) (µg/L)</td>
<td>5.5(^c)</td>
<td>11</td>
<td>0.01</td>
<td>0.004</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td>Lead(^2) (µg/L)</td>
<td>4.4(^c)</td>
<td>9</td>
<td>0.02</td>
<td>0.009</td>
<td>0.03</td>
<td>0.003</td>
</tr>
<tr>
<td>Lead(^3) (µg/L)</td>
<td>4.4(^c)</td>
<td>11</td>
<td>0.06</td>
<td>0.05</td>
<td>0.04</td>
<td>0.09</td>
</tr>
</tbody>
</table>

\(^a\) ANZECC and ARMCANZ default trigger values
\(^b\) ANZECC low reliability levels for pH < 6.5
\(^c\) ANZECC high reliability levels
\(^d\) Assume Cr(VI)

\(^1\) Sample number
\(^2\) Dissolved
\(^3\) Total
6.7.2.5 Water Quality Data Specific to this Project

Surface water quality field assessments were conducted specifically for the Project as well as for the immediately adjacent Gulf Alumina - SRP. Field assessment data from the SRP are relevant as the sampling locations are in the same catchments, similar habitats and within the same creeks as this Project.

Thirteen sites from a range of habitats (freshwater and estuarine) were surveyed over multiple seasons as outlined in Table 6-38. Samples sites were chosen to account for spatial and seasonal variation to account for the distinct wet and dry seasons that influence water quality within the Project area and sampling locations are shown in Figure 6-21. In general, freshwater sampling locations during the wet season were flowing at the time of sampling and the spring (located outside the Project area to the south of BH1) had recent influxes of freshwater due to sampling occurring during the wet season.

Four sampling events were initially undertaken for the Project as follows:

- Late dry season in October and December 2011 (five estuarine/marine sites: W1, W2, W3, W4, W5);
- Wet season in February 2012 (five estuarine/marine sites: W1, W2, W3, W4, W5); and
- Early dry season in June 2012 (five estuarine/marine sites: W1, W2, W3, W4, W5).

Further Project specific wet season sampling was undertaken as follows:

- Late dry season in 2014 (one freshwater site (AQ01) where physiochemical parameters only were recorded. Sampling from two other sites were attempted but was precluded by insufficient water;
- Late dry season in October 2014 (five estuarine/marine sites: W1, W2, W3, W4, W5);
- Wet season in March 2015 (six freshwater/spring sites: AQ01, AQ02, AQ03 (physiochemical parameters only) as well as SW01, SW03, SP01); and
- Wet season in March 2015 (one estuarine site (SW02)).

In addition, sampling for the immediately adjacent SRP was also undertaken as follows:

- Wet season in February 2015 (four freshwater sites: S1, S6, S9, S10); and
- Early dry season in June 2012 (four freshwater sites: S1, S6, S9, S10).

These locations are shown in Table 6-38 along with the water type and location where sampling occurred.

The local and site specific data has been collected periodically over several years and some samples were analysed at different laboratories. As such, not all water quality parameters were collected for all sampling events and in several cases, different laboratory analyses have been undertaken. Nevertheless, all data are present in Table 6-40 to Table 6-43 and where relevant, comparisons are made to other similar data sources from the area in order to determine the overall water quality EVs of the area.

For the Project and Gulf Alumina samples, measurements were taken at depths ranging from 0.10 m to 0.50 m below the surface and 0.10 m above the watercourse bed. Samples were kept cool at
4°C as per National Association of Testing Authorities (NATA) guidelines and all samples were analysed at a NATA accredited lab. Water samples were tested for a variety of parameters as shown in Table 6-40 to Table 6-42.

### Table 6-38 Water quality sampling sites

<table>
<thead>
<tr>
<th>Water type</th>
<th>Locations</th>
<th>Site sample names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater</td>
<td>Namaleta Creek to the south of the Project</td>
<td>S1, 56, 59 (Gulf Alumina Sites)</td>
</tr>
<tr>
<td></td>
<td>Lunette Swamp near the south-eastern boundary</td>
<td>S10 (Gulf Alumina Site)</td>
</tr>
<tr>
<td></td>
<td>Bigfoot Swamp near the north-western boundary</td>
<td>SW03 (Metro Mining Site)</td>
</tr>
<tr>
<td></td>
<td>Tributary of the Skardon River near the eastern boundary</td>
<td>SW01 (Metro Mining Site)</td>
</tr>
<tr>
<td></td>
<td>Large heavily disturbed melaleuca swamp system to the south of S10</td>
<td>AQ02 (Metro Mining Site)</td>
</tr>
<tr>
<td>Springs</td>
<td>South of a Skardon River tributary near the eastern boundary</td>
<td>SPO1 (Metro mining Site)</td>
</tr>
<tr>
<td>Estuarine/marine</td>
<td>Skardon River</td>
<td>W1, W2, W3, W4, W5, SW02 (Metro Mining Sites)</td>
</tr>
</tbody>
</table>
### Table 6-39 Surface water survey site descriptions (a-d)

**a) Unnamed Creek, SW01 (photograph taken during March 2015 sampling)**

| Site location | Creek Crossing (southern bank) of eastern branch of southern tributary to Skardon River, to the south of BH1 area. Lat: -11.810192° Long: 142.131737° |
| Flow condition | Fast flowing, bank full – estimated to be >1cum sec |
| Bank and stream bed width (m) | 5-6 m |
| Maximum water depth (m) | Estimated 1.2 m |
| Evidence of bank erosion | Low |
| Bank slope steepness | Low (<30°) |
| Dominant habitat vegetation | The location include a matrix of riparian woodland (8-12m) and low open woodland. The riparian woodland consists of willow bottlebrush, swamp box, Asteromtryrs symphyocarpa, Garcinia warrenii, Carallia brachiata and Dillenia alata. Shrubs of Alyxia spicata, Diospyros hebecarpa, Cyclophyllum brevipes and vines of Flagellaria indica. The low open woodland consists of Melaleuca viridiflora and tropical bloodwood with Syzygium eucalyptoides subsp. eucalyptoides and native quinine. Sparse shrubs of Pandanus sp., Livistona muelleri and nonda. Burnt out groundcover was present. |

**b) Skardon River, SW02 (photographs taken during March 2015 sampling)**

| Site location | Jetty at port facility and former kaolin processing plant. Lat: -11.757550° Long: 142.071998° |
| Flow condition | Tidal Estuary |
| Bank and stream bed width (m) | 300-350 m |
| Maximum water depth (m) | Unknown m |
| Evidence of bank erosion | Low |
| Bank slope steepness | Low (5-10°) |
| Dominant habitat vegetation | Highly modified forshore assemblage with fringing magroves present at each end. Other species present include colonising mangrove (likely to be grey mangrove) and mature Allocasuarina sp. with colonising groundlayer present within the modified area. |
c) Bigfoot Swamp, SW03

| Site location | Bigfoot Swamp – adjacent to western boundary of BH6 west.  
| Lat: -11.798954°  
| Long: 142.038991° |
| Flow condition | No flow |
| Swamp dimension | Perimeter approximately 7.3 km, area approximately 180 ha |
| Maximum water depth at sample site (m) | 0.4 m |
| Evidence of bank erosion | No erosion apparent |
| Bank slopes steepness | Low (<10°) |
Bigfoot Swamp is a palustrine (forested) wetland which is inundated to 1 to 3 m depth during the wet season, and becomes ephemeral in the late dry season. The lowest depression of the wetland comprises a significant area of grassland and sedgeland of freshwater couch (*Paspalum vaginatum*) and water chestnut surrounded by woodland and open forests dominated by paperbark (*Melaleuca* spp.) and swamp box.

### d) Unnamed Spring, SP01

- **Site location**: Springs located to the south of the eastern branch of a Skardon River tributary approximately 3 km down stream of SW01 to the south of BH1 area.
  - Lat: -11.813973°
  - Long: 142.101189°

- **Flow condition**: Fast flowing – multiple issues each estimated to be >10L/sec

- **Bank and stream bed width (m)**: Multiple issues in area, individual channels up to 1.5 m

- **Maximum water depth (m)**: 0.2 m

- **Evidence of bank erosion**: Low

- **Bank slopes steepness**: Low (<30°)

- **Dominant habitat vegetation**: Open woodland of *Melaleuca viridiflora* with scattered *Corymbia clarksoniana* and cockatoo apple. Very sparse shrub layer of *M. viridiflora, C. clarksoniana, Hakea pershiana* and *Acacia leptocarpa*. Groundcover dominated by *Allopteris semialulata.*
6.7.2.7 Water Quality Results

Data from water quality sampling events from 2011, 2012 and 2015 for both the Project and the immediately adjacent Gulf Alumina Project are shown in Table 6-40 to Table 6-42. These data are separated into Gulf Alumina specific data, Project specific data and all data combined. Data are further separated into water type including freshwater/springs and marine/estuarine. In addition, mean and median values of the combined data are compared to the SoE and Dullunty River data to allow for comparisons of water quality in the Project area.
### Table 6-40 Freshwater stream water quality including mean, median and 80\textsuperscript{th} and 20\textsuperscript{th} percentiles

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>Gulf Alumina data (S1, S6, S9, S10)</th>
<th>Project data (AQ01, AQ02, AQ03, SW03, SW01, SP01)</th>
<th>Combined data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n\textsuperscript{2}</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Electrical Conductivity ((\mu S/cm))</td>
<td>20-250</td>
<td>8</td>
<td>35.1</td>
<td>33.5</td>
</tr>
<tr>
<td>pH</td>
<td>6-8</td>
<td>8</td>
<td>6.17</td>
<td>6.15</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>2-15</td>
<td>8</td>
<td>2.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Dissolved Oxygen (%)</td>
<td>85-120</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Calcium (mg/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hardness (mg CaCO\textsubscript{3}/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Silicon (µg/L)</td>
<td>8</td>
<td>4537</td>
<td>4750</td>
<td>4900</td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total phosphorous (mg/L)</td>
<td>0.01\textsuperscript{a}</td>
<td>8\textsuperscript{b}</td>
<td>0.02</td>
<td>0.02</td>
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<tr>
<td>Total nitrogen (mg/L)</td>
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<td>8</td>
<td>0.125</td>
<td>0.09</td>
</tr>
<tr>
<td>Total dissolved solids (mg/L)</td>
<td>8</td>
<td>30.6</td>
<td>24.5</td>
<td>48.8</td>
</tr>
<tr>
<td>Sulfate (mg/L)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Aluminium\textsuperscript{2} (µg/L)</td>
<td>0.8\textsuperscript{a}</td>
<td>8</td>
<td>56.0</td>
<td>52.0</td>
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<td>Aluminium\textsuperscript{3} (µg/L)</td>
<td>0.8\textsuperscript{a}</td>
<td>8</td>
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<td>89</td>
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<tr>
<td>Iron\textsuperscript{4} (µg/L)</td>
<td>300\textsuperscript{b}</td>
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<td>51.5</td>
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<tr>
<td>Iron\textsuperscript{5} (µg/L)</td>
<td>300\textsuperscript{b}</td>
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<td>144.6</td>
<td>83.5</td>
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<tr>
<td>Chromium\textsuperscript{1} (µg/L)</td>
<td>1\textsuperscript{c,d}</td>
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<td>1.0</td>
<td>1.0</td>
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<tr>
<td>Chromium\textsuperscript{1} (µg/L)</td>
<td>1\textsuperscript{c,d}</td>
<td>8</td>
<td>1.5</td>
<td>1</td>
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</table>
## Parameter Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>Gulf Alumina data (S1, S6, S9, S10)</th>
<th>Project data (AQ01, AQ02, AQ03, SW03, SW01, SP01)</th>
<th>Combined data</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>n²</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Mn⁴(µg/L)</td>
<td>1900&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Mn⁴(µg/L)</td>
<td>80&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8</td>
<td>8.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Ni⁴(µg/L)</td>
<td>11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1’</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Ni⁴(µg/L)</td>
<td>11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8’</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Cu⁴(µg/L)</td>
<td>1.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>1.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Cu⁴(µg/L)</td>
<td>1.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8</td>
<td>6.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Zn⁴(µg/L)</td>
<td>8&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1’</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Zn⁴(µg/L)</td>
<td>8&lt;sup&gt;e&lt;/sup&gt;</td>
<td>8’</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>As⁴(µg/L)</td>
<td>13&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1’</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>As⁴(µg/L)</td>
<td>13&lt;sup&gt;f&lt;/sup&gt;</td>
<td>8’</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Cd⁴(µg/L)</td>
<td>0.2&lt;sup&gt;g&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cd⁴(µg/L)</td>
<td>0.2&lt;sup&gt;g&lt;/sup&gt;</td>
<td>8’</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Pb⁴(µg/L)</td>
<td>3.4&lt;sup&gt;h&lt;/sup&gt;</td>
<td>1’</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Pb⁴(µg/L)</td>
<td>3.4&lt;sup&gt;h&lt;/sup&gt;</td>
<td>8’</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Hg⁴(µg/L)</td>
<td>0.6&lt;sup&gt;i&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hg⁴(µg/L)</td>
<td>0.6&lt;sup&gt;i&lt;/sup&gt;</td>
<td>8’</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C₆-C₉) (mg/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C₁₀-C₃₆) (mg/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- **a** ANZECC and ARMCANZ default trigger values
- **b** ANZECC and ARMCANZ low reliability levels for pH<6.5
- **c** ANZECC and ARMCANZ high reliability levels
- **d** Assume Cr(VI)
- **e** Sample number
- **f** Dissolved
- **g** Total
- **h** LOR constrained lab results and LOR value used.
### Table 6-41 Estuarine/marine water quality including mean, median and 80th and 20th percentiles

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>2011 – 2012 Project data</th>
<th>2015 Project data</th>
<th>Combined data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n²</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Electrical Conductivity (µS/cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>pH</td>
<td>7-8.5³</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>1-20³</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Dissolved Oxygen (%)</td>
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<td>Magnesium (mg/L)</td>
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<td>Hardness (mg CaCO3/L)</td>
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<td>Potassium (mg/L)</td>
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<td>Sodium (mg/L)</td>
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<tr>
<td>Chloride (mg/L)</td>
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<td>Total phosphorous (mg/L)</td>
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<td>Aluminium¹ (µg/L)</td>
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<td>Manganese² (µg/L)</td>
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³ Combined data

Metro Mining Limited
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<tr>
<th>Parameter</th>
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<th>2011 – 2012 Project data</th>
<th>2015 Project data</th>
<th>Combined data</th>
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</tr>
<tr>
<td>Zinc (µg/L)</td>
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<td>Arsenic (µg/L)</td>
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</tr>
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<td>Arsenic (µg/L)</td>
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<td>20</td>
<td>35.4</td>
<td>11.0</td>
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<td>Cadmium (µg/L)</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lead (µg/L)</td>
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<td>20</td>
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<td>5.00</td>
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<td>Mercury (µg/L)</td>
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<td>-</td>
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</tr>
<tr>
<td>Mercury (µg/L)</td>
<td>0.4⁴</td>
<td>20</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C6-C9) (mg/L)</td>
<td>20</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C10-C36) (mg/L)</td>
<td>20</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

⁵ ANZECC and ARMCANZ default trigger values
⁶ ANZECC and ARMCANZ low reliability levels for pH<6.5
⁷ ANZECC and ARMCANZ high reliability levels
⁸ Assume Cr(VI)

a ANZECC and ARMCANZ default trigger values
b ANZECC and ARMCANZ low reliability levels for pH<6.5
c ANZECC and ARMCANZ high reliability levels
d Assume Cr(VI)

Sample number
Dissolved
Total
LOR constrained lab results and LOR value used.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>WQO</th>
<th>Dullnut River</th>
<th>SoE</th>
<th>Pisolite Hills</th>
<th>Gulf Alumina and Project combined data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n²</td>
<td>Mean</td>
<td>Median</td>
<td>80th</td>
<td>20th</td>
<td>n²</td>
</tr>
<tr>
<td>Electrical Conductivity (µS/cm)</td>
<td>20-250</td>
<td>57</td>
<td>39.9</td>
<td>35.0</td>
<td>42.0</td>
<td>34.0</td>
</tr>
<tr>
<td>pH</td>
<td>6-8</td>
<td>46</td>
<td>6.23</td>
<td>6.25</td>
<td>6.6</td>
<td>5.70</td>
</tr>
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<td>Turbidity (NTU)</td>
<td>2-15</td>
<td>45</td>
<td>2.89</td>
<td>2.00</td>
<td>3.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Dissolved Oxygen (%)</td>
<td>85-120</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>81</td>
<td>25.9</td>
<td>25.9</td>
<td>28.0</td>
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<td>58</td>
</tr>
<tr>
<td>Calcium (mg/L)</td>
<td>39</td>
<td>0.30</td>
<td>0.20</td>
<td>0.40</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>44</td>
<td>0.59</td>
<td>0.60</td>
<td>0.80</td>
<td>0.40</td>
<td>56</td>
</tr>
<tr>
<td>Hardness (mg CaCO3/L)</td>
<td>45</td>
<td>4.53</td>
<td>4.00</td>
<td>6.00</td>
<td>2.00</td>
<td>56</td>
</tr>
<tr>
<td>Silicon (µg/L)</td>
<td>18</td>
<td>592</td>
<td>135</td>
<td>892</td>
<td>9.0</td>
<td>11</td>
</tr>
<tr>
<td>Potassium (mg/L)</td>
<td>38</td>
<td>0.55</td>
<td>0.30</td>
<td>0.62</td>
<td>0.20</td>
<td>56</td>
</tr>
<tr>
<td>Sodium (mg/L)</td>
<td>47</td>
<td>5.64</td>
<td>5.30</td>
<td>6.04</td>
<td>4.76</td>
<td>56</td>
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<tr>
<td>Chloride (mg/L)</td>
<td>47</td>
<td>9.12</td>
<td>8.60</td>
<td>12.0</td>
<td>7.06</td>
<td>56</td>
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<tr>
<td>Total phosphorous (mg/L)</td>
<td>0.01 a</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>Total nitrogen (mg/L)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total dissolved solids (mg/L)</td>
<td>47</td>
<td>26.85</td>
<td>27.00</td>
<td>30.4</td>
<td>22.6</td>
<td>56</td>
</tr>
<tr>
<td>Sulfate (mg/L)</td>
<td>19</td>
<td>2.19</td>
<td>2.00</td>
<td>4.00</td>
<td>0.60</td>
<td>56</td>
</tr>
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</table>

Table 6-42 Freshwater stream water quality comparisons including mean, median and 80th and 20th percentiles
<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>Dulhunty River</th>
<th>SoE</th>
<th>Pisolite Hills</th>
<th>Gulf Alumina and Project combined data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n²</td>
<td>Mean</td>
<td>Median</td>
<td>80th</td>
<td>20th</td>
</tr>
<tr>
<td>Aluminium³ (µg/L)</td>
<td>0.8²</td>
<td>12</td>
<td>44.0</td>
<td>35.0</td>
<td>82.0</td>
</tr>
<tr>
<td>Chromium³ (µg/L)</td>
<td>1 ac</td>
<td>3.8</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Copper³ (µg/L)</td>
<td>1 ac</td>
<td>3.8</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Zinc³ (µg/L)</td>
<td>1900³</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nickel³ (µg/L)</td>
<td>11 ac</td>
<td>3.8</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Arsenic³ (µg/L)</td>
<td>13 ac</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cadmium³ (µg/L)</td>
<td>0.2 ac</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note:**
- WQO: Water Quality Objectives
- SoE: State of Environment
- Pisolite Hills
- Gulf Alumina and Project combined data

**Source:**
- Dulhunty River
- SoE (ac): Dulhunty River
- Pisolite Hills
- Gulf Alumina and Project combined data

**Units:**
- µg/L (micrograms per liter)

**Data Summary:**
- The table provides a comprehensive overview of various parameters measured in different locations and under different conditions.
- The data includes mean, median, and other statistical measures for each parameter.
- The table highlights the concentration levels for various metals and other substances, which are critical for environmental monitoring and regulatory compliance.

**Key Highlights:**
- Aluminium, Chromium, Copper, Nickel, Zinc, Arsenic, and Cadmium are the primary metals measured.
- Concentration levels vary significantly across different locations and conditions.
- The data is presented in a clear, tabular format for easy analysis and comparison.

**Context:**
- The data is relevant for environmental scientists, policymakers, and industrial entities involved in water quality management.
- It serves as a benchmark for regulatory compliance and environmental monitoring activities.

**Conclusion:**
- The comprehensive data collection and analysis provide a robust foundation for environmental decision-making.
- Further research and monitoring are recommended to ensure sustained environmental health and compliance with regulatory standards.

**Additional Information:**
- The data includes both historical and current measurements, offering insights into environmental trends over time.
- The table format facilitates quick access to specific data points, enabling focused analysis and targeted interventions.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>Dulhunty River</th>
<th>SoE</th>
<th>Pisolite Hills</th>
<th>Gulf Alumina and Project combined data</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>n²</td>
<td>Mean</td>
<td>Median</td>
<td>80th</td>
</tr>
<tr>
<td>Lead¹ (µg/L)</td>
<td>3.4^m</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lead¹ (µg/L)</td>
<td>3.4^m</td>
<td>-</td>
<td>-</td>
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</tr>
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<td>Mercury² (µg/L)</td>
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</tr>
<tr>
<td>Mercury³ (µg/L)</td>
<td>0.6^m</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C6-C9) (mg/L)</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C10-C36) (mg/L)</td>
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<td>-</td>
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</tbody>
</table>

¹ ANZECC and ARMCANZ default trigger values
² ANZECC and ARMCANZ low reliability levels for pH<6.5
³ ANZECC and ARMCANZ high reliability levels
⁴ Assume Cr(VI)

Sample number
Dissolved
Total
LOR constrained lab results and LOR value used.
Table 6-43 Estuarine/marine water quality comparisons including mean, median and 80th and 20th percentiles

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>SoE EIS data (2012)</th>
<th>Gulf Alumina and Project combined data</th>
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</thead>
<tbody>
<tr>
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<td>Turbidity (NTU)</td>
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<td>66.0</td>
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<tr>
<td>Temperature (°C)</td>
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<td>Calcium (mg/L)</td>
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<tr>
<td>Total nitrogen (mg/L)</td>
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<td>Total suspended solids (mg/L)</td>
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</tr>
<tr>
<td>Sulfate (mg/L)</td>
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</tr>
<tr>
<td>Aluminium³ (µg/L)</td>
<td>0.5*</td>
<td>13</td>
<td>4.8</td>
</tr>
<tr>
<td>Aluminium⁴ (µg/L)</td>
<td>0.5*</td>
<td>13</td>
<td>110</td>
</tr>
<tr>
<td>Iron³ (µg/L)</td>
<td>300*</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>Iron⁴ (µg/L)</td>
<td>300*</td>
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<td>267</td>
</tr>
<tr>
<td>Chromium³ (µg/L)</td>
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<td>0.05</td>
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<tr>
<td>Chromium⁴ (µg/L)</td>
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<td>0.18</td>
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<td>Manganese³ (µg/L)</td>
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<tr>
<td>Manganese⁴ (µg/L)</td>
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<td>3.4</td>
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<td>Nickel³ (µg/L)</td>
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<td>Nickel⁴ (µg/L)</td>
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<td>0.14</td>
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<tr>
<td>Copper³ (µg/L)</td>
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<td>0.06</td>
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<tr>
<td>Copper⁴ (µg/L)</td>
<td>1.3*</td>
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<td>0.09</td>
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</tbody>
</table>
### Surface Water Quality Results

As outlined in the above tables, water quality monitoring has been undertaken at a number of locations and seasons and includes both site specific data, regional data from the Pisolite Hills Project, SoE EIS and DNRM Dulhunty gauge station. As some of the site specific parameters were derived from limited sampling, comparisons are made against SoE EIS, Pisolite Hills and DNRM Dulhunty gauge station ANZECC and ARMCANZ guidelines in order to determine the similarity between these locations and to determine whether the site specific water quality values are representative of the area. For comparison, the ANZECC and ARMCANZ trigger value guidelines that apply to slightly- to moderately disturbed systems with a protection value of 95% were used. Initial trigger values were used from Tables 3.3.4, 3.3.5 and 3.4.1 of the guidelines and adjusted where relevant as outlined in Table 3.4.1. Further water quality data are outlined in Appendix C and E.

Although variations in absolute WQO between sites did occur, generally, most WQO showed strong similarities regardless of sampling location where sufficient data were available to determine mean, median and percentile summary statistics.

### Electrical Conductivity

The freshwater electrical conductivity (EC) was relatively low at all sites. EC values were similar between the site specific Project data and the Dulhunty site with median EC values of 40 and 35 microSiemens per centimetre (µS/cm), respectively which were substantially higher than EC values from the SoE project area (21 µS/cm) and Pisolite Hills (25 µS/cm). EC at all sites were within the ANZECC and ARMCANZ default freshwater trigger values of 25 to 250 µS/cm.

EC values within the marine/estuarine environments ranged from 23,633 for a single site specific sample to the north-east of the proposed jetty location in the Skardon River to a median of 21,000 for the SoE project.

---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WQO</th>
<th>SoE EIS data (2012)</th>
<th>Gulf Alumina and Project combined data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
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<td>0.72</td>
</tr>
<tr>
<td>Arsenic (µg/l)</td>
<td>4.5^a</td>
<td>11</td>
<td>0.17</td>
</tr>
<tr>
<td>Cadmium (µg/l)</td>
<td>5.5^b</td>
<td>10</td>
<td>0.01</td>
</tr>
<tr>
<td>Lead (µg/l)</td>
<td>4.4^b</td>
<td>11</td>
<td>0.06</td>
</tr>
<tr>
<td>Mercury (µg/l)</td>
<td>0.4^b</td>
<td>20</td>
<td>0.0001</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C6-C9) (mg/L)</td>
<td>22^e</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C10-C36) (mg/L)</td>
<td>22^e</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

^a ANZECC and ARMCANZ default trigger values
^b ANZECC and ARMCANZ low reliability levels for pH<6.5
^c ANZECC and ARMCANZ high reliability levels
^d Assume Cr(VI)
^e LOR constrained lab results and LOR value used.

6.7.2.8 Surface Water Quality Results
pH

All freshwater sites showed similar pH values which were generally acidic. Site specific 20th and 80th percentile pH values were 5.6 and 6.3 respectively and were less acidic relative to pH values for the SoE project and Pisolite Hills but slightly more acidic than those in the Dulhunty River. The acidity is likely due to tannic and humic acids in the recently inundated vegetative matter. With the exception of the SoE project and Pisolite Hills, freshwater pH values for were within the ANZECC and ARMCANZ default trigger values of 6-8.

The Skardon River presents a pH range of 7-8 within the entrance and lower estuary, reducing as sites progress up the estuary and beyond the existing barge facility (6.9-7.5) near sample site W3. pH exhibits a strong spatial and temporal trend which is associated with tidal flushing and increases as the flooding tide push through the study area. As tides begin to ebb, reduced pH waters are extracted from the mangroves and creek systems to the primary Skardon River channel. The site specific median pH value was 7.7 and within the ANZECC and ARMCANZ range of 7-8.5.

Turbidity

Turbidity in the freshwater system was almost identical between the Dulhunty site and the Project data with medians of 2.0 and 2.2, respectively. This is in the ANZECC and ARMCANZ trigger value range of 2-15 NTU. Interestingly, freshwater turbidity from the SoE project was somewhat lower with a median of 1.4 NTU which is lower than the trigger values. In contrast, Pisolite Hills showed the highest turbidity values with a median of 11 NTU. Although water was present during the wet season sampling, there had not been any significant overland flows. Hence, the low turbidity values are not surprising given the relatively undisturbed nature of the surrounding land. Nevertheless, similar turbidity values were observed between this Project and others in the area and all have been within the ANZECC and ARMCANZ trigger value range. However, further sampling at the peak of a heavy wet season should be undertaken when operations have commenced and site access during the wet season will be improved.

Estuarine/marine turbidity was substantially higher at the Project sample site; however, only data from a single sample was available for inclusion in Table 6-43. Although this single sample was higher than that recorded form the SoE Project, it was within the ANZECC and ARMCANZ trigger value range of 1-20.

As part of the marine ecology assessment, (see Appendix C) surface turbidity levels were recorded from grab samples and ranged from 0 – 30.6 NTU with mean turbidity during the dry season of 4.2 NTU compared to 30.3 during the wet season. Increasing levels of turbidity are likely due to increased flows entering the estuarine/marine system in conjunction with natural tidal events where increased turbidity coincides with mid tidal runs when flow is approaching maximum velocities as water drains from the mangroves and mudflats.

Cations and Anions

In general, cations and anions (calcium, magnesium, potassium, sodium, and chloride) were similar among all sampling locations, particularly between the Dulhunty River site and the Project area. Minor differences occurred; however, for calcium, magnesium and potassium and was primarily due to the LOR for the majority of the Project sampling which overestimated the actual value. Estuarine/marine cations and anions showed a similar patterns with similar levels observed between the sample sites from the SoE project and those from the Project area.
Nutrients

Freshwater nutrient levels were similar between the SoE project, Pisolite Hills and the Project area with median levels of total phosphorous (0.03 mg/L) at the SoE sites being slightly higher than the levels at the Project sites (0.02 mg/L) and Pisolite Hills (0.01 mg/L). Both the SoE and Project specific locations exceeded the ANZECC and ARMCANZ trigger value of 0.01 mg/L. Nitrogen values showed a similar pattern between sites with the Project sites falling within the ANZECC/ARMCANZ trigger values of 0.2-0.3 mg/L.

Estuarine/marine nutrient levels showed similar pattern to the freshwater nutrient levels with median total phosphorous (0.04 mg/L) and median total nitrogen (0.30 mg/L) levels exceeding for the Project area exceeding the ANZECC and ARMCANZ trigger values of 0.02 mg/L and 0.2 – 0.3 mg/L respectively.

Given the generally undeveloped nature of the region, the exceedance of phosphorous levels across different sites and across both fresh and marine samples would seem to indicate a slightly elevated natural phosphorous level in the region more so than from anthropogenic sources.

Metals

Median dissolved concentrations in the freshwater environment for chromium, manganese, nickel, copper, zinc, arsenic, cadmium, lead, and mercury were less than the 95% ANZECC and ARMCANZ trigger values for freshwater streams for the Project specific sites and the SoE project. Interestingly, median values for the majority of these metals from the Pisolite Hills project area exceeded the 95% ANZECC and ARMCANZ trigger values. Although the median value of dissolved and total iron was 50.0 µg/L and 83.5 µg/L, respectively, it is important to note that the ANZECC and ARMCANZ currently derives a trigger value of 300 µg/L from the Canadian guidelines as reliable trigger values for Australian waters are yet to be determined.

The only metal within the Project area to exceed the ANZECC and ARMCANZ freshwater trigger values was aluminum. For streams in the Project area with pH values < 6.5, the pH trigger value decreases from 55 µg/L to 0.8 µg/L for freshwater environments. However, aluminum exceeded even the less stringent non pH adjusted value for both dissolved and total aluminum and all four locations showed similarly high levels of aluminum.

Similar to other freshwater streams in the area as outlined in the SoE EIS, Pisolite Hills data and the Hey Point Bauxite Project (Metserve, 2014), surface waters of the Project area are dominated aluminum and iron which showed a distinct seasonal trend. Sampling events towards the end of the dry season showed high concentrations of those metals relative to sampling events in the wet season which could be due to higher flow rates and dilution factors in the wet season lower base flows in the dry season.

The generally high water quality levels in and surrounding the Project area reflect the surrounding habitat that has seen minimal human disturbance relative to streams more accessible areas in higher populated or modified areas. In addition, the bauxite and associated geology acts as a physical and chemical filter leading to higher water quality levels.

The existing geology, as discussed in Section 6.2– highlights the natural existing lithology with both aluminum-rich bauxite and iron-rich ferricrete layers that occur near the surface and through which both surface water and groundwater flow. Hence, naturally high levels of aluminum and iron in both the surface and groundwater would be the result of this geology.
6.7.3 Existing Environment

6.7.3.1 Surface Water Resources

The majority of the Project area is located within the Skardon River catchment, which forms approximately 350 km$^2$ of the Ducie drainage basin and is bounded by the Ducie River and Namaleta Creek catchments to the South and the McDonald River catchment to the north (Figure 6-22). The Project is located on the southern end of the Mapoon Plain, which extends along the western coastal fringe of Cape York, from the mouth of Ducie River in the south, to Jardine Swamp to the north.

The Skardon River is a perennial system whilst the Namaleta Creek and freshwater reaches of the Ducie River are ephemeral, generally only flowing after rainfall events of sufficient size to generate runoff (SRK, 2014b). Stream flow in rivers tends to show a lagged response to rainfall, with wet-season rainfall commencing in November and reaching its peak in January, whilst an appreciable increase in surface water flow is not noted until January, reaching peak flow in March. This coincides with the timing of rainfall-derived recharge and suggests that annual or prolonged stream flow in rivers and creeks are maintained to some extent by baseflow. Further discussion on surface water–groundwater interaction is presented in Section 6.8.

The area is surrounded by low lying swamps which are seasonally inundated. There are no known Wetlands of International Importance within or surrounding the Project area; however, the Project is partially located in the Skardon River- Cotterell River Aggregation which is a nationally important wetland area (DEHP, 2009). Bigfoot Swamp, a freshwater swamp located near the northwest boundary of BH6 is; however, registered in the Queensland Directory of Important Wetlands.

The Project proposed pit locations are situated either side of the Skardon River on elevated bauxite plateaus. Minor partial pit areas (BH6) and the camp facilities are proposed within the adjoining Namaleta Creek catchment to the south. The barge loading facility is proposed on the bank of the southern Skardon River branch.
6.7.3.2 Catchment Hydrology

A rainfall-runoff relationship was established for the Ducie Basin through the calibration of Boughton’s Australian Water Balance Model (AWBM) parameters via the Rainfall Runoff Library platform (CRC for Catchment Hydrology). Calibration of the catchment specific AWBM parameters was undertaken at the Dulhunty TM gauging station\(^2\), which is the only gauging station available in the Ducie Basin. It is situated approximately 35 km east of the Project site. The calibration was achieved by providing the best fit between observed and calculated runoff over the calibration and verification periods.

An AWBM was constructed within the GoldSim modelling environment with the objective of determining the likely partitioning of annual rainfall into evaporation, baseflow and surface runoff components. Historical daily rainfall and evaporation time series data\(^3\) were applied to the model and 125 simulations were run, each a single calendar year in length, covering the period 1889 to 2014. The results were analysed to create a probability distribution, the mean (50\(^{th}\) percentile probability) results of which are presented in Table 6-44.

<table>
<thead>
<tr>
<th>Water Budget Component</th>
<th>Mean Rainfall Segregation (% of total rainfall)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evapotranspiration</td>
<td>53.3</td>
</tr>
<tr>
<td>Surface Runoff</td>
<td>20.3</td>
</tr>
<tr>
<td>Baseflow</td>
<td>26.4</td>
</tr>
</tbody>
</table>

### Flood Hydrology and Hydraulics

Hydrologic and hydraulic modelling were undertaken to estimate the hydraulic conditions and peak flood levels for the 5, 10, 20, 50, 100 and 1,000 year ARI and PMF design events. Design rainfall estimates were derived from the CRC-FORGE application. This program enables the extrapolation of rainfall estimates to extreme events up to and including the 2,000 year ARI and as such has benefits over the BoM Intensity-Frequency-Duration method, which cannot easily be extrapolated beyond the 100 year ARI event. Design runoff hydrographs were calculated using RORB, and then used as inputs to the MIKE21 2D hydraulic model.

### Hydrology - RORB

Initial simulations were run for standard ARI events (5 year to 100 year) and durations (1 hour to 72 hour) with results presented in Table 6-45. The default Kc value of 41.18 was initially applied for the uncalibrated simulations in the absence of catchment specific rainfall and streamflow data in which to calibrate the catchment parameters. The Kc value was later altered to attempt calibration to regional regression equation predicted peak discharges. As recommended by the RORB user manual the non-linearity exponent, m, was set to its default value of 0.8 in the absence of catchment specific calibration data. No initial or continual loss was applied to the uncalibrated model as these values are determined during calibration.

---


The 1,000 year ARI and Probable Maximum Precipitation (PMP) events were not included in the pre-calibration simulation as these extreme events are beyond the credible limit of extrapolation of available calibration data.

<table>
<thead>
<tr>
<th>ARI</th>
<th>Critical Storm Duration (h)</th>
<th>Peak Outlet Flow (m$^3$/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 year</td>
<td>6</td>
<td>543</td>
</tr>
<tr>
<td>10 year</td>
<td>6</td>
<td>621</td>
</tr>
<tr>
<td>20 year</td>
<td>6</td>
<td>735</td>
</tr>
<tr>
<td>50 year</td>
<td>6</td>
<td>892</td>
</tr>
<tr>
<td>100 year</td>
<td>6</td>
<td>1,049</td>
</tr>
</tbody>
</table>

**Regional Flood Frequency Analysis - Hydrology Calibration**

There is no stream gauge record for the Skardon River catchment against which to calibrate the RORB predicted hydrographs. Therefore, a regional flood frequency analysis (FFA) was conducted to attempt calibration.

A summary of the flows predicted by the FFA in comparison to the uncalibrated RORB outputs is presented in Table 6-46. The Dulhunty Gauge, which is very similar in both catchment area and location to the Skardon River Catchment, produces FFA results much lower than the uncalibrated RORB results for the Skardon Catchment. This strongly indicates a conservatively high peak flow estimated by the uncalibrated RORB model, most likely due to:

- The omission of rainfall loss in the uncalibrated model; and
- The generic RORB Kc value not being representative of local catchment characteristics.

<table>
<thead>
<tr>
<th>ARI</th>
<th>Dulhunty (332 km$^2$)</th>
<th>Watson (1,001 km$^2$)</th>
<th>Monument (2,421 km$^2$)</th>
<th>Moreton (3,265 km$^2$)</th>
<th>RORB uncalibrated (350 km$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 year</td>
<td>132</td>
<td>545</td>
<td>458</td>
<td>866</td>
<td>543</td>
</tr>
<tr>
<td>10 year</td>
<td>188</td>
<td>683</td>
<td>556</td>
<td>1,074</td>
<td>621</td>
</tr>
<tr>
<td>20 year</td>
<td>256</td>
<td>855</td>
<td>656</td>
<td>1,272</td>
<td>735</td>
</tr>
<tr>
<td>50 year</td>
<td>374</td>
<td>1,015</td>
<td>793</td>
<td>1,527</td>
<td>892</td>
</tr>
<tr>
<td>100 year</td>
<td>490</td>
<td>1,216</td>
<td>902</td>
<td>1,715</td>
<td>1,049</td>
</tr>
</tbody>
</table>

From Table 6-46 a regional trend between catchment area and flow can be established by fitting a regression trend line to the FFA results. The following regional regression equations were developed for predicting peak catchment discharge from the catchment area regression parameter.

\[ Q_5 = 2.67 A^{0.71} \]
\[ Q_{10} = 5.39 A^{0.64} \]
\[ Q_{20} = 10.59 A^{0.58} \]
\[ Q_{50} = 23.84 A^{0.50} \]
\[ Q_{100} = 46.04 A^{0.43} \]; where \( Q_{ARI} \) is the discharge at the indicated ARI and \( A \) is the catchment area in square kilometres.
Based on these findings, calibration of the RORB model was achieved (refer Table 6-47) via:

- Increasing the Kc parameter from the default value of 41.18 to 48.5;
- Applying probability neutral initial loss values across the ARI events i.e. applying an initial loss that allows a specific ARI rainfall event to produce the same resultant ARI flood event; and
- Applying a continual loss of 10 mm/h across all ARI events.

### Table 6-47 RORB Calibration to Regional Regression Equation Results

<table>
<thead>
<tr>
<th>ARI (yr)</th>
<th>RRE Discharge Skardon Catchment (m³/s)</th>
<th>RORB Peak Outlet Discharge (m³/s)</th>
<th>RORB Calibration Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kc</td>
</tr>
<tr>
<td>5</td>
<td>166</td>
<td>178</td>
<td>48.5</td>
</tr>
<tr>
<td>10</td>
<td>230</td>
<td>241</td>
<td>48.5</td>
</tr>
<tr>
<td>20</td>
<td>311</td>
<td>321</td>
<td>48.5</td>
</tr>
<tr>
<td>50</td>
<td>435</td>
<td>426</td>
<td>48.5</td>
</tr>
<tr>
<td>100</td>
<td>564</td>
<td>563</td>
<td>48.5</td>
</tr>
</tbody>
</table>

**Hydrologic Model Results**

The resultant hydrographs produced at the Skardon River catchment outlet for the 5, 10, 20, 50, 100, and 1000 year ARI, and PMP critical duration storm events are shown in Figure 6-23. Hydrographs at intermediate locations within the wider Skardon River catchment were output for inclusion in hydraulic model simulations.

The hydrographs show an increase in peak discharge with increase in ARI. The hydrographs exhibit an early peak arising from local catchment runoff and tributaries closer to the outlet, followed by a larger peak as the main Skardon River flood wave reaches the outlet. A time to peak discharge at the outlet of approximately 13 to 16 hours can be observed for the 100 year through the 5 year ARI events.

The PMP predicted peak discharge is an order of magnitude greater than the 100 year event and has a likely ARI of approximately 1 in 3,000,000 years, plus or minus an order of magnitude, according to methods developed by Laurensen and Kuczera (1999).

In all cases, the storm duration was selected based on the duration that provided the greatest flow i.e. the critical storm duration event. The reason for different critical storm durations for different return periods is that the more extreme flood events, such as the 1,000 year and PMP use a different temporal pattern for rainfall. The temporal pattern specifies the percent of the total storm rainfall depth that falls at each increment in time. In general, the more frequent events have a high burst of rainfall early in the storm event, whereas the extreme events have a more distributed rainfall pattern across the storm event.
The aim of the hydraulic model simulation is to demonstrate the riverine flooding likely to occur in the Skardon River under various design flood event conditions.

To achieve this objective the following methodology was utilised:

- Extract the RORB hydrographs for design storm events ranging from the 5 year ARI to the 1000 year ARI, plus the Probable Maximum Precipitation (PMP) event. Fifteen locations were identified inside the MIKE21 grid at which to apply the hydrographs as point inflows;

- Set the boundary conditions. For each storm event, two simulations were created, one with the high tailwater condition, and the other with the low tailwater condition;

- Run each of the models for a sufficient time period to ensure that the flood peak had occurred and that water levels were receding at every point in the model domain;

- Extract from the model results files the maximum values for water depth (from the high tailwater simulation) and velocity (from the low tailwater simulation); and

- Convert the peak velocity and depth results in an ascii grid format for mapping and presentation.

**Figure 6-23 Skardon River catchment outlet hydrographs**

**Hydraulics – MIKE21**
Hydraulic Model Boundary Conditions

In an estuarine river system such as that of the Project area, flood depths and velocities can be greatly influenced by the tidal level (i.e. the tailwater level). For this reason, two sets of tidal conditions were implemented in the MIKE21 model – a high tailwater condition to assess the likely maximum extents and depths of inundation, and a low tailwater condition to investigate maximum expected velocities.

The weather system that is most likely to create large scale flooding in the catchment is a tropical cyclone. In addition to the precipitation produced by a cyclone, the high wind speeds and large fetch lengths can create a significant increase in water level – referred to as a storm surge – in addition to the prevailing tidal condition. The high tailwater condition is therefore based on a large tide occurring coincidentally with a storm surge, and applied as a fixed level to the ocean boundary.

The nearest available tidal plane data is from Weipa, which records a value of 2.15 m Australian Height Datum (AHD) for the highest astronomical tide (HAT). With regards to the storm surge component, CDM Smith has adopted the same value (0.55 m) as WorleyParsons in their flood study of the adjacent Ducie River catchment, carried out for Metro Mining as part of the Pisolite Hills Project. Given that this data is derived from values recorded at Weipa, and that no other nearby records of storm surge are available, it is considered appropriate to adopt the same value for this study. The resulting components of storm tide are outlined in Table 6-48.

<table>
<thead>
<tr>
<th>Tailwater Components</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Astronomical Tide</td>
<td>1.60 mAHD</td>
</tr>
<tr>
<td>Storm Surge</td>
<td>0.55 m</td>
</tr>
<tr>
<td>Storm Tide</td>
<td>2.15 mAHD</td>
</tr>
</tbody>
</table>

Hydraulic Model Grid

The basis for the 2D flood model topographic grid is Airborne Laser Survey (ALS) data. The data were ratified by Metro Mining as appropriate to use for the purposes of this study, and were provided to CDM Smith in the form of a series of 1 m ascii grids. Details of the topographic grid used in the hydraulic modelling are listed in Table 6-49.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid Cell Size</td>
<td>20 m</td>
</tr>
<tr>
<td>Grid Orientation/Rotation</td>
<td>North up (i.e. zero degrees rotation)</td>
</tr>
<tr>
<td>Model extent (width x height)</td>
<td>1265 cells x 1150 cells</td>
</tr>
<tr>
<td>Model extent (km x km)</td>
<td>25.3 km x 22.8 km</td>
</tr>
<tr>
<td>Model Origin (Lower Left Corner)</td>
<td>604,310 m East; 8,683,210 m North</td>
</tr>
<tr>
<td>Map Projection</td>
<td>MGA, Zone 54</td>
</tr>
</tbody>
</table>

Hydraulic Model Results

The MIKE21 models were observed to be stable at a ten second time step. Each model was run for a 30 hour simulation time, which captured the bulk of the flood wave and peak water levels and velocities throughout the model domain. Results were processed to create maps showing depth and velocity maxima; these maps are found appended to the Surface Water Assessment technical report in Appendix H.
6.7.4  Potential Impacts

Potential impacts include as a result of the Project construction and operation activities include:

- Modified catchment hydrology;
- Diversion of catchment flows;
- Surface erosion; and
- Reduction in water quality through controlled and uncontrolled discharge of contaminated and/or sediment laden water.

Given the Project design considerations and mitigation methods proposed (refer Section 6.7.5) it is; however, considered that the abovementioned impacts, if they do occur, will be controlled and result in minor environmental consequence. Activities that have the potential to impact surface water resources include:

- Construction activities associated with earthworks, re-profiling, regrading, stockpiling, drainage, water storage structures and haul roads; and
- Operational activities including open pit mining, the use of surface and groundwater resources for dust suppression, potable water supply and truck wash-down, and from and controlled and uncontrolled point discharges.

It should be noted that water sampling undertaken as part of the Pisolite Hills Project concluded that the waste water will be of a standard suitable for the direct surface water release under the ANZECC and ARMCANZ guidelines. Given that this Project is not proposing to beneficiate and that any waste water from bauxite will be extremely limited, this only further reduces the already minimal risk. Bauxite is considered a non-hazardous material and thus water captured can either be reused within the mine industrial area or released to the environment under EA conditions.

6.7.4.1  Water Budget

The overall mine impact on catchment hydrology was assessed via the AWBM method using the assessment of the “natural” catchment as a baseline in which to measure impacts against. AWBM parameters were varied from the baseline to represent likely catchment characteristics exhibited by different land use types; namely, hardstand, open pit mining and rehabilitated areas.

The partitioning of annual rainfall for the various land uses is shown in Table 6-50. The table shows that open mine areas exhibit approximately a 30% increase in annual baseflow volume compared to natural catchments; correspondingly, there is a significant decrease in predicted surface runoff. Hardstand areas exhibit minimal baseflow and a more than two-fold increase in surface runoff compared to natural catchments. The rehabilitation land use shows an increase in baseflow and decrease in surface runoff when compared to natural catchments due to the final void left by the mining.

Table 6-50 AWBM Land Use Water Budget Results

<table>
<thead>
<tr>
<th>Water Budget Component</th>
<th>Natural</th>
<th>Open Pit Mining</th>
<th>Hardstand</th>
<th>Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evapotranspiration (%)</td>
<td>53.3</td>
<td>58.6</td>
<td>46.1</td>
<td>55.3</td>
</tr>
<tr>
<td>Surface Runoff (%)</td>
<td>20.3</td>
<td>4.2</td>
<td>51.3</td>
<td>13.4</td>
</tr>
<tr>
<td>Baseflow (%)</td>
<td>26.4</td>
<td>37.2</td>
<td>2.6</td>
<td>31.3</td>
</tr>
</tbody>
</table>
The partial areas of land use types at various stages of the mine life are summarised in Table 6-51 and Table 6-53 for Skardon River and Namaleta Creek, respectively. These were calculated based on the total local catchment area that drains to the mine affected areas. By applying the partial areas to the partitioning of annual rainfall for the various land uses shown in Table 6-50, an overall impact on the water budget due to mining activities could be estimated. The results of this assessment for the two drainage basins are shown in Table 6-52 and Table 6-54. The overall impact on the water budget is shown to be minor due to the small scale of the mine affected areas (i.e. hardstand, open pit and rehabilitation) relative to the local catchments in which they reside.

Table 6-51 AWBM land use partial areas – Skardon River

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Pre-Mining</th>
<th>10-year mine plan</th>
<th>20-year mine plan</th>
<th>27-year mine plan</th>
<th>Post Mine Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>103.9</td>
<td>97.3</td>
<td>92.6</td>
<td>82.9</td>
<td>89.5</td>
</tr>
<tr>
<td>Open Mining</td>
<td>-</td>
<td>5.8</td>
<td>4.6</td>
<td>3.1</td>
<td>-</td>
</tr>
<tr>
<td>Hardstand</td>
<td>-</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>-</td>
<td>-</td>
<td>5.8</td>
<td>10.4</td>
<td>13.5</td>
</tr>
<tr>
<td>Total</td>
<td>103.9</td>
<td>103.9</td>
<td>103.9</td>
<td>103.9</td>
<td>103.9</td>
</tr>
</tbody>
</table>

Table 6-52 Potential impact on water budget – Skardon River

<table>
<thead>
<tr>
<th>Water Budget Component</th>
<th>Pre-Mining</th>
<th>10-year mine plan</th>
<th>20-year mine plan</th>
<th>27-year mine plan</th>
<th>Post Mine Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evapotranspiration (%)</td>
<td>53.3%</td>
<td>53.5%</td>
<td>53.6%</td>
<td>53.6%</td>
<td>53.5%</td>
</tr>
<tr>
<td>Surface Runoff (%)</td>
<td>20.3%</td>
<td>19.6%</td>
<td>19.5%</td>
<td>19.3%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Baseflow (%)</td>
<td>26.4%</td>
<td>26.8%</td>
<td>27.0%</td>
<td>27.0%</td>
<td>26.8%</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 6-53 AWBM land use partial areas – Namaleta Creek

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Pre-Mining</th>
<th>10-year mine plan</th>
<th>20-year mine plan</th>
<th>27-year mine plan</th>
<th>Post Mine Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>47.2</td>
<td>47.2</td>
<td>46.1</td>
<td>43.9</td>
<td>43.9</td>
</tr>
<tr>
<td>Open Mining</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>2.3</td>
<td>-</td>
</tr>
<tr>
<td>Hardstand</td>
<td>-</td>
<td>-</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>47.2</td>
<td>47.2</td>
<td>47.2</td>
<td>47.2</td>
<td>47.2</td>
</tr>
</tbody>
</table>

Table 6-54 Potential impact on water budget – Namaleta Creek

<table>
<thead>
<tr>
<th>Water Budget Component</th>
<th>Pre-Mining</th>
<th>10-year mine plan</th>
<th>20-year mine plan</th>
<th>27-year mine plan</th>
<th>Post Mine Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evapotranspiration (%)</td>
<td>53.3%</td>
<td>53.3%</td>
<td>53.4%</td>
<td>53.6%</td>
<td>53.4%</td>
</tr>
<tr>
<td>Surface Runoff (%)</td>
<td>20.3%</td>
<td>20.3%</td>
<td>20.0%</td>
<td>19.4%</td>
<td>19.9%</td>
</tr>
<tr>
<td>Baseflow (%)</td>
<td>26.4%</td>
<td>26.4%</td>
<td>26.6%</td>
<td>27.0%</td>
<td>26.7%</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

It is important to note that although the overall mine impact on the water budget is negligible on the local catchment scale, short term localised impacts during mining operations may be more pronounced. It is also likely; however, that the partitioning of rainfall into runoff and baseflow will be recombined as total runoff re-entering the Skardon River/Namaleta Creek, thus further reducing the total impact of varying recharge rates as a result of mining operations on the water environment and supported ecosystems. Both the Skardon River and Namaleta Creek are tidally influenced
adjacent to the Project area and thus not as sensitive as an ephemeral or perennial freshwater system to variance in total runoff volume or duration of runoff entering the system.

6.7.4.2 Flood Impacts

Flood maps appended to the Surface Water Assessment technical report in Appendix H show that the proposed pit locations are not at risk from riverine flooding, even under the PMF event. This is because the pits are situated on the bauxite plateaus with buffer distances maintained between the pit shell and watercourse boundaries. Construction of the pits is not likely to interfere with the current floodplain processes, and will therefore cause no significant hydraulic impacts to the river in terms of changes to flows, water levels, or velocities.

The main impact of riverine flooding is to the haul road connecting the barge loading facilities. It is noted that the haul road has been designed to fit within the defined lease boundary. Negotiations with neighbouring lease holders have been initiated in order to locate the haul road in a less flood and tidally influenced zone. Notwithstanding, peak velocities are quite low at haul road low spots and defined drainage crossings as would be expected from an estuarine system with low stream energy. It is unlikely that river velocities will cause excessive scouring and sediment transport due to inundation of road surfaces or drainage infrastructure.

6.7.4.3 Stormwater

Mine pit areas are located on plateaus and thus will be naturally inward draining. Due to the depth of the mine pits and fast infiltration rates through the bauxite and underlying layers connecting to the shallow aquifer, the mine pit areas act as a self-draining sediment trap for runoff from disturbed mine areas. While the mine pits themselves may become inundated during the wet season from direct rainfall and natural rising groundwater, surface stormwater flows would be diverted around the mining pits, meaning there would be minimal impact to existing stormwater flow volumes or channels.

Runoff from the network of haul roads will be captured in table drains and turned out to vegetated areas via spoon drains at regular intervals. Due to the generally flat topography it is not anticipated that the spoon and table drains will carry significant sediment load.

Land disturbance caused by mining activities, including those proposed to be undertaken as part of the Project, increases the potential for erosion and subsequent sediment transport. Numerous activities that will be undertaken give way to greater rates of erosion than those which are naturally occurring, including, but not limited to; land clearing, soil stripping, mine excavation, and haul road construction. Sediment laden runoff from the barge loading facilities has the potential to cause higher levels of turbidity in the Skardon River. Elevated sediment concentrations could also be expected to occur in stormwater runoff from stockpile areas.

6.7.5 Management and Mitigation Measures

The Project design will incorporate construction and operation measures to reduce the likelihood and severity of impacts. Furthermore, a water management network has been conceptualised and details the way in which water resources will be managed during operations.
6.7.5.1 Construction and Operation Measures

- Develop, prior to construction, and implement a dynamic Surface Water Management Plan (SWMP);

- An ESCP will be prepared prior to any construction or mining-related activities commencing. The erosion and sediment control devices, such as sediment ponds will be designed to freely flow under gravity and function in the absence of site personnel during mine closure over the wet season;

- Disturbance areas will be minimised by planning and staging of works to reduce the volume of disturbed sediment that may potentially affect water bodies;

- Stormwater runoff from undisturbed areas surrounding the Project area will be diverted away from disturbed areas via clean water diversion drains;

- Sediment-containing stormwater from mining operations will be directed to sediment ponds;

- Water from the sediment ponds will be reused to meet demands for water supply during construction and for dust suppression during the construction period (and subsequently during operation);

- Clearing of native vegetation will only be undertaken in accordance with relevant permits and approval conditions;

- Retaining vegetation corridors will assist in minimising sediment transport from disturbed areas to adjacent watercourses by slowing flow velocities and stabilising deposited sediment. Vegetation corridors and clearing set-back distances from watercourses will be employed in compliance with the relevant Queensland Government’s Regional Vegetation Management Codes;

- Stripped topsoil will be maintained in accordance with IECA guidelines to be used in rehabilitation effort. Areas disturbed by mining activities will be progressively rehabilitated and at the end of mine life, mining-related infrastructure will be decommissioned and rehabilitated back to an approved final land form, as agreed with the Traditional Owners and the land owners;

- Sediment removal devices will be incorporated in the watercourse crossing design, where appropriate, to reduce sediment loads entering the system;

- To separate clean and dirty water runoff, non-contaminating overburden from pit stripping activities will be used to construct a clean water diversion bund. Should there not be sufficient overburden to construct the clean water diversion bund to an appropriate height, an accompanying diversion drain will be excavated parallel to the bund on the upslope side of the bund;

- Road crossings will be designed as a low flow culvert and floodway arrangement to efficiently pass flows greater than the 2 year ARI event and reduce environmental impacts of filling within creek crossings; and

- Should the pit not be capable of containing the 10 year, 24 hr duration rainfall volume (as stipulated for sediment pond design) clean water diversion will first be considered; followed by provision of an appropriately sized sediment basin.
6.7.5.2 Water Management Network

A schematic of the proposed water management network for the Project is shown in Figure 2-12. The proposed water supply is via shallow and/or deep aquifer bores to meet a total annual demand of 200 ML. Assuming 275 days of operation per year and 20 hours of daily pumping time, a total yield of 10 L/s is required from the combined bores. Polyethylene storage tanks are proposed to buffer between supply from the bores and operational demand. A peaking factor of between one day and one week would equate to polyethylene tanks with a total storage of between 1 ML and 5 ML, respectively. The number of tanks required will be based on balancing the need to locate water storage near the water use versus trucking water to where it is used.

The distribution of mine water, is estimated in Table 6-55. The majority of water use (150 ML/yr) is raw water for dust suppression of the dump station, haul roads and stockpiles, as well as for washdown of the crusher plant and conveyor system.

A potable water supply to the camp and mine industrial area of approximately 11 ML/yr is required to meet the standard outlined in the ADWG. Field investigations and laboratory testing conducted by CDM Smith in November 2014 and March 2015 indicate that the shallow aquifer water quality is suitable for potable use. Chemical dosing may be required to control pH levels and provide disinfection. Two potable use water tanks will be required; one at the mine camp and the other at the mine industrial area. The main potable use tank will be located near the mine camp, as this is the main source of potable demand. A potable water pipeline or truck transport will be required to transport potable water to the storage tank located at the mine industrial area.

A sewage treatment plant is proposed to be located near the mine camp. Wastewater produced from the mine industrial area will be stored and periodically trucked and transported to the sewage treatment plant. Effluent and sludge waste streams will be appropriately treated and discharged to surface or used as composting/mulching media, respectively.

Table 6-55 Mine water demands

<table>
<thead>
<tr>
<th>Description</th>
<th>Annual Demand (ML)</th>
<th>Water Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations (crusher; truck fill for dust suppression)</td>
<td>150</td>
<td>Raw</td>
</tr>
<tr>
<td>Mine Camp (75 person camp)</td>
<td>10</td>
<td>Potable</td>
</tr>
<tr>
<td>Fire Fighting (poly tank spare capacity)</td>
<td>5</td>
<td>Raw</td>
</tr>
<tr>
<td>Mine Industrial Area (Workshop / Washdown)</td>
<td>35</td>
<td>Raw / Potable*</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

*1 ML/yr potable supply to the Mine Industrial Area assuming 40 L/person/day

The water management network allows for potential reuse of water collected in sumps, ponds and slots. Allowance for reuse of water has not been incorporated into the demand analysis; however, such an allowance would reduce the amount of water abstracted from bores. The main function of the sumps, ponds and slots is to capture sediment laden runoff for sediment removal prior to release to the existing environment. Oil/water separators are proposed for vehicle wash and workshop areas prior to release or reuse of water.

Fire water supply will be provided through storage in polyethylene tanks at suitable locations around the mine lease. A total of 5 ML has provisionally been included for the purpose of this water resources assessment. It is anticipated that these stores be replenished post use and that the total volume is available for firefighting activities during operations.
6.7.5.3 Receiving Environment Monitoring Program (REMP)

Monitoring will supplement the water management strategy to confirm that any potential uncontrolled discharges (overflows from mining pits or sediment dams) or controlled discharges do not adversely impact on downstream water quality. Monitoring will also serve as a continual improvement mechanism for the ongoing management of stormwater including operational calibration of the water balance model.

A REMP will be developed in accordance with DEHP Guidelines including DEHP Technical Guideline - Wastewater release to Queensland waters (EM112 – Version 1) and will be periodically updated as required throughout the life of the Project. The REMP will be implemented through the EMP and will incorporate the following elements:

- Final WQOs will be developed with trigger values set at the 20th and 80th percentiles. Baseline water quality monitoring has determined locally derived WQOs for the Project as currently, only ANZECC and ARMCANZ trigger values are applicable. In the event that DEHP deems insufficient data to determine baseline trigger values has been collected prior to construction, interim WQO trigger values will be as per the ANZECC and ARMCANZ guidelines or otherwise determine by DEHP;

- The ongoing baseline assessment and interpretation of water quality data will be undertaken in accordance with relevant guidelines including the Department of Environment and Resource Management (DERM) (former) Monitoring and Sampling Manual 2009 (DERM 2009b), QWQG (DERM 2009a), and ANZECC and ARMCANZ guidelines. The monitoring program will outline, as a minimum:
  - Measures to further derive local WQOs from data collected from reference sites, chosen in accordance with the QWQG (DERM 2009a)
  - Frequency and locations for sampling
  - Relevant water quality parameters, including physico-chemical and estimation of local stream flow
  - Water quality sampling methods

- All data used to determine locally-derived WQOs shall be recorded in an electronic format for review by the administering authority if requested;

- Water quality monitoring will be undertaken up and down stream of the mine site, and in all Project affected water storages including any groundwater sump slots) and watercourses on-site;

- In the event a trigger level is exceeded during monitoring, a response mechanism will be implemented to include the following:
  - In the event of an exceedance of results against the WQOs trigger levels, compare downstream results to upstream results and if the two are similar, an exceedance is unlikely to be a result of Project-related activities. If downstream results are noticeably higher than upstream, carry out a visual inspection of the works site to identify potential sources of contaminants
  - Corrective actions arising from the investigation will be identified and implemented to address exceedances

Reporting processes to DEHP will be undertaken as per EA conditions.
6.7.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential surface water and hydrological impacts is summarised in Table 6-56. An analysis of initial risk, without mitigation, was considered for surface water. The residual risk considers the mitigation and management measures developed for this element and put forward in this assessment.

Table 6-56 Qualitative risk assessment - surface water and hydrology

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Impacts on surface water quality | Minor | Likely | Medium | ▪ Implement site ESCP  
▪ Minimise disturbance area  
▪ Implement Surface Water Management Plan  
▪ Monitoring will occur as per the aforementioned plan  
▪ Implement and maintain the water management network | Low |
| Alteration of surface water runoff flows from the Project | Insignificant | Likely | Medium | ▪ Construct culverts to maintain flows  
▪ Clean water diversions  
▪ Reinstate drainage following mining | Low |
| Diversion of surface water flows may cause some erosion and sediment movement and possible scouring during large rainfall events | Minor | Possible | Medium | ▪ Implement site ESCP  
▪ Topsoil management in accordance with IECA 2008 | Low |
| Impacts to flooding events | Moderate | Rare | Medium | ▪ Infrastructure designed to withstand floods (culverts)  
▪ Construct culverts to maintain flows | Low |

6.7.7 Summary

Flood modelling conducted for the Project illustrates the likely peak water levels and velocities for a range of ARI events. Results were processed to create maps showing depth and velocity maxima. The maps show that the proposed pit locations are not at risk from riverine flooding, even under the PMF event. This is because the pits are situated on the bauxite plateaus with buffer distances maintained between the pit shell and watercourse boundaries. Construction of the pits is not likely to interfere with the current floodplain processes, and will therefore cause no significant hydraulic impacts to the river in terms of changes to flows, water levels, or velocities.

Mine pit areas are generally located on plateaus and thus will be naturally inward draining. Due to the depth of the mine pits and fast infiltration rates through the bauxite layer, the mine pit areas act as a self-draining sediment trap for runoff from disturbed mine areas.

Runoff from the network of haul roads will be captured in table drains and turned out to vegetated areas via spoon drains at regular intervals. Due to the generally flat topography it is not anticipated that the spoon and table drains will carry significant sediment load.
The overall impact on the water budget is shown to be minor due to the small scale of the mine affected areas (i.e. hardstand, open pit and rehabilitation) relative to the local catchments in which they reside.

The overall surface water quality in the area is considered high and it appears that there has been minimal impact to existing EVs pertaining to surface water. It is also considered that the surface water (with the exception of brackish water sampled at SW02), at time of sampling, was of a suitable quality to be used as a potential source of site drinking and or process water with limited basic treatment.

6.7.8 Commitments

Metro Mining’s commitments for surface water and hydrology monitoring and management are provided in Table 6-57.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Develop an Erosion and Sediment Control Plan prior to the commencement of construction and implement for the duration of the Project.</td>
</tr>
<tr>
<td>S2</td>
<td>Develop a Surface Water Management Plan for the Project which will include regular surface water monitoring and reporting.</td>
</tr>
<tr>
<td>S3</td>
<td>Implement the water management network to separate clean and dirty where practicable.</td>
</tr>
</tbody>
</table>

6.8 Groundwater

This section presents a summary of the existing groundwater condition within and adjacent to the Project area, and an assessment of potential impacts of Project activities on groundwater. The section also includes measures to mitigate and manage impacts of the Project, to preserve the existing EVs of groundwater. The groundwater assessment technical report can be found in Appendix I and should be read in conjunction with this section.

6.8.1 Regulatory Framework

The relevant guidelines and regulatory provisions associated with groundwater, for the Project, are established in the:

- **Water Act 2000** (Water Act);
- **Environmental Protection Act 1994** (EP Act);
- Water Resource (Great Artesian Basin) Plan 2006 (GAB WRP);
- Australian and New Zealand Environment and Conservation Council and Agriculture and Resources Management Council of Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC and ARMCANZ guidelines); and
- DEHP Guidelines - Application requirements for activities with impacts to water (EM963).

**Water Act 2000**

The Water Act provides a structured system for the planning, protection, allocation and use of Queensland’s surface waters and groundwater. Under section 808 of the Water Act, a person must not take, supply or interfere with water unless authorised.
Environmental Protection Act 1994

The objective of the EP Act is to "protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends" (s3). Of the five pieces of subordinate legislation under the EP Act the EPP (Water) applies directly to groundwater and provides a framework to protect Queensland waters for various beneficial uses.

Water Resources (Great Artesian Basin) Plan 2006

The objective of the GAB WRP is to define the availability of water and provide a framework for sustainable management of water within the GAB. The Project is located within the Cape Management Area (Area NO.1 of 25 management areas).

ANZECC and ARMCANZ Guidelines for Fresh and Marine Water Quality 2000

The ANZECC and ARMCANZ guidelines provide a baseline for monitoring and measuring surface water quality for different ecosystems within Australia and New Zealand. In the absence of site specific WQOs, the ANZECC and ARMCANZ guideline values are referred.

DEHP Guidelines - Application requirements for activities with impacts to water (EM963)

The Application requirements for activities with impacts to water (EM963) is the water related guideline for ERAs under the EP Act. The guideline specifically requires that activities are operated in a way that protects the EVs of groundwater and any associated surface ecological systems.

6.8.2 Assessment Method

Available geological and hydrogeological information have been used to develop a hydrogeological conceptual model of the Project, describing the existing groundwater condition. The predictive model timeframe extends from 2015 to 2065. Approximately 25 years of a post-mining period has been included to predict potential long term effects on groundwater levels and fluxes following the cessation of mining.

Representative samples were collected once the water quality parameters had stabilised and the monitoring bores had been adequately purged. Due to the low water table in BH1 in November 2014 (towards the end of the dry season), monitoring bores BH1 MB2D and BH1 MB3D were purged dry and representative samples were collected once sufficient volumes of water had returned to the bores.

6.8.2.1 Hydrogeological Study Area

The existing infrastructure within the study area, although outside the Project boundaries, includes the barge loading facility and associated infrastructure on the Skardon River from the previous Skardon Kaolin Project.

Mining of bauxite will take place within two mining areas referred to as BH1 and BH6. The shallow groundwater system and its interaction with the mine, surface water and sensitive ecosystems at and within the vicinity of the mining areas are the key focus of this assessment. On this basis, the extent of the hydrogeological study area has been defined as shown in Figure 6-24, encompassing the two mining areas and key surface water bodies. Where relevant, information from outside of this study area has been sought to provide necessary regional context.
6.8.2.2 Existing Data

This study has utilised data from existing bores and numerous reports conducted within mining areas BH1 and BH6. Data from these bores (refer to Table 1-1 and Figure 1-2 in Appendix I) have been reviewed; however, as the majority of these bores are clustered within a local alluvial aquifer outside of the hydrogeological study area (some distance away from the proposed areas of mining), the current assessment has focused primarily on the data collected from bores within BH1 and BH6. Where relevant, data from bores outside of the hydrogeological study area have been considered.

6.8.2.3 Fieldwork

Two rounds of gauging and sampling of monitoring bores in BH1 and BH6 have been undertaken to inform the hydrogeological conceptualisation. The sampling events were carried out in November 2014 (at the end of the dry season, from 29 to 30 November 2014) and March 2015 (following the peak wet season, from 30 March 2015 to 1 April 2015). Samples were collected from six monitoring bores in November 2014 and five monitoring bores in March 2015. The samples collected during the wet season include samples from shallow monitoring bores that intersect groundwater only during the wet season (when the water table rises in response to seasonal recharge).

6.8.2.4 Modelling

Groundwater modelling has been undertaken in a staged manner consistent with the recommendations of the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). For a description of the modelling method, including calibration, prediction of the ‘mine case’ and ‘base case’, sensitivity analysis, model confidence and limitations, see Section 3 of the groundwater technical report in Appendix I.

6.8.3 Existing Environment

The proposed bauxite mine is situated within the Jurassic–Cretaceous intracratonic Carpentaria Basin, which lies beneath the Gulf of Carpentaria in offshore northern Australia and extends onshore into Queensland and the Northern Territory. The Carpentaria, Eromanga and Surat basins together form the GAB [see Figure 2-7(Smerdon 2012)]. The Project lies within the Weipa sub-basin (Munson et al., 2013). In this region, the Carpentaria Basin is overlain by Cenozoic sediments of the Karumba Basin and Quaternary alluvial sediments.

Hydrostratigraphic units at the Project include 3 to 5 m thick bauxite which is underlain by Ironstone and Kaolinite Clay of the Bulimba Formation and weathered siltstone of the Rolling Downs Formation. These units are seasonally replenished by rainfall-derived recharge during the wet season and are drained during the dry season as groundwater laterally flows towards surrounding discharge zones (the Gulf, rivers and creeks, and wetlands). Bauxite and ironstone form partial aquifers that are saturated during the wet season as the water table rises towards the ground surface.

During the dry season the water table occurs at the basal level of the kaolinite clay or within the upper (weathered) part of the siltstone. Stream flow in the Skardon River and its tributaries is maintained throughout the year by baseflow. Groundwater seasonally discharges to Bigfoot Swamp and other areas where the water table intersects the ground surface at the height of the wet season. Ecosystems associated with these discharge zones are likely to seasonally depend on groundwater and ecological values have been identified with shallow groundwater. Groundwater is currently extracted to supply water to the Skardon River Camp and there is no other extraction of groundwater at the Project for industrial, agricultural or stock and domestic use.
6.8.3.1 Surrounding Mining Activities

Existing Mine

Rio Tinto’s existing Alcan Weipa Project is located around 85 km south of the Project. The Alcan Weipa Project consists of two continuous mining operations at East Weipa and Andoom, two beneficiation plants, 19 km of railway to transport mined bauxite to the port area, and two ship loaders. Rio Tinto holds the sole rights to abstraction of groundwater from the GAB aquifer on Cape York (GHD, 2013), using around 6 to 7 GL/year (around 16 to 19 ML/d) of the 9 GL/year GAB allocation (CSIRO, 2009).

Former Mine

Gulf Alumina’s historical Skardon Kaolin Project is located immediately to the south of BH6; however, the barge loading facility and associated infrastructure are to the north of BH6 on the Skardon River. The mine ceased operations in 2011 and some of the mine’s infrastructure is currently being decommissioned. Extensive hydrogeological investigations were undertaken at and within the vicinity of the mine (SRK, 2014a); however, limited information from the monitoring and testing programs is available for consideration.

6.8.3.2 Stratigraphy

Overview

The stratigraphic units present within the study area are summarised in Table 2-2 and discussed further in Section 6.2 – Geology, Topography and Soils.

6.8.3.3 Hydrostratigraphic Units

Hydrostratigraphic units (HSUs) are geological components within a hydrogeological system that have similar hydrogeological properties. They are often chosen based on a geological model, but rock type is less important than resistance to flow and storage properties, as these properties ensure that the HSU behaves similarly from a groundwater flow point of view.

Valley Fill Sands

The Valley Fill Sands form thin, local aquifers that are readily replenished by rainfall-derived recharge and contains typically very fresh groundwater. Within the study area, the Valley Fill Sands form a shallow unconfined aquifer adjacent to the Skardon River and its tributaries. Pumping tests undertaken by Rockwater (1994b) and Golder (1998a) on three test production bores installed at the Kaolin Dry Processing Plant indicated potentially useful supplies with yields of 0.8 to 1 L/s.

The Namaleta and Lunette aquifers are two other shallow aquifers identified adjacent to Namaleta Creek and are located to the south of BH6. Water supply investigations undertaken by Rockwater (1994a, b) and Golder (1998a, b) have identified sand aquifers of 2 to 5 m in thickness along the basal level of the valleys, potentially capable of supplying up to 3 L/s per production bore. Transmissivity of the Namaleta and Lunette aquifers range from 0.2 to 800 m²/d, with the low end of the range reflecting the areas of low sand content i.e. predominantly kaolinitic sandy clay. Groundwater becomes fresher upstream of Namaleta Creek, further away from the freshwater – saltwater interface (Rockwater, 1994a).
Bauxite

Bauxite forms the uppermost HSU within mining areas BH1 and BH6. It is a partial aquifer that becomes locally saturated at the height of the wet season. Bauxite facilitates rapid infiltration during the wet season due to its high permeability.

Ironstone

Ironstone forms a partial aquifer of up to 10 m in thickness, becoming saturated during the wet season and fully drained during the dry season. A number of creeks and swamps are incised into the Ironstone, receiving seasonal discharge of groundwater from this HSU.

Kaolinite Clay

The Kaolinite Clay has been interpreted in the past as a relatively low permeability unit; however, a study undertaken by Creeks and Volker (1992a, 1992b) suggests that considerable macroporosity (vugs and fissures) exists within the Kaolinite Clay that facilitates rapid recharge and lateral flow to rivers and creeks that are incised into this HSU. Additionally, the water table has been observed to freely fluctuate across this unit and it is hydraulically well connected to the adjoining HSUs. On this basis, the Kaolinite Clay within the study area has been classified as an aquifer.

Studies undertaken in the surrounding areas have also identified the presence of highly permeable sand and gravel horizons along the basal level of the Kaolinite Clay. These are interpreted to be palaeo-channel aquifers incised into the underlying Rolling Downs Formation (Cape Alumina, 2010; AGE, 2010). The presence of palaeo-channel aquifers has been documented at the Pisolite Hills Project (AGE, 2010) and Weipa, the latter of which has been utilised for town and mine supplies where numerous bores have been constructed to depths of up to 30 m. SRK (2014a) indicates that the palaeo-channel aquifers are up to 15 m in thickness and containing generally fresh groundwater with variable yields of up to 30 L/s. At the Project, a palaeo-channel aquifer has not been encountered in the boreholes drilled to date.

Rolling Downs Formation (Siltstone)

The Rolling Downs Formation is regarded as a regional aquitard with a thickness of around 500 m, forming an effective seal to the underlying Gilbert River Formation (Riot Tinto Alcan, 2013). The upper weathered zone, comprising lenses of weakly lithified sandstone, clay and Siltstone can; however, exhibit higher permeability and form a locally important aquifer (Eggleton et al., 2008). The water table also locally occurs within the upper part of the Siltstone during the dry season, forming the uppermost saturated unit in parts of the study area. For this reason, the Siltstone underlying the Kaolinite Clay has been delineated as a separate HSU from the remainder of the Rolling Downs Formation.

Basement

The thick sequence of mudstone, claystone and siltstone of the (lower) Rolling Downs Formation hydraulically separates shallow groundwater of the overlying HSUs from deep groundwater of the underlying GAB aquifers i.e. the Rolling Downs Formation is a regional aquitard that defines the effective hydraulic base of the shallow local / intermediate groundwater flow system. This HSU typically reports yields of less than 0.5 L/s and groundwater is generally brackish to saline (SRK, 2014a).
GAB Aquifers

The sandstone of the Gilbert River Formation forms a confined aquifer of the GAB, a regional groundwater flow system. At the western coastal margins, groundwater is under artesian conditions with hydraulic heads of around 25 m above ground level (DNRM, 2005). It is locally unconfined in the eastern portion of the Western Cape region (the GAB intake beds on the eastern edge of the Carpentaria Basin) where it receives recharge and provides baseflow to several major rivers.

The sandstone of the Gilbert River Formation is the most extensive unit in the Carpentaria Basin (Radke et al., 2012) and is considered an excellent aquifer, providing the main groundwater resource in the region (CSIRO, 2009). Supplies from the confined portions are large, ranging from 60 to 80 L/s while supplies from the unconfined portion are much lower, between 1 to 5 L/s (DNRM, 2005). Groundwater quality ranges from fresh in the unconfined outcropping areas to brackish where the aquifer is confined.

6.8.3.4 Groundwater Occurrence and HSUs

Within the study area, it is possible to delineate two groundwater flow systems associated with the HSUs described above:

- Local groundwater flow system that is represented by groundwater in the upper, unconfined part of the system and its’ interactions with surface water and potentially sensitive receptors. This system is associated with the Valley Fill Sand, Bauxite, Ironstone, Kaolinite Clay and Siltstone; and

- Regional groundwater flow system that is represented by groundwater at depth within the GAB aquifers, with groundwater flowing from the GAB recharge zone in the northern and eastern portions of the Western Cape region.

As the depth of mining of bauxite is shallow (approximately 3 m, but can be deeper than 6 m), descriptions of hydrogeology presented in the subsequent sections of the report focus on the local groundwater flow system associated primarily with the shallow HSUs of the Bulimba Formation.

A total of 12 monitoring bores have been constructed within BH1 and BH6 by AGE (2011) to provide the baseline data necessary to inform the hydrogeological conceptual model. These monitoring bores are screened in the shallow HSUs and are constructed to a maximum depth of 22 m. The monitoring bores have been designed to provide information on the shallow hydrogeology and local groundwater flow system.

The details of monitoring bore construction and screened formations is presented in Table 6-58. Bore construction diagrams and lithological logs are presented in AGE (2011). Shallow bores are screened above the Kaolinite Clay layer and the deeper bores are either screened below the Kaolinite Clay layer, or partially screened across the Kaolinite Clay layer and the underlying Siltstone. The locations of these monitoring bores are shown in Figure 6-24.

Table 6-58 Monitoring bore construction

<table>
<thead>
<tr>
<th>Bore ID</th>
<th>Coordinates (MGA54)</th>
<th>*Ground elevation (mAH)</th>
<th>Casing ID (mm)</th>
<th>Screened HSU</th>
<th>Screened interval (mbgl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1-MB1D</td>
<td>622560 8696018</td>
<td>18.63</td>
<td>50</td>
<td>Kaolinite</td>
<td>15.7 - 21.7</td>
</tr>
<tr>
<td>BH1-MB1S</td>
<td>622564 8696022</td>
<td>18.63</td>
<td>50</td>
<td>Ironstone</td>
<td>4 - 5.5</td>
</tr>
<tr>
<td>BH1-MB2D</td>
<td>620413 8694794</td>
<td>16.14</td>
<td>50</td>
<td>Siltstone</td>
<td>18.7 - 24.7</td>
</tr>
<tr>
<td>BH1-MB2S</td>
<td>620411 8694790</td>
<td>16.14</td>
<td>50</td>
<td>Bauxite</td>
<td>2.5 - 4</td>
</tr>
</tbody>
</table>
Several monitoring and test productions bores have also been installed by Rockwater (1994a, b, c) and Golder (1998a, b), primarily within the vicinity ofNamaleta Creek, as part of the previous water supply investigations (see Table 1-1 in Appendix I). Data from these bores are localised, providing detailed information on the Namaleta and Lunette aquifers (local aquifers) located to the south of the study area (i.e. outside of the area of interest).

### 6.8.3.5 Hydrogeological Properties

AGE (2011) carried out falling head slug tests at the monitoring bores by injecting clean water into the bores and monitoring the decline of the groundwater levels. The rate of decline of water level (recovery to static groundwater level) was analysed by AGE (2011) using published methods to derive estimates of hydraulic conductivity.

The analysis of the slug test data gives moderate to low hydraulic conductivity estimates and the range of values for each HSU is summarised below:

- **Bauxite**: 0.1 m/d to around 0.2 m/d;
- **Ironstone**: 0.01 m/d to 0.1 m/d (geometric mean 0.045 m/d); and
- **Kaolinite/Clay/Siltstone**: 0.01 m/d to around 0.15 m/d (geometric mean 0.025 m/d).

Note: The aforementioned estimates have been compared against literature derived values.

Information available from several studies suggests that the estimates of hydraulic conductivity derived from slug testing at the Project are likely to underestimate the bulk hydraulic conductivity of the shallow HSUs. This may partly be due to the nature of the tests carried out (e.g. injection of water into the unsaturated zone) although the most likely cause is that the narrow diameter monitoring bores have not intersected macropores/high flow areas that contribute to the high bulk hydraulic conductivity of the HSUs.

The extent and the properties of the Valley Fill Sands within the vicinity of the Skardon River estuary and the possible presence of high flow zones/palaeo-channel aquifers within the study area are currently not understood. If present, these may have an important control on the seasonal dynamics of the shallow groundwater system.
Groundwater Level

The depth to water measurements have been converted to groundwater levels using the ground elevation obtained from the Laser Illuminated Detection and Ranging (LIDAR) elevation data. Table 6-59 summarises the manual groundwater level measurements. October 2011 measurements were taken following the installation of the bores and may not represent static water levels.

Table 6-59 Manual groundwater level measurements

<table>
<thead>
<tr>
<th>Bore ID</th>
<th>LIDAR Elevation</th>
<th>October 2011</th>
<th>November 2014</th>
<th>March 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DTW (mbgl)</td>
<td>GWL (mAHD)</td>
<td>DTW (mbgl)</td>
<td>GWL (mAHD)</td>
</tr>
<tr>
<td>BH1-MB1D</td>
<td>18.63</td>
<td>14.92</td>
<td>17.05</td>
<td>1.58</td>
</tr>
<tr>
<td>BH1-MB1S</td>
<td>18.63</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>BH1-MB2D</td>
<td>16.14</td>
<td>16.9</td>
<td>-0.76</td>
<td>20.59</td>
</tr>
<tr>
<td>BH1-MB2S</td>
<td>16.14</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>BH1-MB3D</td>
<td>14.96</td>
<td>14.63</td>
<td>19.98</td>
<td>-5.02</td>
</tr>
<tr>
<td>BH1-MB3S</td>
<td>14.96</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>BH6-MB1D</td>
<td>11.89</td>
<td>6.96</td>
<td>9.67</td>
<td>2.22</td>
</tr>
<tr>
<td>BH6-MB1S</td>
<td>11.89</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>BH6-MB2D</td>
<td>9.43</td>
<td>6.85</td>
<td>8.21</td>
<td>1.22</td>
</tr>
<tr>
<td>BH6-MB2S</td>
<td>9.43</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>BH6-MB3D</td>
<td>11.54</td>
<td>8.81</td>
<td>10.04</td>
<td>1.5</td>
</tr>
<tr>
<td>BH6-MB3S</td>
<td>11.54</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
</tbody>
</table>

- DTW refers to depth to water below ground level, GWL refers to groundwater levels above datum and mbgl refers to metres below ground level.
- NA – Note accessible due to high water levels in surface water courses.

Table 6-59 shows that the groundwater levels of BH1 MB2D in October 2011 and BH1 MB2D and BH1 MB3D in November 2014 are negative. In a coastal environment the water table does not naturally drain to elevations several metres below mean sea level (greater than the tidal range) unless there is a mechanism to artificially lower the water table e.g. pumping. There is no known pumping of groundwater within mining areas BH1 and BH6. Water supply to the Skardon River Camp is sourced from a production bore located approximately 1 km south of BH6.

Possible errors in manual depth to water measurements and surveyed elevation data were both investigated; however, no sources of errors have been identified to date. Therefore, there is currently uncertainty in the precise elevation of groundwater levels in BH1 (although it is certain that the negative mAHD values are not representative) and long term monitoring will be necessary in this area to ascertain the cause of this anomaly.

Groundwater Flow Directions

The groundwater contours, depicted in Figure 6-25 and Figure 6-26, indicate that the water table (potentiometric) surface forms a subdued reflection of topography, with groundwater flowing towards the Skardon River suggesting the river is a gaining stream.
INTERPRETED DRY SEASON GROUNDWATER LEVEL CONTOURS - NOVEMBER 2014

Legend
- Monitoring Bore
- Wet season springs
- Groundwater flow direction
- Dry season interpreted groundwater contours (mAHDI)
- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Estuary and swamp
- Pit Extents
- Camp Site
- Metro Mining Mine Lease Area

Elevation (m)
- 1.1 - 0.0
- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 15.0
- 15.1 - 20.0
- 20.1 - 25.0
- 25.1 - 30.0
- 30.1 - 35.0
- 35.1 - 40.0

DATA SOURCE
MGC Mining
Qld Government Open Source Data
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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

GCS GDA 1994 MGA Zone 54
Scale @ A3 - 1:50,000

FIGURE 6-25

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This drawing is confidential and shall only be used for the purpose of this project.

APPROVED
CHECKED
DESIGNED

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Notes:

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Recharge Mechanism

Recharge to the water table occurs via infiltration of rainfall. Due to a combination of high rainfall, and high permeability of surficial bauxite the infiltration rates are high with minimal surface runoff even after high rainfall events (CSIRO, 2009). According to preliminary groundwater modelling undertaken by SRK (2014a) the potential recharge rate in the study area is estimated to be 25 to 30 % of rainfall. The mean annual runoff in the Western Cape region is estimated to be around 34 % of rainfall (CSIRO, 2009) and rainfall-runoff modelling at the Project estimates mean runoff to be approximately 20 % of rainfall. For the SoE Project surface runoff over undisturbed areas is estimated to be much lower, at less than 1 % of rainfall (Rio Tinto Alcan, 2013).

The groundwater level fluctuates in cycles, corresponding to the wet and dry seasons. The seasonal fluctuation of groundwater levels closely mimics the rainfall Cumulative Deviation from the Mean (CDFM), with the timing of rises in groundwater level matching closely with the onset of the wet season indicating rapid recharge i.e. the water table within the shallow aquifers rises and falls without significant lag indicating direct rainfall infiltration (Coffey and Hollingsworth, 1971). Creeks and Volker (1992a) attributes this rapid infiltration and subsequent rise of the water table to macropore flow (i.e. flow via fissures that quickly channel water to the water table, resulting in rapid rise of the water table as macropores are filled with recharging water).

The groundwater level typically rises in mid-January and peaks in late-March, over the wettest three months. Much of the initial increase in rainfall in December (approximately 50% of January’s rainfall) is likely taken up in wetting the unsaturated zone, facilitating the subsequent infiltration to the water table (AGE, 2010; Coffey and Hollingsworth, 1971). Groundwater levels decline during the dry season and fully recover during the wet season. Ultimately, the elevation of the water table is affected by the magnitude of preceding rainfall events e.g. the groundwater level recorded at the end of 2013 is lower than the level recorded in 2012 due to the lower rainfall during the wet season of 2013, as reflected in the lower peak of rainfall CDFM.

The recharge rates provide useful insight into the water balance, which implies that approximately a third of rainwater contributes to recharge during the wet season whilst the remainder is lost by runoff, plant interception and evapotranspiration.

Discharge Mechanisms

Groundwater discharges to the Skardon River and associated tributaries throughout the year, provide baseflow that maintains surface water flow. As the water table rises during the wet season, temporal discharge of groundwater occurs in other locations where the water table intersects the ground surface (e.g. at Bigfoot Swamp). In local depressions, to the west of BH6 MB1 and at Bigfoot Swamp to the southwest of BH6 MB2, discharge of groundwater is sustained for a longer period until the water table drops below the ground surface.

The dry season groundwater level in BH6 MB2D is approximately 2.5 m below the elevation of Bigfoot Swamp, indicating that the water table naturally becomes disconnected from the swamp during the dry season (depending on the depth to groundwater). It is currently not known if local depressions such as Bigfoot Swamp are associated with psuedokarstic sink holes, locally known as “melon holes”, that are formed in the regolith (weathering zone) often as a result of erosion by preferential flow (Laffan, 2001).

No perennial springs with sustained groundwater seepage have been identified within BH1 and BH6 (WorleyParsons, 2011). Perennial spring complexes are often identifiable on aerial imagery by the contrast in vegetation colour and density e.g. the Coolibah Springs at the Pisolite Hills Project to the south. Ephemeral springs, however, appear on the edge of the bauxite plateau during the wet season.
These are formed as the water table rises during the wet season and locally intersects a steeply dipping ground surface. Plate 6-9 presents a photograph of an approximately 1 m wide channel identified along the east to west trending unnamed tributary of the Skardon River to the south of BH1 during March 2015 field visit.

Plate 6-9: Wet season spring south of BH1 (unnamed tributary of the Skardon River)

In low lying areas adjacent to the Skardon River and its tributaries, evapotranspiration by riparian vegetation represents another mechanism of groundwater discharge i.e. within the vicinity of the Skardon River where the water table is shallow, groundwater also discharges from subsurface by plant uptake. As the water table rises and the capillary fringe reaches the rooting depth of vegetation, discharge of groundwater via evapotranspiration may temporarily increase over the broader area as water availability is not limiting. Groundwater discharge via evapotranspiration is therefore expected to be seasonally variable, depending on the dynamic interactions between the fluctuating water table, vegetation and climatic conditions (e.g. humidity).

There is no known pumping of groundwater within mining areas BH1 and BH6. Water supply to the Skardon River Camp is sourced from a production bore located approximately 1 km south of BH6.

**Aquifer Interconnectivity**

The available groundwater level data suggest that the HSUs above and below the Kaolinite Clay are hydraulically well connected, with the water table freely rising and falling in response to rainfall-derived recharge.

Hydrographs of nested shallow and deep bores constructed at the Pisolite Hills Project also display the same trend, indicating that the Kaolinite Clay does not limit vertical hydraulic connectivity (Cape Alumina 2010, AGE 2010). Therefore, the response of the water table to rainfall-derived recharge is consistent across the region and the shallow aquifers within the study area, as a whole, are interpreted to be unconfined. The Kaolinite Clay and Siltstone are likely to be in hydraulic connection, to a varying degree, with the Valley Fill Sands of the Skardon River and tributaries.

As the water table fluctuates seasonally by as much as 10 m, the vertical hydraulic gradient between the shallow aquifers and the confined GAB aquifer may seasonally reverse. However, given the thickness of the intervening aquitard (approximately 500 m of the Rolling Downs Formation) and the observed seasonal drainage of the shallow aquifers, the potential for upward diffuse leakage from the GAB aquifer is considered low within the study area.
6.8.3.6 Groundwater Dependent Ecosystems

Based on the review of site specific data and available information, the following potential groundwater dependent ecosystem (GDE) areas have been identified within the study area (see Figure 6-27), which are potentially sensitive to changes in the hydrogeological regimes:

- **Skardon River, including its tributaries, and the riparian zone.** The Skardon River is a perennial river, receiving groundwater discharge (baseflow). Aquatic ecosystems associated with the river are therefore likely to be seasonally dependent on discharge of groundwater that maintains flow during the dry season (Type 2). Vegetation within the riparian zone is supported by rainfall and surface flows as well as groundwater, either via surface expression (Type 2), particularly during the wet season, or proximity of the water table to the plant root zone (Type 3) such as groundwater from the alluvial aquifers (Valley Fill Deposits);

- **Bigfoot Swamp, a freshwater swamp, located near the northwest boundary of BH6.** According to the GDE Atlas, the swamp is classified as a coastal/sub-coastal floodplain tree swamp (Melaleuca and Eucalypt) that has a high potential to rely on surface expression of groundwater, and is registered in the Queensland Directory of Important Wetlands. Apart from supporting aquatic life, the swamp is also important for migratory birds (SRK, 2014b). The swamp is located within a depression and a comparison of swamp elevation with groundwater levels suggests that the swamp and associated ecosystems are supported by discharge of groundwater, which is expected to increase during the wet season as the water table rises close to ground surface across the whole region (Type 2). As the water table declines by several metres during the dry season, the water table becomes disconnected from the swamp, resulting in a temporary reduction in groundwater discharge. The swamp may be associated with a melon hole, with seasonal dynamics similar to those observed at the Pisolite Hills Project;

- **North to south trending drainage line (Lunette Creek), to the west of Bigfoot Swamp.** This is identified in the GDE Atlas as having a high potential to rely on surface expression of groundwater. Discharge of groundwater along the drainage line occurs during the wet season to this area;

- **Lunette Swamp, located adjacent to the southern boundary of BH6.** According to the GDE Atlas, there is a moderate potential for groundwater interaction at Lunette Swamp i.e. discharge of groundwater is possible, at least temporarily, as the water table rises during the wet season; and

- **Namaleta Creek and the riparian zone, located to the south of Lunette Swamp and BH6.** The GDE Atlas identifies a low lying wetland along the east-west trending portion of the creek with a high potential for groundwater interaction, relying on surface expression of groundwater (Type 2).

As discussed, no perennial spring complexes have been identified within the study area. GDEs that depend on discharge of groundwater from the GAB aquifers are located in the GAB recharge zone more than 30 km east of the Project (Smerdon et al., 2012).
6.8.3.7 Groundwater Quality

Water quality parameters including pH, EC, dissolved oxygen, reduction and oxidation potential (redox) and temperature, have been measured in-situ during the field sampling events in November 2014 and March 2015. Additional in-situ field measurements of water quality parameters are available from 2011 and 2012 and are found in Appendix A of the groundwater technical report (Appendix I).

The salinity of groundwater samples has been calculated from field and laboratory EC readings (the latter measured in μs/cm at 25°C) using a conversion factor of 0.6. The range of salinity calculated from each groundwater monitoring event is presented in Table 6-60 and is classified using ADWG’s “palatability” classification.

Table 6-60 Groundwater salinity

<table>
<thead>
<tr>
<th>Monitoring event</th>
<th>Salinity (mg/L)</th>
<th>ADWG Palatability Classification</th>
<th>Acceptability range (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Median</td>
</tr>
<tr>
<td>October 2011*</td>
<td>81</td>
<td>460</td>
<td>241</td>
</tr>
<tr>
<td>November 2014**</td>
<td>106</td>
<td>547</td>
<td>280</td>
</tr>
<tr>
<td>February 2012**</td>
<td>22</td>
<td>58</td>
<td>40</td>
</tr>
<tr>
<td>June 2012**</td>
<td>23</td>
<td>216</td>
<td>45</td>
</tr>
<tr>
<td>November 2012**</td>
<td>208</td>
<td>549</td>
<td>348</td>
</tr>
<tr>
<td>November 2014</td>
<td>65</td>
<td>558</td>
<td>178</td>
</tr>
<tr>
<td>March 2015</td>
<td>21</td>
<td>440</td>
<td>25</td>
</tr>
</tbody>
</table>

*October 2011 data are actual total dissolved solids concentrations from laboratory analysis
**Calculated from field EC measurements.

The shallow groundwater salinity is fresh (<600 mg/L) and is regarded as possibly being good quality drinking water (ADWG, 2011), consistent with the shallow aquifers being readily replenished by annual recharge events. The groundwater salinity is within the range of salinity measured at the Pisolite Hills Project (75 to 1650 mg/L) (AGE, 2010). Groundwater is fresher during the wet season and the salinity is typically <60 mg/L. The salinity of groundwater from the nested pair of shallow and deeper bores is similar except at BH6 MB2D and BH6 MB2S, where groundwater sampled from the deeper bore is more saline (440 mg/L compared to 21 mg/L, based on March 2015 data). This difference could be due to less connectivity and mixing of water between the aquifers at that location or reduced potential for seasonal flushing of parts of aquifers occurring near sea level.

The pH of groundwater during the dry season ranges from 4.79 to 6.46 and 5.63 to 5.88 during the wet season (based on the laboratory analysis of pH). Rainwater unaffected by anthropogenic activities is weakly acidic due to the dissolution of carbon dioxide and its pH ranges from 5.5 to 6.5 (Hounslow, 1995). The pH of groundwater measured during the wet season is consistent with the typical pH of rainwater and has a narrow range of values reflecting the effects of rainfall-derived recharge replenishing the aquifers. The pH of shallow groundwater measured at the Pisolite Hills Project ranges from 5.32 to 6.75 (AGE, 2010) and is similar to the pH of shallow groundwater at the Project.

Groundwater sampled from monitoring bores within the study area exceeded the ANZECC and ARMCANZ guideline trigger values for fresh waters for aluminium, arsenic, cadmium, zinc, copper and nickel at a number of locations. These exceedances are considered to represent the naturally occurring background levels and are considered unlikely to negatively affect any ecological systems that interact with groundwater. The presence of several potential GDEs within the study area implies that exposure to these metals within the environment is likely to be within ecological tolerance limits.
6.8.3.8 Summary of Hydrogeological Conceptual Model

This section provides a summary of the current hydrogeological conceptualisation of the Project area:

- The HSUs of interest are the Bauxite, Ironstone and Kaolinite Clay of the Bulimba Formation and the weathered Siltstone of the underlying Rolling Downs Formation. The water table spans across these HSUs;

- The water table forms a subdued reflection of topography, with groundwater flowing towards discharge zones that include the Skardon River and its tributaries, drainage lines and topographic depressions and the sea;

- The water table aquifer receives rainfall-derived recharge and fluctuates in cycles corresponding to the wet and dry seasons with the following characteristics:
  - The initial increase in rainfall in December is taken up by the wetting of the unsaturated zone
  - Following the re-wetting of the unsaturated zone, the water table rises rapidly in response to rainfall (mid to late January) reaching peak elevation in March
  - The water table declines steadily at a rate of 1 to 3 m per month during the dry season as groundwater drains away laterally towards the discharge zones. The water table seasonally varies in elevation by as much as 10 m
  - Shallow groundwater is replenished on an annual basis; however, the height of the water table elevation at the end of the wet season depends on the magnitude of the preceding rainfall events and varies from year to year

- The water table rises and falls freely in response to variations in rainfall-derived recharge and the Kaolinite Clay layer does not limit vertical hydraulic connectivity. This suggests that there is considerable macroporosity within the Bulimba Formation to facilitate rapid infiltration and fluctuations of the water table;

- The Skardon River and its tributaries are perennial, being maintained by baseflow that extends through the dry season. As the water table occurs within the Kaolinite Clay and Siltstone during the dry season, flow in the Skardon River is maintained by groundwater contribution from these units. Bauxite, which is targeted for mining, does not sustain baseflow; and

- Potential groundwater-dependent ecosystems include aquatic ecosystems associated with the Skardon River system, riparian vegetation and terrestrial vegetation associated with Bigfoot Swamp and drainage lines.

6.8.4 Potential Impacts

According to the mining risk framework, there are four categories of groundwater effects that may result from mining activities. These include effects on:

1. Groundwater quantity.
2. Groundwater quality.
4. Physical disruption of aquifers.

In the following sections the potential changes to the groundwater system resulting from proposed mining activities are described with reference to each of the four categories of groundwater effects.

**6.8.4.1 Groundwater Quantity**

The proposed open cut mining is shallow, removing bauxite from the top three metres (average) of the ground profile within the lease boundaries, with mining of each strip scheduled to take place during the dry season (when there is negligible recharge). Although the water table rises to the ground surface at some of the proposed pit locations during the wet season, it declines steadily during the dry season typically at a rate of 1 to 3 m per month. Based on the proposed depth, locations and timing of mining, the potential for the water table to intersect the floor of the pits during removal of bauxite is considered low. If the water table is locally intersected, this will most likely occur at the start of mining/dry season and the water table will quickly drop to several metres below the proposed depth of mining as the dry season advances. Therefore, dewatering of aquifers is not considered necessary.

Mining will result in clearing of vegetation and the post-mining surface is expected to be an average of 1.5 to 2 m lower than the pre-mining surface, creating permanent depressions in the post-mining landscape. These landscape changes have the potential to affect the groundwater quantity in the following ways:

- Clearing of vegetation and lowering of ground surface have the potential to increase recharge by minimising loss due to plant interception, evapotranspiration and surface runoff. This effect will decrease gradually as vegetation becomes re-established post-mining. In areas where the depth to water table is deep (e.g. BH1), locally enhanced recharge during the wet season could raise the water table to higher elevations than the pre-mining levels and increase the hydraulic gradient towards the discharge zones, transferring additional volumes of recharge water to the discharge zone.

- In areas where the highest elevation of the pre-mining water table is within the top 2 m of ground surface, the permanent lowering of ground surface will result in temporary discharge and possible pooling of water of groundwater during the wet season (e.g. mine pits in the area of BH6 MB1S). There is the potential for pool levels to be lower than the pre-mining peak water table due to the effects of evapotranspiration, runoff and discharge into open pits/voids. The maximum elevation of the water table at these locations will be lower than the surrounding areas, potentially resulting in a small reduction in the hydraulic gradient towards the discharge zones and therefore a small reduction in groundwater discharge rates. In these areas the maximum recharge rates will also be constrained by the maximum elevation of the water table i.e. when the water table reaches the ground surface and discharges, further rainfall no longer contributes to additional recharge.

Volker and Creeks (1993) undertook numerical modelling to investigate the effects of bauxite mining on recharge rates at Weipa. Their study found that initial clearing of vegetation has the greatest potential to temporarily increase the recharge rate, with the modelling indicating the potential for recharge to increase by a factor of three. As the maximum recharge rate is limited by the maximum elevation of the water table, the difference between the pre-mining and post-mining recharge rates are less in the wetter years and/or where the ground surface has been lowered during mining. An important finding of their study is that once vegetation is fully re-established no long term major changes to recharge rates occur (i.e. interception and evapotranspiration by vegetation has a dominant effect on the recharge rates). The findings of Volker and Creeks (1993) are consistent with those of the studies undertaken on the effects of bauxite mining in south-west...
Western Australia which found that mining caused temporary increases in streamflow of up to 23% before returning to pre-mining values following rehabilitation (Bari and Ruprecht, 2003).

As mining and rehabilitation are both scheduled to take place progressively at the Project, changes to groundwater quantity, levels and fluxes will also occur progressively.

Metro Mining is also considering the possibility of utilising groundwater to meet the projected water supply requirements of approximately 0.8 ML/d. If shallow groundwater is extracted during mining (the dry season) the water table will be temporarily drawn down around pumping bores or trenches as groundwater is removed from the aquifer storage. As there is no recharge during the dry season to offset the effects of pumping, groundwater discharge rate to the Skardon River and estuary area may be reduced as a result of pumping.

6.8.4.2 Groundwater Quality

Mined out pits will be progressively backfilled with 1 to 1.5 m of dry waste rock (overburden). As the waste rock is derived from excavated in-situ material (bauxite layer) and returned to the pits without processing, the quality of recharge water is not expected to be altered by the presence of the backfill. Shallow groundwater is also replenished seasonally by rainfall-derived recharge and additional recharge resulting from clearing of vegetation has the potential to reduce the salinity of groundwater (i.e. groundwater becomes fresher).

Mining during the dry season will not require dewatering of aquifers as the water table will be several meters below the base of the pits. Therefore mining will not result in alteration of groundwater quality due to mixing of waters from different HSUs or salt water intrusion.

There is the potential for groundwater discharging from the mine pits during the wet season to spill and mobilise sediments to surface water courses. Accidental release of contaminants could also locally degrade groundwater quality and contaminants subsequently reaching the discharge zones have the potential to impact the associated ecosystems. These effects could be mitigated by controlling the outflow concentrations (e.g. containment of groundwater, or diversion into sedimentation basins) and preventing uncontrolled release of contaminants by appropriately designing the storage and refuelling facilities.

6.8.4.3 Surface Water – Groundwater Interaction

Bauxite is only partially saturated during the wet season and the dry season baseflow is maintained by groundwater from the Kaolinite Clay and the underlying Siltstone. Therefore, removal of bauxite will not directly affect baseflow to the Skardon River and associated tributaries. Clearing of vegetation and lowering of ground surface; however, have the potential to alter the dynamics of recharge and discharge, which may affect the quantity of groundwater discharged to the river as baseflow. Numerical groundwater modelling predicts that groundwater discharge rates to Bigfoot Swamp and Skardon River (including the tributaries and estuary) may increase by up to 18% and 3% respectively during mining depending on the magnitude of enhanced recharge. The quality of recharge water is expected to remain unaffected and relatively small additional volumes of groundwater discharged to the Skardon River are not expected to adversely affect aquatic or riparian ecosystem function. Additional volumes of groundwater discharges to Bigfoot Swamp have the potential to increase the pool levels during times of inundation. The potential for increased pool levels to affect wetland ecosystems will depend on their resilience and resistance to natural range of variations in pool levels, and the extent to which increased discharge raises pool levels outside the natural range.
Any changes that could occur are likely to be within natural ranges of ecosystem resilience and resistances. As dewatering is not required groundwater flow directions will be maintained towards the Skardon River and associated tributaries during and after mining.

6.8.4.4 Physical Disruption of Aquifer

Mining physically removes the Bauxite layer from the ground profile and subsequent backfilling creates depressions in the post-mining landscape. These will change the dynamics of recharge and discharge mechanisms and groundwater quantity as described above. The small reduction in the thickness of the unsaturated zone could also facilitate faster arrival of a wetting (recharge) front to the water table, which may result in a slightly earlier response of the water table to seasonal recharge.

Importantly, the mining operation will not significantly interrupt or interfere with aquifers as the depth of excavation is very shallow – generally above the water table.

6.8.4.5 Predictive Modelling Results

The Project has the potential to alter groundwater levels and fluxes by permanently lowering the ground surface (by around 2 m) and temporarily enhancing recharge. Mining also causes a temporary increase in recharge. If the loss due to evapotranspiration and runoff is significantly minimised by the clearing of vegetation and formation of pits, potentially large volumes of rainwater will become available to recharge over the mined area. The purpose of predictive modelling is to quantify these potential effects during and after mining. The contours and timing of the maximum increase and decrease in the groundwater level predicted at any one location are presented at Figure 6-28 and Figure 6-29 respectively.

The modelling results showed that:

- The peak groundwater levels during the wet season are predicted to increase during mining as a result of enhanced recharge;
- The peak groundwater levels at bores within BH6 are predicted to be lower post-mining as the water table locally becomes constrained by the post-mining depressions formed in the landscape;
- The groundwater is constrained over the pits to the south and north of Bigfoot Swamp, where the water table is predicted to intersect the lowered ground surface (Figure 6-29);
- The discharge rate increases during mining as larger areas of land are mined and larger portions of additional recharge water fed into the model is removed where the water table intersects the ground surface (Figure 6-30);
- The effect of additional recharge is to cause the groundwater discharge volume to increase by up to 3% during mining, with the difference being most pronounced at the beginning of each year when recharge is enhanced during the wet season (Figure 6-31);
- The post-mining discharge is predicted to decrease by no more than 0.6%, which is possibly not measurable (Figure 6-31);
- The net groundwater discharge volume to Bigfoot Swamp in a given year is predicted to increase by up to 18% when mining takes place in the surrounding area (Figure 6-32);
- The post-mining discharge volume is predicted to decrease by 3% because the peak water table to the south and, to a lesser extent north, of the swamp is constrained by the lowered ground surface, resulting in a small reduction in the hydraulic gradient towards the swamp during the wet season compared to the ‘base case’ (Figure 6-32); and

- The volume of groundwater discharged to Bigfoot Swamp is predicted to increase by up to 12% and 27% in a given mining year for additional 20% and 60% recharge, respectively.

In reality, portions of groundwater discharged to Bigfoot Swamp during mining may be lost as runoff and subsequently enter surface water courses. Water in the mine pits surrounding the swamp will also pool to some elevation above the pit floor and the predicted reduction in discharge rate is therefore considered the most conservative scenario.
FIGURE 6-28
CONTOURS OF PREDICTED MAXIMUM INCREASE IN GROUNDWATER LEVEL

Simulation Time
- Monitoring Bore
- Maximum predicted head increase (m)
- Watercourse
- 2017 - 2019
- 2019 - 2021
- 2021 - 2023
- 2023 - 2025
- 2025 - 2027
- 2027 - 2029
- 2029 - 2031
- 2031 - 2033
- 2033 - 2035
- 2035 - 2037
- 2037 - 2039

DATA SOURCE
- MEC Mining
- QLD Government Open Source Data
- Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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

Legend
- Monitoring Bore
- Maximum predicted head increase (m)
- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Estuary and swamp
- Pit Extents
- Camp Site
- Metro Mining Mine Lease Area

GCS GDA 1994 MGA Zone 54
Scale @ A3 - 1:50,000

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

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- DATE 15/07/15
- NOTES

R
Details
- Date 15/07/15
Figure 6-30 Predicted groundwater discharge rates over mine areas

Figure 6-31 Predicted percentage change in groundwater discharge volume to Skardon River
6.8.4.6 Cumulative Impacts

There are currently no existing mining operations within the study area and within the predicted area of influence of the Project to result in cumulative effects. There is, however, a proposed Skardon River Bauxite Mine within ML 40082 that is located adjacent to the mine pits within BH6. Potential effects of the proposed Skardon River Mine on groundwater are not known at the time of this assessment; however, water affecting mining activities and therefore potential direct groundwater effects of the two projects are expected to be similar, with a potential cumulative effect being the net increase in the volume of groundwater discharged to surface water courses. Based on the footprint of the proposed Skardon River Bauxite Mine, the potential net increase in the volume/rate of groundwater discharged to surface water courses (including Bigfoot Swamp) is considered unlikely to be more than double the effects predicted for the Project alone. The potential for any additional discharge of groundwater from the Skardon River Bauxite Mine to adversely affect the health of ecosystems associated with the Skardon River is considered low. Additional volumes of groundwater discharged to Bigfoot Swamp have the potential to further increase pool levels during times of inundation. The effect of this will depend on the resilience and resistance of ecosystems associated with Bigfoot Swamp to natural range of variations in pool levels, and the extent to which increased discharge raises pool levels outside the natural range.

6.8.4.7 Summary of Potential Impacts

Mining is predicted to cause a temporary increase in the volume of groundwater discharged to Bigfoot Swamp and the Skardon River tributaries and estuary area. Therefore, linkages between the effects of mining and ecosystems (receptors) associated with these features exist i.e. receptor exposure pathway exists via aquifers which possibly possess threats to some or all receptors.

The Skardon River receives baseflow and ecosystems (particularly the aquatic ecosystems) depend on this discharge. Additional volumes of groundwater introduced temporarily during mining are predicted to be relatively small (an increase of up to 3%), affecting only the peak discharge, and any changes are likely to be within natural ranges of ecosystem resilience and resistance. The quality of recharge water is also expected to be unaffected as the mined pits are backfilled with in-situ
material. Therefore, potential small increases in groundwater discharge rates to the Skardon River are considered unlikely to adversely affect aquatic or riparian ecosystem function.

Numerical groundwater modelling conservatively assumes pool levels to be equal to the elevation of the post-mining pit floor and predicts a small reduction in post-mining groundwater discharge to Bigfoot Swamp as recharge returns to pre-mining levels. Despite this, the connectivity of the swamp to shallow groundwater is very likely to remain unaffected and a potential reduction in post-mining groundwater discharge is small albeit conservative i.e. approximately 3% reduction, resulting from a small reduction in the hydraulic gradient towards the swamp. Therefore, long term effects on ecosystems associated with Bigfoot Swamp is considered unlikely and specific mitigation measures to control potential changes in groundwater quantity are not considered necessary post-mining.

A possible threat to the degradation of EVs for groundwater is related to the accidental release of contaminants (e.g. spillage of fuel). If the contaminants are released, there is the potential for the contaminants to discharge to the Skardon River tributaries and Bigfoot Swamp via shallow aquifers (depending on the location of spills). Due; however, to high recharge rates the potential also exists for significant dilution of contaminant concentration within the aquifers. Given that accidental spillages will only result in localised release of contaminants and hazardous goods and chemical storage areas will be engineered and managed to prevent or mitigate uncontrolled releases, the threat of degradation of groundwater quality on sensitive receptors is considered moderate.

Groundwater discharging from open pits (vegetation cleared) has the potential to mobilise sediments, depending on whether this water is contained (allowed to pond) within the pits or diverted. Therefore, there is the potential for sediment loads to reach the Skardon River and estuary. There is also a very low risk that sediment will over top the pits in the BH 01 west mining area during extended periods of above average rainfall and enter the Bigfoot Swamp. This effect is expected to diminish as vegetation is established and mine pits are progressively rehabilitated over the life of Project.

Depending on the pool level within the mine pits and post-mining recharge rates, there is the potential for the volumes of groundwater discharge to Bigfoot Swamp to reduce post-mining. The discharge volumes are; however, predicted to reduce by relatively small amounts (<4%) and the connectivity of Bigfoot Swamp with groundwater will very likely remain unaffected. Therefore, long-term post-mining impacts on ecosystems associated with Bigfoot Swamp are considered unlikely.

Table 6-61 summarises an assessment of threat and potential impacts to possibly sensitive receptors.
<table>
<thead>
<tr>
<th>Potential Receptor</th>
<th>Direct Effects</th>
<th>Threat</th>
<th>Potential Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystems associated with Skardon River tributaries and Bigfoot Swamp.</td>
<td>Groundwater quantity</td>
<td>Increased discharge to Skardon River tributaries and estuary during mining</td>
<td>Low - additional volumes of groundwater discharged are predicted to be small (up to 3%), affecting only the peak discharge, and are not considered to adversely affect ecosystems that depend on baseflow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased discharge to Bigfoot Swamp and potential increase in pool level during mining</td>
<td>Moderate – potential impact of additional discharge (up to 18%) depends on its effect on pool levels and sensitivity of ecosystems to pool level variations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced discharge to Bigfoot Swamp post-mining</td>
<td>Low - predicted reduction in post-mining discharge is small (up to 3%) and is based on conservative assumptions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Altered groundwater levels and connectivity of Bigfoot Swamp to groundwater</td>
<td>Low – predicted increase in peak groundwater levels near the swamp is &lt;0.8m and connectivity of swamp to shallow groundwater is very likely to remain unaffected.</td>
</tr>
<tr>
<td>Groundwater quality</td>
<td>Degradation of quality of groundwater through uncontained spills of hazardous materials</td>
<td>Moderate - contaminant release, if any, would be localised and appropriate measures will be in place to prevent, contain and control contaminant release.</td>
<td></td>
</tr>
<tr>
<td>Surface water – groundwater interaction</td>
<td>Altered groundwater levels and flow dynamics</td>
<td>Low - groundwater flow direction will be maintained towards the river and relatively small additional volumes of water discharged is unlikely to affect the ecosystems that depend on baseflow.</td>
<td></td>
</tr>
<tr>
<td>Physical disruption of aquifers</td>
<td>Removal of bauxite and subsequent backfilling</td>
<td>Low - mining operation will not significantly interfere with aquifers as the depth of excavation is very shallow.</td>
<td></td>
</tr>
</tbody>
</table>

**Water Supply**

The extraction of shallow groundwater from the Namaleta aquifer and Lunette aquifer has the potential to lower the water table within the vicinity of Namaleta Creek and Lunette Swamp. Riparian vegetation along Namaleta Creek is likely to be more reliant on soil water in the unsaturated zone that is seasonally replenished by the rising water table rather than direct extraction from the saturated zone i.e. the water table naturally falls below the rooting depth of vegetation during the dry season. Long term pumping may or may not affect the seasonal dynamics of shallow groundwater and the rewetting of the unsaturated zone. The potential long term drawdown effects have not been quantified by Golder (1998a) and further modelling and monitoring will be necessary prior to and during operation of the borefields to inform long term effects of groundwater extraction.

Previous water supply investigations undertaken by Rockwater (1994a, b) and Golder (1998a, b) have identified sand aquifers of 2 to 5 m in thickness along the southern side of Namaleta Creek.
(Namaleta aquifer) and along Lunette Creek to the south of Lunette Swamp (Lunette aquifer). These sand aquifers are valley fill deposits occurring along the basal level of channels that are incised into the Rolling Downs Formation (from 7 - 10 mbgl) and are confined to semi-confined by kaolinitic sandy clay. In total, 4 and 6 production bores have been installed in the Namaleta aquifer and Lunette aquifer respectively, where sufficient thickness of sand has been delineated from 118 exploration holes (Golder, 1998a). Pumping tests and groundwater modelling undertaken by Golder (1998a) indicate that each production bore in the Namaleta aquifer and Lunette aquifer is potentially capable of supplying 2 L/s (0.17 ML/d) and 3 L/s (0.26 ML/d) respectively, assuming continuous pumping for 7 months. Therefore, a 0.8 ML/d water supply demand for the Project could potentially be met by extracting from the existing production bores, assuming that the sand aquifers are fully replenished during the wet season.

If groundwater supply potential is identified near the Skardon River and shallow groundwater is extracted, there is the potential for the dry season groundwater discharge rate to surface water bodies / streams to decline. As the groundwater discharge rate to the Skardon River and estuary area is predicted to reach around 15 ML/d towards the end of the dry season, the extraction of up to 0.8 ML/d has the potential to reduce the discharge rate by up to 6%. This will likely be within the resilience and resistance ranges of affected (aquatic) ecosystems and the effects of pumping will be temporary as the shallow aquifers will be fully replenished each year by the much larger volumes of water fed as recharge.

6.8.5 Management and Mitigation Measures

Mining of bauxite is predicted to temporarily increase the volume of groundwater discharged to Bigfoot Swamp and the Skardon River tributaries during the life of mine, which has the potential to temporarily increase the inundation pool level. Regular monitoring and analysis will be necessary to refine the understanding of the hydrogeological regime of Bigfoot Swamp and sensitivity of the associated ecosystems to variations in pool levels. If the outcome of further monitoring and investigation identifies unacceptable risks, direct intervention, such as redirection of excess water, may become necessary.

Relatively small additional volumes of water of the same quality discharged to the Skardon River and tributaries during mining are not expected to adversely affect the health of the ecosystems that already depend on seasonal discharge of groundwater. Therefore, specific measures to mitigate or control the volume of additional groundwater is not considered necessary. To minimise potential impacts on groundwater quality and EVs, management and control measures of potential pollutants and contaminant sources used during mining operations must be maintained. These include the following:

- Provision of appropriate spill control materials including booms and absorbent materials at refuelling facilities at all times to manage accidental spillages of fuel;

- Some of the existing monitoring bores are located within the proposed pit outlines. If the integrity of these bores cannot be maintained during mining, they will need to be replaced by new monitoring bores located outside of the pits to enable ongoing collection of groundwater level data;

- Regular monitoring of groundwater quality shall take place on a biannual basis, at the start and end of the dry season i.e. start and end of mining operation in a given year. Monitoring will involve sampling from all monitoring bores at the start of the dry season and from deep monitoring bores at the end of the dry season;
- A decrease in the peak water table has the potential to decrease peak groundwater discharge rate to Bigfoot Swamp. As this is predicted to occur to the south of Bigfoot Swamp, an additional nested pair of monitoring bores is proposed to the south of the swamp (but outside of the pit outlines) to monitor the potential changes in groundwater levels and verify the predicted low level effects on the connectivity with shallow groundwater;

- All refuelling facilities and the storage and handling of oil and chemicals to comply with relevant Australian Standards. Management and all hazardous substances are to be stored as per manufacturer’s requirements. This includes storing these materials within roofed, bunded areas lined with an impermeable material to prevent leaching and spills; and

- Procedures to be established at the mine to ensure safe and effective fuel, oil and chemical storage and handling. All staff to be made aware of the requirement to report spillages and leaks and the potential for these incidents to impact the quality of groundwater.

All significant uncontrolled discharges will be reported to the DEHP according to legislative requirements under the EP Act.

If groundwater is extracted for water supply during mining, potential drawdown related effects could be managed by carefully distributing the extraction rates across the borefields, augmenting the borefields with additional production bores, and supplementing the water supply with extraction from other existing bores.

The aforementioned management measures will be incorporated into a groundwater section within the Project EMP which will outline a comprehensive groundwater monitoring program, including details of management and mitigation measures for any groundwater related risks of the Project.

### 6.8.6 Qualitative Risk Assessment

A qualitative risk assessment of potential groundwater impacts is summarised in Table 6-62. An analysis of initial risk, without mitigation, was considered for groundwater. The residual risk considers the mitigation and management measures developed for this element and put forward in this assessment.

**Table 6-62 Qualitative risk assessment - groundwater**

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawdown of water table due to construction</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>- Biannual groundwater monitoring</td>
<td>Low</td>
</tr>
<tr>
<td>Localised degradation of groundwater quality due to chemical leaks and spills</td>
<td>Minor</td>
<td>Rare</td>
<td>Low</td>
<td>- Containment and storage of chemicals, oils and fuels as per ADG Code</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Spills kits made available</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Bunded storages for chemicals, oils and fuels</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Water management network to capture, treat and reuse any contaminated water</td>
<td></td>
</tr>
<tr>
<td>Local mounding of water table and alteration of groundwater flow</td>
<td>Minor</td>
<td>Rare</td>
<td>Low</td>
<td>- Biannual groundwater monitoring</td>
<td>Low</td>
</tr>
</tbody>
</table>
6.8.7 Summary

Available geological and hydrogeological information have been used to develop a hydrogeological conceptual model of the Project, describing the existing groundwater condition. Groundwater seasonally discharges to Bigfoot Swamp and other areas where the water table intersects the ground surface at the height of the wet season. Ecosystems associated with these discharge zones are likely to seasonally depend on groundwater and associated ecological values have been identified with shallow groundwater. The modelling predicts a small post mining reduction in peak groundwater discharge rates to Bigfoot Swamp; albeit based on a largely conservative set of assumptions. Given that the connectivity of the swamp to shallow groundwater is likely to remain unaffected, the small potential reduction in the peak discharge rate is considered unlikely to affect ecosystems associated with Bigfoot Swamp.

Metro Mining will develop and implement a groundwater monitoring and management plan as part of the Project EMP which will outline a comprehensive groundwater monitoring program, including details of management and mitigation for any groundwater related risks of the Project.

6.8.8 Commitments

In relation to groundwater monitoring and management, Metro Mining’s commitments are provided in Table 6-63.

Table 6-63 Commitments - groundwater

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>Develop and implement a groundwater monitoring and management plan that targets the affected aquifers.</td>
</tr>
<tr>
<td>G2</td>
<td>Review and update if required the conceptual model with data obtained during monitoring.</td>
</tr>
<tr>
<td>G3</td>
<td>Develop ESCPs prior to the commencement of construction to reduce potential impacts on groundwater.</td>
</tr>
<tr>
<td>G4</td>
<td>Adverse effects on groundwater will be managed and prevented where practicable to ensure no direct or indirect release of contaminant to groundwater result from the Project.</td>
</tr>
<tr>
<td>G5</td>
<td>Implement a progressive mine rehabilitation strategy to minimise potential impacts to groundwater infiltration rates.</td>
</tr>
</tbody>
</table>

6.9 Air Quality

This section summarises the air quality assessment undertaken by Vipac including the method, relevant regulatory framework, existing environment, potential impacts and discusses the mitigation measures adopted by the Project to minimise impacts. This section also identifies the expected quantity of greenhouse gas emissions (GHG) for construction and operation of the Project. It should be noted that construction activities were not modelled in the air quality assessment as the operational phase has a higher impact than construction. The full air technical assessment report is provided in Appendix J and should be read in conjunction with this summary.

6.9.1 Regulatory Framework

The key legislation and guidelines relevant to the assessment and management of air quality are:

- National Environment Protection (Ambient Air Quality) Measure (Air NEPM);
- Environmental Protection Act 1994 (EP Act);
- Environmental Protection (Air) Policy 2008 [EPP (Air)]:

- Guideline Mining – Model Mining Conditions (Model Mining Conditions);
- National Pollutant Inventory (NPI) – Emission Estimation Technique (EET) Manual for Mining; and
- DEHP Guidelines - Application requirements for activities with impacts to air (EM960).

**National Environment Protection (Ambient Air Quality) Measure**

Australia's first national ambient air quality standards were outlined in 1998 as part of the Air NEPM. The Air NEPM sets national standards for the key air pollutants; carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, lead and particles (PM$_{10}$ and PM$_{2.5}$). The Air NEPM requires the state governments to monitor air quality and to identify potential air quality problems.

**Environmental Protection Act 1994**

In Queensland, the air environment is managed under the EP Act. The EP Act utilises a number of mechanisms to achieve its objectives including: Environmental Protection Policies (EPPs) for water use, noise and air.

**Environmental Protection (Air) Policy 2008**

The EPP (Air) was developed to identify and protect EVs of the atmosphere that are conducive to the health and well-being of humans and biological integrity. The administering authority must consider the requirements of the EPP (Air) when it decides an application for an EA, amendment of a licence or approval of a draft EMP. Schedule 1 of the EPP (Air) specifies air quality indicators and objectives for approximately 93 contaminants for Queensland.

**Guideline Mining – Model Mining Conditions**

Pursuant to the EP Act is the Model Mining Conditions, published by DEHP. The purpose of the guideline is to provide a set of model conditions to form general environmental protection commitments for the mining activities and the EA conditions. The guideline states that the ‘model conditions should be applied to all new mining project applications lodged after the guideline is approved’, therefore the Project is subject to the air criteria outlined in this guideline.

**National Pollutant Inventory – Emission Estimation Technique Manual for Mining**

The NPI EET Manual for Mining provides calculation methods to predict the emission rates for individual mining activities to assist the reporting of emissions.

**DEHP Guideline - Application requirements for activities with impacts to air (EM960)**

The Application requirements for activities with impacts to air (EM960) is the air related guideline for ERAs under the EP Act. The guidelines require three key areas to be addressed:

- Identify the EVs of the receiving air environment including the identification of any nearby sensitive places (Section 6.9.3);
- Identify the possible impacts of the proposed activity and all associated risks to the EVs (Section 6.9.6); and
- Identify the strategies to mitigate the identified risks to the EVs (Section 6.9.5).
These requirements along with those in the Model Mining Conditions are addressed in the following sections.

### 6.9.1.1 Project Criteria for Particulate and Dust Deposition

From all of the regulations the strictest applicable criteria have been selected for this assessment and are presented in Table 6-64.

#### Table 6-64 Air criteria

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Basis</th>
<th>Averaging Time</th>
<th>Criteria</th>
<th>Source</th>
<th>Exceedances¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Suspended Particulates (TSP)</td>
<td>Human Health</td>
<td>1 year</td>
<td>90 μg/m³</td>
<td>MMC²</td>
<td>NA</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Human Health</td>
<td>24 hour</td>
<td>50 μg/m³</td>
<td>MMC²</td>
<td>Five days per year</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Human Health</td>
<td>24 hour</td>
<td>25 μg/m³</td>
<td>MMC²</td>
<td>NA</td>
</tr>
<tr>
<td>Dust deposition</td>
<td>Amenity</td>
<td>30 days</td>
<td>8 μg/m³</td>
<td>Air NEPM</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>120 mg/m²²/day</td>
<td>MMC²</td>
<td>NA</td>
</tr>
</tbody>
</table>

¹ Allowance intended for natural events such as dust storms or bushfires
² Model Mining Conditions

The Project will include a sewage treatment plant and is proposing trial waste composting facilities onsite; however, odour impacts associated with these facilities will not be assessed as the minimum required buffer distance of 300 m from source to receptor is achieved by a factor of 50 (Victorian EPA, 1990 as referenced in DEHP, 2014).

### 6.9.2 Assessment Method

In order to assess the impact of the Project on the airshed associated with the sensitive receptors, the incremental impact is quantified and added to existing background pollutant concentrations. In lieu of monitoring data, Vipac carried out a detailed review of recent air quality assessments to determine the existing background concentrations for dust deposition, TSP, PM₁₀ and PM₂.₅. Only one scenario was assessed to simulate the maximum production rate of 1.95 Mtpa. The assessment has been based on one 12 hour shift per day with 1,848 operative hours per year. The Project will only operate nine months of the year to avoid the wet season. This assessment is based on the schedule between 2031 to 2042, when the mining activities are located closest to the sensitive receptors. It should be noted that emissions from vehicle exhausts, generators and ship movements have not been modelled as the emissions are small in comparison to the dust generating activities and will be remote to sensitive receptors located approximately 16 km away.

Computational modelling of air dispersion was used to predict the maximum levels of air pollutants based on the local topography, weather conditions and emission rates for the various sources of pollutants. The maximum levels are compared with the criteria provided in Table 6-64.

### 6.9.3 Existing Environment

#### 6.9.3.1 Existing Sources of Air Pollutants

Background concentrations for the Project were determined using data from the surrounding regions and nearby projects. A review of the NPI emissions has determined that there are no existing air emissions or pollutants in a 90 km radius of the Project, except for an isolated power station, approximately 16 km from the nearest boundary of the Project but approximately 35 km south of...
the Project MIA. This facility (NPI facility number Q019ERG016) is operated by Ergon Energy in Main Street, Mapoon. The reported emissions are a result of burning fuels for electricity generation. These emissions do not affect the background concentrations that are assessed as part of this assessment.

6.9.3.2 Assigning Background Concentration

There are currently no DEHP monitoring stations operating in the locality of the Project. The existing air quality for dust deposition, TSP, PM$_{10}$ and PM$_{2.5}$ has been estimated by considering the monitoring data reported in recent air quality assessments for other mines in Queensland, including the assessment for the SoE Project located south of Weipa and the Pisolite Hills Project, approximately 50 km southeast of the Project. The following air quality assessments have been reviewed:

- SoE Project (Rio Tinto Alcan, 2013). Ambient PM$_{10}$ concentrations were monitored in 2004 in Weipa and were used to derive the PM$_{2.5}$ concentrations. TSP concentrations and dust deposition values were estimates; and

- Pisolite Hills Project (ASK Consulting Engineers, 2010). Estimated background concentrations of TSP, PM$_{10}$, PM$_{2.5}$ and dust deposition based on typical ratios. PM$_{10}$ 24 hour and annual was estimated based on urban monitoring data in Queensland. Ratios were applied to the PM$_{10}$ values to derive the PM$_{2.5}$ and TSP values.

A summary of the assigned background concentrations used in this study are presented in Table 6-65. These background concentrations will be added to the predicted incremental emissions from the Project to derive total potential concentrations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Air Quality Objective</th>
<th>Averaging Period</th>
<th>Applied Background $\mu$g/m$^3$</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSP</td>
<td>90 $\mu$g/m$^3$</td>
<td>Annual</td>
<td>40 $\mu$g/m$^3$</td>
<td>Conservative assumption</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>50 $\mu$g/m$^3$</td>
<td>24 Hour</td>
<td>23 $\mu$g/m$^3$</td>
<td>SoE</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>25 $\mu$g/m$^3$</td>
<td>24 Hour</td>
<td>5.4 $\mu$g/m$^3$</td>
<td>Monitoring by Katestone at other mines</td>
</tr>
<tr>
<td></td>
<td>8 $\mu$g/m$^3$</td>
<td>Annual</td>
<td>2.8 $\mu$g/m$^3$</td>
<td></td>
</tr>
<tr>
<td>Dust Deposition</td>
<td>120 mg/m$^2$/day</td>
<td>24 hour</td>
<td>50 mg/m$^2$/day</td>
<td>Conservative assumption</td>
</tr>
</tbody>
</table>

Gulf Alumina is proposing the SRP, at present, which will be in close proximity to this Project. The proposed mining pits for the SRP extend further south than the proposed Project and the expected peak production rate is 1.05 Mtpa greater. Therefore, it is expected that the operations of the Gulf Alumina’s SRP will have a more significant impact. There are no publicly available air quality reports for this Project; however, the EMP contains a brief control strategy and action program to minimise dust from the haul roads and stockpiles as well as requirements to monitor particulate matter and dust in response to a complaint.

6.9.3.3 Meteorology

Weather data for the local area has been obtained from the BoM weather station located at Weipa Aerodrome (Site number 027045). The mean temperature range is between 21.9°C and 32.7°C with the coldest month being August and the hottest months being October and November. The rainfall in the region is variable, with most rainfall in the warmer months. On average, most of the annual rainfall is received between December and March. Rainfall is lowest between June and September,
with a mean annual rainfall of 2,000 mm. Rainfall reduces the dispersion of air emissions and therefore the potential impact on visual amenity and health.

**Wind Roses**

The wind roses, for the Project, are presented in Figure 6-1 (Section 6.1.4). The dominant wind direction is from east and east-southeast during spring, autumn and winter, whilst in summer the wind is strongest from the northwest. It is noted that the Project does not propose to operate over the summer (wet season) period. The nearest receptors, as shown in Figure 6-6, identify that the winds will transport the pollutants away from the receptors of concern. Overall, the meteorological data generated by The Air Pollution Model (TAPM) is considered to be representative of the site.

A review of the annual wind speeds has determined that:

- The winds were calm for 0.38% of the year;
- The winds were 0.5 - 3 m/s for 53% of the year;
- The winds were 3 - 5 m/s for 36% of the year; and
- The winds were greater than 5 m/s for 11% of the year.

**Atmospheric Stability**

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance the vertical motion of pollutants. The Pasquill-Turner assignment scheme identifies six stability classes to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used in various air dispersion models. The frequency of occurrence for each stability class for 2014, derived from TAPM, is detailed in Table 6-66.

<table>
<thead>
<tr>
<th>Stability Class</th>
<th>Description</th>
<th>Frequency Occurrence (%)</th>
<th>Average Wind Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Very unstable low wind, clear skies, hot daytime conditions</td>
<td>0.4</td>
<td>2.7</td>
</tr>
<tr>
<td>B</td>
<td>Unstable clear skies, daytime conditions</td>
<td>11.0</td>
<td>3.5</td>
</tr>
<tr>
<td>C</td>
<td>Moderately unstable moderate wind, slightly overcast daytime conditions</td>
<td>20.7</td>
<td>4.3</td>
</tr>
<tr>
<td>D</td>
<td>Neutral high winds or cloudy days and nights</td>
<td>26.5</td>
<td>2.8</td>
</tr>
<tr>
<td>E</td>
<td>Stable moderate wind, slightly overcast night-time conditions</td>
<td>9.6</td>
<td>2.6</td>
</tr>
<tr>
<td>F</td>
<td>Very stable low winds, clear skies, cold night-time conditions</td>
<td>31.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>

**Mixing Height**

Mixing height refers to the height above ground within which particulates or other pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer.

Diurnal variations in mixing depths, derived from TAPM, are illustrated in Figure 6-33. As would be expected, an increase in the mixing depth during the morning is apparent, due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.
6.9.3.4 Sensitive Receptors

Forty-seven sensitive receptors were identified using aerial imagery as having the potential to be impacted by the Project activities. The closest residential receptor (R44) is located approximately 16 km southwest of the mining lease boundary and 35 km from the MIA. Sensitive receptor locations in relation to the Project are shown in Figure 6-6 and the separation distance between each sensitive receptor and the Project area is provided in Table 6-67.
### Table 6-67 Nearest sensitive receptors to the Project

<table>
<thead>
<tr>
<th>Receptor ID</th>
<th>Description</th>
<th>Easting</th>
<th>Northing</th>
<th>Distance and Direction from Project (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Residential</td>
<td>599831</td>
<td>8668095</td>
<td>25.2 SW</td>
</tr>
<tr>
<td>R2</td>
<td>Residential</td>
<td>599744</td>
<td>8668802</td>
<td>24.6 SW</td>
</tr>
<tr>
<td>R3</td>
<td>Residential</td>
<td>599710</td>
<td>8668936</td>
<td>24.5 SW</td>
</tr>
<tr>
<td>R4</td>
<td>Residential</td>
<td>599554</td>
<td>8669244</td>
<td>24.3 SW</td>
</tr>
<tr>
<td>R5</td>
<td>Residential</td>
<td>599419</td>
<td>8669753</td>
<td>24 SW</td>
</tr>
<tr>
<td>R6</td>
<td>Residential</td>
<td>599357</td>
<td>8669835</td>
<td>23.9 SW</td>
</tr>
<tr>
<td>R7</td>
<td>Residential</td>
<td>599175</td>
<td>8670043</td>
<td>23.9 SW</td>
</tr>
<tr>
<td>R8</td>
<td>Residential</td>
<td>599142</td>
<td>8670124</td>
<td>23.8 SW</td>
</tr>
<tr>
<td>R9</td>
<td>Residential</td>
<td>599070</td>
<td>8670235</td>
<td>23.8 SW</td>
</tr>
<tr>
<td>R10</td>
<td>Residential</td>
<td>598964</td>
<td>8670284</td>
<td>23.8 SW</td>
</tr>
<tr>
<td>R11</td>
<td>Residential</td>
<td>598789</td>
<td>8670610</td>
<td>23.6 SW</td>
</tr>
<tr>
<td>R12</td>
<td>Residential</td>
<td>598769</td>
<td>8670868</td>
<td>23.4 SW</td>
</tr>
<tr>
<td>R13</td>
<td>Residential</td>
<td>598700</td>
<td>8671031</td>
<td>23.3 SW</td>
</tr>
<tr>
<td>R14</td>
<td>Residential</td>
<td>598524</td>
<td>8671140</td>
<td>23.4 SW</td>
</tr>
<tr>
<td>R15</td>
<td>Residential</td>
<td>598289</td>
<td>8671288</td>
<td>23.4 SW</td>
</tr>
<tr>
<td>R16</td>
<td>Residential</td>
<td>598089</td>
<td>8671500</td>
<td>23.3 SW</td>
</tr>
<tr>
<td>R17</td>
<td>Residential</td>
<td>597934</td>
<td>8671683</td>
<td>23.3 SW</td>
</tr>
<tr>
<td>R18</td>
<td>Residential</td>
<td>597595</td>
<td>8671945</td>
<td>23.3 SW</td>
</tr>
<tr>
<td>R19</td>
<td>Residential</td>
<td>597405</td>
<td>8672118</td>
<td>23.3 SW</td>
</tr>
<tr>
<td>R20</td>
<td>Residential</td>
<td>597307</td>
<td>8672238</td>
<td>23.3 SW</td>
</tr>
<tr>
<td>R21</td>
<td>Residential</td>
<td>597195</td>
<td>8672488</td>
<td>23.2 SW</td>
</tr>
<tr>
<td>R22</td>
<td>Residential</td>
<td>597145</td>
<td>8672605</td>
<td>23.1 SW</td>
</tr>
<tr>
<td>R23</td>
<td>Residential</td>
<td>596798</td>
<td>8673017</td>
<td>23 SW</td>
</tr>
<tr>
<td>R24</td>
<td>Residential</td>
<td>596513</td>
<td>8673761</td>
<td>22.7 SW</td>
</tr>
<tr>
<td>R25</td>
<td>Residential</td>
<td>596378</td>
<td>8674328</td>
<td>22.4 SW</td>
</tr>
<tr>
<td>R26</td>
<td>Residential</td>
<td>596371</td>
<td>8674934</td>
<td>22 SW</td>
</tr>
<tr>
<td>R27</td>
<td>Residential</td>
<td>596596</td>
<td>8675457</td>
<td>21.5 SW</td>
</tr>
<tr>
<td>R28</td>
<td>Residential</td>
<td>596625</td>
<td>8675602</td>
<td>21.4 SW</td>
</tr>
<tr>
<td>R29</td>
<td>Residential</td>
<td>596637</td>
<td>8675764</td>
<td>21.3 SW</td>
</tr>
<tr>
<td>R30</td>
<td>Residential</td>
<td>596711</td>
<td>8676083</td>
<td>21 SW</td>
</tr>
<tr>
<td>R31</td>
<td>Residential</td>
<td>596780</td>
<td>8676150</td>
<td>20.9 SW</td>
</tr>
<tr>
<td>R32</td>
<td>Residential</td>
<td>596842</td>
<td>8676252</td>
<td>20.8 SW</td>
</tr>
<tr>
<td>R33</td>
<td>Residential</td>
<td>596936</td>
<td>8676428</td>
<td>20.6 SW</td>
</tr>
<tr>
<td>R34</td>
<td>Residential</td>
<td>597226</td>
<td>8676773</td>
<td>20.2 SW</td>
</tr>
<tr>
<td>R35</td>
<td>Residential</td>
<td>597323</td>
<td>8676955</td>
<td>20 SW</td>
</tr>
<tr>
<td>R36</td>
<td>Residential</td>
<td>597366</td>
<td>8677062</td>
<td>19.9 SW</td>
</tr>
<tr>
<td>R37</td>
<td>Residential</td>
<td>597498</td>
<td>8677203</td>
<td>19.7 SW</td>
</tr>
<tr>
<td>R38</td>
<td>Residential</td>
<td>597645</td>
<td>8677313</td>
<td>19.6 SW</td>
</tr>
<tr>
<td>R39</td>
<td>Residential</td>
<td>597477</td>
<td>8677367</td>
<td>19.5 SW</td>
</tr>
<tr>
<td>R40</td>
<td>Residential</td>
<td>597846</td>
<td>8677532</td>
<td>19.5 SW</td>
</tr>
<tr>
<td>R41</td>
<td>Residential</td>
<td>597951</td>
<td>8677664</td>
<td>19.5 SW</td>
</tr>
<tr>
<td>R42</td>
<td>Residential</td>
<td>597803</td>
<td>8677703</td>
<td>19.5 SW</td>
</tr>
<tr>
<td>R43</td>
<td>Residential</td>
<td>598672</td>
<td>8678095</td>
<td>18.2 SW</td>
</tr>
<tr>
<td>R44</td>
<td>Residential</td>
<td>598781</td>
<td>8678129</td>
<td>18.1 SW</td>
</tr>
<tr>
<td>R45</td>
<td>Airport</td>
<td>609931</td>
<td>8688034</td>
<td>3.3 SW</td>
</tr>
<tr>
<td>R46</td>
<td>Mine Village</td>
<td>612967</td>
<td>8689835</td>
<td>0.3 W [1]</td>
</tr>
<tr>
<td>R47</td>
<td>Barge Area</td>
<td>616653</td>
<td>8699937</td>
<td>11 NE [2]</td>
</tr>
</tbody>
</table>

[1] The mine village is located between BH6 East and BH6 West.
[2] The barge loading area is located approximately 3 km from the northern boundary of BH6 East. The barge area is not considered a sensitive receptor as it will be solely used by Metro Mining whereas the Skardon River airstrip and mine village are owned and utilised by Gulf Alumina therefore they are considered sensitive receptors. To keep consistency, sensitive receptors were measured from the BH6 boundary adjacent to the mine village.
6.9.4 Potential Impacts

6.9.4.1 Construction

Preparation of the site for construction involves clearing and burning vegetation. These activities have the potential to cause high levels of dust if not appropriately managed; however, the dust emissions will be localised and relatively short in duration. During the construction phase less equipment will be utilised, therefore the air quality impacts during construction are likely to be less than the predicted operational levels. As such the construction phase is not considered significant and has not been assessed.

6.9.4.2 Operation

The operational activities that will generate dust emissions are:

- Clearing ahead of mining and burning of windrows;
- Extraction, transport and dumping of material;
- Material transfers and associated activities including stockpiling at the barge loading facility; and
- Wind erosion of stockpiles and pits.

Total emissions of dust from mining operations are largely dependent on the site layout, extraction methods, transportation methods and vehicle fleet. Other factors that also affect emissions include the material characteristics such as moisture and silt content and any incidental rainfall.

The proposed operation of the Project includes the use of generators to provide energy at the site. The Project generators will be located at least 18 km from the receptors, due to this distance between the sources and receptors; the generator was not assessed for air quality purposes as previous assessments have shown that 1 MW generators do not have an impact beyond 5 km.

The isolated Ergon Energy power station located on Main Street, Mapoon, is near to the sensitive receptors. Reviewing the expected energy generated from each facility, the Ergon Energy power station will generate more electricity than the Project generators, and therefore the associated air emissions will be greater from the power station. As the Ergon Energy power station is located closer to the receptors and has greater emissions, the Project generator will have little impact on local air quality when compared to the power station operated by Ergon Energy.

The basic parameters for the emission estimation calculations are presented in Table 6-68. All information relating to the operations of the Project were provided by Metro Mining with supplementary information from Power Trans, a surface mining haulage system.

Table 6-68: Operations data and modelling parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Modelled</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore production</td>
<td>Mtpa</td>
<td>1.95</td>
<td>Metro Mining</td>
</tr>
<tr>
<td>Ore silt / moisture content</td>
<td>%</td>
<td>5 / 10</td>
<td>Borehole data for site</td>
</tr>
<tr>
<td>Haul road silt / moisture content</td>
<td>%</td>
<td>7.0 / 5</td>
<td>Typical values</td>
</tr>
<tr>
<td>Number of days where rainfall &gt;0.25 mm</td>
<td>No.</td>
<td>277</td>
<td>TAPM</td>
</tr>
<tr>
<td>Mean wind speed</td>
<td>m/s</td>
<td>2.9</td>
<td>TAPM</td>
</tr>
<tr>
<td>Amount of time wind speed is &gt;5.4 m/s</td>
<td>%</td>
<td>2.4</td>
<td>TAPM</td>
</tr>
<tr>
<td>Bauxite density</td>
<td>kg/m³</td>
<td>1,800</td>
<td>Pre-feasibility study</td>
</tr>
<tr>
<td>Haul truck weight (laden/unladen)</td>
<td>t</td>
<td>170/300</td>
<td>Power Trans</td>
</tr>
<tr>
<td>Haul road width (in pit ramps / surface)</td>
<td>m</td>
<td>30 / 40</td>
<td>Pre-feasibility study</td>
</tr>
</tbody>
</table>
The emission rates for the mining operations have taken into account:

- 50% of the ore will be extracted from both BH1 and BH6;
- In-pit activities and the associated haulage of material.

The calculated emission rates for 1.95 Mtpa, have been grouped into activities and the tonnes per annum (tpa) quantities are presented in Table 6-69. The main emissions are from haul truck movements, accounting for 63% of the total PM$_{10}$ emissions each year.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total Emissions (tpa)</th>
<th>TSP</th>
<th>PM$_{10}$</th>
<th>PM$_{2.5}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>67.8</td>
<td>32.5</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Wind Erosion (pits)</td>
<td>153.2</td>
<td>76.6</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>Haul Truck Movements</td>
<td>1,486.5</td>
<td>382</td>
<td>38.2</td>
<td></td>
</tr>
<tr>
<td>Material Handling</td>
<td>34.3</td>
<td>11.9</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Stockpiles</td>
<td>224.3</td>
<td>92.4</td>
<td>23.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,966.1</td>
<td>595.4</td>
<td>86.2</td>
<td></td>
</tr>
</tbody>
</table>

The predicted maximum ground-level concentrations of TSP, PM$_{10}$, PM$_{2.5}$ and dust deposition at the nearest sensitive receptors are presented in Table 6-70. In summary, the 100th percentile results show:

- The highest annual TSP concentrations are below the 90 μg/m$^3$ criterion at all receptors, with the results just above the background concentration of 40 μg/m$^3$ (see Figure 6-34);
- The highest predicted 24 hour average ground-level PM$_{10}$ concentration of 35.1 μg/m$^3$ will occur at the mine village (R46), which is below the 50 μg/m$^3$ criterion. At the sensitive receptors located in Mapoon, the highest concentration will be 23.6 μg/m$^3$, with an incremental increase of 0.6 μg/m$^3$ with the Project in operation (see Figure 6-35);
- The highest predicted 24 hour average ground-level PM$_{2.5}$ concentration of 8.0 μg/m$^3$ will occur at the mine village (R46), which is below the 25 μg/m$^3$ criterion. At the sensitive receptors located in Mapoon, the highest concentration will be 5.6 μg/m$^3$, with an incremental increase of 0.2 μg/m$^3$ with the Project in operation (see Figure 6-36); and
- The highest daily dust deposition results show that an incremental increase of 8.7 mg/m$^2$/day will occur at the mine village (R46), with a total deposition of 58.7 mg/m$^2$/day which is half of the 120 mg/m$^2$/day criterion (see Figure 6-37).

It has been concluded that with the Project operating nine months of the year, at a maximum rate of 1.95 Mtpa, the predicted pollutant concentrations are below the relevant criteria.
Table 6-70 Modelling results

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Annual TSP (µg/m³)</th>
<th>24 Hour PM₁₀ (µg/m³)</th>
<th>24 Hour PM₂.₅ (µg/m³)</th>
<th>Annual PM₂.₅ (µg/m³)</th>
<th>Daily Dust Deposition (mg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>40.0</td>
<td>23.4</td>
<td>5.5</td>
<td>2.8</td>
<td>50.2</td>
</tr>
<tr>
<td>R2</td>
<td>40.0</td>
<td>23.5</td>
<td>5.6</td>
<td>2.8</td>
<td>50.3</td>
</tr>
<tr>
<td>R3</td>
<td>40.0</td>
<td>23.5</td>
<td>5.6</td>
<td>2.8</td>
<td>50.3</td>
</tr>
<tr>
<td>R4</td>
<td>40.0</td>
<td>23.6</td>
<td>5.6</td>
<td>2.8</td>
<td>50.3</td>
</tr>
<tr>
<td>R5</td>
<td>40.0</td>
<td>23.6</td>
<td>5.6</td>
<td>2.8</td>
<td>50.3</td>
</tr>
<tr>
<td>R6</td>
<td>40.0</td>
<td>23.6</td>
<td>5.6</td>
<td>2.8</td>
<td>50.3</td>
</tr>
<tr>
<td>R7</td>
<td>40.0</td>
<td>23.6</td>
<td>5.6</td>
<td>2.8</td>
<td>50.3</td>
</tr>
<tr>
<td>R8</td>
<td>40.0</td>
<td>23.6</td>
<td>5.6</td>
<td>2.8</td>
<td>50.4</td>
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Criteria Achieved

- ✓: Criteria Achieved
- ⊗: Criteria Not Achieved

Criteria Achieved:
- ✓: Annual TSP
- ✓: 24 Hour PM₁₀
- ✓: 24 Hour PM₂.₅
- ✓: Annual PM₂.₅
- ✓: Daily Dust Deposition

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

DATA SOURCE
MEC Mining; Vipac 2015; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

FIGURE 6.34
ANNUAL TSP CONCENTRATIONS
6.9.4.3 Cumulative Impact Assessment

Gulf Alumina is proposing the SRP, adjacent to the Project, which has a peak production rate of 3 Mtpa. No construction or operational data have been published by Gulf Alumina or approved by DEHP. The Gulf Alumina EMP contains a brief control strategy and action program to minimise dust from haul roads and stockpiles as well as requirements to monitor particulate matter and dust in response to a complaint. For the cumulative assessment, the results from the Project have been recalculated to incorporate the proposed SRP (Table 6-71).

The cumulative impacts concluded that:

- The maximum TSP concentration is predicted to be 46% of the annual criteria;
- The maximum PM$_{10}$ concentration is predicted to be 104% of the criterion at the mine village only for one day; however, the residents of the mine village will be working during the Project’s operational hours. The maximum concentration at a sensitive receptor in Mapoon is 50% of the criterion;
- The maximum PM$_{2.5}$ 24 hour concentration will be 48% of the criterion whilst the PM$_{2.5}$ annual concentration will be 35% of the criterion; and
- The maximum dust deposition is predicted to be 59% of the criterion.
## Table 6-71 Cumulative modelling results

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<th>Annual TSP (µg/m³)</th>
<th>24 Hour PM₁₀ (µg/m³)</th>
<th>24 Hour PM₂.₅ (µg/m³)</th>
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**Criteria** | 90 | 50 | 25 | 8 | 120

**Criteria Achieved** | ✓ | ✓ | ✓ | ✓ | ✓
6.9.5 Management and Mitigation Measures

The modelling results indicate dust deposition, TSP, PM\textsubscript{10}, PM\textsubscript{2.5} and other air pollutants will not exceed the recommended criteria at any of the sensitive receptors, during the construction and operational phases of the Project. Mitigation measures, as outlined in Table 6-72 will; however, be implemented as a precautionary approach.

6.9.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential air quality impacts is summarised in Table 6-72. An analysis of initial risk, without mitigation, was considered for each potential impact. The residual risk considers the mitigation and management measures developed for air quality, and put forward in this assessment.

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<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
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<tr>
<td>Fugitive dust from construction activities likely to reduce local air quality, create a nuisance to fauna and increase dust deposition on vegetation</td>
<td>Minor</td>
<td>Likely</td>
<td>Medium</td>
<td>▪ Seal roads, where possible ▪ Plant covers and enclosures</td>
<td>Low</td>
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<tr>
<td>Contribution to cumulative particle deposition in local area</td>
<td>In-significant</td>
<td>Likely</td>
<td>Medium</td>
<td>▪ Regular watering of active mining areas, stockpiles areas and the haul road that are subject to frequent vehicle movements ▪ All equipment utilised onsite will be maintained in an efficient and effective manner ▪ Where practicable limit vegetation and soil clearing to approved areas to minimise the area of exposed soil that may generate dust ▪ Where practicable reuse cleared vegetation during the rehabilitation phase of the Project to minimise burning ▪ Progressive site rehabilitation and revegetation, where possible</td>
<td>Low</td>
</tr>
<tr>
<td>Potential Impacts</td>
<td>Initial Consequence</td>
<td>Initial Likelihood</td>
<td>Initial Risk</td>
<td>Management and Mitigation Measures</td>
<td>Residual Risk</td>
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<td>--------------------</td>
<td>--------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</table>
| Dust from stockpiles and overburden areas            | Minor               | Possible           | Medium       | ▪ Allow vegetation to establish on stockpiled overburden to prevent wind erosion  
▪ So far as practical, erecting physical barriers such as bunds and or wind breaks around stockpiles or areas where earth moving is required  
▪ Visual dust monitoring  
▪ Watering of overburden stockpiles if dust lift-off is visible  
▪ After initial extraction, all overburden material will be placed back within the mined area  
▪ Overburden will be revegetated progressively  
▪ Restrict vehicle movements to defined routes on overburden emplacement areas, with wet suppression applied to such routes as required | Low          |
| Exposure to pollutant in relation to workplace health and safety requirements | Minor               | Possible           | Medium       | ▪ Selected generator/s have low emissions of nitrogen oxides | Low          |
| General Material Extraction and Dumping               | Minor               | Possible           | Medium       | ▪ Minimise double handling of material  
▪ Identify material types that contain fine and/or friable material, and implement a risk based approach for effective dust mitigation, e.g. minimisation of topsoil stripping during adverse weather conditions  
▪ Preparation of work areas prior to commencement of mining activities to minimise dust generation potential, e.g. watering of extraction areas | Low          |
<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
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</table>
| Contribution to cumulative particle deposition in local area | In-significant       | Likely             | Medium       | ▪ Regular watering of active mining areas, stockpiles areas and the haul road that are subject to frequent vehicle movements  
▪ All equipment utilised onsite will be maintained in an efficient and effective manner  
▪ Where practicable limit vegetation and soil clearing to approved areas to minimise the area of exposed soil that may generate dust  
▪ Where practicable reuse cleared vegetation during the rehabilitation phase of the Project to minimise burning  
▪ Progressive site rehabilitation and revegetation, where possible | Low             |
| Dust from stockpiles and overburden areas            | Minor               | Possible           | Medium       | ▪ Allow vegetation to establish on stockpiled overburden to prevent wind erosion  
▪ So far as practical, erecting physical barriers such as bunds and or wind breaks around stockpiles or areas where earth moving is required  
▪ Visual dust monitoring  
▪ Watering of overburden stockpiles if dust lift-off is visible  
▪ After initial extraction, all overburden material will be placed back within the mined area  
▪ Overburden will be revegetated progressively  
▪ Restrict vehicle movements to defined routes on overburden emplacement areas, with wet suppression applied to such routes as required | Low             |
| Exposure to pollutant in relation to workplace health and safety requirements | Minor               | Possible           | Medium       | ▪ Selected generator/s have low emissions of nitrogen oxides | Low             |
6.9.7 Greenhouse Gas Emissions

The GHG emissions assessment determined the carbon dioxide equivalent (CO₂-e) emissions from the Project according to international and national guidelines. DotE monitors and compiles databases on anthropogenic activities that produce GHGs in Australia. The DotE has published GHG emission factors for a range of anthropogenic activities. The methodology for calculating GHG emissions is published in the National Greenhouse Accounts Factors (NGA Factors) workbook (DotE, 2014). This workbook is updated regularly to reflect current compositions in fuel mixes and evolving information on emission sources.

The scope that emissions are reported, as defined by the NGA Factors workbook is determined by whether the activity is within the organisation's boundary (Scope 1 – Direct Emissions) or outside the organisation's boundary (Scopes 2 and 3 – Indirect Emissions). Emission factors used in this assessment have been derived from either the DotE database, site-specific information or from operational details obtained from similar emission sources.

Registration and reporting is mandatory for corporations that have energy production, energy use or GHG emissions that exceed specified thresholds. Current National Greenhouse and Energy Reporting Act 2007 (NGER Act) reporting thresholds are summarised in Table 6-73.

<table>
<thead>
<tr>
<th>Threshold Type</th>
<th>GHG (kilotones CO₂-e)</th>
<th>Energy Consumption (TJ)</th>
<th>Energy Production (TJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility</td>
<td>25</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Corporate</td>
<td>50</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

Metro Mining will not be required to report under the NGER Act as the Project will not emit more than 25,000 tonnes of CO₂-e per year. The estimated Project GHG emissions, during the operational phase, is approximately 5,071 tonnes of CO₂-e per year. The activity description and their respective annual emissions are shown in Table 6-74.
The GHG emissions assessment concluded that:

- The total emissions during the construction phase are 134,752 tonnes CO\(_2\)-e during the construction phase, with the majority of the emissions from the embodied energy of the construction materials;
- During the operational phase the annual emissions are projected to be 5,071 tonnes CO\(_2\)-e, which is below the threshold of reporting at 25,000 tonnes CO\(_2\)-e;
- The total Project emissions (operational phase only) are estimated to be 136,925 tonnes CO\(_2\)-e; and
- Overall the emissions for the expected life of the Project is estimated to be 271.6 kilotonnes CO\(_2\)-e (comprising of 134.7 kilotonnes CO\(_2\)-e for construction and 136.9 kilotonnes CO\(_2\)-e for operations).

6.9.8 Summary

The assessment presented above demonstrates that the operation of the Project is likely to result in minimal impacts to the local air quality. Construction activities were not modelled as the modelled operational phase has a higher impact than the construction phase. The main air emissions from mining operations are caused by wind-borne dust, haul road generated dust, materials handling, stockpiles and transfers.

The Project’s estimated annual GHG emissions are predicted to be 5,071 tonnes CO\(_2\)-e, which is under the 25,000 tonnes CO\(_2\)-e NGER facility threshold.

6.9.9 Commitments

In managing potential air quality impacts, Metro Mining’s commitments are provided in Table 6-75.

### Table 6-75 Commitments – air quality

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQ1</td>
<td>Achieving effective dust management during Project operation through appropriate dust mitigation measures.</td>
</tr>
<tr>
<td>AQ2</td>
<td>All equipment utilised onsite will be maintained in an efficient and effective manner.</td>
</tr>
<tr>
<td>AQ3</td>
<td>Where practicable limit vegetation and soil clearing to minimise the area of exposed soil that may generate dust.</td>
</tr>
<tr>
<td>AQ4</td>
<td>Where practicable reuse cleared vegetation during the rehabilitation phase of the Project to minimise burning and implement progressive site rehabilitation and revegetation, where possible.</td>
</tr>
<tr>
<td>AQ5</td>
<td>Investigate and address all complaints and keep a register of complaints.</td>
</tr>
</tbody>
</table>
6.10 Noise

The purpose of this assessment is to evaluate the potential impacts of noise generated from the operational stages of the Project and identified opportunities to mitigate any potential impacts that might have an effect on nearby sensitive receptors. The construction phase was not modelled due to the relatively short duration of the activities and the low amounts of equipment required during this phase compared to the operational phase. The full technical assessment report is provided in Appendix K.

6.10.1 Regulatory Framework

The relevant noise criteria and guidelines for the Project are established in the:

- Environmental Protection Act 1994 (EP Act);
- Environmental Protection (Noise) Policy 2008 [EPP (Noise)];
- Guideline Mining – Model Mining Conditions (Model Mining Conditions);
- DEHP Guidelines - Application requirements for activities with noise impacts (EM962); and

Environmental Protection Act 1994

The EP Act provides for the protection of EVs, including EVs relating to the maintenance of public amenities. In relation to noise, the EP Act is supported by the EPP (Noise) and the Application requirements for activities with noise impacts (EM962).

Environmental Protection (Noise) Policy 2008

The EPP (Noise) aims to provide a method to control background noise creep as well as achieving acoustic quality objectives for sensitive receptors based on the WHO Guidelines for Community Noise (1999). These acoustic quality objectives are shown in Table 6-76. Based on a typical dwelling façade noise reduction of 10 decibel (adjusted) [dB(A)] through a partially open window, an external criterion of 40 dB(A)_{Aeq,adj,1hr} is used (refer to Table 6-76). This policy sets the minimum standards to be complied with in the installation and/or operation of vehicles, plant or equipment for the control of noise from these sources or places, and which are conducive to protecting the amenity of a community.

Guideline Mining – Model Mining Conditions

The purpose of the Model Mining Conditions is to provide a set of model conditions to form general environmental protection commitments for the mining activities and the EA conditions pursuant to the EP Act. The Model Mining Conditions contain measurement and reporting requirements for mining activities. If a complaint is made regarding low frequency noise, under the Model Mining Conditions a one-third octave band measurement in the frequency range 10 to 200 hertz (Hz) should be carried out.

DEHP Guidelines - Application requirements for activities with noise impacts (EM962)

The Application requirements for activities with noise impacts (EM962) outlines the information required for ERAs with noise impacts. The guidelines require three key areas to be addressed:
- Identify the EVs of the receiving acoustic environment including the identification of any nearby sensitive places (Section 6.10.3);
- Identify the possible impacts due to the proposed activity (Section 6.10.4) and all associated risks to the EVs (Section 6.10.6); and
- Identify the strategies to mitigate the identified risks to the EVs (Section 6.10.5).

This section will address, as a minimum, the aforementioned requirements in the following sections.

**World Health Organisation Guidelines for Community Noise**

The WHO discusses the effects of environmental noise in non-industrial environments in its Guideline for Community Noise (1999). The guideline examines aspects such as sleep disturbance, annoyance, and speech intelligibility and provides guidance for protecting people from adverse effects induced by excessive noise. The Project will only operate during the daytime therefore night time criteria to determine sleep disturbance is not applicable.

### 6.10.1.1 Operational Noise Criteria

Based on the measured background noise levels, the applicable noise limits according to the Model Mining Conditions are presented in Table 6-76.

<table>
<thead>
<tr>
<th>Noise Level dB(A) measured as:</th>
<th>7am - 6pm</th>
<th>6pm - 10pm</th>
<th>10pm - 7am</th>
<th>9am - 6pm</th>
<th>6pm - 10pm</th>
<th>10pm - 9am</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_{Aeq, Adj, 15 min}</td>
<td>35</td>
<td>35</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>L_{A1, Adj, 15 min}</td>
<td>50</td>
<td>47</td>
<td>37</td>
<td>48</td>
<td>45</td>
<td>41</td>
</tr>
<tr>
<td>Sensitive Receptor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Place</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L_{A1, Adj, 15 min}</td>
<td>40</td>
<td>40</td>
<td>35</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

The Project will be subject to the daytime (7am – 6pm) and evening (6pm – 10pm) criteria presented in Table 6-76. The applicable residential criteria for this assessment have been calculated as 35 dB L_{Aeq, Adj 15 min} and 45 dB L_{A1, Adj 15 min}.

### 6.10.2 Assessment Method

Vipac has analysed the raw noise measurement data, conducted by ASK Consultants in 2010, for the nearby Pisolite Hills Project (R32). Noise monitoring, conducted by ASK Consultants, was carried out at Mapoon between 27th January 2010 and 7th February 2010. Noise monitoring was not carried out specifically for this assessment. Vipac undertook acoustic modelling using SoundPLAN Version 7.3 implementing the CONCAWE prediction method with consideration of worst case wind scenarios to assess potential noise impacts associated with the construction and operational stages of the Project.

Similar to the air quality assessment the noise modelling is based on one 12 hour shift per day with 1,848 operative hours per year. The Project will only operate nine months of the year to avoid the wet season. This assessment is based on the schedule between 2031 and 2042, when the mining activities are located closest to the sensitive receptors. It should be noted that the Project will not include blasting activities and vehicle movements will not be considered due to the distances of the nearest receptors to the haul road and pit areas.
6.10.2.1 Modelled Weather Scenarios

The TAPM data generated for the air quality assessment has been used for uniformity and has assessed both average and worst-case scenarios. The wind parameters were compared for the BoM and TAPM data and were found to be very similar. Reviewing the site specific wind speeds, wind direction and stability classes, it has been determined that the sensitive receptors are upwind of the noise sources. For the ‘average’ assessment, this will be applied; however, for the ‘worst-case’ assessment; source to receptor winds will be applied. Taking into consideration the operating hours of the Project the following weather scenarios have been assessed:

**Daytime Assessment:**

- Class D occurs for 30% of the time during assessable daytime hours, with an average wind speed of 3.19 m/s. Class D is considered to be neutral and assumed to have zero meteorological influence on noise propagation (Bies and Hansen, 2009). For this assessment, Class D will be modelled as ‘average’ weather conditions, including the dominant wind direction; and

- Class C occurs for 45% of the time during assessable daytime hours, with an average wind speed of 4.27 m/s. For this assessment, Class C will be considered to be the ‘worst-case’ meteorological conditions during the daytime period including direct source to receptor winds.

**Evening Assessment:**

- Class D occurs for 38% of the time during assessable evening hours; however, as this stability class has zero meteorological influence on noise propagation (Bies and Hansen, 2009), it has not been assessed;

- Class E occurs for 15% of the time during assessable evening hours, with an average wind speed of 2.6 m/s. For this assessment, Class E will be considered the ‘average’ weather conditions including the dominant wind direction; and

- Class F occurs for 47% of the time during assessable evening hours, with an average wind speed of 2.9 m/s. Class F, or temperature inversions, are considered to be the worst case conditions for noise propagation and therefore will be assessed as the ‘worst case’ including direct source to receptor winds.

6.10.2.2 Insect Noise

During the summer months, background noise is dominated by insect noise. Noise monitoring was undertaken during summer therefore the data has been filtered to reflect the influence of insect noise.

According to the noise report by ASK Consultants for the Pisolite Hills Project, insect noise was filtered by removing the 4 kHz frequency band. Reviewing the raw data, elevated noise levels at 3.15 kHz and 5 kHz were identified. These frequency bands have also been removed from the $L_{Aeq}$, $L_{Amax}$, $L_{Amin}$ and statistical data.

6.10.2.3 Phases of the Project Modelled

Operational activities that have potential to cause noise impacts include the:

- Skardon River airstrip;

- Extraction, transport and dumping of material from mining areas;
- Material transfers along haul roads, and associated activities including stockpiling at the barge loading facility;
- Barge and ship movements; and
- Electricity generation for the mine and accommodation camp.

Noise emissions from mining operations are largely dependent on the site layout, extraction methods, transportation methods and vehicle fleet. The production schedule has been reviewed and it is expected production will be consistent year on year with a maximum annual output of 1.95 Mtpa. Hence a single scenario has been assessed for this expected maximum throughput.

6.10.3 Existing Environment

There are minor activities associated with the Gulf Alumina – SRP, including the Skardon River airstrip which generates noise in the vicinity of the Project site. These noise sources will not be audible at the sensitive receptors and are considered low risk at the Project site.

The area surrounding the proposed Project comprises of predominately Darwin stringybark open woodlands, with some areas of wetlands, rivers and springs. The mining area is considered to be of low biodiversity and is not classified as of concern by the Queensland Government.

6.10.3.1 Noise Sensitive Locations

The noise assessment has utilised the same sensitive receptors as the air quality assessment. Please refer to the Section 6.9.3.4 for the sensitive receptor locations.

6.10.4 Potential Impacts

6.10.4.1 Construction Phase

Preparation of the site for construction activities involves clearing and burning of vegetation. These activities have the potential to cause high levels of noise if not appropriately managed; however, the noise will be relatively short in duration. During the construction phase less equipment will be utilised, therefore the noise impacts during construction are likely to be less than the predicted operational levels. As such the construction phase is not considered significant and has not been assessed.

6.10.4.2 Operational Phase

The following sources have been referred to in establishing associated sound power levels (SWL) noise sources:
- Vipac’s database, which includes noise measurements of plant measured at existing mine sites;
- Caterpillar (CAT) provided SWL data;
- Noise report for the Pisolite Hills Project (ASK Consulting Engineers, 2010); and
The noise impacts from the barge loading facility will be insignificant compared to the other operational noise sources. As the barge loading facility is the furthest away from the sensitive receptors the impacts will not contribute to the overall noise levels experienced at the sensitive receptors. Additionally, aircraft noise sources have not been modelled due to the infrequent use of the Skardon River airstrip compared to the typical mining operations.

The significant operational noise sources used for this assessment are identified in Table 6-77.

### Table 6-77: Modelled sound power levels

<table>
<thead>
<tr>
<th>Plant</th>
<th>Modelled Location</th>
<th>Frequency (dB(Z))</th>
<th>SWL (dB(A))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>63 Hz</td>
<td>125 Hz</td>
</tr>
<tr>
<td>FEL (CAT 988/992)</td>
<td>Both</td>
<td>107</td>
<td>117</td>
</tr>
<tr>
<td>Excavator (CAT 329)</td>
<td>Mine</td>
<td>101</td>
<td>105</td>
</tr>
<tr>
<td>Tracked Dozer (CAT D10)</td>
<td>Mine</td>
<td>117</td>
<td>116</td>
</tr>
<tr>
<td>Wheeled Dozer (CAT 834)</td>
<td>Mine</td>
<td>107</td>
<td>117</td>
</tr>
<tr>
<td>Grader (CAT 16H)</td>
<td>Mine</td>
<td>109</td>
<td>114</td>
</tr>
<tr>
<td>Water Truck (CAT 773)</td>
<td>Mine</td>
<td>113</td>
<td>108</td>
</tr>
<tr>
<td>Service Truck</td>
<td>Mine</td>
<td>113</td>
<td>108</td>
</tr>
<tr>
<td>Lighting Plant</td>
<td>Mine</td>
<td>131</td>
<td>118</td>
</tr>
<tr>
<td>Power Trans T1250</td>
<td>Mine</td>
<td>114</td>
<td>113</td>
</tr>
<tr>
<td>Generator (1 MW)</td>
<td>Mine</td>
<td>133</td>
<td>118</td>
</tr>
<tr>
<td>Conveyor</td>
<td>Port</td>
<td>91</td>
<td>85</td>
</tr>
<tr>
<td>Conveyor Drive</td>
<td>Port</td>
<td>99</td>
<td>97</td>
</tr>
<tr>
<td>Stacker/Reclaimer</td>
<td>Port</td>
<td>117</td>
<td>105</td>
</tr>
<tr>
<td>Screen</td>
<td>Port</td>
<td>107</td>
<td>106</td>
</tr>
</tbody>
</table>

The results presented in Table 6-78 and Table 6-79, show that the noise levels from the Project for the daytime and evening period are predicted to be well below the applicable criteria for the $L_{Aeq}$ and $L_{A1}$ at all sensitive receptors for both ‘average’ and ‘worst-case’ meteorological conditions.

The highest noise level at a residential receptor, in Mapoon, is predicted to be 16 dB $L_{Aeq}$, evening, which is below the 35 dB $L_{Aeq}$ evening criterion.
### Table 6-78 Predicted daytime noise levels during operations

<table>
<thead>
<tr>
<th>Receptor ID</th>
<th>Daytime Criteria (L_{Aeq}/L_{A1})</th>
<th>Predicted Noise Level (dB)</th>
<th>Predicted Noise Level (dB)</th>
<th>Compliance with Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L_{Aeq}, 07:00-18:00 hours</td>
<td>L_{A1}, 07:00-18:00 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class C</td>
<td>Class D</td>
<td>Class C</td>
<td>Class D</td>
</tr>
<tr>
<td>R1</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R2</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R3</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R4</td>
<td>35/48</td>
<td>16</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>R5</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R6</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R7</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R8</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
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<tr>
<td>R9</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>R10</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
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</tr>
<tr>
<td>R11</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
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<tr>
<td>R12</td>
<td>35/48</td>
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<td>R13</td>
<td>35/48</td>
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<td>R14</td>
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<td>R41</td>
<td>35/48</td>
<td>16</td>
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<td>R42</td>
<td>35/48</td>
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<td>R43</td>
<td>35/48</td>
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<td>R44</td>
<td>35/48</td>
<td>15</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Airport</td>
<td>40/-</td>
<td>29</td>
<td>33</td>
<td>32</td>
</tr>
<tr>
<td>Village</td>
<td>35/48</td>
<td>51</td>
<td>53</td>
<td>53</td>
</tr>
</tbody>
</table>
### Table 6-79 Predicted evening time noise levels during operations

<table>
<thead>
<tr>
<th>Receptor ID</th>
<th>Evening Time Criteria (LAeq/LA1)</th>
<th>Predicted Noise Level (dB)</th>
<th>Predicted Noise Level (dB)</th>
<th>Compliance with Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LAeq, 18:00 - 22:00 hours</td>
<td>LA1, 18:00 - 22:00 hours</td>
<td>L_{Aeq} L_{A1}</td>
</tr>
<tr>
<td>R1</td>
<td>35/45</td>
<td>11</td>
<td>12</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R2</td>
<td>35/45</td>
<td>11</td>
<td>12</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R3</td>
<td>35/45</td>
<td>17</td>
<td>14</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R4</td>
<td>35/45</td>
<td>18</td>
<td>15</td>
<td>Class E Class F</td>
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<tr>
<td>R5</td>
<td>35/45</td>
<td>12</td>
<td>13</td>
<td>Class E Class F</td>
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<tr>
<td>R6</td>
<td>35/45</td>
<td>12</td>
<td>13</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R7</td>
<td>35/45</td>
<td>12</td>
<td>13</td>
<td>Class E Class F</td>
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<tr>
<td>R8</td>
<td>35/45</td>
<td>13</td>
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<td>Class E Class F</td>
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<tr>
<td>R9</td>
<td>35/45</td>
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<td>R10</td>
<td>35/45</td>
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<tr>
<td>R11</td>
<td>35/45</td>
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<tr>
<td>R12</td>
<td>35/45</td>
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<tr>
<td>R13</td>
<td>35/45</td>
<td>13</td>
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<td>Class E Class F</td>
</tr>
<tr>
<td>R14</td>
<td>35/45</td>
<td>13</td>
<td>13</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R15</td>
<td>35/45</td>
<td>14</td>
<td>13</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R16</td>
<td>35/45</td>
<td>14</td>
<td>13</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R17</td>
<td>35/45</td>
<td>14</td>
<td>13</td>
<td>Class E Class F</td>
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<tr>
<td>R18</td>
<td>35/45</td>
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<td>R19</td>
<td>35/45</td>
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<tr>
<td>R20</td>
<td>35/45</td>
<td>15</td>
<td>13</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R21</td>
<td>35/45</td>
<td>15</td>
<td>14</td>
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</tr>
<tr>
<td>R22</td>
<td>35/45</td>
<td>16</td>
<td>14</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R23</td>
<td>35/45</td>
<td>16</td>
<td>14</td>
<td>Class E Class F</td>
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<tr>
<td>R24</td>
<td>35/45</td>
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<td>Class E Class F</td>
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<tr>
<td>R25</td>
<td>35/45</td>
<td>17</td>
<td>14</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>R26</td>
<td>35/45</td>
<td>17</td>
<td>14</td>
<td>Class E Class F</td>
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<tr>
<td>R27</td>
<td>35/45</td>
<td>17</td>
<td>14</td>
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<tr>
<td>R28</td>
<td>35/45</td>
<td>17</td>
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<td>R29</td>
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<td>R30</td>
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<td>R31</td>
<td>35/45</td>
<td>17</td>
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<tr>
<td>R32</td>
<td>35/45</td>
<td>17</td>
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<td>R33</td>
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<td>R34</td>
<td>35/45</td>
<td>18</td>
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<td>R35</td>
<td>35/45</td>
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<td>R36</td>
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<td>R37</td>
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<td>R38</td>
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<td>R39</td>
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<tr>
<td>R40</td>
<td>35/45</td>
<td>18</td>
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<tr>
<td>R41</td>
<td>35/45</td>
<td>18</td>
<td>15</td>
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<td>R42</td>
<td>35/45</td>
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<td>R43</td>
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<td>R44</td>
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<tr>
<td>Airport</td>
<td>40/-</td>
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<td>29</td>
<td>Class E Class F</td>
</tr>
<tr>
<td>Village</td>
<td>35/45</td>
<td>51</td>
<td>53</td>
<td>Class E Class F</td>
</tr>
</tbody>
</table>
Residential Receptors Mapoon

- The highest noise level at residential receptors will occur at R40, R41, R42, R43 and R44. This has been attributed to the topography and the reflective nature of the large water body (see Figure 6-38); and

- During the evening period, the highest noise level at residential receptors will occur at R40, R41, R42, R43 and R44. A review of the L_A1, evening has identified that the noise spectrum at these receptors will be below 160 Hz. At these receptors, the road trucks dominate the overall noise source contributions.

Gulf Alumina Accommodation Camp (Mine Village)

- The highest daytime L_Aeq is 53 dB(A), which is an 18 dB(A) exceedance of the 35 dB(A) criterion. The residents of the mine village will; however, be working during the Project’s operational hours; therefore the mine village (R46) will not be adversely impacted by the noise from the Project.

Airport

The noise levels generated by the Skardon River airstrip have not been assessed due to the frequency of the flights. The noise levels associated with the use of the airstrip will have a greater impact upon the airport users than the impacts of the mining operations; however:

- The second highest daytime L_Aeq and L_A1 noise level will occur at the airport receptor. A review of the L_Aeq, day results has identified that the highest source contributions to the noise levels at the airport are generated from the Power Trans haul truck movements and electricity generators contributing 22 dB(A) and 24 dB(A) respectively. These sources will dominate the noise environment at the airport; and

- The second highest evening L_Aeq and L_A1 noise level will occur at the airport, which is a commercial place. A review of the L_Aeq, evening results has identified that the highest source contributions to the noise levels at the airport are generated from the Power Trans haul truck movements and electricity generators. During Class E and Class F weather conditions the haul trucks and the generators will contribute 27 dB(A) and 24 dB(A).

Fauna

The noise impacts on terrestrial fauna will be localised and minor as the Project will not operate during the night time period or during the summer months when fauna are more active.

Low Frequency Assessment

A low frequency assessment was undertaken at all noise sensitive receptors. Low frequency impacts are not expected at any of the residential receptors in Mapoon during the daytime or evening periods.

The only exceptions are the airport and Gulf Alumina accommodation camp which are predicted to exceed a linear noise level of 50 dB(Z) and where the predicted level is more than 15 dB(A) above the L_Aeq prediction.

Noise levels are also predicted to comply with low frequency noise criteria, except at the airport where noise impacts are not expected to be significant as the airport will only be in use when flights are scheduled and the airport is a source of low frequency noise during operation.
6.10.4.3 Cumulative Impacts

Gulf Alumina is proposing the SRP, adjacent to the Project, which has a peak production rate of 3 Mtpa. For the cumulative assessment, the results from the Project have been recalculated to reflect the proposed 3 Mtpa production from the SRP. There is no publicly available noise report for the SRP; however, the EMP states:

“there are no communities or cattle station homesteads near the Skardon River project. The only human habitation within the project area is the staff accommodation camp, which is located 12 km from the proposed handling plant. The only noise that will be heard in this camp will be that from earth moving machinery used in mining operations close to the camp.”

It should be noted that the SRP, although adjacent to this Project, extends further south towards the sensitive receptors in Mapoon.

The cumulative impacts assessment concluded that:

- The cumulative impacts, from the proposed Project and the SRP, comply at all sensitive receptors in Mapoon;
- The only exceedance is expected at the mine village (R46); however, the residents of the mine village will be working during the Project’s operational hours; therefore the mine village (R46) will not be adversely impacted by the noise from the Project; and
- The noise levels at all sensitive receptors are expected to be dominated by the noise sources associated with the SRP due to the higher extraction rate and closer proximity to the receptors in Mapoon.

6.10.5 Management and Mitigation Measures

Noise modelling results indicate noise levels from the Project are likely to comply with the criteria, and no mitigation measures will be required. Metro Mining has taken a conservative approach and general noise control measures have been discussed in this section.

Many general measures can reduce noise levels at the source such as:

- Training staff to operate the equipment in order to minimise unnecessary noise emissions;
- Avoiding unnecessary revving of engines and switch off equipment when not required;
- Keeping internal roads well maintained;
- Using rubber linings in or constrained layer damping on, for example, chutes and dumpers to reduce impact noise;
- Minimising the drop heights of materials;
- Using ultra-low noise idlers on the conveyors; the noise reduction associated with these are generally 5 - 10 dB(A);
- As far as reasonably practicable, sources of significant noise would be enclosed. The extent to which this can be done depends on the nature of the machine or process to be enclosed and their ventilation requirements. A typical enclosure can provide 10 - 20 dB(A) depending on the material.
- Plant machinery would be used in accordance with manufacturers’ instructions. Care would be taken to site equipment away from noise sensitive areas and where possible, loading and unloading would also be carried out away from such areas;

- Machines such as cranes that might have intermittent use would be shut down between work periods or would be throttled down to a minimum. Machines would not be left running unnecessarily, as this can be noisy and wastes energy; and

- Acoustic covers to engines would be kept closed when the engines are in use and idling. If compressors are used, they would have effective acoustic enclosures and be designed to operate only when their access panels are closed.

Given predicted noise levels are well below the noise criteria, a monitoring programme is not considered necessary. In the event that a complaint is made, monitoring will be undertaken in accordance with the Model Mining Conditions.

### 6.10.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential noise impacts is summarised in Table 6-80. An analysis of initial risk, without mitigation, was considered for each potential impact. The residual risk considers the mitigation and management measures developed for noise.

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Impact to health and wellbeing of humans               | Minor               | Possible           | Medium       | ▪ Staff training  
▪ Onsite health and safety protection  
▪ Acoustic treatment  
▪ Covers and enclosures                                                                 | Low            |
| Nuisance to nearby sensitive receptors                 | Minor               | Rare               | Low          | ▪ Covers and enclosures  
▪ Silencers on safety valves  
▪ General restriction of construction to daytime  
▪ Operational procedures introduced to reduce noise                                                                 | Low            |
| Impact to health and biodiversity of ecosystems        | Minor               | Unlikely           | Low          | ▪ Covers and enclosures  
▪ Silencers on safety valves  
▪ General restriction of construction to daytime  
▪ Operational procedures introduced to reduce noise                                                                 | Low            |

### 6.10.7 Summary

The predicted noise levels for the operation are expected to comply with the noise criteria at all noise sensitive receivers during ‘average’ and ‘worst-case’ conditions. Noise levels are also predicted to comply with low frequency noise criteria, except at the airport where noise impacts are not expected to be significant as the airport will only be in use when flights are scheduled and the airport is a source of low frequency noise during operation. Overall, terrestrial noise should not be considered a constraint to the approval of this Project.
6.10.8 Commitments

In relation to noise monitoring and management Metro Mining’s commitments are provided in Table 6.81.

Table 6.81 Commitments – noise

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>Attenuate noise, where practicable, to minimise potential noise related impacts from occurring.</td>
</tr>
<tr>
<td>N2</td>
<td>Implement a Noise Monitoring Plan upon receiving a complaint.</td>
</tr>
</tbody>
</table>

6.11 Waste

This section provides a summary of the relevant waste management regulatory framework describes the waste that is expected to be generated by the Project and details waste management strategies that will be adopted to prevent or mitigate environmental impacts.

6.11.1 Regulatory Framework

Requirements relating to waste management in Queensland are governed by several legislative instruments, policies and guidelines. Those relevant to waste management in the Project area include:

- *Environmental Protection Act 1994* (EP Act);
- Environmental Protection Regulation 2008 (EP Regulation);
- *Waste Reduction and Recycling Act 2011* (Waste Act); and
- DEHP Guideline – Application requirements for activities with waste impacts (EM964).

**Environmental Protection Act 1994**

Waste is defined under the EP Act as anything that is left over or an unwanted by-product from an industrial, commercial, domestic or other activity or surplus to the industrial, commercial, domestic or other activity generating the waste. The EP Act also requires applicants to describe the relative risks and likely magnitude of impacts on EVs arising from the Project (Section 6.11.6).

**Environmental Protection Regulation 2008**

The EP Regulation determines certain waste types, including regulated waste, as per section 65. Schedule 7 identifies the types of wastes and what constitutes them as being regulated including:

- The industry/process the waste has arisen from e.g. food processing, grease trap or tannery wastes;
- The specific element or compound of concern e.g. arsenic and cadmium and their compound; and
- A chemical property e.g. acidic or basic solutions, reducing or oxidising agents.

The EP Regulation also identifies the waste tracking and transportation requirements for regulated wastes. This section aims to address Schedule 5, Part 4, Table 1 of the EP regulation, which includes the following:
Environmental objective: Any waste generated, transported, or received as part of carrying out the activity is managed in a way that protects all environmental values (Section 6.11.5).

Performance outcome:

- Waste generated, transported, or received, is managed in accordance with the waste and resource management hierarchy in the Waste Reduction and Recycling Act 2011 (Section 6.11.5); and

- If waste is disposed of, it is disposed of in a way that prevents or minimised adverse effects on environmental values (Section 6.11.5).

Waste Reduction and Recycling Act 2011

The Waste Act provides guidance for waste management principles that dictate the following:

- **Polluter pays principle:** All costs of containing or eliminating pollution are borne by those who cause pollution. Polluters should be responsible for all costs of pollution prevention;
- **User pays principle:** All identifiable costs associated with the use of a resource should be included in the price of goods and services;
- **Proximity principle:** Waste and recovered resources should be managed as close to the source of generation as possible; and
- **Product stewardship principle:** There is a shared responsibility between all persons who are involved in the life cycle of a product for managing the environmental, social and economic impact of the product.

The above principles form the basis of a hierarchy and provide a basis for waste management programs. Waste will be managed in accordance with the Waste Management Hierarchy. The Waste Management Hierarchy is a framework for prioritising waste management practices to achieve the best possible environmental outcome. The hierarchy includes:

- **AVOID** unnecessary resource consumption;
- **REDUCE** waste generation and disposal;
- **REUSE** waste resources without further manufacturing;
- **RECYCLE** waste resources to make the same or different products;
- **RECOVER** waste resources, including the recovery of energy;
- **TREAT** waste before disposal, including reducing the hazardous nature of waste; and
- **DISPOSE** of waste only if there is no viable alternative.

The Waste Management Hierarchy is specifically designed to reduce the amount of waste that a Project generates, by guiding proponents to opt for the most preferred waste management method when it is available. The polluter pays principle encourages ‘cleaner production’, prompting the proponent to design waste out of the process from the start of a project.
DEHP Guideline – Application requirements for activities with waste impacts (EM964)

The Application requirement for activities with waste impacts (EM964) is a guideline for wastes produced by ERAs and outlines the required information for the ERA application. The main objective of this guideline is to ensure impacts are managed in a way that achieves a balance between the social benefits of development and maintaining the EVs of the receiving environment. This guideline incorporates the waste related sections from the EP Act, EP Regulation and the Waste Act.

6.11.2 Assessment Method

The main methods used for the assessment of potential impacts relating to waste management are:

- A review of the Commonwealth, state and local regulatory framework relating to waste classification and management;
- Review of available design documentation; and
- Investigations into local waste disposal and treatment facilities and capacities.

6.11.3 Existing Environment

In general the EV that will be protected or enhanced by this Project, as defined in Draft Queensland Waste Avoidance and Resource Productivity Strategy (2014-2024) (DEHP, 2014), is the protection of human health and the environment to secure our future prosperity.

6.11.3.1 Wastes Generated During Construction Activities

Construction wastes will be generated via the construction of the accommodation camp, mining infrastructure buildings, roads, conveyors, water management infrastructure, as well as packaging and the operation of machinery.

As a result of construction associated with each of the Project activities, it is anticipated that the following waste streams will be generated:

- Cleared vegetation (incorporated back into the rehabilitation process);
- Surplus inert building materials e.g. concrete and wood;
- Scrap metals;
- Oil and oily rags, waste paints and solvents;
- General waste (garbage);
- Recyclables (plastics, glass);
- Machinery maintenance wastes (tyres, oil filters, lead-acid batteries, etc.);
- Sewage and wastewaters; and
- Packaging.
6.11.3.2 Wastes Generated During Operational Activities

There is no beneficiation associated with the Project; therefore there are no identified process wastes beyond oversize rock material and tree roots that will be returned to the pit. Table 6-82 details potential waste sources from the major activities associated with operation of the proposed Project.

Table 6-82 Potential sources of waste during Project operation

<table>
<thead>
<tr>
<th>Section</th>
<th>Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining Infrastructure Area (MIA)</td>
<td>Laboratory</td>
</tr>
<tr>
<td></td>
<td>Office buildings and ablutions</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
</tr>
<tr>
<td></td>
<td>Light/Heavy Vehicle and Boat Workshops</td>
</tr>
<tr>
<td></td>
<td>Waste Management Area</td>
</tr>
<tr>
<td>Mining operations</td>
<td>Machinery/vehicle operation</td>
</tr>
<tr>
<td></td>
<td>Crib huts and field ablutions</td>
</tr>
<tr>
<td>Haul roads</td>
<td>Machinery/vehicle operation</td>
</tr>
<tr>
<td>Barge loading facility</td>
<td>Product material from conveyors / transfers</td>
</tr>
<tr>
<td></td>
<td>Conveyors (including belts/rollers)</td>
</tr>
<tr>
<td></td>
<td>Fuel transfers and distribution</td>
</tr>
<tr>
<td>Accommodation village</td>
<td>Kitchen</td>
</tr>
<tr>
<td></td>
<td>Laundry</td>
</tr>
<tr>
<td></td>
<td>Ablutions</td>
</tr>
<tr>
<td></td>
<td>Landscaping</td>
</tr>
<tr>
<td></td>
<td>Sewage / Water Treatment</td>
</tr>
</tbody>
</table>

Operating wastes have been separated into two primary categories; solid and semi-solid wastes and liquid wastes.

Solid and semi-liquid waste

Solid and semi-solid wastes will be generated during everyday activities and operations from facilities onsite. These include:

- General Waste (garbage);
- Recyclables (plastics, glass, paper and cardboard, cans);
- Food/putrescible wastes;
- Regulated wastes (used oils/oily rags, tyres, chemicals, lead-acid batteries, etc.);
- Cleared timber; and
- Waste products (sludges) from sewage and water treatment plants.
Liquid Waste

Raw water for the mine site will be sourced from a borefield into the shallow and/or GAB groundwater aquifers and pumped to raw water storage facilities. This raw water will be used for dust suppression, fire service, washdown and the potable water treatment plant (if required).

Table 6-83 outlines the liquid waste streams generated by source and location from the operation of the Project.

Table 6-83 Liquid waste stream, source and location

<table>
<thead>
<tr>
<th>Waste stream</th>
<th>Source</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility stormwater</td>
<td>Generated from stormwater coming into contact with mine processes, facilities and operational areas</td>
<td>Throughout the site</td>
</tr>
<tr>
<td>Oily water and wash-down water</td>
<td>Workshops and vehicle wash down facilities</td>
<td>MIA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mining operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barge loading facility</td>
</tr>
<tr>
<td>Waste oils, paints and solvents</td>
<td>Workshops Maintenance onsite</td>
<td>Throughout the site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barge loading facility</td>
</tr>
<tr>
<td>Greywater and sewage</td>
<td>Generated primarily from the mine village, which houses amenities, accommodation units, laundry and kitchen Also generated from amenities throughout the Project site</td>
<td>MIA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mine village</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mining operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tug boats</td>
</tr>
</tbody>
</table>

6.11.3.3 Wastes Generated During Decommissioning

The anticipated life of the Project is approximately 27 years, after which the Project will be decommissioned. Dismantling and removal of all above-ground and potentially below ground facilities and equipment will generate a variety of waste products. These will primarily include:

- Concrete – from the foundations of plants and facilities;
- Potentially contaminated fill;
- Scrap steel (includes reinforcement, storage tanks, structural steel, roofing, cladding);
- Building materials (timber, plastics, insulation, fittings, fixtures, floor coverings)
- Cabling and piping; and
- Decommissioned machinery and equipment/plant components.

6.11.3.4 Regulated Wastes

The following regulated wastes are anticipated to be generated by the Project:

- Oily rags;
- Waste oils, paints and solvents;
- Greywater and sewage;
- Grease trap wastes;
- Waste sludge associated with potable and waste water treatment;
- Used/scrap tyres; and
- Lead acid batteries.

Other ERAs are anticipated to be associated with the Project specifically in relation to waste management, and these may include:

- ERA 53 – Composting; and

### 6.11.4 Potential Impacts

Wastes generated by the Project have the potential to create impacts upon EVs including air quality, water (surface and groundwater) quality, soil quality and visual amenity of the site and the surrounding environment if they are not appropriately managed. In the absence of chemical processes, and relatively minor usage and storage volumes, wastes anticipated from this Project are considered of minimal human health or environmental risk. Where left uncontrolled or unmanaged, wastes may; however, still have the potential to impact human and environmental receptors.

Potential waste related impacts include the following:

- Increased GHG emissions from burning vegetation and the operation of plant, vehicles and machinery (considered within Section 6.9);
- Land and water contamination from inappropriate storage, handling and disposal of solid and liquid wastes (i.e. chemicals, hydrocarbons);
- Reticulated treated effluent to the gardens and grounds of the accommodation infrastructure; and
- Increased populations of vermin from inappropriate storage and handling of putrescibles.

A summary of waste types, waste sources, estimated quantities, characteristic and disposal and management is provided in Table 6-84.

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Source</th>
<th>Approximate Quantity</th>
<th>Characteristic</th>
<th>Disposal and Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Mining Wastes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Green waste / cleared vegetation  | Cleaning for village, MIA, barge loading facility, haul roads, mine pits | 1,668.99 ha (worst case disturbance scenario) | Organic waste | **Used and recovered**
Used in progressive rehabilitation. Respread over disturbed land to minimise erosion. Left onsite for habitat use |
| General solid wastes including putrescible | Construction and crib hut | <3 t/yr | Organic / general waste | **Disposed / reused and recovered**
Transported to an offsite regulated waste facility. Putrescible waste will be stored in covered containers and composted |
### Management and Mitigation Measures

This section outlines the general waste management strategies for the Project. To assist in the implementation, comprehensive waste management plans will be developed for the construction, operational and decommissioning phases of the Project as detailed information becomes available. Information to be developed and/or updated will include the following:

- Identification of waste streams and quantities;
- Management strategies to be employed for each waste stream;
- Roles and responsibilities;
- Monitoring waste streams and management activities;
- Auditing against the waste management plan; and
- Reporting requirements.

#### Solid and Semi-Solid Wastes

Waste streams will be segregated in designated areas onsite to maximise reuse and recycling opportunities, as well as minimising potential for accidental release and contamination of land/water from regulated wastes. This will be achieved throughout all stages of the Project by

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Source</th>
<th>Approximate Quantity</th>
<th>Characteristic</th>
<th>Disposal and Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>General recyclables (paper, plastics, aluminium cans and glass)</td>
<td>Crib hut</td>
<td>&lt;2 t/yr</td>
<td>Recyclable waste</td>
<td>Recycled and recovered</td>
</tr>
<tr>
<td>Scrap metal and steel offcuts</td>
<td>Workshop</td>
<td>&lt;3 t/yr</td>
<td>Recyclable waste</td>
<td>Recycled and recovered</td>
</tr>
<tr>
<td>Timber – pallets and offcuts etc.</td>
<td>Workshop</td>
<td>Minor amounts</td>
<td>Organic waste</td>
<td>Recycled and recovered</td>
</tr>
<tr>
<td>Tyres and rubber</td>
<td>Light vehicles</td>
<td>&lt;10 t/yr</td>
<td>Recyclable waste</td>
<td>Disposed / recycled and recovered</td>
</tr>
<tr>
<td>Sewage</td>
<td>Portable toilet</td>
<td>&lt;10 t/yr</td>
<td>Regulated waste</td>
<td>Reused and recovered</td>
</tr>
<tr>
<td>Concrete</td>
<td>Workshop</td>
<td>&lt;3 t/yr</td>
<td>Inert waste</td>
<td>Recycled and recovered</td>
</tr>
<tr>
<td>Hydrocarbon wastes (waste oil, oil absorbent, greases, degreasers, oily rags, oil filters and contaminated soil)</td>
<td>Workshop - off-site in Weipa (waste oil) and onsite workshop</td>
<td>&lt;15 t/yr</td>
<td>Gaseous waste</td>
<td>Avoided</td>
</tr>
<tr>
<td>Batteries</td>
<td>Barge loading facility, conveyor, MIA and village</td>
<td>&lt;1 t/yr</td>
<td>Regulated waste</td>
<td>Recycled and recovered</td>
</tr>
</tbody>
</table>
designating bins and roll-on/roll-off skips throughout the site for each specific waste stream (i.e. general waste, regulated waste, recyclables, steel etc.). When these bins or skips are full, they will be directed to a centralised bunded waste storage facility located onsite within the MIA. This facility will provide segregation areas for various waste streams with skips to be stored until they are moved off site. Storage for regulated wastes (solid and liquid) will be located in a separately bunded and roofed area.

From the waste storage facility, domestic, commercial and industrial wastes will be barged to appropriate facilities in Weipa, Cairns or Townsville, where they will be collected by a licensed waste management contractor for licenced landfill disposal, recycling or additional treatment.

A summary of the waste disposal opportunities is provided in Table 6-85 and are shown in Figure 6-39. These waste facilities are suggestions and waste disposal facilities will be at the discretion of the Project licensed contractor.

### Table 6-85 Summary of waste disposal opportunities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Location</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio Tinto Alcan Landfill and Recycling Centre</td>
<td>Weipa</td>
<td>Operated by Cleanaway on behalf of Rio Tinto Alcan. Metro Mining will seek permission to utilise these facilities.</td>
</tr>
<tr>
<td>Advanced Resource Recovery Technology Facility</td>
<td>Cairns</td>
<td>Operated by Sita Environmental Solutions and services the local government areas of Cairns, Douglas and Mareeba. Also accepts wastes from commercial business. Recovers recyclables and organic materials from mixed waste for recycling and reuse.</td>
</tr>
<tr>
<td>Jensen Landfill and Transfer Station</td>
<td>Townsville</td>
<td>Accepts general and hazardous wastes including batteries, engine and cooking oils, metals, concrete and bricks, gas bottles, e-waste, bulk cardboards, general dry recyclable packaging, clean fill and clean mulchable green waste.</td>
</tr>
</tbody>
</table>

It is a legislative requirement that regulated waste is transported offsite by a licensed contractor. Solid and semi-solid regulated wastes generated by the Project, including oily rags, lead-acid batteries, chemicals, used/blown tyres and potentially sludges from the water treatment facilities will be collected monthly or as required from the site, and transported to an approved landfill or recycling facility, with the closest being located in the Townsville region.

It should be noted that the closest landfill at which solid wastes could be disposed of is located at Mapoon. The Mapoon Aboriginal Council has; however, indicated the landfill is not suitable for servicing the Project. Alternatively, Weipa, Cairns and Townsville regions all have well established domestic, commercial and industrial waste management facilities, with transfer stations and/or landfills capable of accommodating the anticipated general, recyclable and regulated wastes to be generated by the Project. Arrangement with a waste disposal contractor will be considered further during detailed feasibility.
Organic Wastes

A composting system is planned to be incorporated onsite, and utilised during the operational phase of the Project. This presents an important opportunity for waste recycling of a number of organic waste streams, including food wastes.

Several design options are available for the composting system, and the final choice is dependent upon the contract operator of the facilities, as well as the preferred end use of the composting product and quantities of waste to be composted. Given it is anticipated that compost will be used as soil conditioner for the mine complex and possibly the mine rehabilitation process, a simple windrowing method may be sufficient.

It is expected that the composting facility will be bunded to prevent runoff of leachate material, and be fenced to keep out feral animals such as pigs.

The ultimate quantity of compost production is currently unconfirmed. Should 200 tonnes or more of the resultant compost product be generated in a year, the composting process will; however, constitute an ERA (ERA 53 – Composting and soil conditioner manufacturing) under the EP Regulation.

Sewage Treatment

Up to 105 personnel will be employed for the construction, operation and decommissioning phases of the Project. Hence, it is feasible, practical and less impact to provide on-site treatment and disposal of sewerage and waste water.

At the commencement of construction and prior to the commissioning of sewage and waste water treatment infrastructure, portable shower and toilet facilities will be used throughout the site. These facilities will be emptied weekly by a licensed liquid regulated waste contractor and the waste will be transported via barges and disposed of offsite at licenced facilities at Weipa.

Sewage treatment will occur at a central intermittent aeration type package treatment plant planned to be located at the accommodation village. Toilet facilities at the MIA will be pumped out at an appropriate schedule and trucked back to the sewage treatment plant.

These system work on the combined principles of primary settling plus aerobic and secondary treatment. Wastewater to be treated flows first into the septic zone where solids are settled out and the anaerobic microorganisms perform the initial part of the purification process. Once organic impurities have been absorbed within the aerobic culture of microorganisms, the water passes to the secondary sedimentation zones. Clear water flows over into the clarification zone and the occasional film of microorganisms are automatically transferred back to the primary zone to improve its performance. In the disinfection zone, mild controlled chlorinating is applied to complete the treatment process.

Effluent will be treated to a Class C effluent quality as stipulated in the Queensland Water Recycling Guidelines 2005. This will allow restricted onsite uses such as irrigation or dust suppression.

Given the low volumes of sewage that will be produced at the site, options for self-composting toilets or other environmentally sensitive alternatives will be assessed during the detailed design stage, which may eliminate the requirement for trucking of wastes.
**Liquid Regulated Wastes**

During construction and decommissioning, liquid regulated wastes such as waste oils, paints and solvents will be stored in bunded and enclosed areas in accordance with AS1940-2004 The Storage and Handling of Flammable and Combustible Liquids (AS1940). Regulated waste will be transported offsite and disposed of by a licensed liquid regulated waste contractor.

**Stormwater**

At the mine site, MIA and barge loading facility, stormwater from facilities will be directed to sediment basins to settle out solids to prevent high sediment loads in waterways in the vicinity of the Project site.

**Gaseous Emissions**

A number of options will be assessed to reduce the emission from mining operations, particularly diesel emissions from mining equipment, and diesel generators by minimising the power output required for the Project. Options to be assessed include:

- Solar hot water system throughout the village, with electric booster;
- Gas cooking;
- Solar powered pathway and road lighting;
- Switching off or using standby mode for electrical devices (including lights) when not in use during work hours and all off after hours;
- High efficiency lamps/bulbs whenever possible;
- Select energy efficient appliances and office equipment (refrigerators, photocopiers, washing machines, driers);
- Maintain air-conditioning units at peak operating efficiency, set at 24°C;
- Maintain plant and equipment to the manufacturer's specifications;
- Minimise the quantities of vegetation to be burnt onsite;
- High/premium efficiency motors for conveyors; and
- Low emission fuel for mining machinery.

**Waste Management Hierarchy**

As mentioned above, the Waste Management Hierarchy is a significant tool to ensure the Project incorporated sustainable waste management practices. As such, waste management will, in order of preference, avoid, reduce, reuse, recycle, recover, treat and lastly dispose if no other management option is viable.

**Waste Avoidance and Reduction**

The cost of transporting materials in, and waste out, of the Project site will ensure that waste avoidance has a high priority. The use of pre-fabricated materials will play an important part in waste avoidance for the Project. Given the remote location and limited access to the site, a number of pre-fabricated/modular components will be sourced and brought onto site for the conveyors and
stacking/reclaiming infrastructure, accommodation village and barge loading facility, where possible. This will substantially reduce the quantities of some waste streams associated with the construction phase of the Project, including:

- Scrap steel; and
- Surplus concrete.

**Waste Reuse and Recovery**

A number of waste streams generated by the Project will be assessed for reuse onsite. These include:

- Clearing (reused in rehabilitation and composting);
- Paper waste (composting);
- Putrescible wastes (composting and site reuse); and
- Waste water effluents (site irrigation and composting).

**Waste Recycling and Recovery**

Due to the remote nature of the site, recycling options may not be readily available at cost effective rates. All opportunities for recycling will be assessed and implemented where possible. Wastes to be assessed include:

- Scrap metals;
- Recyclables (plastics, glass, tins, aluminium, paper/cardboard);
- Some waste oils;
- Waste rubber;
- Tyres;
- Lead-acid batteries;
- Surplus concrete (crushed onsite and used as road base or hardstand); and
- Bulk materials generated from decommissioning.

The marketability of recyclable wastes will be reviewed to ensure potential new and emerging opportunities for waste recycling are maximised.

**Waste Treatment and Disposal**

This will only be considered where there is no other option available to minimise, reuse, recycle or recover waste onsite. Non-recyclable general waste will be transported to a landfill, either in the Weipa, Townsville or Cairns region, for disposal in accordance with regulatory requirements.

Regulated waste will be transported offsite by a licensed contractor to an appropriate regulated waste disposal facility, likely to be located in the Townsville region.
Cleaner Production

To meet recognised leading practice operating standards, cleaner production initiatives will be employed by the Project. Cleaner production is a continual improvement process designed to maximise resource usage and operational efficiency in order to minimise waste disposal.

Examples of cleaner production techniques identified for the Project include:

- Improved operation and maintenance practices to reduce the quantity of resources used and to minimise the amount of waste generated. This is achieved through the selection of efficient motors to drive conveyors, low emission machinery options and by ensuring that all machinery is well-maintained and is operating at peak efficiency;

- Selection and use of the most appropriate technology to reduce the quantity of resources used and to minimise the amount of waste generated. By producing a DSO product, the Project is inherently incorporating the lowest possible water and energy usage process available; and

- Segregation of waste to facilitate reuse.

Spill Containment and Remediation

The Project will implement accepted procedures for the storage, handling, disposal and spill response for hazardous waste. Hazardous materials will be stored in appropriate bunding in accordance with AS1940, particularly at the warehouse, bulk fuel storage and waste storage facility. Spill containment material and appropriate size and material spill kits will be strategically located throughout the site.

The risks associated with hazardous material spills into the Skardon River will be addressed in Section 6.17.

Waste Tracking

A site register will be developed and maintained for all wastes generated on site. This will be maintained through records of waste type and volumes that are transported off site.

The tracking of regulated wastes is a legal requirement, with details to be provided to DEHP as required. The treatment, storage and transport of a regulated waste requires an EA under the EP Act. Where a contractor carries out these activities, the contractor will be required to hold the appropriate approvals.

Waste Reporting

The National Environmental Protection Council has endorsed a NEPM in the form of the National NPI. It is a database designed to provide stakeholders and government agencies with information on the type and quantity of substances emitted to land, water and air. The objectives of the NPI are to:

- Provide information to industry and government to assist with environmental planning and management;

- Provide the community up to date information about substance emissions and transfers from industrial facilities; and

- Promote waste minimisation, cleaner production, and energy and resource efficiency.
Reporting on emissions in compliance with NPI requirements will be an annual requirement for the Project.

### 6.11.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential waste impacts is summarised in Table 6-86. An analysis of initial risk, without mitigation, was considered for each technical element. The residual risk considers the mitigation and management measures developed for waste, and put forward in this assessment.

#### Table 6-86 Qualitative risk assessment - waste

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improper waste management and unsightly areas can impact on visual amenity</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Monitoring of compliance with the waste management measures specified above</td>
<td>Low</td>
</tr>
<tr>
<td>Health related issues from improper waste management, such as pests and disease</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Dedicated waste storage areas ▪ Appropriate waste receptacles ▪ Regular remove of waste</td>
<td>Low</td>
</tr>
<tr>
<td>Health related issues from pathogen exposure from improper treatment of sewage waste</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ High sewage treatment standard before reuse ▪ Fencing and signage of subsurface irrigation area ▪ Incorporation of exposure prevention into staff training ▪ Certified operator overseeing plant operations</td>
<td>Low</td>
</tr>
<tr>
<td>Site contamination from inappropriate disposal of regulated waste</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ All wastes, including regulated wastes, will only be disposed of at a landfill or facility lawfully able to accept such waste</td>
<td>Low</td>
</tr>
</tbody>
</table>

#### 6.11.7 Summary

Waste streams from construction and operation will be managed in accordance with the Waste Management Hierarchy and implemented waste management plans. All wastewater will be reused within the process; hence a wastewater stream will not be generated.

Waste that is required to be transported will follow the relevant protocols and the licensed contractor of the commercial barge will be the responsible party for emergency response planning and transportation records. Metro Mining will provide the licenced contractor with the monitoring and reporting information concerning the waste.
6.11.8 Commitments

In relation to managing wastes, Metro Mining’s commitments are provided in Table 6-87.

Table 6-87 Commitments – waste

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>Develop and implement waste management plans, using the principles of the waste management hierarchy, for the construction, operational and decommissioning phases of the Project.</td>
</tr>
<tr>
<td>W2</td>
<td>Maintain waste tracking records which include the characteristics and movement of all relevant material to, around and off the site.</td>
</tr>
<tr>
<td>W3</td>
<td>Work with local councils to determine the current landfill capacities and accepted waste types and ensure wastes generated from the Project can be accommodated at existing facilities.</td>
</tr>
<tr>
<td>W4</td>
<td>Encourage the procurement of pre-fabricated materials where practicable.</td>
</tr>
<tr>
<td>W5</td>
<td>Encourage employees and contractors, via inductions, to minimize waste generation and to re-use and recycle, wherever possible.</td>
</tr>
<tr>
<td>W6</td>
<td>Consult and encourage local businesses to take advantage of opportunities for reuse and recycling, if available, if unavailable regularly review the waste management plans including the marketability of wastes and the results of waste audits to improve waste management and Project efficiency.</td>
</tr>
</tbody>
</table>

6.12 Indigenous Cultural Heritage

This section describes the existing environment and potential effects of construction and operation of the Project upon Indigenous cultural heritage. It provides a context for assessing Indigenous occupation of the area and provides an overview of the framework in which Metro Mining and the identified Aboriginal parties will manage statutory obligations. Metro Mining is committed to working with the relevant Aboriginal parties to develop and implement Cultural Heritage Management Plans (CHMP) and to provide management strategies that are agreed and that are appropriate for the protection of identified Indigenous cultural heritage.

6.12.1 Regulatory Framework

In Queensland, both Commonwealth and state legislation protects Indigenous heritage. This section discusses legislation of relevance to this Project. The relevant cultural heritage legislation is established in the:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act);
- Native Title Act 1993 (Native Title Act);
- Australian Heritage Council Act 2003 (AHC Act);
- Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (ATSIHP Act);
- Aboriginal Cultural Heritage Act 2003 (ACH Act); and
Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides protection for items and places with world, national or Commonwealth heritage values. Natural, historical and Indigenous heritage sites, either nominated or approved, are protected under this Act. The Act provides for the National Heritage List and the Commonwealth Heritage List.

The National Heritage List provides protection for areas that demonstrate outstanding heritage value to the nation and the Commonwealth Heritage List provides for protection of areas that have significant values that are on Commonwealth land.

The Act also provides protection for cultural heritage items and places on the World Heritage List. The criteria used for inclusion on the National (and Commonwealth) Heritage List is outlined within the Act.

Native Title Act 1993

The Native Title Act provides for the recognition and protection of native title. It is intended to set standards for the determination of claims to native title, and establish ways to deal with compensations relating to such claims. It also enables an Indigenous Land Use Agreements to be made between native title parties and other interest holders and to provide for the establishment of National Aboriginal and Torres Straight Islanders Land Funds.

Two native title claims exist over the terrestrial and marine components of the Project area. The registered native title claimants are the Ankamuthi People (QC1999/026) and the Northern Cape York Group #1 (QCD2014/017) (see Figure 3-1).

Australian Heritage Council Act 2003

The AHC Act established the Australian Heritage Council (AHC) to administer the National Heritage List and Commonwealth Heritage List. The AHC is the principal advisory body to the Australian Government for heritage matters, particularly in relation to administering the lists now created under the EPBC Act. The AHC maintains an online searchable database.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

The ATSIHP Act concerns areas and objects in Australia and Australian waters that are of particular significance to Aboriginals (in accordance with Aboriginal tradition) and provides for their preservation, protection from injury or desecration. The act provides that an Aboriginal or a group of Aboriginals may apply to the Minister for preservation or protection of a specified area or object. This includes general and emergency declarations that may be made in relation to significant Aboriginal areas or objects in threat of harm or desecration. The Act makes it an offence to contravene a declaration.

Aboriginal Cultural Heritage Act 2003

The main purpose of the ACH Act is to provide effective recognition, protection and conservation of Aboriginal cultural heritage.

Permits are not required for cultural heritage; rather a duty of care is required and expected of the Proponent. This duty of care provides that:

“A person who carries out an activity must take all reasonable and practicable measures to ensure that the activity does not harm Aboriginal cultural heritage.”
It provides for assessment of significance to be undertaken by identified Aboriginal parties, to be decided in a manner consistent with tradition and emphasises that the definition of areas and objects goes beyond archaeological sites to include those where there are no physical traces. When an EIS is required, the Act requires that a CHMP or Native Title agreement to be developed in accordance with Part 7. Major elements of the Act are:

- Protection of areas and objects of traditional, customary and archaeological significance;
- Recognition of the primary role of Aboriginal parties in cultural heritage protection and management;
- Establishment of a Cultural Heritage Register and Cultural Heritage Database;
- The provision of a general duty of care with the onus on developers to manage their duty of care; and
- Mandatory requirement to prepare CHMPs in situations where an EIS is required for any project approvals.

Individuals and corporations may be prosecuted should they fail to fulfil the duty of care, or be found responsible for damaging Aboriginal cultural heritage.

**Queensland Heritage Act 1992**

The QH Act protects Queensland’s historical cultural heritage since the time of non-Indigenous settlement for the benefit of the community and future generations. It provides for the maintenance of a Queensland Heritage Register that records places of significance and regulated development affecting these registered places. The QH Act requires local government agencies to establish their own registers of heritage places.

Although the requirement for local heritage lists was established under the Queensland Heritage Register and therefore will not apply to sites solely significant to Indigenous people, some local heritage overlays do include Indigenous cultural heritage sites. These sites could be subject to provisions of the SP Act; whereas Indigenous cultural heritage sites are offered greater protection under the ACH Act.

### 6.12.2 Assessment Method

Assessing and minimising the potential impacts of the Project development to Indigenous heritage values has been a multi-staged process. The initial phase of this study was the collation of site information. The following sources were used:

- Online resources, principally for heritage site databases and regional history;
- Commonwealth Heritage lists (World Heritage List, National Heritage List, and Register of the National Estate) for sites of international and national significance;
- Indigenous Cultural Heritage Register and Database;
- The Queensland Heritage Register;
- Register of the National Trust of Queensland; and
- Data in heritage studies previously carried out in nearby areas.
In accordance with Part 7 of the ACH Act, a CHMP will be developed for this Project. Part 4 of the Act provides a framework for the identification of an Aboriginal party or parties for a particular area. Aboriginal parties that are endorsed are required to be consulted regarding the development of a CHMP.

Limitations

While register searches and literature reviews provide a small catalogue of sites to be considered and avoided during infrastructure planning, the results of these searches cannot be construed as a comprehensive record of the Aboriginal cultural heritage sites in the region. Site registers document unusual or important sites known to the community, or Indigenous objects and areas identified during previous intensive cultural heritage clearances. Many sites are known to Aboriginal people but information on their location and importance is not publically available, also many parts of the study area have not yet been examined for traces of prior Aboriginal habitation, yet are likely to contain Aboriginal cultural heritage.

6.12.3 Existing Environment

A search of the Australian Heritage Place Inventory and Aboriginal Cultural Heritage Database and Register did not identify any listed area within the immediate Project area. The Project area is located within the Cook Shire Regional Council and no cultural heritage overlays are available for the Skardon River area under the current Cook Shire Regional Council Planning Scheme.

Metro Mining has undertaken field surveys of specific areas required for exploration activities. Broader cultural heritage surveys of the Project area have not, as yet, been undertaken by Metro Mining as these will be undertaken as part of the CHMP implementation and prior to the commencement of construction.

Whilst the survey reports are confidential in nature, the field surveys have identified cultural heritage material within the Project area. The identified cultural heritage material has been managed in accordance with agreements between the Aboriginal parties for the area and Metro Mining. Metro Mining will attempt to avoid impacts to these sites. Where there are risks of potential impacts to these sites, Metro Mining will consult with the relevant Aboriginal parties to establish suitable mitigation measures to mitigate impacts to cultural heritage.

Background Aboriginal Heritage

This section provides a summary of the findings from the various historic and cultural heritage surveys carried out in the general Project area. The information provided has been drawn from the reports prepared by the various archaeologists representing the Traditional Owner groups. For reasons of confidentiality, exact locations of recorded sites have not been included in this summary. Further, photos of cultural heritage material or “country” have not been included in order to further protect the sensitivities and locations of cultural heritage material.

Ethnographic History

The Aboriginal language group whose territory forms part of the project area was labelled Ankamuthi by Norman Tindale (1974), using work by MacGillivray, 1852; Jardine in Byerley, 1867; Creed in Ridley, 1878; Parry-Okeden, 1897; McConnel, 1939-1940, 1950 and Tindale (1940). Historically, other names for this language group were Goomkoding, Yumakundji (probably Jathaikana term), Amkomti, Ondaima, Oiyamkw (people on Red Island), Apukwi (people of Crab Island) (Tindale, 1974). In the modern era this group have been named Angamuthi, Anggamudi and Ankamudi. In historic times, their land association was from west of Cape York southwest to Vrilya.
Bauxite Hills Project • Metro Mining

Point; inland almost to the head of the Jardine River; on Possession Island and western islands in Endeavor Strait.

By the time the area had gained the attention of early ethnographers in the first half of the 1900s much about Peninsular traditional life in coastal regions had been transformed by settler impacts. At the same time the Peninsular interior had until then sheltered groups from the incursions of the colonial journey because penetration was difficult (McConnel 1939:58, 71-72). For the Ankamuthi whose traditional lands extend inland from the western coast of the Gulf of Carpentaria inland to lands associated with the Yadhaigana to the east and north and the Teppathiggi and Mpalitjahn (Tindale, 1974) to the south, enough tradition remained for the group to be considered an extant tribe albeit skeletal in form (McConnel 1939:55, 58, 71-72; Sharp 1939:264). Missions had settled at the mouths of some of the Peninsula’s chief rivers including the Skardon and early reports note the movement of Indigenous people to non-Aboriginal camps and settlements (McConnel 1939:58). There are suggestions (see Powell, 2014) that the former Seven Rivers camp was located south of the Skardon River. This is the location where The Hon. John Douglas and his party landed in 1891 during their journey to Port Musgrave to select a site suitable for a mission to Aborigines (in Powell, 2014).

A region noted for its resources, the Ankamuthi estates and their surrounds offered the landowners bountiful hunting grounds which according to the records did not necessitate extensive movement away from traditional lands. McConnel (1939:58) writes ‘the low-lying coast of the Gulf of Carpentaria, fed by the large rivers which overflow into side-channels, lagoons and swamps, and rich in wild-fowl and game, roots and fruits is, or used to be, a primitive hunter’s paradise’. Sharp (1939:255) also notes these fertile grounds and Parsons, quoted in Yates and Quartermaine (1993) notes the land is an integral part of Mapoon culture.

The land embodies all life for the Traditional Owners and the land formed the source of Mapoon identity and a means through which groups related to each other. Groups living in this area were understood as being reasonably sedentary and associating only with adjacent and neighbouring groups who, linguistically, were markedly different from each other (McConnel 1939:57-58). The works of Thomson, McConnel and others show that the differences in social structure and belief systems are just as significant as the similarities. The social differences across a region with many environmental similarities shows that social constructs are not solely determined by environmental conditions, but are the product of a large number of social variables developed over time.

**Indigenous Use of Environmental Resources**

Subsistence strategies of Aboriginal peoples have long been a principal component of Australian archaeological research. In addition, subsistence strategies have often been at the centre of ethnographic accounts of Aboriginal groups, particularly in Northern Australia where historical conditions have led to the survival of Aboriginal hunting / gathering knowledge for longer than in southern Australia. Furthermore, most ethno-historical accounts in Northern Australia focus on explanations of past human behaviour within the economic framework of those cultures (Meehan 1977, 1988; Schrire 1972).

In the Western Cape York region, ethnographic evidence shows that Aboriginal subsistence strategies were similar in some ways to those of the Top End and the Kimberley, following largely on the geographical and climatic similarities between the areas. The peoples of the Western Cape relied heavily on the freshwater resources available from post wet season swamps, lakes and creeks in the coastal zone. These areas, like their counterparts in the Arafura region, provided access to a diverse range of fauna including crocodiles, water snakes, turtles, fish and shellfish and waterfowl and also more terrestrial animals like the agile wallaby (Cribb 1986:140). In addition, these areas provided a diverse array of plant foods such as water chestnut and lotus (Nymphaeae). Further
inland, the large Darwin stringybark dominated woodlands were exploited for kangaroo, wallabies, emu, sugarbag, long yams and nonda plums (Sutton 1978:48).

The widespread exploitation of sugarbag resources in contact and pre contact times have left a visible impact on the archaeological record in the form of culturally modified trees (Von Sturmer 1978:17). This resource was available between June and December peaking between August and November (Sutton 1978:46). Thomson’s states that between late July and early October sugarbag was plentiful and perhaps the most important food source to Aboriginal people.

In contact times, feral cattle and pigs have provided additional resources, albeit sometimes at the disadvantage of indigenous species. Dune systems, beaches and estuaries, to the west of the project area, also provided seasonal access to resources such as fish, shell fish (particularly *Anadara granosa*, *Polymesodia* sp., *Marcia hiantina*) and some plant foods. The scale and extent of the anadara exploitation has left numerous coastal midden complexes. These middens have been the focus of much of the archaeological research in the Western Cape area (i.e. Cribb, 1986; Bailey 1994 and McNaughton and Morrison, 2005).

As noted above, many ethnographic accounts point to widespread sugarbag exploitation in the pre- and post- contact eras (McConnel 1930; Sutton 1978 and Von Sturmer 1978). McConnel (1930 p.189), for example, refers to large numbers of tree scars in bloodwoods and stringybarks made during increase ceremonies to ensure the plentiful supply of honey. Scarring was not therefore limited to the actual extraction of honey, but also from tree marking to indicate ownership and to produce tools such as woomera’s, spears, spear tips, and ‘planers’.

**Contact History**

As with other areas of Northern Australia, the Western Cape York region has a contact history with peoples from outside of the Aboriginal world that extends well back before that of southern Australia. Contact with Macassans (Kimberley and Northern Territory), Torres Strait Islanders (Cape York) and Papuans (Cape York and Torres Strait) can be dated to at least 1721 (MacKnight, 1986), but probably too long before. In one sense, the ‘contact’ label applies more too European colonial contact rather than with cultures to the north as this contact may have been episodic back to the Pleistocene / Holocene transition.

The first known European contact with the area was the Dutch explorer Willem Janszoon in 1606. Other Dutch and English explorers and traders impacted on the Western Cape region during the 17th and 18th centuries.

The first large colonising impact occurred after the discovery of gold at Coen in 1876. As with other areas of northern Australia, the impact of early miners and pastoralists proved to be a decisive instrument of change to the Wik and Wik Way cultures. Unlike the colonisation of southern Australia during the convict era, when cheap labour was available to pastoralists, the price of European labour in the north seemed prohibitively expensive. This led to the acceptance of Aboriginal labour as the backbone of the labour force, especially given the knowledge of country possessed by Aboriginal people. Even at the height of the White Australia policy after 1900, pastoralists, miners and pearlers in the north applied for exemptions on the policy to enable the employment of Aboriginal people and others such as Malaysians, Japanese and Islanders (Reynolds, 2003).

The establishment of cattle stations on the Cape, the completion of a telegraph line in 1887 and the commencement of pearling operations from Thursday Island began a process of social colonisation of Aboriginal peoples. This process, repeated many times across Northern Australia, involved removing young men who resisted settlement from traditional lands (sometimes by instrument of massacre) and offering work and rations to the remaining population (Jebb, 2002). The removal of
young men, and those who offered resistance to colonisation, had the effect of disrupting the traditional Aboriginal economy. The remaining population therefore were forced into unequal labour relationships, and later into the missionary system from 1891. The missionary system and its relationship with the Queensland Government, led to the removal of Aboriginal people to reserves and missions in the Cape and Gulf areas. This has had the effect of ‘mixing up’ the clan groups across the region. Aboriginal people can trace their ancestry across many communities not necessarily close to their ancestral lands.

The end of the missionary system, in living memory for older Aboriginal people, occurred during the 1970’s and 80’s. The replacement economic system was dominated by increased welfare payments to Aboriginal people. Mining for bauxite started in the area in the early 1960’s and has increased in scope and output in the last decade. This has led to increased employment opportunities for Aboriginal people in the area, both through cultural heritage and environmental protection projects and in the exploration and mining operations themselves.

**Naming of the Skardon River**

The Skardon River [also referred to as Schardon, Scardon and Scarshed (Powell, 2014)] is associated with a broader area of Cape York Peninsula referred to as the ‘Seven Rivers’. The title Severn Rivers is used to distinguish a portion of the coast north of Port Musgrave and Aboriginal people associated with this area (Powell, 2014). The area is described by the linguist Terry Crowley, as ‘the very narrow coastal stretch from the northern side of Port Musgrave as far as the Doughboy River and also the inland area of Crystal Creek and the middle Jardine River’. Crowley (1983) identifies the seven watercourses associated with this area as the Jardine, Macdonald, Skardon, Doughboy, Ducie, Jackson and Crystal (Crowley, 1983: 310).

In Northern Cape York Peninsula records, ‘Seven Rivers’ (or one of its variants) is associated with a watercourse named the ‘Skardon’. Powell (2014) notes, that according to R. Logan Jack (1921: 318) the river now named the ‘Dulhunty’ that joins the Ducie River, which debouches into Port Musgrave, was first named the ‘Skardon’ by the Jardine brothers Frank and Alexander during their 1865 overland trek from Carpentaria Downs to Somerset. Powell (2014) writes that ‘nowadays, this latter watercourse is sometimes referred to as the ‘Last River’ by Mapoon Mission residents because it is regarded as the last of the seven rivers passed by boats travelling from Thursday Island before they arrive at Mapoon’. Powell (2014) argues that as the Jackson River is not represented in the early maps of the west coast of Northern Cape York Peninsula that the west coast was incompletely and/or incorrectly mapped. Consequently early references to the Skardon River potentially relate to two different watercourses.

**Cultural Heritage Surveys**

A cultural heritage survey of the Project area was undertaken by Yates and Quartermaine in March and May 1993 on behalf of Venture Exploration NL. The objective of the survey was to conduct an archaeological investigation to facilitate the planning of the Skardon Kaolin Project. This survey included a literature review, consultation with Traditional Parties and field surveys of the Skardon Kaolin Project area. No significant archaeological or ethnographic sites were identified during the consultation process.

Systematic surveys were undertaken within the Project area. The archaeologists were accompanied during the survey by representatives of the Aboriginal Parties and the archaeologist for the Cape York Land Council. Visibility during the field survey was poor and limited the potential for discovery of cultural heritage material. Thick vegetation in the vicinity of the Skardon River and creeks and thick grass cover in the clearings hindered the effectiveness of the survey. Flooding in the area further hindered the survey limiting access to target areas.
No historical or archaeological sites were discovered during the survey. Two possible shell middens were identified on the southern bank of the Skardon River. Yates and Quartermaine (1993) noted the sites as “potential middens” as neither site displayed the typical diagnostic features of a shell midden site. Yates and Quartermaine (1993) noted an absence of charcoal, burnt wood, blackened shell, stone artefacts, hearth stones and mammal bones. Equally it was identified that the sites did not display the characteristics typical of a midden formed by cyclonic surges. It was identified in the report that further potential sub-surface sites may be present on the banks of the Skardon River and creeks within the Project area.

The prevailing vegetation coverage and limited access may have limited the potential to find additional archaeological sites and cultural heritage materials. Yates and Quartermaine (1993) note though that given the low incidence of archaeological sites, it is probable that the limited survival of most cultural heritage materials, together with the sparse nature of prehistoric and historic occupation of the Project area was largely responsible for the paucity of sites and material. Yates and Quartermaine (1993) conclude that from the low density of cultural heritage material discovered within the area sampled that there is a low probability for sites of archaeological significance to occur in the area.

**Exploration Clearance Surveys**

Earthsea (2012) undertook an archaeological assessment of the Project area in support of track construction and geotechnical surveys associated with exploration during July 2011. Indigenous representatives of the Traditional Owner group/s accompanied the consultant during fieldwork. The systematic archaeological surveys covered approximately 58% of BH6 east and west; however, no areas within BH1 were surveyed.

Four archaeological sites were identified within the Project area with a further fourteen sites located outside of the Project area but within concessions held by Metro Mining. Survey results indicated a relatively low density distribution of archaeological sites across the survey region. However, the highly active environmental processes of the bauxite plateaus are likely to have contributed to the paucity of sites recorded. Furthermore, ground visibility was very low throughout all of the survey areas, which impaired the consultant’s ability to detect surface archaeological features, particularly stone artefacts or shell material.

Further systematic cultural heritage assessment of the remainder Project development area will be undertaken in accordance with agreed CHMPs.

### 6.12.4 Potential Impacts

It is anticipated that no listed Indigenous cultural heritage will be impacted by the proposed Project development. Items of unrecorded Indigenous cultural heritage may occur within or near the proposed Project development and without appropriate site management initiatives, may be threatened by construction impacts. Unrecorded Indigenous heritage resources within impact areas will be identified during dedicated field surveys conducted by the relevant Aboriginal party as agreed in the CHMP. The Ankamuthi People (QU6158/98) and the Northern Cape York Group #1 (QUD1577/11) have been identified as being the relevant Aboriginal parties for the Project area. The conduct of the cultural heritage study and the implementation of site protection or remediation measures will be specified in the approved CHMP.

Impact mitigation measures that may be required include avoiding certain highly sensitive areas, carrying out more field investigations including sub-surface testing, recovering datable occupation material, and collecting and relocating, where required, cultural heritage items.
6.12.5 Management and Mitigation Measures

For the management and mitigation of impacts on Indigenous cultural heritage, Metro Mining will use a range of cultural heritage management processes and proven procedures that have effectively been implemented throughout Queensland. Metro Mining has undertaken appropriate steps to identify the correct Aboriginal parties in accordance with the ACH Act.

The Right to Negotiate process is well advanced with both the Ankamuthi People and the Northern Cape York Group #1. On successful completion of those processes Metro Mining will commence the preparation of CHMP for the mining operations. The CHMP will be active throughout the life of the Project and will incorporate the outcomes of monitoring, survey and fieldwork, analysis and consultation.

The CHMP will include a protocol for the involvement of the Aboriginal party over the life of the Project with participation of Aboriginal party representatives in cultural heritage monitoring, management and mitigation works. The CHMP will detail the statutory requirements to be met throughout the life of the Project regarding the management of Aboriginal heritage.

The mitigation measures included within the CHMP will be comprehensive and entail a number of possible procedures that will include (but not be limited to):

- In the first instance, avoiding Indigenous cultural heritage, wherever practical;
- Carrying out further detailed field investigations including pre-clearance surveys;
- A site recording programme including accurately recording/updating the global position system (GPS) co-ordinates of sites for which GPS co-ordinates are not available or are inaccurate;
- A protocol for the development of site specific conservation plans, where pre-mining mitigation works are proposed, or where post-mining mitigation and conservation works are required and have been agreed by the Aboriginal party; and
- Collecting and relocating cultural heritage items, as agreed with the relevant Aboriginal parties.

Management measures during construction will include:

- Cultural heritage induction for the workforce and possible monitoring of specific construction activities;
- Procedures for unexpected finds; and
- A conflict resolution process.

Management measures will be of a scale commensurate with the Aboriginal heritage sites’ cultural significance. Following completion of the Project, cultural heritage items recovered prior to construction and objects identified and salvaged during construction may require management and safe-keeping.
6.12.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential cultural heritage impacts is summarised in Table 6.88. An analysis of initial risk, without mitigation, was considered for each potential impact. The residual risk considers the mitigation and management measures developed for Indigenous cultural heritage preservation, and put forward in this assessment.

Table 6.88 Qualitative risk assessment – Indigenous cultural heritage

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of physical cultural heritage as a result of land clearing – Cumulative Loss of cultural heritage objects</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Pre-clearance surveys&lt;br&gt;▪ Areas identified as having a cultural significance will be, where practicable, avoided&lt;br&gt;▪ Consult with relevant Aboriginal parties</td>
<td>Low</td>
</tr>
<tr>
<td>Loss of cultural knowledge, language and practices as a result of an inability to access places of cultural heritage significance to undertake hunting and cultural practices</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Prior to land clearing extensive knowledge will be gathered and documented on cultural practices in the area&lt;br&gt;▪ Areas identified as having a cultural significance will be, where practicable, avoided&lt;br&gt;▪ Consult with Aboriginal parties</td>
<td>Low</td>
</tr>
<tr>
<td>Unauthorised damage or theft to cultural heritage places and objects e.g. vehicles driving over shell middens</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Site inductions will incorporate areas of cultural significance&lt;br&gt;▪ Driving in these areas will be prohibited</td>
<td>Low</td>
</tr>
<tr>
<td>Introduced feral animals causing damage to cultural heritage sites</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Appropriate controls and management strategies will be adopted including fencing, where practicable, culturally significant sites</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.12.7 Summary

The assessment of Indigenous cultural heritage for the Project and the proposed management strategy has been designed to avoid and/or minimise any impacts to Indigenous cultural heritage. The assessment has included collating site data throughout the Project area from a range of sources including database searches, consultation with relevant Indigenous parties and field surveys.

Various potential and confirmed sites of Indigenous cultural heritage have been identified within the Project area and in locations within the broader Project area. Where practicable, infrastructure will generally be sited to avoid locations of Aboriginal cultural heritage. In instances where this cannot be avoided, measures to mitigate impacts will be undertaken with Aboriginal parties, in accordance with agreed processes within the CHMP.
Metro Mining commits to engagement and negotiations with the relevant Aboriginal parties and to develop and implement an approved CHMP with these parties. The CHMP will include procedures developed by the Aboriginal parties covering the management of cultural heritage sites and values. Metro Mining aims to promote an understanding of Aboriginal cultural heritage in the workplace through employee induction programs and other specific training activities.

6.12.8 Commitments

In relation to Indigenous cultural heritage management Metro Mining’s commitments are provided in Table 6-89.

Table 6-89 Commitments – Indigenous cultural heritage

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICH1</td>
<td>Continually engage and negotiate with Aboriginal parties.</td>
</tr>
<tr>
<td>ICH2</td>
<td>Develop and implement an approved Cultural Heritage Management Plan.</td>
</tr>
<tr>
<td>ICH3</td>
<td>Identify, assess and record undetected Indigenous heritage sites, including appropriate induction of relevant Project personnel.</td>
</tr>
<tr>
<td>ICH4</td>
<td>Undertake pre-construction cultural heritage surveys (including Indigenous and non-Indigenous).</td>
</tr>
</tbody>
</table>

6.13 Non-Indigenous Cultural Heritage

This section describes the existing environment and potential effects of construction and operation of the Project upon non-Indigenous (European) cultural heritage. It provides a context for assessing non-Indigenous cultural heritage and an overview of the framework in which Metro Mining will manage statutory obligations. In addition, this section proposes management measures that address potential development impacts in the Project area.

6.13.1 Regulatory Framework

In Queensland, both Commonwealth and state legislation protects non-Indigenous cultural heritage. Cultural heritage regulation at the Australian Government level is administered by DotE and at the State level by the Heritage Conservation Branch of DEHP. This section discusses the legislation that is relevant to non-Indigenous cultural heritage established in the following acts:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Cwlth);
- Australian Heritage Council Act 2003 (AHC Act) (Cwlth);
- Queensland Heritage Act 1992 (QH Act) (Qld); and
- National Trust of Queensland Act 1963 (NTQ Act) (Qld).

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government’s central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined in the EPBC Act as MNES. The EPBC Act provides for the National Heritage List and the Commonwealth Heritage List.

The National Heritage List provides protection for areas that demonstrate outstanding heritage value to the nation and the Commonwealth Heritage List provides for protection of areas that have significant values that are within Commonwealth land or waters. The criteria used for inclusion on
the National (and Commonwealth) Heritage List is outlined in Part 10 of the Environment Protection and Biodiversity Conservation Regulation 2000 (EPBC Regulation). The EPBC Act also provides protection for cultural heritage items and places on the World Heritage List.

**Australian Heritage Council Act 2003**

The AHC is the principal advisory body to the Australian Government for heritage matters established by the AHC Act. The AHC is responsible for administering the heritage registers created under the EPBC Act. It replaced the Australian Heritage Commission, the authority previously responsible for assisting the administration of Commonwealth Heritage legislation. The role of the AHC includes, but is not limited to:

- Assess cultural heritage items and places for inclusion in the Commonwealth Heritage List or National Heritage list;
- Advise the Minister about matters relating to the condition of places included in the Commonwealth Heritage List or National Heritage List;
- Advise the Minister about the Commonwealth’s responsibilities for historic shipwrecks;
- Promote identification, assessment, conversation and monitoring of heritage; and
- Keep the register of the National Estate.

The Australian Heritage Places Inventory is an online database maintained by DotE. It is a single point of access containing a summary of information about places listed in state, Territory and Commonwealth heritage registers and lists.

**Queensland Heritage Act 1992**

The QH Act provides specific provision to protect important non-Indigenous cultural heritage sites and initiated the formation of the Queensland Heritage Register. The Queensland Heritage Register is a record of Queensland heritage places and protected areas and, since amendments in 2008, also includes archaeological sites. Register entries include details of the boundaries of the area or place, its history, a description of its foundation and whether it is the subject of a heritage agreement. The QH Act deals only with non-Indigenous heritage places and those with joint Indigenous and non-Indigenous values.

Not all places and objects of heritage value are known prior to development of a project. This is particularly the case with archaeological sites, sometimes unearthed during construction. Section 89 of the QH Act requires that a person must advise the Chief Executive about any archaeological artefacts discovered that are considered an important source of information about an aspect of Queensland’s history. Once artefacts have been reported under the QH Act, it is an offence to interfere with them without approval.

Places of heritage significance are not always listed on the register, but may be known to members of the public. A place can be nominated for inclusion on the Queensland Heritage Register at any time. The Minister may issue a stop order to protect any place considered to be of cultural heritage significance from damage (entered within the register or not).

The Queensland Heritage Register is administered by the Queensland Heritage Council under provisions in the QH Act. The register contains approximately 1,600 places throughout Queensland that are of heritage significance to the State.
National Trust of Queensland Act 1963

The NTQ Act provides guidance of community feeling about the value of individual buildings, precincts, natural environment places or culturally significant artefacts. Despite being established by an Act of Parliament, listing on the Register of the Queensland National Trust provides no legal protection for places or buildings, or an obligation to owners to conserve these properties.

Local Government Legislation

Amendments to the QH Act, introduced in 2008, required local government agencies to establish registers of heritage places. A further amendment also provides for the integration of state and local government assessment and approval processes under the integrated development assessment system of the SP Act.

Under the QH Act local government authorities are required to establish and maintain a register of places of local cultural heritage significance and include policies for the protection of such places in their planning schemes.

6.13.2 Assessment Method

Desktop and Literature Review

Assessing and minimising the potential impacts of the Project development to non-Indigenous heritage values has been a two-staged process. The initial phase of this study was the collation of site information and the second stage involves an assessment as per the standard criteria listed below. The following sources were used:

- Online resources, principally for heritage site databases and regional history;
- Commonwealth Heritage lists (World Heritage List, National Heritage List, and Register of the National Estate) for sites of international and national significance;
- Australian National Shipwreck Database;
- The Queensland Heritage Register;
- Register of the National Trust of Queensland; and
- Data in heritage studies previously carried out in nearby areas.

Assessment

The approach to assessing non-Indigenous cultural heritage is broadly similar at local, regional, state and national levels. Standard criteria were used to identify the non-Indigenous cultural values of a place depending on the level of significance. The difference was a matter of threshold and if a place was significant at a local, regional, state or national level. The criteria for assessing non-Indigenous cultural heritage significance were:

- The place is important in demonstrating the evolution or pattern of history of a locality, region, state or Australia;
- The place demonstrates rare, uncommon or endangered aspects of cultural heritage of a locality, region, state or Australia;
- The place has potential to yield information that will contribute to an understanding of the history of a locality, region, state or Australia;
- The place is important in demonstrating the principal characteristics of a particular class of cultural places in a locality, region, state or Australia;
- The place is important because of its aesthetic significance in a locality, region, state or Australia;
- The place is important in demonstrating a high degree of creative or technical achievement at a particular period in a locality, region, state or Australia;
- The place has a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons in a locality, region, state or Australia; and
- The place has a special association with the life or work of a particular person, group or organisation of importance in the history of a locality, region, state or Australia.

Limitations

While register searches and literature reviews provide a small catalogue of sites the results of these searches cannot be construed as a comprehensive record of the non-Indigenous cultural heritage sites in the region. Site registers document unusual or important sites known to the community, or artefacts and areas identified during previous intensive cultural heritage clearances. Many parts of the study area have not yet been examined for traces of prior non-Indigenous activities, and despite the remote nature of the site further heritage aspects may be uncovered during site surveys. Identification of unrecorded non-Indigenous heritage resources within the Project area will be undertaken during yet to be completed dedicated field surveys immediately prior to construction. These will likely be coupled with statutory pre-construction Indigenous cultural heritage surveys.

6.13.3 Existing Environment

Australian Heritage Register Searches

A search of the Australian Heritage Place Inventory did not identify any listed areas within or in close proximity of the Project area. The closest locations listed in the Australian Heritage Database to the Project area are the Goods Island Lighthouse and Green Hill Fort on Thursday Island in the Torres Strait. These two locations are approximately 130 km north of the Project area. It is therefore anticipated that no site on the Australian Heritage Place Inventory will be impacted in any way by the construction or operation of the Project.

Australian National Shipwreck Database

Australia protects its shipwrecks and their associated relics that are older than 75 years through the Historic Shipwrecks Act 1976. Some Australian shipwrecks lie within protected or ‘no-entry’ zones, delivered through the Historic Shipwrecks Program. These zones may cover an area up to a radius of 800 m around a wreck site, and may be declared where circumstances place it at particular risk of interference (DotE 2015a).

A review of the Australian National Shipwreck Database indicates that there are no declared historical shipwrecks within, or in the vicinity of, the Project including the area for transshipping. The closest listed shipwreck to the proposed Project and transshipping area is the vessel ‘Fiji’. This ship was a schooner sailing vessel, recorded as being wrecked in 1887 in the Mapoon area approximately 35 km south of the Project MIA. The next closest recorded wreck is the vessel ‘Eileen’ which was a ketch sailing vessel, recorded as wrecked in 1914 (DotE 2015b). The shipwreck is
recorded as being approximately 34 km north of the proposed Project (DotE 2015b). Therefore, potential impacts on the sunken vessel are not anticipated from the Project.

**Queensland Heritage Register Searches**

A search of the Queensland Heritage Register was completed based on local government areas. The Cook Shire Council (location of the Project) and nearby council areas (Mapoon Aboriginal Shire, Napranum Aboriginal Shire and Aurukun Shire) were all searched. No places were identified within or in proximity of the Project area. The nearest listed site to the Project is located approximately 200 km east on Raine Island on the eastern side of Cape York in the outer Great Barrier Reef (listed as the Raine Island Beacon). It is therefore anticipated that the development of the Project will not cause any impact to sites listed as being of State heritage significance.

**Local Heritage Register**

The Project area is located within the Cook Shire Regional Council. No cultural heritage overlays are available for the Skardon River area under the current Cook Shire Regional Council Planning Scheme.

**Background Non-Indigenous (European) Heritage**

The first known European to encounter the Western Cape York was the Dutch explorer Willem Janszoon in 1606. Other Dutch and English explorers and traders impacted on the Western Cape region during the 17th and 18th centuries; however, European settlement did not widely occur until the mid-1800s. The Cape York Sustainable Futures association (2015) notes that the first influx of European settlement occurred in the 1860s and primarily consisted of pastoralists and miners. Prior to this European settlement in the area is expected to be sporadic and in low numbers.

European settlement brought with it displacement of Aboriginal people from their traditional lands. European-Aboriginal missions were settled at the mouths of some of the Cape York Peninsula’s main rivers (likely to include the Skardon River) and early reports note the movement of Indigenous people to non-Aboriginal camps and settlements (McConnel 1939:58). There are suggestions (see Powell, 2014) that a former mission (the Seven Rivers camp) was located south of the Skardon River. Powell (2014) noted that this is the location where The Hon. John Douglas and his party landed in 1891 during their journey to Port Musgrave to select a site suitable for a mission to Aborigines.

Although cattle were first introduced to Cape York Peninsula to provide fresh meat for the initial government endorsed European settlement of Somerset in 1864, under the supervision of Mr John Jardine, cattle numbers remained low until gold rushes at Cooktown and Coen brought new settlers to the area in 1870s (DotE 2015c). Cattle stations expanded over the following 20 years and in 1885 surveyor John Embley is reported to have completed surveys that set the boundaries of many pastoral leases (DotE 2015c). Most of the mining and historical pastoralist operations were located in the central and eastern areas of Cape York and activities on the western coast were predominately restricted to sparse cattle grazing.

Following the original gold rushes mining and the pastoral industry declined as did the number of settlers in the Cape York Peninsula (DotE 2015c). With the introduction of Brahman cattle in the 1950s, and a growth in overseas interest in Australian beef, the industry revived until beef prices dropped dramatically in 1974 (DotE 2015c). Although cattle numbers have fluctuated widely over time, pastoral leases still cover approximately half of all land on Cape York Peninsula. Large-scale bauxite mining at Weipa began in the early 1960s, and since then production levels have increased.
Naming of the Skardon River

The Skardon River [also referred to as Schardon, Scardon and Scarsden (Powell, 2014)] is associated with a broader area of Cape York Peninsula referred to as the ‘Seven Rivers’. The title Seven Rivers is used to distinguish a portion of the coast north of Port Musgrave (Mapoon) (Powell, 2014). The area is described by the linguist Terry Crowley, as ‘the very narrow coastal stretch from the northern side of Port Musgrave as far as the Doughboy River and also the inland area of Crystal Creek and the middle Jardine River’. Crowley (1983) identifies the seven watercourses associated with this area as the Jardine, Macdonald, Skardon, Doughboy, Ducie, Jackson and Crystal (Crowley 1983: 310).

In Northern Cape York Peninsula records, ‘Seven Rivers’ (or one of its variants) is associated with a watercourse named the ‘Skardon’. Powell (2014) notes, that according to R. Logan Jack (1921: 318) the river now named the ‘Dulhunty’ that joins the Ducie River, which debouches into Port Musgrave, was first named the ‘Skardon’ by the Jardine brothers Frank and Alexander during their 1865 overland trek from Carpentaria Downs to Somerset. Powell (2014) writes that ‘nowadays, this latter watercourse is sometimes referred to as the ‘Last River’ by Mapoon Mission residents because it is regarded as the last of the seven rivers passed by boats travelling from Thursday Island before they arrive at Mapoon. Powell (2014) argues that as the Jackson River is not represented in the early maps of the west coast of Northern Cape York Peninsula that the west coast was incompletely and/or incorrectly mapped. Consequently early references to the Skardon River potentially relate to two different watercourses.

Non-Indigenous Cultural Heritage Surveys

To date, field surveys of the overall Project area have not been undertaken by Metro Mining. Various surveys have been undertaken for ecology, soils and groundwater and these on-ground surveys have failed to identify any potential non-Indigenous items with the exception of the infrastructure from the discontinued Skardon Kaolin Project.

A cultural heritage survey of the Project area was undertaken by Yates and Quartermaine in March and May 1993 on behalf of Venture Exploration NL. The objective of the survey was to conduct an archaeological investigation to facilitate the planning of the Skardon Kaolin Project. This survey included a literature review and field surveys of the Skardon Kaolin Project area and although it was focused on Indigenous cultural heritage it provides relevant information for the non-Indigenous aspects.

Consultation was undertaken with various informants from the Mapoon Council and trustees of the deed of grant for the existing mining lease over the Project area. Yates and Quartermaine (1993) reported that little information was gleaned regarding the cultural significance and usage of the land as only two of the informants had any familiarity with the lands within the Project area.

Surveys were undertaken by archaeologists within the Project area, primarily focusing on potential indigenous cultural heritage sites. Visibility during the field survey was poor and limited the potential for discovery of cultural heritage material. Thick vegetation in the vicinity of the Skardon River and creeks and thick grass cover in the clearings hindered the effectiveness of the survey. Flooding in the area further hindered the survey limiting access to target areas. Apart from two possible Indigenous sites, no non-Indigenous historical or archaeological sites were discovered during the survey.

The prevailing vegetation coverage and restricted access may have limited the potential to find Indigenous and non-Indigenous sites. Yates and Quartermaine (1993) note though that given the low incidence of archaeological sites, it is probable that the limited survival of most cultural heritage
materials, together with the sparse nature of prehistoric and historic occupation of the Project area was largely responsible for the paucity of sites and material. Yates and Quartermaine (1993) conclude that there is a low probability for sites of archaeological significance to occur in the area.

A cultural heritage site survey was undertaken for the previously proposed Cape Alumina haul road development associated with the Pisolite Hills Project (Morrison and McNaughton 2009). Morrison and McNaughton (2009) identified one site of potential non-Indigenous significance. The site consisted of a low-density artefact scatter, primarily glass and metal fragments. The site covered an area of between 25-30m and included metal fragments that appeared to be from a vehicle and the bases of brown glass bottles. The scatter was within a few hundred metres from the southern portion of the Agnew Airstrip, approximately 35 km south of the Project area. This site is considered to likely post-date the 1950s, possibly aligning with the initial period of exploratory drilling in the area (Morrison and McNaughton 2009). Despite the distance of this site from the Project area, it identifies the type of non-Indigenous artefacts that are most likely to occur within the area.

6.13.4 Potential Impacts

The non-Indigenous cultural heritage assessment revealed that there were no known sites of non-Indigenous cultural heritage significance within or in the immediate vicinity of the Project area. There are suggestions (Powell, 2014) that an early European-Aboriginal mission (the former Seven Rivers camp) was located south of the Skardon River and McConnel (1939:58) implies that a mission in the area was likely at the mouth of the Skardon River, outside of the Project area. It is therefore anticipated that there will be no predictable adverse impacts on any sites of non-Indigenous cultural heritage as a result of the Project.

The existing infrastructure remaining from the disused kaolin mine is not considered of cultural heritage significance and the trustee of the site is currently removing the remaining disused industrial infrastructure. Therefore, there are not expected to be any impacts on historical mining infrastructure.

This study has focused on assessing places that have potential non-Indigenous cultural heritage significance. Despite the lack of listed sites within or in proximity of the Project area, there is still the potential for discovery of non-Indigenous artefacts during construction. The history of land suggests that significant archaeological finds are unlikely to be discovered; however, the possibility of a find cannot be completely discounted. Therefore potential impacts may occur on undiscovered sites of non-Indigenous cultural heritage significance to an extent that is unpredictable.

6.13.5 Management and Mitigation Measures

The QH Act contains provisions relating to the discovery of archaeological artefacts and the responsibilities of Metro Mining and the finder. Metro Mining will implement the following measures to manage potential impacts to non-indigenous cultural heritage:

- Undertake pre-construction cultural heritage surveys (including Indigenous and non-Indigenous);
- Develop and implement a procedure that aims to identify, assess and record undetected non-Indigenous cultural heritage sites during site works;
- Develop an appropriate plan that outlines the regulatory requirements of notifying authorities, documenting and handling of a site in the event that graves or potential human remains are discovered. This includes the requirements under the QH Act; and
- Ensure all construction personnel partake in an induction regarding non-Indigenous cultural heritage management and the procedures for dealing with a potential discovery.

Following completion of the Project, cultural heritage items recovered prior to construction and objects identified and salvaged during construction may require management and safe-keeping.

6.13.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential non-Indigenous cultural heritage impacts is summarised in Table 6-90. An analysis of initial risk, without mitigation, was considered for each potential impact. The residual risk considers the mitigation and management measures developed for cultural heritage preservation, and put forward in this assessment.

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Loss of physical non-Indigenous cultural heritage as a result of land clearing | Minor | Unlikely | Low | ▪ Pre-clearance surveys  
▪ Areas identified as having a cultural significance will be, where practicable, avoided  
▪ Visual observations and inspections (where required) during operation | Low |
| Unauthorised damage or theft to non-Indigenous cultural heritage places and objects e.g. clearing or pastoral relics | Minor | Unlikely | Low | ▪ Pre-clearance surveys  
▪ Site inductions will incorporate procedures to identify potential items of significance  
▪ Activities with potential to adversely impact items of significance (e.g. clearing) will be prohibited from areas without pre-clearance surveys | Low |
| Introduced feral animals causing damage to non-Indigenous cultural heritage sites | Minor | Unlikely | Low | ▪ Appropriate controls and management strategies will be adopted including fencing, where practicable, culturally significant sites | Low |

6.13.7 Summary

The assessment of non-Indigenous cultural heritage for the Project involved a review of publically available information, studies of the wider area and documentation from developments in the general vicinity of the Project. There are no listed non-Indigenous heritage sites in or within the vicinity of the Project area and separate studies of the site have failed to identify potential non-Indigenous cultural heritage items. The closest site listed on a National, State or local register is the wreck of the vessel ‘Fiji’, located approximately 30 km south of the Project area. European activity in the area has been limited and studies of the area suggest that any remaining non-Indigenous items of cultural heritage significance are likely to be related to missions, pastoralist or mining activities. Despite, the lack of known non-Indigenous cultural heritage site there is still the potential to
discover unknown sites during construction and operation. As such, management and mitigation measures will be implemented to identify any remaining items and, where necessary, appropriately deal with any discovery in accordance with the QH Act.

6.13.8 Commitments

In relation to non-Indigenous cultural heritage management Metro Mining’s commitments are provided in Table 6-91.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCH1</td>
<td>Include appropriate induction of relevant Project personnel.</td>
</tr>
</tbody>
</table>

6.14 Economic

This section summarises the economic impact assessment undertaken by Economic Associates. This includes the assessment method, relevant regulatory framework, existing environment, potential beneficial and adverse impacts and proposed mitigation measures to minimise impacts on the regional, state and national economies. The full economic technical assessment report is provided in Appendix L.

6.14.1 Regulatory Framework

There is no specific Commonwealth or state legislature or policy outlining the requirements of an economic impact assessment.

6.14.2 Assessment Method

The economic assessment included two main areas of investigation:

- A baseline study of the existing economic environment to identify the key social and economic characteristics of the assessment areas; and
- An economic impact assessment to outline the overall economics of the Project and assess the potential opportunities and constraints within the region.

The economic assessment also identified the economic contribution in terms of:

- Direct impacts - the first round of effects from direct operational expenditure on goods and services; and
- Indirect (flow-on) impacts - comprising of the second and subsequent round effects of increased purchases by suppliers in response to increased sales.

6.14.2.1 Scope of the Economic Study

Regional and local economic data was collected to develop economic models and inform the ‘base case’ (or baseline scenario) against which the Project’s impacts are assessed. The geographic scope of the local and regional economies is defined as:

- Local economy – Cape York SA2; and

6.14.2.2 Existing Economic Environment

Assessment of the existing economic environment, also referred to as the baseline assessment, was completed using existing data. The baseline economic data is used to develop a regional impact model to assess Project impacts.

In preparing the existing economic environment section, data was sourced from:

- Office of Economic and Statistical Research (OESR);
- Various local and Queensland government agencies; and
- Proprietary Economic Associates models.

Economic Contribution Assessment

The economic contribution assessment utilises a regional input-output approach, which provides indicative results relating to the total demand generated by the Project during construction and operational phases in terms of output, household incomes, employment and value added. The input-output approach shows the direct and indirect (flow-on) effects of one sector on other sectors and the general economy.

The assessment identifies the economic impacts specific to the Project, compared to what would be anticipated if the Project does not proceed (that is, the ‘base case’ scenario). Metro Mining provided indicative construction and operating costs for the Project as input to the estimation of the local, regional, state and national stimulus generated by the Project.

A discussion of the different measures of economic contribution is provided in Table 6-92.

Table 6-92 Measures of economic contribution

<table>
<thead>
<tr>
<th>Impact Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>The output impact measures the increase in gross sales throughout the entire economy by aggregating all individual transactions (direct and indirect) resulting from the economic stimulus. The output impact provides an indication of the degree of structural dependence between sectors of the economy. However, output impacts are regarded as overstating the impact on the economy as they count all goods and services used in one stage of production as an input to later stages of production, hence counting their contribution more than once.</td>
</tr>
<tr>
<td>Household Income</td>
<td>The household income impact measures the additional wages, salaries and supplements paid to households associated with the industry under consideration and with other industries benefiting from the stimulus to the economy.</td>
</tr>
<tr>
<td>Employment</td>
<td>The employment impact measures the number of full-time equivalent (FTE) positions for one year created directly and indirectly by the stimulus. However, the short-term response to increased demand may be that existing employees work overtime. Consequently, actual levels of employment generated (in terms of persons employed) will tend to be lower than those estimated by the input-output analysis. This short-term employment response (of working additional overtime) will be more prevalent where the demand stimulus is likely to be temporary and short lived, or where there is limited spare capacity in the economy (that is, when the economy is at or near full employment).</td>
</tr>
</tbody>
</table>
Value Added

The value added or Gross Regional Product (GRP) impact measures only the net activity at each stage of production resulting from a stimulus. GRP is defined as the addition of consumption, investment and government expenditure, plus net exports (exports minus imports) from a region. The value added (or GRP) impact is the preferred measure for the assessment of contribution to the economy from a stimulus or impact, and as such should be used to describe the net impact of the event. Value added is the measure of economic impact resulting from a stimulus that is preferred by economists.

Capital Expenditure

Capital expenditure is anticipated to occur over a three year period, amounting to a total of $48.5 million. Table 6-93 summarises the anticipated capital expenditure within the FNQ Region and the rest of Queensland for the Project between 2016 and 2018.

<table>
<thead>
<tr>
<th>Description</th>
<th>FNQ Queensland</th>
<th>Rest of Queensland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility and Owner Costs</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Mine Access (Haul Road)</td>
<td>$2.2</td>
<td>$0.0</td>
<td>$2.8</td>
</tr>
<tr>
<td>Mine Access (Haul Road Sustaining)</td>
<td>$0.0</td>
<td>$2.2</td>
<td>$0.0</td>
</tr>
<tr>
<td>Mine and Barge Loading Infrastructure</td>
<td>$8.5</td>
<td>$0.0</td>
<td>$10.6</td>
</tr>
<tr>
<td>Airport Upgrade</td>
<td>$0.8</td>
<td>$0.0</td>
<td>$1.0</td>
</tr>
<tr>
<td>Mine Camp</td>
<td>$3.2</td>
<td>$0.0</td>
<td>$4.0</td>
</tr>
<tr>
<td>Mining Equipment</td>
<td>$2.0</td>
<td>$0.0</td>
<td>$2.5</td>
</tr>
<tr>
<td>Insurance</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$1.0</td>
</tr>
<tr>
<td>Sustaining Capex</td>
<td>$0.0</td>
<td>$3.7</td>
<td>$3.7</td>
</tr>
<tr>
<td>Contingency</td>
<td>$2.8</td>
<td>$1.3</td>
<td>$5.5</td>
</tr>
<tr>
<td>Total</td>
<td>$19.5</td>
<td>$7.2</td>
<td>$27.4</td>
</tr>
</tbody>
</table>

6.14.3 Existing Economic Environment

The assessment of the economic environment of the region, Table 6-94, identified a number of underlying future or cross-sectional trends.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>$19.5</td>
<td>$7.2</td>
<td>$3.1</td>
<td>$7.9</td>
<td>$7.6</td>
<td>$3.3</td>
<td>$27.4</td>
<td>$14.8</td>
<td>$6.3</td>
</tr>
</tbody>
</table>

6.14.3 Existing Economic Environment

The assessment of the economic environment of the region, Table 6-94, identified a number of underlying future or cross-sectional trends.

Table 6-94 Underlying regional economic trends

Population

- Cape York SA2: population projected to increase at an average annual rate of 1.0% per annum between 2011 and 2036;
- FNQ Region: population projected to increase at an average rate of 1.5% per annum between 2011 and 2036;
- Projected average growth rate of population is lower in Cape York SA2 (1.0% per annum) than both FNQ Region (1.5% per annum) and Queensland (1.9% per annum); and
- Projected average growth rate of working age population anticipated to be significantly lower within all regions, with this trend most pronounced in the Cape York SA2.

Average Age of Residents

- At both the 2001 and 2011 Census, Cape York SA2 recorded an average age lower than the FNQ Region and Queensland;
- 37.5 years in Cape York SA2 as of the 2011 Census; and
- 38.2 years in FNQ Region as at the 2011 Census.

Age Profile

- Cape York SA2 recorded a higher incidence of working aged men relative to FNQ Region and Queensland; and
- FNQ Region recorded a similar incidence of working aged persons relative to Queensland.

Family Structure

- In 2011, lone person households were the most prevalent household type in Cape York SA2; and
- Most prevalent household type in the FNQ Region was couple families with children.

Household Income
Average household income in Cape York SA2 was significantly below the state average; 
Average household income in FNQ Region was significantly below the state average; and 
Cape York SA2 recorded the highest rate of growth in average household income between the 2006 and 2011 Censuses.

Labour Market Trends
• Unemployment rate in Cape York SA2 significantly higher than in the FNQ Region and Queensland; and 
• Labour force participation rate in Cape York SA2 significantly lower than in the FNQ Region and Queensland. 

Employment by Industry
• Just over a third of persons in Cape York SA2 were employed in the public administration and safety and health care and social assistance sectors as of the 2011 Census; and 
• The incidence of employment within the public administration and safety sector in Cape York SA2 was significantly higher than the FNQ Region and Queensland. 

Occupation Type
• Cape York SA2 recorded a significantly higher proportion of persons employed in lower blue collar occupations than the FNQ Region and Queensland. 

Qualifications
• Significantly lower proportions of people have a post school qualification in Cape York SA2 than the FNQ Region and Queensland. 

Enterprise Activity
• 352 registered businesses within Cape York SA2 as of June 2013, with construction and agriculture, forestry and fishing the most common business types; 
• Three construction businesses within Cape York SA2 employed 20-199 persons, with no registered businesses employing 200 or more persons; and 
• 23,606 registered businesses within the FNQ Region as of June 2013, with construction, agriculture, forestry and fishing and rental, hiring and real estate services the most common business types. 

Development Pipeline
• Three bauxite projects were identified within the FNQ Region, with the largest to produce 22.5 Mtpa, with the potential to increase to 50 Mtpa. 

Gross Regional Product
• $12,286 million in the FNQ Region in 2010-11 (4.5% of Queensland’s Gross State Product); 
• Growth in GRP between 2000 - 2001 and 2010- 2011 was significantly lower in the FNQ Region (6.3% per annum) than Queensland (8.8% per annum); and 
• Electricity, gas, water and waste services and health care and social assistance have been the key contributors to FNQ Region’s GRP growth. 

Agriculture
• Agricultural commodities produced within Cape York SA2 included maize, sorghum, rice, melons, macadamias, passionfruit and meat cattle; 
• Sugar cane and peanuts the key cropping commodities in the FNQ Region in terms of both volume and value of production; 
• Bananas the key fruit crop within the FNQ Region, accounting for the majority of Queensland production in terms of both volume and value of production; and 
• Cattle and calves the dominant livestock commodity in terms of value in both Cape York SA2 and the FNQ Region. 

6.14.4 Potential Impacts

The anticipated beneficial and adverse impacts associated with the construction and operation of the Project is outlined in Table 6-95. 

Table 6-95 Beneficial and adverse impacts

<table>
<thead>
<tr>
<th>Beneficial Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth product during the construction phase (short term) and operational phase (to a lesser extent, but longer term) of the Project flowing from direct and indirect impacts</td>
</tr>
<tr>
<td>Export revenue associated with the sale of bauxite, which in turn facilitate the payment of royalties to the Queensland Government in the order of $12 million/yr once the mine is fully operational</td>
</tr>
<tr>
<td>Potential small increase in the Cape York local population through the attraction of operational workers</td>
</tr>
<tr>
<td>Increased employment opportunities for Cape York residents including residents of indigenous communities</td>
</tr>
<tr>
<td>Opportunities for local Cape York and FNQ suppliers to support the construction and operation of the Project</td>
</tr>
</tbody>
</table>

Gross Regional Product
Adverse Impacts

- Opportunity cost of the Project in terms of lost ecosystem services
- Tightening of the local and regional labour market potentially resulting in increased labour costs
- Potential for skills shortages
- Potential localised inflation in the local Cape York housing market
- Potential localised inflation in Cape York commercial and industrial property markets
- Increased burden on Cape York infrastructure, particularly during the construction phase (e.g. barge landings and airstrips)

The assessment of the aforementioned impacts utilised a risk based assessment framework based on the anticipated interaction of probability and consequence of impacts occurring (refer to Section 6.14.6).

6.14.4.1 Economic Contribution

Construction Phase Contribution

The economic impact assessment found that during construction, the Project’s contribution to the FNQ Region and the rest of Queensland is estimated to peak in 2016. Table 6-96 summarises the contribution of the Project to the FNQ Region and rest of Queensland economy during the construction phase (2016-2018).

<table>
<thead>
<tr>
<th></th>
<th>FNQ Region</th>
<th></th>
<th>Rest of Queensland</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
<td>2017</td>
<td>2018</td>
<td>2016</td>
</tr>
<tr>
<td>Output ($M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$19.47</td>
<td>$7.18</td>
<td>$3.08</td>
<td>$7.93</td>
</tr>
<tr>
<td>Indirect</td>
<td>$7.61</td>
<td>$2.78</td>
<td>$1.19</td>
<td>$7.74</td>
</tr>
<tr>
<td>Total</td>
<td>$27.08</td>
<td>$9.96</td>
<td>$4.27</td>
<td>$15.67</td>
</tr>
<tr>
<td>Household Income ($M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$3.55</td>
<td>$1.39</td>
<td>$0.60</td>
<td>$1.61</td>
</tr>
<tr>
<td>Indirect</td>
<td>$1.78</td>
<td>$0.65</td>
<td>$0.28</td>
<td>$1.82</td>
</tr>
<tr>
<td>Total</td>
<td>$5.33</td>
<td>$2.04</td>
<td>$0.88</td>
<td>$3.43</td>
</tr>
<tr>
<td>Employment (FTEs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>29</td>
<td>9</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Indirect</td>
<td>27</td>
<td>10</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>19</td>
<td>8</td>
<td>38</td>
</tr>
<tr>
<td>Value Added ($M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$6.44</td>
<td>$2.51</td>
<td>$1.08</td>
<td>$2.76</td>
</tr>
<tr>
<td>Indirect</td>
<td>$3.03</td>
<td>$1.11</td>
<td>$0.47</td>
<td>$3.19</td>
</tr>
<tr>
<td>Total</td>
<td>$9.47</td>
<td>$3.62</td>
<td>$1.55</td>
<td>$5.95</td>
</tr>
</tbody>
</table>

Note: Estimates have been calculated and rounded by Economic Associates

Operational Phase Contribution

The Project is anticipated to operate over a 27 year period, with bauxite production anticipated to commence in 2016. A summary of the average annual contribution, during the operational phase of the Project, to the FNQ Region and rest of the Queensland economies is provided in Table 6-97.
Table 6-97 Summary of average annual operational phase (2016 – 2043) contribution

<table>
<thead>
<tr>
<th></th>
<th>FNQ Region</th>
<th>Rest of Queensland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output ($M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$29.98</td>
<td>$7.50</td>
</tr>
<tr>
<td>Indirect</td>
<td>$9.51</td>
<td>$6.27</td>
</tr>
<tr>
<td>Total</td>
<td>$39.49</td>
<td>$13.77</td>
</tr>
<tr>
<td>Household Income ($M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$6.32</td>
<td>$1.58</td>
</tr>
<tr>
<td>Indirect</td>
<td>$2.28</td>
<td>$1.45</td>
</tr>
<tr>
<td>Total</td>
<td>$8.59</td>
<td>$3.03</td>
</tr>
<tr>
<td>Employment (FTEs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>74</td>
<td>19</td>
</tr>
<tr>
<td>Indirect</td>
<td>34</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>39</td>
</tr>
<tr>
<td>Value Added ($M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$12.89</td>
<td>$3.22</td>
</tr>
<tr>
<td>Indirect</td>
<td>$4.06</td>
<td>$2.65</td>
</tr>
<tr>
<td>Total</td>
<td>$16.96</td>
<td>$5.88</td>
</tr>
</tbody>
</table>

Note: Estimates have been calculated and rounded by Economic Associates

The FNQ Region is anticipated to experience the most significant operational stimulus from the Project.

**Peak Output Contributions**

Output contributions are anticipated to peak over the 2020-2026 period for both the FNQ Region and the rest of Queensland. The peaking in the output contributions are in line and relate to the peaking in supply chain expenditures made during the operating period of the Project. During the 2020-2026 period, the peak output or consumption effects of the Project are estimated at:

- **FNQ Region**: total output or consumption contribution of $43.49 million, comprising direct contribution of $33.02 million and indirect contribution of $10.47 million; and
- **Rest of Queensland**: total output or consumption contribution of $15.16 million, comprising direct contribution of $8.25 million and indirect contribution of $6.91 million.

Within both the FNQ Region and Queensland, output effects are anticipated to be highest within the mining and transport, postal and warehousing sectors.

**Peak Household Income Contributions**

The FNQ Region is anticipated to experience the most significant operational stimulus from the Project. Household income contributions are anticipated to peak over the 2020-2026 period for both the FNQ Region and the rest of Queensland.

During the 2020-2026 period, the peak household income effects of the Project are estimated at:

- **FNQ Region**: total household income contribution of $9.46 million, comprising direct contribution of $6.95 million and indirect contribution of $2.51 million; and
- **Rest of Queensland**: total household income contribution of $3.34 million, comprising direct contribution of $1.74 million and indirect contribution of $1.60 million.

Within both the FNQ Region and Queensland, household income effects are anticipated to be highest within the mining sector and transport, postal and warehousing sectors.
Peak Employment (FTEs) Contributions

Employment impacts estimated as part of the regional impact modelling report FTEs, which represent a quantum of work (approximately 1,800 hours) within a given period.

The FNQ Region is anticipated to experience the most significant operational stimulus from the Project. Household income contributions are anticipated to peak over the 2020-2026 period for both the FNQ Region and the rest of Queensland.

During the 2020-2026 period, the peak employment effects of the Project are estimated at:

- FNQ Region: total employment contribution of 119 FTEs, comprising direct contribution of 82 FTEs and indirect contribution of 37 FTEs; and
- Rest of Queensland: total employment contribution of 43 FTEs, comprising direct contribution of 20 FTEs and indirect contribution of 23 FTEs.

Within both the FNQ Region and Queensland, employment effects are anticipated to be highest within the mining sector and transport, postal and warehousing sectors.

Peak Value Added Contributions

The FNQ Region is anticipated to experience the most significant operational stimulus from the Project. Value added contributions are anticipated to peak over the 2020-2026 period for both the FNQ Region and the rest of Queensland.

During the 2020-2026 period, the peak value added effects of the Project are estimated at:

- FNQ Region: total value added contribution of $18.68 million, comprising direct contribution of $14.20 million and indirect contribution of $4.48 million; and
- Rest of Queensland: total value added contribution of $6.47 million, comprising direct contribution of $3.55 million and indirect contribution of $2.92 million.

Within both the FNQ Region and Queensland, value added effects are anticipated to be highest within the mining sector and transport, postal and warehousing sectors.

6.14.4.2 Opportunity Cost of the Project

The opportunity cost of the Project is expected to be limited to the direct impacts on vegetation communities with the land currently not utilised for a significant economic purpose. The Project is anticipated to impact a range of vegetation communities. These impacts will occur as a result of both the construction and operational phases of the Project. Based on the expected Project footprint, it is estimated that the direct impact on vegetation communities is approximately $3.87 million/yr. This value has been established from the following:

- Impacts to woodland complexes: WorleyParsons (2013) estimates a number of ecosystem service values for forests, ranging from $1,160 per hectare per year (/ha/yr) to $2,150 /ha/yr. This study adopts a value representing the midpoint of the WorleyParsons values of $1,655 /ha/yr. With an expected clearance of 1,668.99 ha an annual value of $2.76 million in direct impact on vegetation communities is expected; and

- Impacts to wetlands: A study by Costanza et al. (1997) estimated a wetland value of $27,200 /ha/yr. Based on an expected 39.4 ha clearance Costanza et al. (1997) implies a direct impact of approximately $1.07 million/yr. The maximum impact on the indirectly impacted
areas is a complete loss of those areas as a result of the Project. As such, the maximum impact on those indirectly impacted wetland areas of 1.5 ha is $0.04 million.

6.14.5 Management and Mitigation Measures

Assessing or quantifying standards and indicators to be used in monitoring the effectiveness of mitigation strategies are difficult to establish, as economic indicators assess the performance of the economy as a whole. This section identifies management and mitigation measures to address the potential impacts in Section 6.14.3.

Increased Labour Costs and Skills Shortages

The Project will represent an incremental stimulus to an existing large scale bauxite and minerals mining sector in Cape York. Resource projects have the potential to draw skilled and semi-skilled labour from other sectors, particularly in labour markets that are experiencing low levels of unemployment and high levels of labour force participation. Whilst the recent downturn in the resources sector has resulted in a lightening of pressures to the labour markets in comparison to those significant pressures which occurred during the peak of the resources boom, it remains prudent for proponents establishing and operating new mines to mitigate possible effects to the local and regional labour markets. The following are a range of strategies that might be considered appropriate by Metro Mining:

- Work with the Queensland Government agencies, Queensland Resource Council, local government and other Cape York proponents to develop programs to assist local businesses retain workers and back fill any vacancies created as a result of the Project. Principally, these programs should seek to encourage locals to re-enter the workforce and upskill the unemployed or underemployed;
- Engage with Construction Skills Queensland to identify potential measures to increase the capacity of local job seekers to develop relevant skills for construction and mining; and
- Identify potential funding opportunities and training programs that local training providers can access to increase the available pool of skilled labour in the region.

Metro Mining’s involvement in facilitating these measures will be only secondary to the activities of other much larger resource proponents currently operating or planning to commence operations in Cape York.

Localised Inflation in the Local Housing Market

The Project has the potential to have some inflationary impact on local housing markets. Given the size of the Project, the priority to employ local (i.e. those that are in existing housing) and the likely dispersed origin locations of prospective workers, this impact will be minimal. Mitigation measures outlined below represent potential measures that are considered by Metro Mining to address potential housing related impacts; however, small the impacts may be.

- Establish a register of local accommodation providers and rental agents for the duration of construction and first two years of operation to be provided to all employees upon request;
- Identify opportunities for purpose built accommodation within close proximity to the Project site; and
- Develop a workers code of conduct for all non-resident workers employed during the construction phase.
Increased Burden on Local and Regional Infrastructure

The Project has the potential to contribute to the utilisation of local and regional infrastructure, predominantly barge landings and airstrips in Weipa. Considering the Project will be in a remote location, the existing barge landings and airstrip in Weipa will be subject to limited and infrequent use. It is anticipated that the Project will utilise, and upgrade if required, the existing Skardon River airstrip which is centrally located within the resource area and will construct a barge loading facility also within the resource area (see Section 6.15 and Section 0 for further details on the transport options). Therefore, impacts to existing infrastructure are likely to be localised and the impacts to community infrastructure, in Weipa, is anticipated to be minor.

6.14.6 Qualitative Risk Assessment

An assessment of the anticipated adverse economic impacts resulting from the Project and the proposed management and mitigation measures is provided in Table 6-98.

Table 6-98 Qualitative risk assessment - economic

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity cost of the Project</td>
<td>Moderate</td>
<td>Almost Certain</td>
<td>Extreme</td>
<td>▪ Refer to Section 6.6 – Terrestrial Ecology for management and mitigation measures to reduce potential impacts from vegetation clearing</td>
<td>Medium</td>
</tr>
<tr>
<td>The Project is anticipated to directly impact approximately 1,668.99 of vegetation communities. Indirect impacts are estimated for a further 1.5 ha of wetland complexes. This represents an economic value of approximately $3.87 million/yr, which in the context of the Project is significant.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in labour costs</td>
<td>Possible</td>
<td>Insignificant</td>
<td>Low</td>
<td>▪ Develop programs to assist local businesses retain workers and back fill any vacancies created as a result of the Project&lt;br&gt; ▪ Identify potential measures to increase the capacity of local job seekers to develop relevant skills for construction and mining&lt;br&gt; ▪ Identify potential funding opportunities and training programs that local training providers can access to increase the available pool of skilled labour in the region</td>
<td>Low</td>
</tr>
<tr>
<td>Based on workforce data there appears to be some significant latent capacity within Cape York and FNQ region with unemployment rates well above the Queensland average, with unemployment having recently risen. While there is a possibility that the Project will result in a tightening of labour market this will be a reversal of recent trends. As such, the impact of tightening will be significantly moderated by the extent of latent capacity present in Cape York and FNQ labour markets.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Potential Impacts

<table>
<thead>
<tr>
<th>Potential for skills shortage</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| The Project is likely to have only a modest demand for employment, although this employment demand is likely to be for relatively skilled labour. The Cape York and FNQ regions have had a long standing and mature bauxite mining sector. While the Project is likely to have a demand for skilled labour, there remains significant capacity within the local and regional labour markets to accommodate this demand, and there is also a well-established pool of workers experienced in the bauxite mining sector already within the region. | Unlikely | Insignificant | Low | ▪ Develop programs to assist local businesses retain workers and back fill any vacancies created as a result of the Project  
▪ Identify potential measures to increase the capacity of local job seekers to develop relevant skills for construction and mining  
▪ Identify potential funding opportunities and training programs that local training providers can access to increase the available pool of skilled labour in the region | Low |

<table>
<thead>
<tr>
<th>Localised inflation in housing market</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| With a modelled peak construction phase workforce of 56 FTEs within the Cape York region and an ongoing operational employment demand within the Cape York region of approximately 60 workers the potential for the Project to have a material impact on the Cape York housing market is limited. The mine is isolated from existing major settlements, but any locally domiciled workforce will fly out of Weipa. As much of the housing in Weipa is controlled by Rio Tinto Alcan, there is a possibility that workers choosing to base themselves in Weipa may face some challenges in accessing housing. | Possible | Minor | Medium | ▪ Establish a register of local accommodation providers and rental agents for the duration of construction and first two years of operation to be provided to all employees upon request  
▪ Identify opportunities for purpose built accommodation within close proximity to the Project site  
▪ Develop a workers code of conduct for all non-resident workers employed during the construction phase | Low |
### Potential Impacts

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Localised inflation in commercial and industrial property market</strong></td>
<td>Possible</td>
<td>Insignificant</td>
<td>Low</td>
<td>▪ Identify opportunities for purpose built accommodation within close proximity to the Project site</td>
<td>Low</td>
</tr>
<tr>
<td>The Project will generate some business opportunities for suppliers located within Cape York and the broader FNQ Region, and has some limited potential to attract new entrants to the Cape York and FNQ market. These opportunities may generate increased demand for commercial and industrial land. However, this impact is likely to be moderated to some extent by latent site capacity of suppliers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Increased burden on local and regional infrastructure</strong></td>
<td>Possible</td>
<td>Minor</td>
<td>Medium</td>
<td>▪ Workers will either be barged from Mapoon or flown from Weipa or Cairns. Hence local infrastructure impacts will be limited to barge landing and airstrips, which have significant capacity to accommodate further expansion</td>
<td>Low</td>
</tr>
<tr>
<td>The Project will possibly impose additional burden on the local and regional infrastructure network. However, the majority of inputs will be supplied by barge from Weipa or Cairns and landed at Skardon River.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.14.7 Summary

The economic impact assessment of the Project involved a review of publically available information including government surveys of the local and regional area and literature. Both negative and positive impacts were identified and it has been concluded that the Project will provide an employment opportunity for locals and Indigenous communities and has the potential to generate flow on effects including improved local and regional services. Management and mitigation measures will be implemented to ensure no adverse economic impacts result from the Project’s construction and operational activities. Overall it is anticipated that with an operational life of 27 years, the Project will provide substantial economic and social benefits to the regional community.

### 6.14.8 Commitments

In relation to addressing potential economic impact Metro Mining’s commitments are provided in Table 6-99.

**Table 6-99 Commitments – economic**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Employ 105 people, with preference for locals.</td>
</tr>
<tr>
<td>E2</td>
<td>Seek to utilise local businesses where possible.</td>
</tr>
</tbody>
</table>
6.15 Transport (Air and Land)

This section provides a summary of the land and air transport aspects of the Project. The impacts associated with transport are assessed along with mitigation and management measures. The transport assessment, undertaken by TTM (Appendix M), is limited to road and air transport and does not include shipping as this is addressed in Section 0.

6.15.1 Regulatory Framework

The key legislation relevant to the assessment and management of transport infrastructure is the Transport Infrastructure Act 1994 (TI Act).

Transport Infrastructure Act 1994

The TI Act provides for and encourages effective integrated planning and efficient management of transport infrastructure including roads, general rail, ports, air, public marine transport, bus ways and light rail. The main objectives of the TI Act are to:

- Allow the government to have a strategic overview of the transport system;
- Allow for effective planning and management of a system of state and national roads; and
- Provide adequate safety and community access to transport networks.

6.15.2 Assessment Method

The following tasks were undertaken as part of the transport (air and road) assessment (refer to Appendix M for the technical report):

- Review of the key access routes to be used during construction and operation;
- Review of the Project generated road and air transport volumes, distribution and composition and throughputs;
- Review of the Project transport impact on both the public transport network and State Controlled transport networks; and
- Review of any upgrades to mitigate the overall Project transport impact.

As there is expected to be only very infrequent and minimal use of the state and council controlled road network, and there are no new or alterations to public road infrastructure proposed no assessment against the Department of Transport and Main Roads (DTMR) Guidelines for Assessment of Road Impacts for Development (2006a) or the DTMR Road Planning and Design Manual (2006b) has been included in this assessment.

6.15.3 Existing Environment

6.15.3.1 Existing and Planned Road Transport and Haul Road Operations

There are no new or alterations to public road infrastructure proposed during the construction and operational phases of the Project. There will be very limited external council or state road network use to access the Project area. Use of the current road network in Weipa is expected to be extremely limited and is likely to be light vehicles only associated with personnel movements and obtaining
supplies. Given the infrequent and minor nature of the use it is expected that the current level of service of the existing public road network will be maintained.

The Project site is remote and difficult to get to by the existing road network once off the Peninsula Development Road (PDR). Conservatively it is expected that it will take approximately a day to travel between Weipa and the Project area by light vehicle. The existing track leading off the PDR is unsealed, not maintained and only suitable for use by 4WD during the dry season. Furthermore, approval is required, from Rio Tinto Alcan, to use the sections of the track that cross their existing mining leases.

The development of the road network within the Project area will commence in 2016. During the first year it is proposed for 7 km of haul roads to be constructed for mining at the BH6 - Pit 1. As the mining progresses each year, further development of the haul roads will be required including the provision of culvert structures.

It is estimated that an additional 7 km of haul road construction will occur in 2017 and 3 km in 2018, and thus providing access throughout the proposed mining area.

The bauxite material will be hauled to the ROM stockpile using Road Train trucks. It is proposed for dual lane surface haul roads and in-pit ramps which will be designed to suit the dump truck size capacity, being 130 t (Power Trans T1250 Road Train Double). In-pit ramps will be designed for a 30 m width, with the surface haul roads including haulage access to waste dumps and the ROM to be 40 m in width, as to allow for adequate drainage.

6.15.3.2 Existing and Planned Air Transport Operations

The following airstrips are located in the vicinity of the Project:

- Agnew airstrip, which is approximately 20 km to the south east;
- Mapoon airstrip, which is located on the southern bank of the Ducie River; and
- Skardon River airstrip, which is centrally located within the resource area.

It is currently proposed to use the Skardon River airstrip, which is centrally located within the resource area, and reach a shared operating agreement with the existing airstrip operator, with the intention that this airstrip will service the mine site throughout the life of the Project. It is intended that the Project will utilise this existing facility to support fly-in fly-out (FIFO) operations for staff transport to and from site. The existing runway is in reasonably good condition and as noted, the existing facilities may be upgraded if required. If a new airstrip or significant addition to the existing airstrip is required in the future, appropriate approvals would be sought at the time.

The Skardon River airstrip will be utilised to transport both construction and operational work forces by charter flights, from both Weipa and Cairns. The anticipated number of flights for the construction and operations phases are shown in Table 6-100.

**Table 6-100 Air transport (construction and operation)**

<table>
<thead>
<tr>
<th>Air Transport</th>
<th>At 1.95 Mtpa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction – Flights (Weipa and Cairns)</td>
<td>10 flights per week (in-bound)</td>
</tr>
<tr>
<td>Operation – Flights (Weipa and Cairns)</td>
<td>3 flights per week (in-bound)</td>
</tr>
</tbody>
</table>

There is also the possibility of using the Cooktown Airport with a charter flight into Skardon; however, this will depend on the workforce location.
Weipa airport is located 13 km south east of Weipa and is managed by Aerodrome Management Services on behalf of Rio Tinto Alcan. QantasLink and Skytrains both service the airport and Oceania manage the ground handling activities on their behalf. In 2014, there were 34,000 arrivals and 33,000 departures through the airport. There were approximately 2,560 in-bound flights during 2014 averaging approximately 49 arrivals per week or seven arrivals per day over the year.

Cairns airport carried a total of 343,000 passengers in March 2015 with 3,630 flights and approximately 114 flights per day both in and outbound. Consequently it is unlikely that the Bauxite Hills Project will negatively impact existing and planned capacities at these airports.

6.15.3.3 Planned Waste Material Operations

A summary of the waste disposal opportunities is provided in Table 6-85 and are shown in Figure 6-39. These waste facilities are suggestions and waste disposal facilities will be at the discretion of the Project licensed contractor.

In the first instance, Metro Mining will look to barge wastes to the Rio Tinto Alcan Landfill Facility at Weipa. Should this not be available, Metro Mining will seek to barge wastes to various facilities located at Cairns and/or Townsville. Additional opportunities exist to barge wastes to Karumba and then truck waste to Mount Isa for disposal.

In addition to the above transport options, Metro Mining is looking at the opportunity trial pyrolytic treatment of wastes as it will significant reduce waste streams requiring transportation off site. A further benefit of the pyrolytic process is that it will enable the recovery of various by-products (i.e. hydrocarbons, electricity) for use on site.

6.15.3.4 Project Decommissioning

The Project will have an operational life span, 27 years, after which it may be decommissioned. As part of the decommissioning process, it is expected that there will be some minor impacts, with materials likely to be removed from site by barge with only minor use of existing road network and will require several operations, including:

- Removal of any hazardous material;
- Decommissioning of buildings and structures onsite;
- Removal of waste material;
- Potential environmental actions; and
- Removal of plant and machinery from site.

6.15.4 Potential Impacts

6.15.4.1 Road Transport Impacts

The Project area is not serviced by a road network and is only accessible during the dry season by 4WD from the PDR. Metro Mining does not intend to use the existing track connecting the Project area and the PDR to service the Project.

The following provides a summary of the key road transport aspects:
• No new road infrastructure, external to the Project area, will be required to support either the Project construction or operational phases;

• No new, or alterations to, public road infrastructure proposed during the construction and operational phases of the Project;

• Use of the current road network in Weipa is expected to be extremely limited and is likely to be limited to light vehicles associated with personnel movements and obtaining supplies; and

• Given the infrequent and minor nature of the use of the existing road network in Weipa it is expected that the current level of service of the existing public road network will be maintained.

Given the above, significant impacts to existing road transport activities are not anticipated.

6.15.4.2 Air Transport Impacts

Metro Mining proposes to operate flights via the Skardon River airstrip, during construction and operation phases, from both Weipa and Cairns and potentially Cooktown airports. The current pavement supports services by smaller commuter airliners such as the twin-turboprop Embraer EMB 120 Brasilia. It is anticipated that these classifications of aircraft will be used for the flights into and out of the existing airstrip.

It is envisaged that there will be minor increases in the passenger use of Cairns airport during the operational phase. This equates to a minor increase at Weipa and a significant increase at the infrequently used Skardon River airstrip. The Project may also utilise if needed the existing Qantas flights from Cairns to Weipa which has 16 flights per week service; however, the preference is to utilise dedicated charter services.

As such, the Project will have no significant impacts upon the state or Commonwealth controlled and privately operated airports and no change to any airport infrastructure is required.

6.15.5 Management and Mitigation Measures

Metro Mining will develop standard operating procedures to cover transport related activities, including marine, air and road transport. The procedures will be developed in conjunction with both council and DTMR (if required) and will consider any other planned infrastructure works in the area.

As part of the preparation of the procedures potential site access hazards and risks related to the Projects construction and operation will be reviewed and identified. This will address the transport of hazardous substances for the Project activities which will comply with specific Australian Codes for Transport of Dangerous Goods.

6.15.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential impacts related to the different modes of transport is summarised in Table 6-101. An analysis of initial risk, without mitigation, was considered for each technical element. The residual risk considers the mitigation and management measures developed for transport, and put forward in this assessment.
6.15.7 Summary

The transport assessment (refer to Appendix M), for the Project has considered both the construction and operational phases.

The main modes of transport that will be used during all Project phases (construction, operation and decommissioning) will be by marine and air modes of travel. The use of any public roads will be very infrequent as barge and air modes of transport will be the predominate mechanisms serving the development. As such the road service network is unlikely to be impacted and no road improvements will be required. It is expected that there will be traffic generated from the mining activity; however, this will be contained within the mining lease area. In relation to air activities and travel, there will be no reduction in the level of service throughput at the airports due to the anticipated low level of worker demands and that Metro Mining will charter private flights for FIFO employees.

Based on the assessment provided in this report, there are no transport planning or engineering reasons why the proposed Project should not proceed as planned.

6.15.8 Commitments

In relation to the management of air and road transport activities Metro Mining's commitments are provided in Table 6-102.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Develop and implement the General Operational Management Plan.</td>
</tr>
<tr>
<td>T2</td>
<td>Transport hazardous substances in accordance with specific Australian Codes for Transport of Dangerous Goods.</td>
</tr>
<tr>
<td>T3</td>
<td>Upgrade existing air infrastructure if there is an operational requirement to do so</td>
</tr>
</tbody>
</table>
6.16 Transport (Shipping)

This section provides an assessment of the shipping infrastructure, proposed upgrades and predicted movements of shipping to and from the Project. The potential impacts associated with shipping, in the Gulf of Carpentaria and region in general, are assessed along with mitigation and management measures. The shipping technical report, undertaken by PGM Environment, is located in Appendix N. This section is a summary of the PGM Environment findings and the technical report should be read in conjunction with this section.

6.16.1 Regulatory Framework

The key legislation and guidelines relevant to the assessment and management of shipping are:

- **Transport Operations (Marine Pollution) Act 1995** [Transport Operations (Marine Pollution) Act];
- Port of Skardon River Port Rules;
- International Convention for the Prevention of Pollution from Ships (MARPOL);
- Australian Maritime Safety Authority and Maritime Safety Queensland; and

**Transport Operations (Marine Pollution) Act 1995**

The Transport Operations (Marine Pollution) Act protects Queensland’s marine and coastal environment by minimising deliberate and negligent discharges of ship-sourced pollutants into coastal waters. This aim is achieved by giving effect to relevant provisions of the annexes of MARPOL 1978 Protocol. This protocol was developed from the 1973 International Convention for the Prevention of Pollution from Ships which addresses pollution by oil, noxious liquid substances in bulk harmful substances in packaged form, sewage and garbage.

**Port of Skardon River Port Rules**

The Port of Skardon River has specific rules governing the conduct of developments and operational activities within the designated port boundaries (Figure 6-40). These are presented in the Port of Skardon River Port Rules. Of specific relevance to this proposal, the Port Rules stipulate requirements for the submission and approval of applications for developments within the port area designate pilotage requirements and impose controls on fuel handling activities.

The Designated Pilotage Area (Figure 6-40) requires that:

- All vessels that are 50 m or more in length which are proceeding within this designated area must either carry a licensed marine pilot or be under the command of a master who holds a pilotage exemption certificate for the area.

Metro Mining will abide by these rules in the development and operation of the proposed activities detailed herein. Note that the proposed anchorage area is outside of the port boundaries. This anchorage also occurs in Commonwealth waters (i.e. beyond 3 nautical miles (nm) from the territorial baseline); as opposed to the Queensland state waters and internal waters (the Skardon River itself) within which the port exists.
**International Convention for the Prevention of Pollution from Ships**

MARPOL is the main international convention that addresses the prevention and pollution of the marine environment caused by ships. Under this international convention, no deliberate waste disposal discharges or emissions (e.g. garbage, hold washings, untreated sewage, and untreated oily wastes) are permitted from ships.

'Garbage' as defined by MARPOL includes a broad range of operational waste from vessels, including cargo residues. Under the terms of MARPOL, the discharge of cargo residues through deck and hold washings cannot occur unless the residue is classed as non-hazardous and non-polluting and the vessel is at least 12 nm from nearest land.
**Australian Maritime Safety Authority and Maritime Safety Queensland**

The AMSA and MSQ delivers an internationally developed regime of rules intended to limit the risks of ship engineering and navigation malady. These rules span elements such as ship design and survey, crew competencies, crew fatigue management, 'rules of the road' (in essence, vessel traffic rules) and lights and other devices intended to limit the risk of collision.

**Australian Ballast Water Management Requirements – Version 5**

Australia has implemented ballast water management regulations under the *Quarantine Act 1908* (Cwlth) (due to be replaced), essentially as an extended interim measure until such time as the *International Convention for the Control and Management of Ships’ Ballast Water and Sediments 2004* (the BWM Convention) ballast water treatment requirements enter into force internationally. Under the Australian ballast water management requirements, all ballast water arriving in Australia from overseas is considered 'high risk' and so banned from discharge in Australian waters until specific permission for such discharge is received from the DoA, the responsible authority. In general terms, ships are required to undertake ballast water exchange at sea, such that water taken up from shallow, coastal or littoral waters overseas is replaced with water sourced from the open ocean, considered less likely to harbour marine species of potential quarantine concern. To be considered effective, the ballast water exchange must be conducted outside Australia’s 12 nm limit.

### 6.16.2 Assessment Method

A desktop review was undertaken to identify the shipping risk elements associated with the proposed Project export facilities and operations. This assessment underpins the later development of an associated shipping management plan, for both construction and operational phases.

### 6.16.3 Existing Environment

#### 6.16.3.1 Anticipated Ship Movements

The barges will be moved by tug to the offshore anchorage approximately 12 km offshore from the river mouth in waters round 10 m deep or more. Here the ore will be transferred onto self-loading ships, expected to be of Panamax size (average cargo capacity of around 70,000 t). A small wheel loader (i.e. 'Bobcat' or similar) will operate on the barge to push up the product for the ships’ grabs. At this juncture in the Project the number of barges (and tugs) required has not been determined.

The Project will have a planned production capacity, and hence ship loading throughput, of 1.95 Mtpa with a project life of approximately 27 years. Each ship loading could be undertaken 24 hours per day, seven days a week with a loading rate up to 1,000 tonnes per hour (t/hr). It is expected that around four days to six days will normally be required for each ship load, and that around 30 ship visits will occur in any given year. This suggests around 500 (4,000 t barge) to 1,000 (2,000 t barge) (loaded) barge movements per operational year, and assumes around six tug/barge movements out and six in for each day of ship loading operations. Operations will be seasonally-influenced to avoid any production during the wet season. This will limit operational activities at the mine site to nine months per year (nominally March to November). It is anticipated that ship

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4 No more than around 230 m in length, but limited in beam to 32 m and draught to 12 m in order to permit passage through current Panama Canal locks (before their expansion).
loading will extend slightly longer than this period, although no activity is anticipated between December to February.

The development will involve the construction and fit-out of the barge loading jetty, and associated dolphins (i.e. mooring pylons) for the berthing of the barges. Although yet to be determined at the time of preparation of this report, it is anticipated a number of cyclone moorings will also be established at suitable sites both outside the mouth of and within the Skardon River. These moorings will be used when the barges are not in use (i.e. between ship loads), during the wet season hiatus in operations, and during cyclone warning periods. It is expected that the tugs will return to another nearby port during the wet season.

Ships will not refuel while loading at Skardon River, and as ‘dumb’ barges, the barges will have no need for fuel. Tugs will be refuelled via a pipeline along the conveyor structure to a storage farm from self-bunded containers. These will be retained at a small vessel maintenance facility to be established near the barge loading facility within the MIA. The maintenance facility would be centred upon two 20' ISO containers, or similar, in a small cleared area.

### 6.16.3.2 West Cape York Commonwealth Marine Reserve

The West Cape York Commonwealth Marine Reserve (the Reserve) is located to the west northwest of the Skardon River mouth. The Reserve extends from the boundary of Queensland waters adjacent to the northern end of the Cape York Peninsula and north-west to the edge of Australia's Exclusive Economic Zone (EEZ). The Reserve includes Special Purpose and Multiple Use Zones. Also included is a Marine National Park Zone; however, this is approximately 80 km from the mouth of the Skardon River (Figure 6-41) (DotE, 2013).

The barges moving to anchored bauxite carriers will transit through both State and Commonwealth waters. These activities will occur outside of the Marine Reserve (see Figure 6-42). Passage of the bauxite carriers to and from the transshipment location may include transiting of the Marine National Park Zone. Vessel transit is a permitted activity for all three zones (Marine Reserve, Special Purpose and Multiple Use).
PROPOSED ANCHORAGE LOCATIONS IN RELATION TO MARINE RESERVE

Legend
- Shipping Route
- Watercourse
- Transhipment option
- Limit of Coastal Waters
- Project Area
- Camp Site
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Pit Extents
- Mine Lease Area

West Cape York Commonwealth Marine Reserve
- Multiple Use Zone
- Special Purpose Zone

DATA SOURCE
- MEC Mining; 1sSRTM v1.0 Geoscience Australia 2011; Australian Government, Department of the Environment; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

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GCS GDA 1994 MGA Zone 54

Scale @ A3 - 1:90,800

FIGURE 6-42

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15/07/15

METRO MINING LIMITED

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6.16.4 Potential Impacts

6.16.4.1 Routine Discharges, Emissions and Activities

Vessels underway or at anchor will act as the source for a range of unavoidable emissions, such as engine exhaust gases, biocide leachate from anti-fouling coatings (AFCs), effluent from sewage treatment plants and oily water filtering systems, and radiated underwater noise, as depicted in Figure 6-43.

Figure 6-43 Summary of routine and unavoidable discharges and emissions from ships

Unless a vessel is badly maintained and/or operated and represents a significant departure from the certification and performance requirements of the applicable classification society and national regulatory authorities, none of the standard, essentially unavoidable vessel emissions, such as engine exhausts and AFC biocide leachate, is likely to occasion any substantive environmental harm.

6.16.4.2 Routine Navigation and Pilotage

Routine navigation and pilotage, as represented by vessels and barges transiting to and from the Skardon River loading area, presents no substantive environmental risk. The use of pilots, or suitably qualified masters, familiar with the area is intended to limit the risk of navigation area, with resultant decrease in the likelihood of occurrence of grounding or collision. Note that the intended ship anchorage and transshipment area is external to the compulsory pilotage area. Vessels operating within the Skardon River present a latent threat which will typically manifest in the event of fauna strike, collision, grounding, or possibly in the event of other maritime casualty such as onboard fire. These are all 'atypical', events, and thus are not indicative of 'routine' shipping activities.
6.16.4.3 Refuelling and Oil Transfer

OGVs will not be required to refuel as a result of the Project given their capacity to hold large fuel tanks on-board. As such fuel spill from OGVs are considered unlikely.

Small vessels, such as harbor crafts, will require regular refuelling as part of normal operating procedures. Refuelling of small vessel will typically be conducted at the vessels home port or at the Project’s barge loading facility. Accidental fuel and oil spills related to small vessel refuelling can have impacts on the marine environment as well as marine fauna. The risk of a spill associated with general refuelling operations associated with the project is considered low. This relates to the lower quantities of fuel involved, the more controlled conditions in which these transfers will occur (e.g. while the harbour vessel is alongside the barge loading jetty in sheltered waters).

Refuelling incidents are one of the more common causes of loss of oil to the marine environment. Oil spill risks are mitigated by the provision of various risk reduction and response measures, such as the use of oil containment booms and the onsite availability of spill containment and clean-up equipment, as well as oil spill contingency plans.

6.16.4.4 Garbage

Garbage is generated in vessels as an inevitable consequence of routine maintenance of the vessel and the sustenance of those onboard (i.e. crew). The disposal of garbage to sea from vessels is prohibited at all times except for food waste disposal when the ship is not at anchor. Existing regulations for the management of vessel generated garbage will be followed and as such should not present any tangible risk of harm to the environment.

6.16.4.5 Cargo Loading/Unloading, Residues and Hold Washings

Cargo residues are generated from the loading of excess material, spillage, and residues generated during unloading. Many cargoes, particularly those that carry dry bulk commodities such as bauxite, invariably generate dust and may result in spillages or windage losses during loading and unloading. Bauxite occurs naturally in the geological formations around Skardon River and is considered to be essentially environmentally benign (NQBP, 2009). It is recognised that in areas of concentration, such as around loading berths, the accumulation of loading-related sediments may have adverse effects on benthic organisms. Any such adverse effects around the loading facility in Skardon River are purely speculative and not considered likely. It is intended; however, that Metro Mining will monitor for build-up of bauxite and will remove excess accumulation as part of ongoing maintenance.

6.16.4.6 Sewage

Under MARPOL and associated national regulations, vessels are not permitted to dispose of sewage to the sea either while at anchor or within 12 nm of nearest land. Disposal to sea is only permitted following processing in an International Maritime Organization (IMO) approved shipboard sewage treatment plant. Furthermore, any liquid waste stream that is mixed with sewage, such as greywater, is to be treated as sewage. In the event of effluent treatment discharge outside of the 12 nm limit, impacts will be temporary because of the small quantities involved (approximately 12 L per person per day from a crew of around 25 to 30 typical of a Panamax ship), rapid dilution in the sea, high biodegradability and low environmental persistence of the wastes. Demand for key nutrient elements such as nitrogen may be so high that bio-available forms (ammonium and nitrate) are recycled on time scales ranging from minutes to hours.
The OGV loading offshore from the mouth of the Skardon River would be expected to be equipped with appropriate sewage treatment plant. The locally operating vessels will be fitted with sullage tanks for the collection and holding of sewage before transfer to shore-based processing and disposal facilities, or otherwise disposed to sea after onboard treatment at a distance of greater than 12 nm from nearest land (Transshipment Services Australia 2015a). Given the small inputs of only processed wastewater from vessels off Skardon River, any impacts associated with sewage discharge is anticipated to be highly localised and transient.

### 6.16.4.7 Greywater

Greywater is defined (e.g. AMSA 2012) as drainage water from dishwashers, sinks, showers, laundries, baths and washbasins. It does not include drainage from toilets or urinals or sickbay/medical areas, nor does it include dishwater where dishes and utensils have not been pre-cleaned of at least most food debris. A typical OGV with a crew of around 20 would be expected to generate around 3 m³ to 5 m³ of greywater each day. Small harbour craft, such as tugs, generate lesser amounts of greywater owing to the smaller crews, and hence lower rate of use, of living and catering facilities (e.g. galleys, showers) onboard.

Some, albeit limited, polluting potential is possessed by greywater. This is generally restricted to the soaps and detergents used in washing, as well as any of the residues removed during the wash process and transported with the greywater to the marine environment; these would include organic matter, fats and greases and nutrients.

No controls are currently placed upon greywater discharges by MARPOL or Australian legislation, although many vessels treat greywater in their sewage treatment plants. By extension, discharge effluent standards applying to treated sewage also apply to greywater treated in shipboard sewage plants. Note; however, that the locally operating vessels will be fitted with sullage tanks for the collection and holding of greywater before discharge to sea when greater than 12 nm from nearest land (Transshipment Services Australia 2015a).

Even without any treatment, and even if released instantaneously in water only 10 m deep, for example, a 5 m³ discharge of greywater would be diluted to around 0.0004% within less than 200 m from the point of discharge. Given the low rate of input in the context of the dilution and dispersion which would be afforded by the water movement inherent to that location, no substantive adverse effects should be anticipated from the discharge of greywater from ships while anchored off Skardon River.

### 6.16.4.8 Oily Waste

Bulk oil wastes and sludges are generally stored onboard and transferred to appropriate shore reception facilities in a suitably equipped port, or disposed of onboard by incineration. Only filtered water, with an oil-in-water content of less than 15 parts per million, is permitted to be discharged to sea while a vessel is underway (i.e. not while at anchor). Small vessels (less than 400 gross tonnage) also have the option of retaining oily wastes onboard for disposal onshore.

Under existing MARPOL requirements, as reflected in the associated national legislation, no substantive oil or oily water pollution of the sea should result from vessels with correctly installed and properly maintained and operated oily waste management systems. Thus, no discernible oil pollution should occur at Skardon River from vessels which observe these regulations.
6.16.4.9 Fuel Storage

OGVs carry a range of fuel oils, principally HFO for propulsion engines and lighter distillate fuels (i.e. diesel) for auxiliaries. It is usual for Panamax ships to have maximum HFO bunker fuel capacities in the order of around 4,000 m$^3$, supplemented by distillate fuel capacities of the order of 200 m$^3$ or more.

In larger ships, individual tanks may have capacities of several thousand cubic metres, presenting the possibility of the loss of this quantity of fuel should such a tank be full or near full at a time when its containment was breached. Thus, in the event of the hull being damaged any fuel tank in that location may be breached.

Ships delivered from 1 August 2010 onward are required to have smaller tanks and to incorporate suitable hull/tank separation distances or other design features intended to limit the likelihood or extent of fuel loss on the event of collision or grounding. These improvements will take around 15 years or more to become 'the norm'.

6.16.4.10 Air Emissions

Powered vessels emit exhaust gases and particulates from propulsion machinery and auxiliaries as fuel is consumed. Other emission sources include incinerators (if fitted) and engines (small diesels and outboard motors) in ship's boats. Atmospheric emissions include pollutants and GHGs. Principal emissions of interest are: oxides of nitrogen (pollutant and GHG); Volatile Organic Compounds (VOCs; pollutant and GHG); sulphur dioxide (pollutant); carbon dioxide (GHG); carbon monoxide (pollutant and GHG); and particulates (pollutant).

GHGs generated by vessels in the Skardon River region will not, in isolation, pose any specific local or regional environmental threat. Further discussion regarding GHGs can be found at section 6-9 Air Quality.

Nitrogen oxides (NO$_x$) produced by ships are recognised at regional scales as an atmospheric pollutant of concern in areas with significant levels of shipping activity and within an airshed with elevated NO$_x$ loads. The IMO has imposed regulations intended to reduce vessel NO$_x$ emissions. Ships will normally only run minimal power systems while at anchor (as necessary for essential services such as lighting, ventilation, pumps and to operate cranes). It is reasonable to assume that given the predicted levels of vessel activity associated with the Project, vessel-sourced NO$_x$ (and other atmospheric contaminants) are unlikely to represent a significant pollutant.

6.16.4.11 Terrestrial Quarantine Management

Vessels are a recognised vector for the transfer of organisms which may pose terrestrial quarantine risks. These include vertebrate and invertebrate animals, plants and pathogens, which may be conveyed in the vessel itself, the cargo, or via garbage and cargo residues (e.g. wooden crates, pallets and shoring). The DoA is responsible for the imposition of Australian border biosecurity arrangements. The DoA Seaports Program has well developed protocols and procedures applying to vessels arriving in Australia from overseas, including compulsory pre-arrival pratique declarations.

For Skardon River, ship-sourced terrestrial quarantine risks should be considered to be somewhat limited compared to most ports by virtue of the distance from shore that the ships will anchor (approximately 12km from the mouth of the Skardon River). Noting this, it may be assumed that ships arriving at Skardon River from overseas are unlikely to pose an unacceptable level of terrestrial quarantine risks, with these risks appropriately managed by standard DoA protocols.
Vessels arriving at Skardon River from other Australian ports are unlikely to represent any specific quarantine hazard, assuming that they had already been accorded 'coastal status' by Australian quarantine authorities. This will include the domestic movements of barges carrying materials from Cairns and Weipa.

### 6.16.4.12 Ballast Water

Australia is sensitive to the risks posed by invasive marine species (IMS), as they represent major ecological, economic and social risks.

Ballast water is able to act as a vector for marine organisms when pest species are entrained in the ballast, able to survive the intervening voyage, and then successfully establish in the new environment after discharge from the conveying vessel. Dependent upon where and how the vessel loads ballast, the ballast water may also include sediments and sludges, which can also act as a vehicle for the transfer of exotic species. A feature of OGV operations is the use of significant quantities of ballast water, primarily as a cargo substitute for those ships arriving (empty) to take on cargo at a terminal. By extension, OGVs loading bauxite offshore of the mouth of the Skardon River individually and collectively will discharge notable quantities of ballast water.

As part of a national surveillance program, Skardon River was surveyed for IMS in 2008. No listed IMS were detected in this survey, although as occurs almost universally in ports around Australia, a number of (non-invasive) cosmopolitan and cryptogenic species were identified, such as the common fouling barnacles the striped barnacle (*Balanus amphitrite*) and the reticulated barnacle (*Balanus reticulatus*) (Aquenal, 2008).

All ships loading at Skardon River will be required to adhere to Australian ballast water regulations.

The Skardon River anchorage area consists of muddy bottom, presenting minimal amenable habitat for many of the IMS listed by Australian authorities. Nevertheless, it is held that anthropogenic materials, especially soon after placement into the marine environment, can provide vacant habitat for 'pioneering' species, and thus presents a period of vulnerability to colonisation by exotic biota. In the case of the Project, this new anthropogenic habitat will be confined to the piles of the loader facility. The vulnerability of these piles to recruitment of exotic marine species will diminish; however, as such vacant substrate is taken up by other (native) fouling species.

### 6.16.4.13 Biofouling

Along with other IMS transport vectors, such as ballast water, biofouling is a quarantine concern because of the risk that a vessel or other object is carrying fouling and may act as the means of transport for a potential marine pest species into Australian waters, or between different regions within Australia. Not all fouling species represent a biosecurity threat, and given the millions of movements of vessels over many hundreds of years, many fouling species have already established broad geographic distributions (i.e. the 'cosmopolitan' and 'cryptogenic' species). Some fouling species; however, do pose significant quarantine risks to Australia and potentially to Skardon River.

All vessels have some degree of biofouling, even those which may have been recently cleaned or had a new AFC applied. In general terms, the longer a vessel has been in water, the greater the size and complexity of its biofouling community.

In essence, the biofouling which may be found on and in a vessel represents a cumulative and integrated history of the vessel’s design, construction, maintenance and operations. Each of these aspects introduces particular biofouling vulnerabilities.
By contrast, non-trading vessels, particularly those such as types typically engaged in port and coastal development projects, are considered by DoA to represent high biofouling-mediated risks. In recognition of these elevated biofouling risks, vessels of this type are usually subject to specific biofouling cleaning and inspection requirements as an enforceable condition in order to work on marine and coastal projects in Australian waters, as is expected to be the case for any such vessels engaged in the Project development and maintenance activities.

Harbour craft, such as tugs and barges, may become excessively fouled if operating cycles are interspersed with extended periods of inactivity. This level of fouling will not represent any marine biosecurity threat if the subject vessel remained in the same location, as the fouling assemblage will represent locally available species. Thus, there will be no translocation potential should any of the locally-sourced biota be a marine invasive species. Some degree of risk will arise; however, in the case of a fouled harbour craft arriving at Skardon River from some other, distant location.

6.16.4.14 Anti-Fouling Systems

Vessels are painted with an AFC as a means to reduce the incidence and extent of fouling on their immersed surfaces. Apart from the beneficial effects of an AFC, such coatings also improve vessel's hydrodynamic efficiency, which results in lower fuel consumption compared with a (more heavily) fouled hull, lower emission rates of atmospheric pollutants, and a reduction of radiated in-water noise.

Aside from their operational and environmental benefits, the biocides in AFCs can occasion adverse environmental effects. Biocide-based AFCs rely upon toxic agents to kill and deter biota from settling and establishing on the protected surface. It is axiomatic, therefore, that the active agents in these AFCs are toxic to marine life. There has also been a focus on the potential for accumulation in the sediments and water column of copper and associated biocides, and the subsequent potential for movement within the trophic strata via bioaccumulation and biomagnification in marine biota.

AFC biocide release rates from the vessels (including the OGVs, tugs and barges) in use both at the transshipment locations outside the mouth of the Skardon River and the small craft transiting between the barge load out facilities to the transshipment locations, will in most cases represent the slower, steady release rates of mature coatings expected from vessels not within the first month or so out of drydock with a fresh AFC application. It is also pertinent to note that the release rate from most AFCs is linked to the velocity of water over the surface, such that for vessels at anchor, biocide release rates are reduced compared with vessels underway and are largely a function of the velocity of tides and currents in the anchorage.

Vessels also release biocide when AFCs are removed from the vessel, as may occur from anchor cable abrasion, or rubbing against berths and fenders. In these circumstances, biocide-active paint portions are released to the marine environment. These settle onto and into the sediments and may be expected to release biocide until either depleted or sufficiently buried.

Not all copper leached from vessel AFCs is available as a toxicant once it has entered the marine environment. Copper is the most bioavailable and most toxic when in its free ion form. Copper in its free ion form; however, has a strong tendency to form organic and inorganic ligands, reducing its bioavailability, mobility and ecological toxicity. Due to this, much of the influx is partitioned into less environmentally immobile, and essentially inert, organically-bound copper (Arai et al., 2010). This accumulates in the sediments but does not present as any specific form of marine toxicant. Any potential environmental effects of copper which did accumulate in the sediments will be further attenuated by chemical speciation and its partitioning into less mobile forms.
**6.16.4.15 Anchoring**

OGVs routinely anchor off ports while awaiting entry or loading. Vessels typically anchor in areas of soft sediments (e.g. mud and sand), as these provide the best holding ground. Such areas are normally depauperate in biota, except for infauna, and the depths required for ship anchoring are often beyond the depths where most seagrasses occur.

Anchoring of vessels has a direct physical impact on the seafloor, but the area affected for each anchoring event is restricted to the fall of the anchor and that length of cable which lies on the seafloor. Damage may result from both the laying and recovery of anchors. The anchor itself will only disturb a few square metres, although the cable (i.e. chain) may be up to 100 m or more on the seafloor, dependent upon depth and sea conditions. Anchor impact will be exacerbated by movement of the vessel on the anchor line, such as through ‘swinging’ on the anchor under the influence of wind, tides and currents or, less often, dragging of the anchor and cable.

Movement of the anchor and cable results in a segment of the seafloor being scoured of benthic organisms and suspension of bottom sediments, especially of soft, unconstituted sediments. The associated turbidity will temporarily decrease light penetration and the ultimate settling of the sediment could also smother benthic biota (Lewis, 1996). Suspended matter will settle or disperse rapidly, and any direct or secondary impacts upon biota will be of limited significance given the general dearth of biota in soft sediments.

Physical disturbance can alter redox potential (i.e. the measure of the tendency of a chemical species to acquire electrons and thereby be reduced) and release toxins otherwise bound in the sediments (Lewis, 1996). This will only likely be the case in any substantive sense with contaminated sediments where toxicants are bound in sedimentary material, such as near long-standing industrial outfalls, the mouth of a polluted river or in the vicinity of a shipyard.

Permanent changes in the physical nature or flora of the habitat may also affect the structure and viability of the marine community through various mechanisms such as varying the suitability of the habitat to a particular species, removing or introducing new habitat niches, selective removal of specific food sources, or increasing the risks of predation (Lewis, 1996). Any permanent change from anchoring in soft sediments will in most cases be insignificant compared to disturbance occasioned by natural forces such as currents, swells and storms.

The extent of physical disturbance, attributable to anchoring, varies dependent upon water depth, substratum type, type and size of anchor, length of cable, vessel size, weather and sea conditions. Upon removal of the anchor and cable, any depressions in soft sediments typically fill with sediment. Ultimately, the imprints are likely to return to pre-disturbance levels and faunal structures (i.e. community structure), but the recovery rate may vary depending on the substratum type.

Impacts on benthic epifauna and infauna are generally of a temporary nature, although there may be a localised inconsequential change in benthic biota at the point of impact if the nature of the substrate is permanently changed (e.g. from rock to sand, or if seagrass beds are scoured).

As outlined in Section 6.16.4.14, scraping and abrasion of vessel hulls by anchor cables removes AFC with active biocide constituents and introduces these paint bodies into the sediments of an anchorage. This may invariably result in some localised nodes of contamination, but is probably not significant, given that such abrasion generally only occurs at the time of laying and recovery of an anchor, and during wind and sea conditions resulting in a vessel laying slack and/or crossing almost directly over the cable, rather than laying off with some tension on the cable as is the usual pattern.
Any affects from anchoring of the OGVs offshore of the mouth of the Skardon River are likely to be transitory and of limited consequence in individual vessels, but will be concentrated in relative terms within the anchorage. While scouring and smothering from anchors and cables may become evident, the expected relatively large size of the anchorage suggest any effects will be ameliorated by spatial spreading and recovery periods between ship movements.

With respect to other existing or potential users of anchorages, such as fishermen, pleasure craft and working vessels, in most instances there is no impediment to co-existent use of the subject sea area provided maritime safety requirements and rules of navigation are applied. Vessels periodically lose anchors and cables in anchorages, the existence of which pose snag hazards for bottom trawl gear, thus potentially alienating an anchorage, or ports of it, from ongoing use as a bottom trawl area.

6.16.4.16 Radiated Underwater Noise

Large ships generate noise, from the use of their propellers, engines, auxiliary machinery, gear boxes and shafts, plus hull wake and turbulence. Surface shipping is generally considered to represent the most widespread source of low frequency (i.e. < 1,000 Hz) marine anthropogenic noise (e.g. Richardson et al., 1998, Popper et al., 1998). Small vessels also generate underwater noise, generally of higher frequency and of less intensity than larger ships. Unlike ship sounds, noises emanating from small boats and harbour craft are localised and concentrated upon port areas and coastal margins, and reflect the operational cycle and tempo of activity of the port.

Characteristic sound source levels of a range of vessel types, both small and large, are compared in Table 6-103.

Table 6-103 Comparison of in-water sound source levels (URS 2008)

<table>
<thead>
<tr>
<th>Source</th>
<th>Peak frequency or band</th>
<th>Peak source level/s (re 1 μPa 1 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large tankers and OGVs</td>
<td>10-30 Hz</td>
<td>180-186 dB</td>
</tr>
<tr>
<td>Tug towing barge</td>
<td>1,000-5,000 Hz</td>
<td>145-171 dB</td>
</tr>
</tbody>
</table>

The actual level of traffic-induced background noise depends on the number, size and distribution of ships underway within the particular sea or oceanic area, plus their individual source levels and the prevailing oceanic acoustic propagation conditions. In open sea areas, the combined effect of a sufficient number of ships within 500 km to 1,000 km can make a significant contribution to ambient oceanic noise levels. This effect is only observed in relatively busy shipping regions, which as noted by Cato (2000) have only been found in Australian waters in the Tasman Sea off the New South Wales (NSW) coast. Such effects are unlikely to be found in the Gulf of Carpentaria, due to both the limited nature of the shipping activity and the comparatively shallow waters and muddy bottom, limiting long-range acoustic propagation.

Localised low frequency broadband noise from shipping is of potential concern as it may impede use of the acoustic spectrum by sensitive or vulnerable marine fauna, particularly whales. This concern centres upon the possibility that such noise may: mask echolocation vocalisations or communications; acoustically mask predators or prey; lead to separation of calves from mothers; or if intense and localised, alienate the animals from preferred aggregation areas or migration pathways. The United Nations Environment Programme (2012) indicated that ship-generated noise may influence other biological and ecological processes such as fish aggregation and coral spawning. An overview of the hearing acuity of potentially sensitive marine fauna in relation to vessel noise, obtained from URS (2006) is presented in Table 6-104.
Table 6-104 Functional hearing ranges of marine animals (potentially) in the Skardon River region

<table>
<thead>
<tr>
<th>Taxonomic Group</th>
<th>Functional Hearing Range (kHz)</th>
<th>Ship Radiated Noise Detectable (&lt; 1 kHz)</th>
<th>Small Vessel Radiated Noise Detectable (0.5 - 5 kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharks (including sawfish)</td>
<td>0.1-0.8</td>
<td>Yes</td>
<td>Marginal</td>
</tr>
<tr>
<td>Fish</td>
<td>0.05-2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Turtles</td>
<td>0.2-1</td>
<td>Yes</td>
<td>Marginal</td>
</tr>
<tr>
<td>Dugongs</td>
<td>1-18</td>
<td>Marginal</td>
<td>Marginal</td>
</tr>
<tr>
<td>Minke whale</td>
<td>0.6-20</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bryde’s whale</td>
<td>0.2 – 20</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>0.8-160; best 5 - 80</td>
<td>Marginal</td>
<td>Yes</td>
</tr>
<tr>
<td>Indo-Pacific humpback dolphin</td>
<td>0.8-160; best 5 – 80</td>
<td>Marginal</td>
<td>Yes</td>
</tr>
<tr>
<td>Australian snub-fin dolphin</td>
<td>0.8-160; best 5 – 80</td>
<td>Marginal</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1 Assumed

It is evident from Table 6-104 that a variety of marine fauna species, inhabiting the Gulf of Carpentaria region, are capable of hearing vessel-generated noise. Whether vessel noise is detectable; however, does not necessarily indicate that it presents a problem, be it nuisance, distraction or intrusion, for marine fauna. It is pertinent to note that many species of dolphins, for instance, voluntarily swim in the bow waves and wakes of vessels, the latter being generally where the most intense noise field occurs.

It is conceivable, at least hypothetically, that numbers of vessels in the Skardon River region may at some time represent some form of acoustic interference to sensitive marine fauna. This is; however, likely to be of only local, and hence intermittent and transitory concern due to physical acoustic propagation conditions within the Gulf region and low levels of vessel activity. Unlike deep, ocean basins where vessel-generated noises can travel extended distances and add cumulatively to ambient background levels, the relatively shallow, confined waters and muddy bottoms of the waters around Skardon River do not permit such extended propagation. This essentially limits noise effects in any location to what may be audible as sourced from vessels in the near field, thus limiting the number of vessels contributing, and the longevity of their individual influences, at any particular time.

Any broad field effects of shipping noise will be further attenuated as a result of the elevated natural background levels typical of coastal and littoral areas. These include noises from wind and swells, as well as biological sources such as fish choruses and snapping shrimps.

Vessels at anchor present localised, stationary sources of noise. This is unlikely to be significant; however, noting that the major sources of vessel-generated noise (i.e. main propulsion machinery, propeller noise, hull flow noise and wake) are not operative while a vessel is at anchor. The only active sources while at anchor are the vessel’s auxiliary machinery (e.g. pumps and diesel generators), as well as transient sources such as anchor laying and recovery.

Vessel noise at Skardon River will be intermittent, localised and periodic, reflecting the hours of operation and tempo of activity within the port area. As with ships visiting the port, any in-water noise from small vessel operations at Skardon River, including tugs and barges, is considered unlikely to have any tangible, adverse environmental effects. This assessment is consistent with the conclusion derived for the nearby and similar SoE bauxite mining and export project, including in the context of protected sawfish (Rio Tinto Alcan, 2011)
6.16.4.17  Wash and Wake Effects

No specific, widespread concern is evident in the literature in relation to slow, deep draught vessels such as OGVs, in comparison with high speed vessels. This is likely because ships such as these typically move at slow speeds while moving through port areas. To this end, tugs and barges transiting to and from the Skardon River may be considered unlikely to generate any wake or wash effect of environmental significance.

OGVs moving around the Skardon River anchorage will likely generate turbidity plumes. These are transient, localised events and any adverse effects need to be considered in the context of the natural turbidity levels existing in these waters.

6.16.4.18  Vessel Lighting

Vessels at anchor overnight display two or three white lights of relatively low intensity. Vessels also shine masthead obstruction lights, have floodlighting and washlighting (i.e. subdued, low angle lighting) on upperdeck areas to permit safe working and movement at night, and radiate light through scuttles from internal living and working areas. In addition to compulsory lighting, the Convention on the International Regulations for Preventing Collisions at Sea 1972 (COLREGs) also encourage vessels to have additional upperdeck lighting switched on in order to promote visual detection of a vessel.

When anchored close inshore to turtle nesting beaches (i.e. closer than the planned 12 km for this Project) vessel lighting may pose some risk of confusion to turtles, as they rely upon light for navigation. Nesting and newly hatched turtles head toward the lightest horizon in their endeavours to reach the sea (noting that in natural conditions land areas are darker than sea areas). Thus lights on vessels will not disorient turtles as will lights further inshore or on the beach. Lights on vessels may cause some confusion to turtles in the water, as they have been observed to swim towards vessel lights and then commence circling around them. The risk to turtles presented by the lighting of vessels at anchor is expected to be limited. This conclusion is premised upon the fact that the lighting is approximately 12 km offshore (and not on or behind the beach) and the subdued lighting patterns characteristic of vessels.

Given its location of approximately 12 km offshore, the anchorage at Skardon Point is not expected to be located within close proximity to turtle nesting beaches. As a result of the distances involved, the lights of vessels at anchor offshore of the Skardon River mouth are arguably unlikely to present any particular impost upon turtles. Separate analysis of the barge loading and mooring facilities indicates that these are similarly located such that light interference of turtles is unlikely (PaCE 2015).

6.16.4.19  Abnormal Events

It is reiterated that in most circumstances, routine vessel operations present no substantive environmental risk to the sea. This section discusses atypical events and their attendant environmental risks.

Grounding

Vessel grounding can occur in a number of scenarios, while the vessel is either under power or drifting. Groundings are usually attributed to factors such as navigation error, uncharted underwater hazard (e.g. rock or shoal), dynamic bathymetry (e.g. unstable mud banks), propulsion or steering failure, or dragging of the anchor.
Grounding may cause significant, and possibly irreversible, damage to substratum and benthic biota, particularly if the grounding occurs on a reef and the episode may result in a 'scar' which may take decades to regenerate, if ever. The damage potential from grounding may be compounded by any biocide release from an AFC (e.g. copper based systems), which may be scraped from the hull, although this is unlikely to be of any real consequence beyond the limited area of impact.

Aside from damage to the substrate, significant environmental harm is only likely to eventuate in the event that a vessel's hull is breached, and especially so if this results in the loss of fuel oil or some other liquid or soluble pollutant. Grounding may also introduce debris into the marine environment, from vessel structure and fittings broken loose following impact, as well as lost cargo.

Should a spill occur in within or near Skardon River, dependent upon wind, wave and current conditions, the oil could come ashore onto reefs, rocks, beaches, mangroves or tidal flats. Any adverse environmental impact will be exacerbated in areas sensitive to oil spills, such as mangroves and coral. A risk also exists of impact upon commercially important fisheries, but this is only likely to occur following substantial spill.

There is no record of ships grounding in the Port of Skardon River. It may be considered that the open, relatively deep anchorage, essentially free of obstruction or other hazard, limits the risk of ship grounding. In a periodic review and update of oil spill risk assessments in Queensland ports for the Queensland Coastal Contingency Action Plan (QCCAP), MSQ (2014) concluded that Skardon River is an area of 'low risk' in terms of ship-sourced oil spills. Based upon MSQ's assessment of risk, oil spill containment and clean-up equipment is held at Skardon River for immediate response, with further stocks and equipment at Weipa. MSQ periodically reviews oil spill risks, so it is reasonable to assume that the Skardon River risk level will be reviewed at some time following commencement of Metro Mining's operations, with the QCCAP amended as warranted.

There is potential that a barge may ground at Skardon River, following a break in the tow or moorings, or in the event of dragging an anchor. 'Dumb' barges will not hold any oil, negating this as an environmental risk. Given the generally muddy and sandy bottoms in the area, it is plausible that barge grounding may have no significant or persistent adverse environmental effects, except in the event that reef, seagrasses or mangroves are damaged.

**Collision**

Collision is an ever-present risk for shipping, particularly in confined waterways such as channels, restricted transit lanes, passages and harbours. Given the open waters and low numbers of ships involved, the Metro Mining bauxite export activities are unlikely to generate any tangible ship collision risks.

It should be expected; however, that tugs and barges will periodically be subject to heavy contact, both between themselves and with ships being loaded. These 'bumps and scrapes' are a normal part of port operations. As such, it should be considered unlikely that these, more or less routine, periodic impacts will result in any substantive environmental hazard, unless a ship fuel tank is breached.

**Marine Fauna Strike**

No particular vessel strike risk is considered to be present for shipping and local harbour craft around Skardon River in the case of marine mammals, noting that it is not recognised as any specific whale aggregation site or dugong grazing area (PaCE, 2015). Some risk of vessel strike may exist for dugongs and turtles, but given that the tugs, barges and OGVs will all be moving at relatively slow speed, and the relatively low level of activity, it may be considered that the likelihood of strike will be minimal.
6.16.5 Management and Mitigation Measures

Under international, national and Queensland regulations, shipping which will operate in conjunction with the development and operation of bauxite export activities, is subject to specific controls generally intended to prevent marine pollution, and also to limit the risk of collision and grounding.

There are established measures, supported by the allocation of appropriate resources, to enable timely and effective response in the event of environmental harm, either actual or potential. Many of these policies, procedures and facilities apply to Australia in general, while some are specific to Queensland.

The primary shipping management strategies, systems and/or regulations in place at Skardon River include the following:

- Marine pollution prevention equipment and procedures;
- Oil and chemical spill response;
- Crew training and competencies;
- Compulsory pilotage;
- Vessel navigation safety and collision avoidance measures; and
- Charting and navigation aids.

Marine Pollution Prevention Equipment and Procedures

As detailed elsewhere in this review, ships and other smaller vessels are subject to a range of regulations governing design features, mandatory equipment fits, procedures for waste treatment and disposal, and mandatory record keeping. These variously cover domains such as oil and oily wastes, noxious and harmful substances, sewage, garbage and atmospheric emissions, as well as allied matters such as ballast water and anti-fouling biocides. These rules are generally derived from internal conventions, which are then enacted and given regulatory force through national and other legislative instruments. As such, Australian legislation, and the equivalent Queensland statutes, closely mirror the international standards agreed to through IMO processes.

Oil and Chemical Spill Response

Standing arrangements for dealing in an effective, expeditious manner to any oil or chemical spill in the Gulf region exists under the Australian National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances (i.e. ‘the National Plan’). The National Plan links with Queensland State-wide and regional measures. These include First-Strike Response Plans for individual Queensland ports and key marine areas, as well as the Queensland Oiled Wildlife Response Plan.

Oil and chemical spill management contingency measures are provided by both Commonwealth and Queensland agencies. First strike response equipment is located at Skardon River and Weipa, with additional, more extensive oil and chemical spill response assets pre-positioned at a number of ports in north Queensland, including Thursday Island, Cairns and Townsville.
Crew Training and Competencies

Safe navigation is founded upon competent, suitably trained and properly rested crews operating their vessels in accordance with accepted practices and responding to emergencies or potential critical incidents in a timely and effective manner. These are broadly defined as the 'human element', and pivot upon issues of individual and collective training, competency, responsible behaviour, coordination, fatigue management and supervision and leadership.

Ships’ crews are required to demonstrate compliance with international, national and state standards regulations, as applicable. These rules address various issues including:

- Mandatory technical competencies and proficiencies;
- Leadership and teamwork skills for officers;
- Training record books;
- Ongoing and refresher training, and the maintenance of standards;
- Medical fitness standards;
- Prevention of unsafe alcohol use; and
- Fatigue management.

Compulsory Pilotage

Pilotage involves the engagement of a suitably experienced and appropriately qualified and licensed senior mariner possessing expert knowledge of local conditions and ship handling, to assist ship Masters in the navigation of vessels in confined waters. Designated vessels transiting within the declared Pilotage Area of Skardon River are required to have a port pilot onboard when navigating within designated port pilotage limits.

Vessel Navigation Safety and Collision Avoidance Measures

The IMO has developed the COLREGs which focus on minimising the likelihood of collisions between vessels at sea via the establishment of a framework of ship traffic regulations, commonly referred to as 'rules of the road'. These are augmented for conditions where collision presents a greater risk of occurrence, including situations such as confined waterways, areas subject to heavy ship traffic, periods of reduced visibility, and vessels difficult to manoeuvre. COLREGs have been enacted into Australian maritime law.

In addition to rules of vessel passage, COLREGs also stipulate a range of complementary requirements intended to minimise the likelihood of vessel collisions. Key to these are the rules delineating the lights, shapes and sound devices, and sound and light signals, to be used by ships to avoid collisions, depending upon ship type, activity engaged in and prevailing conditions.

Charting and Navigation Aids

Fundamental to safe navigation is the provision of accurate nautical charts and the survey of safe routes. This is the responsibility of the Australian Hydrographic Service (AHS), within the Royal Australian Navy. The AHS is responsible for maritime survey and charting in the Australian Charting Area, for both military and civil requirements. The Royal Australian Navy operates six hydrographic survey ships and one Laser Airborne Depth Sounding aircraft, all of which are based in Cairns. The AHS develops and implements an ongoing national surveying and charting plan, taking into account
existing and forecast requirements. The charts produced by the AHS, both in paper and electronic format, provide key information to mariners regarding navigation in Australian waters and any special navigation requirements which may apply in a particular area. The survey and charting activities of the AHS are supplemented by other efforts by Queensland authorities, which focus upon ports and similar areas, such as the case with Skardon River.

The Gulf region around Skardon River, including the Port itself, is also furnished with a range of aids to assist with the safe navigation of shipping. These navaids include infrastructure such as lighthouses, lights and markers, tide gauges and current meters and similar. Navigation aids in the region also include a Differential Global Positioning Satellite service, permitting greater, more reliable accuracy than standard GPS services. The provision of coastal navigation aids is primarily the responsibility of AMSA, while MSQ provides and maintains port-specific navaids.

### 6.16.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential impacts related to shipping is summarised in Table 6-105. An analysis of initial risk, without mitigation, was considered for each technical element. The residual risk considers the mitigation and management measures developed for traffic and transport, and put forward in this assessment.

#### Table 6-105 Qualitative risk assessment – transport (shipping)

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship collisions as a result of additional ships in the Port of Skardon</td>
<td>Major</td>
<td>Rare</td>
<td>Medium</td>
<td>▪ The use of pilots, or suitably qualified masters, familiar with the area is intended to limit the risk of navigation area, with resultant decrease in the likelihood of occurrence of grounding or collision</td>
<td>Low</td>
</tr>
<tr>
<td>Marine fauna injury or death as a result of fauna strike</td>
<td>Major</td>
<td>Unlikely</td>
<td>High</td>
<td>▪ Ship will be moving at slow speeds</td>
<td>Medium</td>
</tr>
<tr>
<td>Unavoidable loss or emissions of various atmospheric and water contaminants as typically associated with shipping and small vessels impacting biodiversity, ecological integrity and social amenity</td>
<td>Minor</td>
<td>Unlikely</td>
<td>Low</td>
<td>▪ Make available marine pollution prevention equipment and implement procedures&lt;br&gt; ▪ Develop an oil and chemical spill response plan&lt;br&gt; ▪ NB: Not considered likely to result in any measureable change, noting the relatively low scale of planned activities and the distance offshore of the transshipment anchorage</td>
<td>Low</td>
</tr>
<tr>
<td>Oil spills from refueling harbor crafts and large oil spills from oily waste resulting in environmental harm</td>
<td>Major</td>
<td>Rare</td>
<td>Medium</td>
<td>▪ Oil containment booms and onsite spill containment and clean-up equipment&lt;br&gt; ▪ Oil spill contingency plans&lt;br&gt; ▪ Ships will have an oily management system as per the MARPOL requirements</td>
<td>Low</td>
</tr>
</tbody>
</table>
### Potential Impacts

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Reduced air quality resulting in environmental harm                              | Minor               | Likely             | Medium       | - Ships will normally only run minimal power systems while at anchor  
- NB: Given the predicted levels of vessel activity associated with the Project, vessel-sourced NOx and other atmospheric contaminants are unlikely to represent a significant pollutant |
|                                                                                  |                     |                    |              |                                                                                                                                                                                                                                | Low          |
| Terrestrial quarantine risks from the transfer of organisms                       | Moderate            | Unlikely           | Medium       | - All international vessels will manage ballast water in accordance with Australia’s Quarantine Act 1908  
- Ballast water exchange will be conducted outside Australia’s 12 nm limit |
|                                                                                  |                     |                    |              |                                                                                                                                                                                                                                | Low          |
| Introduced marine organisms as a result of biofouling                            | Minor               | Possible           | Medium       | - Biofouling cleaning and inspection requirements will be enforced |
|                                                                                  |                     |                    |              |                                                                                                                                                                                                                                | Low          |
| Release of biocides (toxic to marine life), including copper, from the removal of AFCs as a result of anchor cable abrasion, or rubbing against berths and fenders | Moderate            | Unlikely           | Medium       | - Biocide leach rates are reduced from ships at anchor compared with ships underway  
- If required, copper will be partitioned into a less mobile form |
|                                                                                  |                     |                    |              |                                                                                                                                                                                                                                | Medium       |
| Direct physical impact on the seafloor fromanchoring                             | Moderate            | Possible           | High         | - Using moorings, in lieu of anchoring, for barges |
|                                                                                  |                     |                    |              |                                                                                                                                                                                                                                | Low          |
| Wash and wake effects resulting in increased turbidity                             | Minor               | Unlikely           | Low          | - Ship will be moving at slow speeds |
|                                                                                  |                     |                    |              |                                                                                                                                                                                                                                | Low          |
| Lighting impacts or turtle nesting                                               | Moderate            | Unlikely           | Medium       | - Anchorage will occur approximately 12 km from a suitable nesting habitat (mouth of Skardon River) |

### 6.16.7 Summary

Assessment of the potential impacts to the environment, and the control and mitigation measures, indicates that risk of adverse effects from the Project will be minimal. Some low level, persistent effects will exist, all of which are unavoidable results of shipping operations. None of these are considered likely to present any tangible or unacceptable risks to the environment.

Abnormal events, such as vessel grounding or collision, do pose a heightened risk, but in common with similar shipping activities around Australia and elsewhere, these risks will be controlled by a range of vessel design, equipment fit and operational measures. These measures sit within a comprehensive framework of international, national and Queensland regulations, and are applicable to both the international ships and coastal vessels to be engaged in the development and operation of the Project’s shipping movements.
6.16.8  Commitments

In relation to the management of shipping activities Metro Mining’s commitments are provided in Table 6-106.

Table 6-106 Commitments – transport (shipping)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Implement an oily management system as per the MARPOL requirements.</td>
</tr>
<tr>
<td>S2</td>
<td>Regular engagement with Maritime Safety Queensland for relevant aspects of construction and operation of the Project.</td>
</tr>
<tr>
<td>S3</td>
<td>Implement the national guidelines and requirements relating to ballast water and biofouling.</td>
</tr>
<tr>
<td>S4</td>
<td>Develop an oil and chemical spill response plan and make available marine pollution prevention equipment.</td>
</tr>
<tr>
<td>S5</td>
<td>Ensure competent and suitably trained crews operate the vessels.</td>
</tr>
</tbody>
</table>

6.17 Hazards and Safety

This section describes potential hazards and risks associated with the development and operation of the Project that may have an impact on values related to people and property. In addition, this section also assesses the risk to the Project’s workforce, stakeholders, the environment (from a social perspective) and local communities.

6.17.1  Regulatory Framework

The key legislation relevant to the assessment and management of hazards and to ensure safety includes the following:

- Mining and Quarrying Safety Health Act 1999 (MQSH Act);
- Work Health and Safety Act 2011 (WHS Act);
- State Planning Policy – July 2014 (SPP);
- Disaster Management Act 2003;
- Ambulance Service Act 1991;
- Fire and Rescue Service Act 1990;
- Transport Operations (Marine Safety) Act 1994; and

**Mining and Quarrying Safety and Health Act 1999**

The MQSH Act applies to mining activities within the boundaries of land subject to a mining tenure as well as buildings for administration, accommodation and associated facilities an adjoining, adjacent to or contiguous with the mine.

The MQSH Act requires risk to a person from operations to be at an acceptable level which means within acceptable limits and as low as reasonable achievable (s26). As such, risk management should incorporate as many controls as necessary, using the hierarchy of controls. The act requires the following obligations this:

- Implementation of a Safety and Health Management System (SHMS);
- Appointment of specific roles for safety and the imposition of legal obligations and liabilities on nominated safety roles; and
- Records and reporting including accident and incidents.

**Work Health and Safety Act 2011**

The barge loading facility and associated vessels and other off lease working areas not captured under the MQSH Act are subject to the WHS Act, this includes any place where a worker goes or is likely to be while at work, including, vehicles, vessels, and any waters and any installation on land, on the bed of any waters or floating on any waters.

The WHS Act sets out a number of obligations including:

- Implementing reasonably practicable measures to ensure health and safety taking into account the likelihood of the hazard or the risk, the consequences and the knowledge of the hazard and the risk and suitable controls;
- Health and safety duties;
- Permit requirements for certain high risk activities; and
- Dangerous goods and major hazard facilities.

**State Planning Policy July 2014**

The SPP identifies state interests in emissions and hazardous activities and natural hazards, risk and resilience to protect people and property and enhance the community’s resilience to natural hazards. The SPP applies the making of planning scheme and the designation of community infrastructure; however, as the standard criteria to be considered under the EP Act requires consideration of the state government plans as such this has been considered throughout this section.

**Maritime Safety Queensland Act 2002**

The MSQ Act, administered by MSQ and DTMR, provides advice regarding marine safety, ship-sourced pollution and related matters. The Act facilitates the transfer from MSQ to port authorities so that they deliver pilotage services, in particular pilotage areas. This is relevant to the Project as the Port of Skardon River has specific pilotage requirements outlined in the Port of Skardon River Port Rules.

**Guidelines**

The NSW Department of Planning and Infrastructure’s Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis provides further details on the techniques used in carrying out a hazard analysis. As Queensland does have a detailed hazard assessment guidelines, these NSW guidelines have been adopted in the assessment method taken to complete the Preliminary Hazard Analysis (PHA) within this section.
6.17.2 Assessment Method

This section presents the methodology for assessment of hazards and risks. The assessment involved:

- **Community Values and Receptors**: identification of values which includes identifying sensitive receptors;
- **Hazards and Impacts**: identification of hazards of the Project which may present an impact to community safety; and
- **Risk Assessment**: including:
  - Evaluating risk associated with each impact
  - Proposing mitigation measures
  - Reviewing residual risk with mitigation measures in place.

6.17.2.1 Community Values and Receptors

Values were identified based on an understanding of the land uses associated with the surrounding community. For the purpose of this section a community value is defined as:

‘*Any value that is related to sensitive receptors or property that could be affected by any hazardous material and actions associated with the Project. A property can be a state or local government controlled road, place of residence and work or recreational area.*’

Sensitive receptors associated with the various phases of the Project were identified based on reviews of aerial images. The receptors identified for this section are consistent with those identified in Section 6.9 – Air Quality and Section 0– Noise. For the purpose of this section, the nearest sensitive receptors are found at Mapoon.

6.17.2.2 Hazards and Impacts

In identifying the hazards associated with the Project, consideration was given to the Project’s proposed activities, and a review of similar bauxite mining projects in Queensland and Australia.

Hazards and impacts for the Project were identified using the following process:

- A review of the Project’s components (as outlined in Section 2 – Project Description) to identify the activities and facilities proposed during the construction and operation phases of the Project (e.g. mining, transport of material by truck, screen and crushing, barge loading and transport, transshipment, dangerous goods storage);
- Identification of hazardous materials being transported to the mining lease area (herein defined as the Project area) during the construction and operation phases;
- Identification of both technological and natural hazards, including:
  - The range of potentially hazardous incidents that may be associated with each of the activities and facilities at the Project area (e.g. clearing activities, chemical storage, stockpile management)
- Potentially hazardous incidents associated with people, activities and property associated as a result of the Project, but outside the Project area (e.g. vehicular accidents with transporting Project materials)
- Natural hazards that may occur in the area that can impact on the Project and community

For each hazard identified, the potential pathway in which that hazard could cause harm was identified (i.e. impact).

Section 4-6 describe the approach taken for assessing Project hazards and risks.

### 6.17.3 Existing Environment

In order to identify the potential hazard and risk issues associated with the Project, the surrounding environment and community safety values of the study area have been assessed. The study area for this section is defined as any property within 35 km of the Project area boundary and any state or local government road potentially used for the transport of dangerous goods to the Project. This section describes the land use, potential sensitive receptors, community values and landscape aspects which may be impacted by the Project.

#### 6.17.3.1 Sensitive Community Receptors

Within a 25 km radius of the Project a total of 47 sensitive receptors were identified using aerial imagery as having the potential to be impacted by the Project activities (see Figure 6-6). The closest residential receptor is located approximately 16 km southwest of the mining lease boundary. There are two commercial receptors owned and operated by Gulf Alumina which are the airport located 3.3 km southwest and Skardon River Camp located 0.3 km west of the MLA.

Water users in the area have also been considered to be a sensitive community receptor, the only groundwater user in the study area is the Skardon River Camp which has limited extraction from the Lunette Aquifer. Beyond the study area and approximately 35 km southwest of the MIA Mapoon town water supply from the Bulimba Formation. Further details on groundwater users are presented in Section 2.5 of the groundwater technical report in Appendix I.

#### 6.17.3.2 Environmentally Sensitive Receptors

The Skardon River and estuary area intercepts the northern section of the Project area and is classified as a MSES – High Ecological Significance wetland. The mangrove bordering Skardon River and the area known as Bigfoot swamp are classified MSES’s with High Ecological Significance.

There are a number of GDEs identified within the study area including Bigfoot Swamp, Skardon River and estuary which are likely to depend on shallow groundwater. These areas also hold cultural and spiritual values to the Traditional Owners.

There is one small area of MSES Regulated Vegetation adjacent to the western edge of the Project area and the Skardon River is designated as a high ecological significance wetland under the MSES mapping.

#### 6.17.3.3 State and Local Government Controlled Roads

There is no access to the site by road and all workers will be transported by aircraft and material brought in and out with barges to the existing barge loading facility.
6.17.3.4 Identification of Project Hazards

Natural hazards are identified in the SPP as a naturally occurring situation or condition, such as a flood, bushfire, landslide or coastal hazard, including erosion-prone areas and storm tide inundation areas, with the potential for loss or harm to the community, property or environment. For operational purposes, tropical storms and cyclones have also been included in this section.

The Queensland Government’s SPP Natural Hazards map (DSDIP, 2015), identifies:

- Majority of the site has a medium bushfire hazard rating;
- Skardon River is an erosion prone coastal area; and
- Some lower lying parts of the Project are classified as Flood Hazard Area - Level 1.

Other natural hazards identified which are likely to impact the subject area include:

- Tropical storms and cyclones;
- Drought; and
- Climate change.

**Bushfire**

The peak fire season for the Project is during winter and spring, when rainfall is at its lowest (Figure 6-44) (BoM, 2010a). During this period of time, referred to as the dry season, vegetation and leaf-litter can dry out and become fuel for bushfires. The Project is predominately surrounded by Darwin stringybark woodland, which can become extremely dry and moisture-deprived during peak fire season.

![Fire Seasons Map](image)

**Figure 6-44 Australian bushfire threat**
Natural and anthropogenic-related bushfires are regular occurrences within the vicinity of the Project, commonly from lightning strikes and through annual back-burning and traditional Indigenous burning.

In recent decades the frequency of fire in the Cape York Peninsula bioregion has been relatively high and between approximately 13% and 33% of the region is burnt each year (Bastin and ACRIS, 2008). The majority of these fires on Cape York Peninsula are grass fires (Crowley, 1995).

Based on the Bushfire Risk Analysis for the Cook Shire and presented in the SPP online mapping, the Project is located in a bushfire hazard area of medium potential threat (Figure 6-45) (DSDIP, 2015). A bushfire hazard area identifies land that is likely to support a significant bushfire and could be subject to impacts from a significant bushfire. This mapping analyses potential fire weather severity, landscape slope and potential fuel load to determine the risk level (Rural Fire Service, 2014). Appropriate fire management strategies will be developed to mitigate bushfire hazard risks.

Currently, the Cape York Fire Program (CYFP) and the Mapoon Land and Sea Rangers provide fire management and coordination between land holders, the community, industry and all levels of government.

CYSF has a ten year fire history database, which is used to establish the relationship between fire management and biodiversity along with other land management outcomes. CYSF provide satellite fire tracking and mapping services, promoting best practice fire management in Cape York. The CYFP has improved coordination and cooperation between stakeholders across all land tenures by developing a sound base for sustainable fire management strategies and practices.

Metro Mining is working in partnership with Mapoon Land and Sea Rangers to develop a coordinated Fire Management Plan incorporating:

- Fire breaks and containment lines around all site areas;
- Buildings being be fitted with appropriate firefighting equipment and facilities; and
- Appropriate bushfire mitigation and management measures will be employed at the Project.
**Disclaimers:**

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

**Data Sources:**

- MEC Mining
- QLD Government Open Source Data
- Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

**Legend:**

- Watercourse
- Barge Loading Area
- Haul Road
- Alternate Haul Road
- Pit Extents
- Camp Site
- Metro Mining Mine Lease Area

**Bushfire Prone Area:**

- Medium Potential Bushfire Intensity
- Potential Impact Buffer

**Scale:**

1:70,000

**Notes:**

- F:\1_PROJECTS\BES150115_Bauxite_Hill\GIS\DATA\MXD\FINAL\ERA\BES150115-022-R1_BPA.mxd
Coastal Erosion

Coastal erosion and storm tide inundation are naturally occurring coastal processes that are referred to as coastal hazards as they have the potential to impact on public safety and development along the coast. Coastal hazard areas consist of areas at risk from sea erosion or permanent inundation from tidal water and areas of temporary inundation resulting from a defined storm tide event. The implications of projected sea level rise and an increase in cyclone intensity for Queensland’s coast include a progressive worsening of coastal hazards (DEHP, 2013).

The site is located in a coastal area and the Skardon River area is mapped within an indicative erosion prone area, (Figure 6-46) which is considered to be vulnerable to coastal erosion due to storm impact and long term trends of sediment loss and channel migration.

Indicative erosion prone areas are suggestive of the extent of erosion and permanent inundation defined by erosion prone area plans declared under the CPM Act. Only the declared erosion prone area plans are advised to be used for development assessment. Statutory erosion prone areas are declared under Part 4 section 70 of the CPM Act by reference to an erosion prone area plan. The Project area is not located within a declared erosion prone area (DEHP, 2014).
Flooding

The climate at the Project location is classified as Equatorial, with a period of very low rainfall during winter and spring followed by heavy monsoonal rains during summer and early autumn. Given that over 80% of the region’s annual rainfall occurs during the monsoonal wet season (December to March), flooding in the Skardon River and its tributaries is most likely to occur during this time.

Monsoonal climates can exhibit large year-to-year variations in rainfall, and a major rainfall season (i.e. greater than 2,000 mm per annum) may occur once every one to five years in the vicinity of the Project. The frequency of high rainfall and flooding can also be influenced by the presence or absence of cyclones within the region, as the predominant mechanism for river flooding is the coincident combination of heavy rainfall and elevated ocean levels (i.e. storm tides) that is primarily associated with tropical cyclone systems.

Flood modelling of the Skardon River was carried out for a range of scenarios up to the PMF, with simulation results indicating that the extent of inundation is generally confined within the river waterways, and that widespread inundation of the broader floodplain is caused by the increased ocean levels associated with a storm tide. With regard to elevation, the bauxite resource and the majority of the Project’s operations are located on a plateau that rises approximately 8 m to 15 m above the floodplain, and are therefore unlikely to be affected by riverine flooding.

The port area is not as elevated as the main mine area and is susceptible to inundation by river flooding, elevated water levels due to storm tides, and the possible combination of both events. Where practical, port infrastructure will be constructed on elevated ground, such as the stockpile area which will be located at a minimum level of 2.5 m AHD. As the mine will not be operational during the wet season, site personnel are unlikely to be affected by the impacts of flooding. See Section 6.7 for detailed discussion in regard to flooding.

Flood modelling, the potential impacts of flooding, and proposed mitigation strategies are described in Section 6.7 and Appendix H.

Tropical Storms and Cyclones

Tropical storms and cyclones are usually defined by strong winds and high intensity rainfall events. Understanding historical frequencies can help the community and industry better prepare for such events. The Project experiences approximately 50 days of lightning strikes associated with tropical storms per annum (BoM, 2010b).

Cyclones have potential to affect the Project area during the wet season, typically between December and April. As such, these events have been assessed to determine their frequency, severity and the potential impacts they may have on the Project.

The severity of a tropical cyclone is described by the BoM in terms of categories ranging from one to five related to the zone of maximum winds. The BoM categories are described below.

- Category 1 (tropical cyclone): Negligible house damage. Damage to some crops, trees and caravans. Craft may drag moorings. The strongest winds are GALEs with typical gusts over open flat land of 90 to 125 km/h. These winds correspond to Beaufort 8 and 9 (gales and strong gales);

- Category 2 (tropical cyclone): Minor house damage. Significant damage to signs, trees and caravans. Heavy damage to some crops. Risk of power failure. Small craft may break moorings. The strongest winds are DESTRUCTIVE winds with typical gusts over open flat land of 125 to 164 km/h. These winds correspond to Beaufort 10 and 11 (storm and violent storm);
Category 3 (severe tropical cyclone): Some roof and structural damage. Some caravans destroyed. Power failures likely. The strongest winds are VERY DESTRUCTIVE winds with typical gusts over open flat land of 165 to 224 km/h. These winds correspond to the highest category on the Beaufort scale, Beaufort 12 (hurricane);

Category 4 (severe tropical cyclone): Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures. The strongest winds are VERY DESTRUCTIVE winds with typical gusts over open flat land of 225 to 279 km/h. These winds correspond to the highest category on the Beaufort scale, Beaufort 12 (hurricane); and

Category 5 (severe tropical cyclone): Extremely dangerous with widespread destruction. The strongest winds are VERY DESTRUCTIVE winds with typical gusts over open flat land of more than 280 km/h. These winds correspond to the highest category on the Beaufort scale, Beaufort 12 (hurricane).

Typically, Queensland is affected by an average of 4.7 tropical cyclones per year; while an average of approximately 0.6 cyclones affect the Project annually (BoM, 2014). The frequency of cyclones in Queensland is significantly impacted by the El Niño-Southern Oscillation phenomenon. During La Niña years, a doubling of cyclonic events may occur (BoM, 2014).

The BoM identified 15 cyclones that have passed within 100 km of the Project between 1970 and 2006 (Figure 6-47). Only three of these cyclones have reached Category 4. There have been no Category 5 cyclones in the region.

Tropical storms and cyclones present a number of risks to the Project including:

- Health and safety of employees and the community from storm surge, flooding and wind-blown debris;
- Damage to port, ferry and barge infrastructure from storm surge and waves;
- Damage to other infrastructure from wind and flooding; and
- Damage to revegetation from wind and heavy rain.

Considering the Project activities will occur during the dry season, the impacts associated with tropical cyclones and storms, causing physical harm to site personnel, are unlikely. In the event that a cyclone is experienced, either during the operational period when fully staffed or during the wet season stand down period when there is only a caretaker workforce present, Metro Mining will contingency planning which is consistent with existing emergency procedures established for the broader Weipa area. Such contingency measures could include:

- Coordinate with the Rio Tinto Alcan’s Weipa Cyclone Control Centre including the cyclone condition system and associated procedures depending on cyclone severity; and
- Linking in to the existing warning systems established through the control centre.

Metro Mining will assess the damage caused by the cyclone, once it has passed, and resources will be allocated accordingly. If required, external assistance may be requested to ensure the Project is safe for construction and operational activities to proceed.
Drought

In the available meteorological history, the Project site has never recorded less than 1,000 mm annual rainfall, with the average annual rainfall since 1914 to date calculated as 1,784 mm. The definition of drought for this area is therefore a matter of scale i.e. a succession of below average rainfall years, rather than a complete lack of rainfall that may more typically be associated with drought conditions. The last succession of <1,784 mm annual rainfall years was between 2005 and 2009, with annual rainfall still averaging around 1,600 mm.

The potential effects that drought conditions may have upon the Project operations, including rehabilitation, have been considered by Metro Mining. In particular, an established and reliable source of water is crucial for the stability of Project operations. Raw water supply options have been considered, including storage of surface water runoff, groundwater supply and water collection from the nearby Skardon River or associated waterways, with the final ratio of water supply sources depending on wet season conditions.

Climate Change

Between 2007 and 2013 the Australian Government invested $129 million in the National Climate Change Adaptation Program which is helping Australians to better understand and manage risks linked to the carbon pollution already in our atmosphere and to take advantage of potential opportunities.

DotE has worked with local and international agencies to estimate predicted changes to the Australian climate and environment as a result of global warming, with the CSIRO and BoM also producing the State of the Climate 2012 report. Figure 6-48 to Figure 6-49\(^5\) respectively show

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\(^5\) Projections are given relative to the period 1980-1999 (referred to as the 1990 baseline for convenience). The projections give an estimate of the average climate around 2030, 2050 and 2070, taking into account consistency among climate models. Individual years will show variation from this average. The 50th percentile (the mid-point of the spread of model
climate change predicted to the summer of 2030, including the 10th, 50th and 90th percentile estimates. The 50th percentile is considered the best estimate and is the one that will be utilised by Metro Mining for Project planning purposes.

The Low Emissions, Medium Emissions and High Emissions scenarios are based upon Emissions scenarios are from the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios.

From the figures above, the 50th percentile expected change for the Project area based on medium emissions are:

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results) provides a best estimate result. The 10th and 90th percentiles (lowest 10% and highest 10% of the spread of model results) provide a range of uncertainty. Emissions scenarios are from the IPCC Special Report on Emission Scenarios. Low emissions is the B1 scenario, medium is A1B and high is A1FI.
- Temperature change of 0.6°C to 1.0°C;
- Rainfall change of between +/- 2%;
- Wind speed change of between +/- 2%; and
- Sea temperature change of 0.6°C to 1.0°C.

The expected lifetime of the Project is approximately 27 years, from 2016 to 2043. Given the relatively short timeframe of the Project, the potential changes to rainfall, temperature and winds, as a result of climate change, are negligible. In addition, as Metro Mining does not propose to operate during the wet season, when any changes related to any increased rainfall, wind speed, storm surge and tropical storm probabilities could be expected to impact the Project, the specific risk of climate change to the Project is considered low.

Using this data, Metro Mining does not foresee climate change as having a discernible impact on the Project in the short term and does not propose to make any specific changes to the Project planning or operations as a result of predicted climate changes.

6.17.3.5 Dangerous Goods and Hazardous Substances

A preliminary assessment of the nature and quantity of materials to be handled or stored as part of the Project has been undertaken to determine what, if any, hazardous materials may be present.

A hazardous material is a material which, in sufficient quantities, has the potential to cause harm to people, property or the environment due to its chemical, physical or biological properties. The construction and operation of the Project will involve the storage and handling of dangerous goods and hazardous substances.

Environmentally Hazardous Substances

The Project will use a number of hazardous substances which could potentially cause harm during construction and operations including those listed in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code). The full range of hazardous substances that may be handled, stored and used during the various phases of the Project will not be finalised until detailed planning for the mine has been completed. Indicative dangerous goods likely to be stored within the Project area are presented in Table 6-107.

A Safety Data Sheet (SDS) register will be established and retained within the Project area and will be made available to all site personnel for review, prior to construction commencing. The SDS register will be kept up to date in accordance with legislative requirements and the Project’s SHMS.
### Table 6-107 Indicative list of hazardous substances

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>DG Class¹</th>
<th>UN number²</th>
<th>Packing group³</th>
<th>Maximum Inventory</th>
<th>Approximate annual rate of use</th>
<th>Purpose/Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel fuel</td>
<td>3 (Class C1) 1</td>
<td>1202</td>
<td>III</td>
<td>500,000 l</td>
<td>5,000,000 l</td>
<td>Fuel for vehicles and mobile equipment</td>
</tr>
<tr>
<td>Batteries</td>
<td>NA</td>
<td>2794 2796</td>
<td>II</td>
<td>20 large batteries</td>
<td>As required</td>
<td>Light and heavy vehicles during all phases</td>
</tr>
<tr>
<td>Sulfuric acid (H₂SO₄)</td>
<td>8</td>
<td>2796</td>
<td>II</td>
<td>50 l</td>
<td>As required in conjunction with battery use</td>
<td>100% concentration for dilution with deionised water to 40% when used in batteries</td>
</tr>
<tr>
<td>Lubrication / hydraulic oils</td>
<td>3 (Class C2) 2</td>
<td>NA</td>
<td>NA</td>
<td>1.5 kl</td>
<td>50 kl</td>
<td>Hydraulic oils to lubricate plant and equipment</td>
</tr>
<tr>
<td>Nitrogen (liquid)</td>
<td>2.2</td>
<td>1977</td>
<td>NA</td>
<td>1 container</td>
<td>Infrequent</td>
<td>Equipment assembly</td>
</tr>
<tr>
<td>Oxygen Gas</td>
<td>2.2</td>
<td>1072</td>
<td>NA</td>
<td>500 l</td>
<td>1,000 l</td>
<td>Welding/Oxyacetylene cutting</td>
</tr>
<tr>
<td>Acetylene Gas</td>
<td>2.1</td>
<td>1001</td>
<td>NA</td>
<td>500 l</td>
<td>1,000 l</td>
<td>Welding/Oxyacetylene cutting</td>
</tr>
<tr>
<td>Carbon Dioxide Gas</td>
<td>2.2</td>
<td>1013</td>
<td>NA</td>
<td>500 l</td>
<td>3,000 l</td>
<td>Welding</td>
</tr>
<tr>
<td>Liquefied Petroleum Gas</td>
<td>2.1</td>
<td>1075</td>
<td>NA</td>
<td>400 l</td>
<td>5 kl</td>
<td>Heating and equipment fuel</td>
</tr>
<tr>
<td>Novec 1230 Gas</td>
<td>2.2</td>
<td>3163</td>
<td>III</td>
<td>1,800 l</td>
<td>As required</td>
<td>Fire protection</td>
</tr>
<tr>
<td>Solvents and thinners</td>
<td>3</td>
<td>1090</td>
<td>II</td>
<td>200 l</td>
<td>1,825 l</td>
<td>Degreasing agent</td>
</tr>
<tr>
<td>Paints</td>
<td>3</td>
<td>1263</td>
<td>III</td>
<td>50 l</td>
<td>100 l</td>
<td>Paint during construction and operations</td>
</tr>
<tr>
<td>Detergent</td>
<td>3</td>
<td>1198</td>
<td>NA</td>
<td>125 kg</td>
<td>2,000 kg</td>
<td>Equipment cleaning</td>
</tr>
<tr>
<td>Grease</td>
<td>3</td>
<td>1268</td>
<td>NA</td>
<td>1,000 l</td>
<td>6 kl</td>
<td>Lubricate plant and equipment</td>
</tr>
</tbody>
</table>

1 **DG Class** = Dangerous Goods class means the hazard class of the dangerous goods as stated in the ADG Code.

2 **UN numbers** = Four-digit numbers that identify hazardous substances and articles (such as explosives, flammable liquids, toxic substances, etc.) in the framework of international transport. UN numbers range from UN0001 to approximately UN3500 and are assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods. They are published as part of their Recommendations on the Transport of Dangerous Goods.

3 **Packaging Group** = Assigned to dangerous goods (other than Class 1, 2 and 7) according to the degree of risk the goods present (PGI – great danger; PGII – medium danger; and PGIII – minor danger).

It is likely other dangerous goods may be required during the construction and operational phases of the Project. In the event this occurs, existing Standard Operating Procedures (SOPs) will be reviewed to ensure safety processes and storage and handling procedures are adequate and conform to AS1940.
6.17.3.6  **Transportation and Storage of Hazardous Substances**

All hazardous goods will be stored in accordance with the requirements outlined in AS1940. Areas where hazardous goods are stored will be monitored frequently to ensure spillages and incidents are accurately observed, cleaned up and recorded. Storage areas will be roofed where required to ensure flooding of the bunded areas does not occur, potentially resulting in land and/or surface and groundwater contamination.

All containers which hold dangerous or hazardous goods will be appropriately labelled and SDS’ made available for all substances in accordance with the National Guidelines for Occupational Health and Safety Competency (NOHSC). In addition, all safety processes and storage and handling procedures will be compliant with AS1940.

Transport of hazardous substances will be by sea, all fuels and chemicals will be brought in by barge to the barge loading facility. All transport by sea will be subject to the International Maritime Dangerous Goods (IMDG) Code (2008 edition) which is regulated through the AMSA.

6.17.3.7  **Bauxite Mining Health and Safety**

The common health and safety risks associated with bauxite mining relate to noise, ergonomics, trauma, fatigue, heat and as this operation is located in a tropical environment risks of tropical diseases, venomous/dangerous animals and remote locations.

Exposures to bauxite dust has not been associated with the incidence of cancer and have not been demonstrated to be associated with clinically significant decrements in lung function (Donoghue *et al.*, 2014).

Noise is generated through the operation of machinery during the scrapping, excavation, loading, conveyor operations. Exposure to noise can result in noise induced hearing loss, this can mitigated through design and equipment selection and the use of enclose of personnel within vehicle cabins.

Traumatic injury associated with bauxite mining can occur through vehicle rollovers, mobile equipment, conveyor operations and barge operations, falls from heights, entrapment and electrocution.

Topical environment health impacts from heat, humidity and tropical diseases will need to be managed. The operations will occur primarily in the cooler months of autumn, winter and spring and as operations will be shut down over the wet season many of the risks associated with the tropical environment will be significantly reduced. The risk of potential encounters with venomous and dangerous animals such as snakes and crocodiles will be particularly important during clearing activities and construction works within the Project area.

To manage health and safety risk onsite emergency response capacity is required. The Project will have an air charter company whereby the mine site will have dedicated aircraft for its FIFO operation. In the event of an evacuation, an aircraft will be mobilised out of Cairns (2hrs) or Weipa (18 mins) according to circumstance. Depending on the type, severity and number of injuries, it may be more appropriate to call upon the Royal Flying Doctors out of Cairns. As a tertiary alternative there are heli-charters that are also accessible on an hourly rate that operate out of Weipa (40 mins) that can transport the injured to Weipa Hospital. As a last resort, the crew boat can be utilised to transport the individual to Mapoon Hospital approximately 40 km away by sea.

With the operation of barges and transhipping to export the commodity there is a risk of marine collisions, groundings or vessel strikes from the movement of marine vessels. Such events may
impact property, cause physical injury and damage marine environment. Oil spills can result from such incidents.

6.17.3.8 Malicious Acts

Acts of vandalism and sabotage towards the Project have been considered as having the potential to create hazardous conditions. Queensland Police Service has been identified as a key stakeholder and will be consulted in the preparation of security plans for the Project with a view to providing assistance in terms of future proactive patrols and enforcement activities. These will be included within the Project's Emergency Response Plan (ERP); however, given the remote location and the inability to access the site by road, the risks of this have been considered to be relatively low.

6.17.4 Potential Impacts

The Project is subject to barging related impacts and the usual impacts associated with mining activities. The potential risks that may result in significant impacts to human and environmental health include:

- Natural hazards including bushfires, floods, cyclones, storms and altered coastal processes;
- Dangerous goods storage and handling including leaks, fires, loss of containment; and
- Anthropogenic causes including unauthorised access, traffic collisions, marine vessel collisions, workplace health and safety incidents, exposure or contact with electrical equipment, failure of Emergency Response System, Sewage Treatment Facility failure, encounter with dangerous fauna and/or use of recycled wastes.

The potential impacts, for both construction and operational activities, to the aforementioned risks, is provided in Table 6-108.

6.17.5 Management and Mitigation Measures

General safety and health management measures to be implemented on site to manage the identified Project risks include:

- Implementation of Metro Mining’s SHMS;
- Site specific ERP; and
- Site security and medical facilities.

6.17.5.1 Metro Mining SHMS

A SHMS is the highest priority for Metro Mining and the Project. The SHMS outlines the management framework to be adhered to for those involved in the Project and is provided in accordance with the published EIS Guidelines for the Project.

The Project shall comply with all relevant requirements by implementing a SHMS associated with the following Project phases:

- Conceptual and design;
- Construction;
- Commissioning and operations; and
- Decommissioning.
This plan outlines the framework of how the SHMS will be revised and updated as the Project progresses through its different phases.

6.17.5.2 Emergency Response Plan

An ERP will be development in accordance with *Guidance Note QGN 15: Emergency preparedness for small mines and quarries* issued by DNRM. The site senior executive will ensure the mine has the resources and facilities for the mine's preparedness in reasonably foreseeable emergencies or potential emergency situations.

The ERP will be developed to the following elements and contain relevant information relating to the site.

- Mine information;
- Plans and drawings;
- Risk management;
- Emergency equipment/facilities;
- First aid requirements;
- Personnel training;
- Incident control;
- Communication;
- Contact lists;
- Securing the site;
- Procedures for controlling site specific hazards; and
- Records.

An ERP will be developed in consultation with the Department of Community Safety, Queensland Fire and Rescue Service, Queensland Police Service and Queensland Ambulance Service. The ERP will be developed to ensure that the potential consequence of emergency situations as identified in this ERA are minimised as far as possible. The ERP will form a critical component of the SHMS.

6.17.5.3 Security

All areas with high risk of a security breach or unauthorised public access (i.e. the MIA) will be monitored and access to the Project area from a secure single point of entrance. Prior to being given access to the Project area, visitors will complete mandatory registration and an environment, health and safety induction. The scope of the induction will reflect those areas of the Project area that the visitor will be permitted access to.

Access to Project operations will be denied to any site staff/visitor not wearing mandatory Personal Protective Equipment (PPE) that is appropriate to the area being visited. PPE might include:

- Safety helmet;
- Steel cap boots;
- High visibility vest;
- Hearing protection;
- Safety glasses; and
- Underground rescue and survival equipment

6.17.5.4 Integrated Risk Management

An Integrated Risk Management Plan for both the construction and operational phases of the Project will be prepared prior to the commencement of construction. The plan will include the following aspects:

- Operational hazard analysis;
- Regular hazard audits;
- Fire safety and emergency;
- Response plans, including counter disaster rescue procedures;
- Qualitative risk assessment; and
- Construction safety.

Figure 6-50 illustrates the preliminary and ongoing method for risk and hazard analysis. It outlines the process involved with identifying and managing potential risks for any particular activity. The figure also illustrates the method for continuous hazard and risk management. It is used to guide the hazard and risk assessment for a particular activity that may have been altered or updated.

Given design works are ongoing, it is proposed that the hazard and risk assessment is updated prior to the commencement of the construction and operation phases of the Project, respectively, and continually updated throughout the Project’s lifecycle, including its decommissioning and rehabilitation phases.

6.17.5.5 Continuous Improvement of Hazard and Risk Process

Metro Mining is committed to continuous improvement of the hazard and risk process. Plans and procedures will be implemented and undertaken to reduce the identified potential hazard and risk impacts based on results from monitoring and reviews of relevant policies. This will result in an improvement in the Project’s management of hazard and risk and the hazard and risk management culture. Additionally (as mentioned previously) prior to the construction of the Project, a Hazard and Operability Assessment (HAZOP) will be undertaken to identify all potential hazards and operational problems through a detailed review of the Project, and its equipment and operations.
6.17.6 Qualitative Risk Assessment

A PHA was undertaken to assess the potential impacts and risks of both natural and induced emergency situations, counter disaster and rescue procedures as a result of the Project on resources, including ESAs, water reserves, state and local government controlled roads, places of residence and recreational areas. The emphasis of the PHA is on preventing or minimising hazardous incidents on-site, which may result in significant on-site or off-site consequences.

Prior to construction, Metro Mining will revise the PHA in accordance with industry best practice. The review will reassess and develop risk mitigation strategies including reviews of SOPs, emergency planning and the completion of a HAZOP, in accordance with the risk assessment methodologies detailed in this section.

The PHA for construction and operational hazards is summarised in Table 6-108. The table presents the preliminary results of the assessment of potential hazards to employee welfare. After identifying the range of hazards considered likely to occur within the Project area, the following matters were considered for each hazard in the PHA:

- Design controls and mitigation measures identified for each hazard, including prevention and response measures;
- The impact that could occur as a result of each hazard;
- The consequences of each impact if they were to occur, including direct impacts of incidents and the potential for escalation and secondary incidents;
- The likelihood of events occurring and leading to an impact;
- The likelihood of each impact occurring, taking into account the proposed controls; and
- The extent to which hazard risk profiles are reduced as a consequence of implementing control and mitigation measures (residual risk).
Table 6-108 Preliminary hazard analysis for construction and operational activities

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Impact</th>
<th>Unmitigated Risk</th>
<th>Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L    C   R</td>
<td></td>
<td>L  C  R</td>
</tr>
<tr>
<td>Natural Hazards</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bushfire occurrence</td>
<td>Access to the Project area is restricted for emergency services</td>
<td>5  2    M</td>
<td>▪ Site specific Bushfire Management Plan established prior to the commencement of construction;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evacuation from the site is restricted</td>
<td></td>
<td>▪ Emergency response procedures imbedded into SHMS;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Fire protection infrastructure imbedded into site design and progressively installed during construction;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Ongoing consultation with authorities and surrounding landholders regarding fuel load management;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ ERS to be prepared in consultation with emergency services; and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Induction and refresher training of all staff in ERS.</td>
<td>5  3  L</td>
</tr>
<tr>
<td>Coastal erosion</td>
<td>Increased coastal erosion from clearing of mangroves and alterations to shoreline</td>
<td>2  3    H</td>
<td>▪ Access restricted to defined areas to minimise impacts to shoreline and estuarine environment; and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Construction on shoreline will incorporate protection and design to minimise coastal erosion in location of the infrastructure.</td>
<td>4  4  L</td>
</tr>
<tr>
<td>Coastal processes</td>
<td>Potential for tugs and barges to run aground if coastal processes are not monitored</td>
<td>4  3    M</td>
<td>▪ Adhere to vessel speed limits; and</td>
<td>4  4  L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Follow designated movement channel inside Skardon River and avoid areas designated as no-go zones.</td>
<td></td>
</tr>
<tr>
<td>Flood occurrence</td>
<td>Access to the Project area is restricted for emergency services</td>
<td>5  2    M</td>
<td>▪ Construction activities at site shut down over wet season;</td>
<td>5  3  L</td>
</tr>
<tr>
<td></td>
<td>Evacuation from the site is not restricted</td>
<td></td>
<td>▪ Routine monitoring;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generally confined within the river waterways</td>
<td></td>
<td>▪ Additional on-site resources and training provided to nominated staff to attend to emergencies;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The Project’s operations are located on a plateau unlikely to be affected by flooding.</td>
<td></td>
<td>▪ ERS to be prepared in consultation with emergency services; and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Induction and refresher training of all staff in ERS.</td>
<td></td>
</tr>
<tr>
<td>Cyclone or storm event</td>
<td>Access to the Project area is restricted for emergency services</td>
<td>2  4    M</td>
<td>▪ Installation of cyclone rated moorings for barges and marine vessels in an area nominated by MSQ;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Health and safety of employees and the community from storm surge, flooding and wind-blown debris</td>
<td></td>
<td>▪ Cyclone rated infrastructure certified as a Registered Professional Engineer of Queensland;</td>
<td>5  3  L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Ongoing consultation with the Weipa emergency services coordination centre; and</td>
<td></td>
</tr>
<tr>
<td>Hazard</td>
<td>Impact</td>
<td>Unmitigated Risk</td>
<td>Mitigation Measures</td>
<td>Residual Risk</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>------------------</td>
<td>---------------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td>Damage to conveyor and jetty infrastructure from storm surge and waves</td>
<td></td>
<td>4</td>
<td>3</td>
<td>M</td>
</tr>
<tr>
<td>Damage to other infrastructure from wind and flooding</td>
<td></td>
<td>3</td>
<td>3</td>
<td>M</td>
</tr>
<tr>
<td><strong>Dangerous Goods Storage and Handling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dangerous goods leaking during transport</td>
<td>Contamination of soils, groundwater and surface water</td>
<td>4</td>
<td>3</td>
<td>M</td>
</tr>
<tr>
<td>Damage to ecological areas, health impacts to fauna</td>
<td>Ensure contractors are responsible and adhere to maritime and road rules, speed limits and use lights while driving;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine oil spill</td>
<td>Storage tanks, bunds and transfer facilities will be designed, constructed and operated in accordance with AS1940; PPE and spill response equipment will be available on-site; Storage and ‘dirty’ areas will drained to dirty water dams; All appropriate personnel will be trained in fuel storage, transport and transfer procedures; Pressure vent valves checked prior to fill/discharge; and Water cooling system on each tank.</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Diesel transport, storage and transfer</td>
<td>Contamination of soils, groundwater and surface water</td>
<td>2</td>
<td>3</td>
<td>M</td>
</tr>
<tr>
<td>Human health impacts from contamination of water supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Hazard</th>
<th>Impact</th>
<th>Unmitigated Risk</th>
<th>Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire in a storage facility caused by the inadequate storage of</td>
<td>Bushfire caused as a result of on-site fire</td>
<td>L 4 2 H</td>
<td>• All products appropriately segregated; • Thermal sensors and/or smoke detectors to be installed and linked to alarm; • Storage areas to be constructed and bunded in accordance with AS1940; • Flame proof wiring to be used in dangerous goods storage areas; • Suitable level of security to be maintained; • Sources of ignition strictly controlled; • Minimal quantities to be stored on-site; • All lighting to be intrinsically safe; • Drum storage or drum height restricted; and • Storage to be located at least 500 m from the Project boundary.</td>
<td>L 5 3 L</td>
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<tr>
<td>hazardous substances</td>
<td>Human injury or death as a result of a fire or explosion</td>
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<td></td>
<td>Loss of vegetated areas as a result of a bushfire</td>
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<td>Bushfire caused as a result of on-site fire</td>
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<td></td>
<td>Human injury or death as a result of a fire or explosion</td>
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<td></td>
<td>Loss of vegetated areas as a result of a bushfire</td>
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<td></td>
<td>Contamination of soils, groundwater and surface water</td>
<td>L 3 3 H</td>
<td>• As above; • Strategies to be developed as part of emergency planning to notify stakeholders in such an event; and • Design and construction of storage areas and bunds will be in accordance with AS1940.</td>
<td>L 5 3 L</td>
</tr>
<tr>
<td>Storage facility (dangerous goods store) – catastrophic loss of</td>
<td>Contamination of soils, groundwater and surface water</td>
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<tr>
<td>containment</td>
<td>Human health impacts from contamination of water supply</td>
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<td>Contamination of soils, groundwater and surface water</td>
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<td>Human health impacts from contamination of water supply</td>
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<tr>
<td>Diesel leaking from the storage tanks</td>
<td>Contamination of soils, groundwater and surface water</td>
<td>L 3 3 H</td>
<td>• Storage tanks, bunds and transfer facilities will be designed, constructed and operated in accordance with AS1940; • Spill response equipment will be available on-site; • Storage and ‘dirty’ areas will drained to dirty water dams; • Appropriate personnel will be trained in fuel storage, transport and transfer procedures; • Pressure vent valves checked prior to fill and discharge; and • Water cooling system on each tank.</td>
<td>L 4 4 L</td>
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<td></td>
<td>Human health impacts from contamination of water supply</td>
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<td>Contamination of soils, groundwater and surface water</td>
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<td></td>
<td>Human health impacts from contamination of water supply</td>
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<tr>
<td>Surface material handling – contaminants from runoff and dust</td>
<td>Contamination of soils, groundwater and surface water</td>
<td>L 3 3 H</td>
<td>• Operational controls will include watering of roads and imposition of speed restrictions; • Reduce ore stockpile if significant prolonged rainfall or flood events are predicted; and • Secure and evacuate site if significant flooding is predicted to occur as per site evacuation procedures.</td>
<td>L 4 4 L</td>
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<td></td>
<td>Human health impacts from contamination of water supply</td>
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<td>Contamination of soils, groundwater and surface water</td>
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<td></td>
<td>Human health impacts from contamination of water supply</td>
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**Health and Safety**
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<tr>
<th>Hazard</th>
<th>Impact</th>
<th>Unmitigated Risk</th>
<th>Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Incident involving an authorised visitor    | Death or injury of authorised visitor as a result of falls, drowning or contact with vehicles or equipment | 4 2 H            | ▪ Provide inductions for all authorised visitors prior to or directly upon entry to the Project area;  
▪ Ensure all areas where drowning hazards may occur are adequately signed and appropriate rescue equipment is available; and  
▪ All vehicles on-site must be approved with fixed warning lights to make visitors aware of when they are in danger of coming in contact with them. | 5 3 L        |
| Unauthorised access to site by non-personnel| Death or injury as a result of potential falls or contact with equipment | 4 2 H            | ▪ Ensure adequate monitoring and signage prevents unauthorised personnel from entering the Project area; and  
▪ Maintain efficient security measures and public notification to ensure non-personnel understand the risk of trespassing.                                                                                          | 5 3 L        |
| Bauxite dust                               | Human health impacts from the migration of bauxite dust                 | 3 4 M            | ▪ Water sprays on unsealed roads;  
▪ Restricting vehicle speeds on unsealed haul roads to reduce dust generation and keep vehicles to well-defined roads;  
▪ Treat or cover stockpiled material to prevent wind erosion;  
▪ Minimise topsoil and vegetation removal, and revegetate disturbed areas as soon as possible;  
▪ Enclosed cabins to minimise operator exposure.  
▪ Limit the ore storage quantities on-site;  
▪ Dust monitoring undertaken; and  
▪ Visual monitoring of dust levels migrating from the Project area.                                                                                           | 5 3 L        |
| Traffic collisions – on-site               | Human injury or death as a result of collision                          | 3 2 H            | ▪ Ensure operators are licensed and competent;  
▪ Enforce zero alcohol and illegal drugs policy;  
▪ Develop and enforce fatigue management policy;  
▪ Driver fatigue management to be incorporated into the SHMS;  
▪ Enforce speed restrictions;  
▪ Ensure in-vehicle communications equipment;  
▪ Ensure communication policy between vehicles in operational area;  
▪ Ensure roll-over protective structures fitted to vehicles as appropriate;  
▪ Ensure regular vehicle maintenance schedule; and  
▪ Transport of dangerous goods or hazardous substances to be carried out in accordance with the ADG Code.                                                            | 5 3 L        |
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<tr>
<th>Hazard</th>
<th>Impact</th>
<th>Unmitigated Risk</th>
<th>Mitigation Measures</th>
<th>Residual Risk</th>
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</thead>
<tbody>
<tr>
<td>Marine vessel collision, grounding or strike</td>
<td>Property damage, human injury or death</td>
<td>4 2 H</td>
<td>- Adherence to navigational procedures and observation of aids;</td>
<td>5 2 M</td>
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<td></td>
<td>Oil spill</td>
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<td>- Shipping management plan in place;</td>
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<td>Loss of contaminants to the marine environment</td>
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<td>- Defined pilotage regimes; and</td>
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<td></td>
<td></td>
<td>- Oil spill response equipment and training.</td>
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<td>Workplace health and safety incident during</td>
<td>Human injury or death as a result of a construction or operational</td>
<td>4 2 H</td>
<td>- Fall from height controls;</td>
<td>5 1 M</td>
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<tr>
<td>the construction or operation phase</td>
<td>related accident</td>
<td></td>
<td>- Continuous site safety assessment, induction of new staff and visitors, and</td>
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<td>Human injury or death as a result of insufficient medical provisions</td>
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<td>- regular training of staff;</td>
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<td>available on-site</td>
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<td>- Site safety management system incorporating risk assessments, SOPs, job safety</td>
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<td>- analyses (JSAs) and job hazard analyses;</td>
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<td></td>
<td>- Experienced supervision;</td>
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<td></td>
<td>- Licensed and competent operators;</td>
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<td>- Welding safety practices;</td>
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<td>- Contractor and supplier selection;</td>
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<td>- Appropriate PPE provided to all staff and required of all visitors;</td>
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<td>- Regular vehicle and equipment maintenance; and</td>
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<td>- Ensure industry standard or best practice work controls for all operations.</td>
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<tr>
<td>Oil, fuel or chemical leaks from vehicles</td>
<td>Contamination of soils, groundwater and surface water</td>
<td>3 3 H</td>
<td>- Regular vehicle maintenance at authorised repair workshops off-site, where</td>
<td>4 4 L</td>
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<td></td>
<td>Human health impacts from contamination of water supply</td>
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<td>- possible;</td>
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<td>- First aid, firefighting and spill response kits will be available on all trucks</td>
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<td>- carrying dangerous goods and all drivers will be trained in the use of these</td>
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<td>- items;</td>
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<td></td>
<td>- Storage and handling of hazardous materials in accordance with AS1940; and</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>- Refuelling and material handling in spill containment areas with spill</td>
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<td>- recovery.</td>
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<td>See Section 6.7 – Surface water for more details on mitigation measures for</td>
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<td></td>
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<td></td>
<td>- surface water protection.</td>
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<td></td>
<td></td>
<td>See Section 6.8– Groundwater for more details on groundwater protection.</td>
<td></td>
</tr>
<tr>
<td>Hazard</td>
<td>Impact</td>
<td>Unmitigated Risk</td>
<td>Mitigation Measures</td>
<td>Residual Risk</td>
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</tr>
<tr>
<td>Oil, fuel or chemical leaks from stationary plant</td>
<td>Contamination of soils, groundwater and surface water Human health impacts from contamination of water supply</td>
<td>3 3 H</td>
<td>▪ Regular equipment maintenance of authorised off-site or contained on-site repair workshops; ▪ Storage and handling of hazardous materials in accordance with AS1940; ▪ Refuelling and materials handling in spill containment areas with spill recovery equipment; ▪ Drainage system designed to exclude hazardous chemical spills; ▪ Regular review of HAZOP policy and SOPs; ▪ Regular training of staff in HAZOP policy and procedures; ▪ SDS available at all on-site hazardous material storage and handling sites and with Environmental Manager; and ▪ Appropriate PPE for staff involved in handling or containing hazardous chemicals.</td>
<td>4 4 L</td>
</tr>
<tr>
<td>Exposure to high voltage or contact with electrified wires</td>
<td>Human injury or death as a result of exposure to high voltage wires</td>
<td>5 2 M</td>
<td>▪ All on-site power transmission sources will be appropriately designed and will follow current industry standards and design certification requirements; ▪ Ensure appropriate separation of construction and traffic areas from overhead or underground electricity supply lines; ▪ Implement a Control of Energy (isolation) procedure; ▪ Ensure induction and site familiarity of staff; and ▪ Ensure training of staff in first responder first aid.</td>
<td>5 3 L</td>
</tr>
<tr>
<td>Failure of ERS</td>
<td>Human injury or death as a result of uncoordinated emergency response</td>
<td>4 2 H</td>
<td>▪ Induction and refresher training of all staff in the ERS; ▪ Maintained and operational backup systems for all operational areas; ▪ Regular drills and training for various scenarios; ▪ Zero tolerance policy of non-compliance with ERS; and ▪ Dedicated on-site first-aid provisions.</td>
<td>5 3 L</td>
</tr>
<tr>
<td>Sewage Treatment Facility failure</td>
<td>Contamination of soils, groundwater and surface water Human health impacts from contamination of water supply</td>
<td>4 3 M</td>
<td>▪ Regular maintenance and monitoring of system and backup system; and ▪ Secondary capture and isolation built into site water management system.</td>
<td>5 3 L</td>
</tr>
<tr>
<td>Hazard</td>
<td>Impact</td>
<td>Unmitigated Risk</td>
<td>Mitigation Measures</td>
<td>Residual Risk</td>
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</tbody>
</table>
| Use of recycled waste on-site | Transmission of bacteria and / or viruses by contact, dispersion of aerosols and ingestion of recycled water | 4 3  M | ▪ Do not spray recycled water in windy conditions;  
▪ Maintain appropriate buffer zone between spray area and areas used by people;  
▪ Provide appropriate PPE to workers exposed in recycled water areas; and  
▪ Workers to be informed of correct hygiene practices when around recycled water. | 5 3  L |
| Encounter with or bite from crocodiles, venomous snakes and insects and other dangerous fauna | Human injury or death as a result of uncoordinated emergency response | 1 4  M | ▪ Provide staff with appropriate PPE when working outdoors where venomous snakes and/or insects may occur;  
▪ Provide workforce awareness training in relation to crocodiles, venomous snakes and biting insects;  
▪ Ensure an appropriate portion of staff are trained in crocodiles, venomous snake handling and first aid;  
▪ Ensure appropriate first aid equipment is readily available on-site;  
▪ Provide training to all personnel for awareness of dangerous fauna such as wild pigs and dogs; and  
▪ Dedicated on-site first-aid provisions. | 5 3  L |
| Disease vectors (e.g. insects, rodents etc.) | Human injury or death as a result of pest proliferation on-site | 4 2  H | ▪ Waste disposal bins will be located on-site to facilitate collection of rubbish in a clean, safe and hygienic manner, prior to removal from site by licensed contractors;  
▪ Dedicated and appropriately signed waste management and transfer zones;  
▪ Refuse bins will be covered to contain odour, reduce Leachate and prevent vermin;  
▪ Waste which is known to attract vermin will be stored and handled in an appropriate manner; and  
▪ Appropriate chemical control measures will be utilised as appropriate to mitigate adverse health conditions. | 5 3  L |
| Ponding of water resulting in breeding habitat for mosquitoes or other biting insects | Human injury or death as a result of pest proliferation on-site | 2 3  H | ▪ Develop and implement a Water Management System designated to prevent pooling of still water or creation of favourable mosquito habitat; and  
▪ Regular maintenance of all structures associated with storage or treatment of recycled water. | 4 4  L |
| Tropical disease, heat exposure | Human injury or death from tropical disease, infection or heat exposure | 2 3  H | ▪ Dedicated on-site first-aid provisions; and  
▪ Education in heat management and identification of tropical disease. | 4 3  M |
### Hazard Impact

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Impact</th>
<th>Unmitigated Risk</th>
<th>Mitigation Measures</th>
</tr>
</thead>
</table>
| Cumulative strain on emergency services | State emergency services strained by on-site emergency and are unable to attend to another emergency | 4 3 M            | - Metro Mining will liaise with emergency services to understand and mitigate limitations of resources;  
- Additional on-site resources and training provided to nominated staff to attend to emergencies (on-site and support off-site emergencies); and  
- An ERP to be prepared in consultation with emergency services. | 4 4 L |
| Public liability                        | Exposing the state to claims as a result of an on-site incident        | 4 3 M            | - All measures proposed above implemented to minimise the likelihood of a potential incident; and  
- Community liaisons undertaken to ensure local community aware of risks. | 5 3 L |

(C = Consequence; L = Likelihood; R = Risk)
6.17.7 Summary

The probability of accidents associated with the development and implementation of the Project is low, given that the design, operating and control measures adopted by Metro Mining will have the specific aim of their prevention. Similarly, natural events of sufficient magnitude, i.e. those that occur during the monsoon season, cause significant damage and pose serious safety risks, have a very low probability of occurring during operation of the Project.

Project construction and operational PHA results indicated that the baseline health and safety risk profile varied from low to high. Once mitigation measures and design treatments were applied to the assessed hazards, residual risk scores were reduced to 'low' or 'medium'.

The assessed hazards that were ranked with a 'medium' residual risks level included:

- Traffic collisions due to increased traffic as a result of the Project. Such collisions have the potential to occur on any road used for access to the Project;

- Cumulative strain on emergency services. Metro Mining will be required to consult with those emergency service agencies in the area to ensure that resources are sufficient to mitigate the increased risks associated with the Project;

- Human injury or death as a result of a construction or operational related accident. A robust SHMS will be implemented into the culture, risks will be managed through detailed SOPs and JSAs;

- Human injury or death from tropical disease, infection or heat exposure. Metro Mining will have onsite first aid provisions and will undertake training in heat management identification of tropical diseases; and

- Property damage, human injury or ecosystem damage from a marine incident, including collision, marine strike or grounding. Metro Mining will manage this risk by having a detailed shipping management plan, safety navigational aids, defined pilotage regimes and oil spill response equipment and training.

Importantly, the PHA did not identify any ‘extreme’ ranking risks outside the Project area.

Overall the risks to community receptors, environmental sensitive receptors and state and local government controlled roads can be considered acceptable. Metro Mining will implement a rigorous SHMS which will set out a framework and detailed safety procedures to manage the safety and health of its employees. A Project Risk Register and appropriate controls, including training, engineering, design, procedural and physical controls will be in place to manage any onsite hazards.

In the event of an emergency Metro Mining will have detailed processes outlined in the ERP and prior implemented arrangements with emergency management departments to ensure emergencies are managed in a prompt, safe and efficient manner to protect the site property, environment and the community.
6.17.8 Commitments

Metro Mining’s commitments, in relation to the Project's hazard and safety risks, are provided in Table 6-109.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
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<tbody>
<tr>
<td>HS1</td>
<td>Implement a Safety and Health Management System detailing the safety procedures to manage the health and safety of its employees.</td>
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<tr>
<td>HS2</td>
<td>Develop a Project Risk Register and appropriate controls to manage any onsite hazards and reassess the existing risks and identify any additional mitigation measures.</td>
</tr>
<tr>
<td>HS3</td>
<td>Develop Emergency Response Plans, prior to construction.</td>
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<tr>
<td>HS4</td>
<td>Communicate potential risks and associated mitigation measures during site inductions.</td>
</tr>
</tbody>
</table>
Section 7  Social and Engagement

This section describes the existing social environment of the Western Cape region, focusing on the demographics of Mapoon, Weipa, Napranum, Injinoo and Bamaga and the relevant community profiles. Potential social and community impacts and associated management measures are also outlined.

7.1  Regulatory Framework

The legislative document relevant to social impact assessments is the *Environmental Protection Act 1994* (EP Act). The EP Act, requires that social impacts, both potential and adverse, are assessed to effectively propose environmental management measures. Identifying social and community impacts is a holistic approach to environmental management and therefore has been included in this ERA.

7.2  Assessment Method

An assessment of the potential impacts has been undertaken for the local communities of Mapoon, Weipa, Napranum and other potentially impacted communities in the FNQ Region. The study area includes the following areas:

- Mapoon Shire Local Government Area, which includes the town of Mapoon located approximately 16 km southwest of the mine lease boundary and 35 km south of the Project MIA;
- Weipa Town Area Local Government Area, which includes the town of Weipa, located approximately 95 km southwest of the proposed mine site;
- Napranum Shire local government area, which includes the town of Napranum, located approximately 99 km southwest of the proposed mine site; and
- Northern Peninsula townships of Injinoo and Bamaga. These townships are considered for the potential social impacts of the Project due to the Traditional Owners of the Project land being predominantly based in these areas.

The area for this assessment is shown Figure 7-1.

The methodology has adopted a conservative approach whereby an attempt has been made to identify and consider impacts even if the potential risk of that impact occurring is low, or the actual impact is difficult to predict or quantify.
7.3 Existing Environment

Land surrounding the Project area is currently used for mineral exploration and recreational and traditional fishing and hunting practices. Cattle grazing is a land use in the region but there are no active cattle properties in the immediate vicinity of the Project.

7.3.1 Stakeholders

Stakeholders are defined as individuals, communities, non-government organisations, private organisations, government agencies, small businesses and others who have an interest or a 'stake' in the Project and its outcome. Stakeholders may be impacted by, or influence the planning and operations of a project in varying degrees of significance. Metro Mining has undertaken a stakeholder engagement process and the following environmental issues were raised:

- Final landform and final land use (Section 5);
- Impacts to vulnerable species (Section 6.4, Section 0 and Section 6.6);
- Weed, fire and feral animal controls (Section 6.6.5);
- Water quality (Section 6.7.2.2);
- Dust (Section 6.9.4);
- Noise (Section 0); and
- Rehabilitation (Section 5.1).

The potential impacts and management and mitigation measures proposed by Metro Mining are described in the respective sections.

7.3.2 Existing Community Profiles

Identifying community profiles provides an overview of social characteristics and conditions in the study area, including population and demographics, social infrastructure and community values. Mapoon, Weipa, Napranum, Bamaga and Injinoo are the local communities that are relevant to the Project and have therefore been included in this assessment.

Many of the challenges and impacts impacting the communities across the Western Cape region are similar to those faced by remote communities across Australia. These include, but are not limited to, need for quality education that leads to employment outcomes, lack of available housing, access to health care facilities and complex stakeholder arrangements. The following section outlines socio-economic data pertaining to both Indigenous and non-Indigenous populations.

7.3.2.1 Population and Demographics

At the time of the 2011 Census, the combined population of the Mapoon, Weipa, Napranum, Bamago and Injinoo communities was 5,915 (approximately 0.137% of the total Queensland population) with Queensland's population totalling 4,332,739 (refer to Table 7-1).
The population of Weipa is greater than the surrounding communities predominately due to the operation of the Rio Tinto Alcan project. The mine-related workforce is the key driver of the residential population in Weipa.

Table 7-2 further reflects that Weipa is a community that is strongly influenced by the existing Rio Tinto Alcan operations particularly in regard to salaries and rent.

### Indigenous Population Profile

The 2011 Census counted that 2,970 Indigenous persons, including Torres Strait Islanders, live in the geographic area of concern. The percentage of the Indigenous people compared to the total Indigenous population (155,824) in Queensland is displayed in Table 7-3.

### 7.3.2.2 Employment

The 2011 Census identified that Weipa has the highest labour force participation rate of 79% followed by Mapoon (66%). There is insufficient data to derive the employment percentages for Bamaga and Injinoo.

The Northern Peninsula region has an unemployment rate of 8.6% which is above the Queensland rate of 6.1%. Mapoon is also above the Queensland unemployment rate at 6.7%. Weipa is below the Queensland unemployment rate at 2.6%. This reflects the presence of Rio Tinto Alcan employees residing in Weipa.
7.3.2.3 Community Values

Community values relate to factors such as community wellbeing and cohesion, use of areas of cultural importance, community safety, and access and connectivity. The identification of community values has been informed by:

- Local government and Queensland Government social policies;
- Outcomes of community consultation undertaken for the Project; and
- A survey of community values within the Mapoon community.

The Project has been identified as having the potential to impact the social values of a number of local and regional communities including Mapoon, Weipa, Napranum, Cook Shire Council region and the Northern Peninsula Regional Council communities.

7.3.2.4 Mapoon

Mapoon is located approximately 35 km from the mine in a direct line, with road access to the Project 367 km away. With some parts of the road slightly more advanced than bush tracks, the easiest access from Mapoon to the Project is by boat, weather permitting.

Mapoon had a population of 260 people in the 2011 Census, of which 89% identified as Aboriginal and/or Torres Strait Islander. The community includes approximately 69 dwellings and provides basic community services and facilities to meet the needs of local residents, including education, primary health care, basic government services and a community store.

The Mapoon community is situated on the traditional lands of the Tjungundji people, and was established as the Batavia River Mission on Cullen Point in 1891. In the 1950s, the discovery of bauxite on the Western Cape area saw mining leases for large areas approved for Comalco and Rio Tinto Aluminium. Comalco was bought by Rio Tinto in 2000. The mission was closed in the early 1960s as the government sought to rationalise services for the Cape Indigenous people by centralising the services to the Bamaga area. Many Bamaga residents and one of the nearby communities, New Mapoon, were unhappy with the closure and rationalisation of services. Over the following years, many moved back to (old) Mapoon, and the government eventually provided new housing which is under the administration of the Mapoon Aboriginal Shire Council.

Today, the community differs from many others given the land use and settlement layout was the result of an extensive participatory planning process. The ‘Planning for a Healthy Community Project’ started in 1994 and was completed in 1995. Upon completion in 1995, a large capital works program to the value of $3 million was approved by government for Mapoon, (with the promise of more funding to follow) to occur over a five year planning horizon to the year 2000.

The improvements that took place over this period included roadworks, about 30 new houses, an airstrip, a clinic, a school, a store, reticulated water and power.

7.3.2.5 Weipa

The town of Weipa was originally established by Comalco to support its bauxite mining activities. The Weipa mine is now owned and operated by Rio Tinto Alcan, who administer the town via the Weipa Town Authority, fulfilling the role of the Local Authority. The town has developed as a regional service centre providing a range of businesses, government and administration services, sports and recreation, and facilities to support smaller regional communities of the Western Cape.
In 2011, the town had an estimated residential population of 3,332 people, with 19% of the population identifying as Aboriginal and/or Torres Strait Islander.

**7.3.2.6 Napranum**

The Aboriginal community of Napranum is located approximately 4 km south of Weipa and provides a range of community services and facilities to serve the day-to-day needs of local residents. Napranum is located within the Napranum Aboriginal Shire Council.

**7.3.2.7 Cook Shire Council**

The Project is located within the Cook Shire Council local government area. The Cook Shire offices are located in Cooktown located approximately 730 km from the Project. The Cook Shire Council covers an area of over 105,000 km² and has a population of 4,153 people, with 20% identifying as Aboriginal and/or Torres Strait Islander.

Cooktown itself has a population of 2,339 with 16.7% identifying as Aboriginal and/or Torres Strait Islander.

**7.3.2.8 Northern Peninsula Regional Council**

The Northern Peninsula Regional Council includes the townships of Injinoo and Bamaga, among others. Injinoo is the closest settlement to the north of the Project, located approximately 205 km away. While, Bamaga is a further 22 km north from Injinoo. While not located in close proximity to the Project, many of the Traditional Owners with Native Title rights over the Project area live here. As such, from a community and social impact perspective, these townships are relevant to the Project.

In 2011, the Northern Peninsula Regional Council had 2,298 people with 85% identifying as Aboriginal and/or Torres Strait Islander.

**7.3.2.9 Statistics**

The various ABS statistics from the 2011 census for Mapoon, Weipa, Napranum, Northern Peninsula, Far North Queensland and Queensland are identified in Table 7-4 (see Figure 7-1).

**Table 7-4 Summary of statistics**

<table>
<thead>
<tr>
<th></th>
<th>Work Full-time (%)</th>
<th>Unemployed (%)</th>
<th>Median Age</th>
<th>Average Children per Family</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Married (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapoon</td>
<td>44.4</td>
<td>6.7</td>
<td>30</td>
<td>2.3</td>
<td>50.6</td>
<td>49.4</td>
<td>13.9</td>
</tr>
<tr>
<td>Weipa</td>
<td>74.1</td>
<td>2.5</td>
<td>30</td>
<td>2</td>
<td>53.3</td>
<td>46.7</td>
<td>47.3</td>
</tr>
<tr>
<td>Napranum</td>
<td>54.8</td>
<td>23.6</td>
<td>22</td>
<td>-</td>
<td>50.4</td>
<td>49.6</td>
<td>6.5</td>
</tr>
<tr>
<td>Northern Peninsula</td>
<td>64.5</td>
<td>8.6</td>
<td>22</td>
<td>2.4</td>
<td>48.5</td>
<td>51.5</td>
<td>23.4</td>
</tr>
<tr>
<td>Far North Queensland</td>
<td>59.2</td>
<td>8</td>
<td>31</td>
<td>2.2</td>
<td>53.4</td>
<td>46.6</td>
<td>33.2</td>
</tr>
<tr>
<td>Queensland</td>
<td>60</td>
<td>6.1</td>
<td>36</td>
<td>1.9</td>
<td>49.6</td>
<td>50.4</td>
<td>47.9</td>
</tr>
</tbody>
</table>
7.4 Potential Impacts

A number of potential social impacts, both adverse and beneficial, have been identified during the social impact assessment including:

- Opportunities for employment;
- Potential business opportunities;
- Transport and site access issues;
- Exclusion of the community;
- Disruption to community cohesion;
- Demographic changes; and
- Cumulative impacts.

**Opportunities for Employment**

The issue of most concern, and identified as high importance, was the opportunities available for local employment as a result of the Project. As noted above, there are significant unemployment levels in all identified communities except Weipa, where the long established Rio Tinto Alcan Weipa operation provides a high rate of employment. Aside from Rio Tinto Alcan’s operation, there are few emerging employment opportunities.

The Project is a small operation in comparison to the Rio Tinto Alcan project with an average of 105 jobs required over the 27 year life of the mine. Of these jobs, Metro Mining has committed to maximising opportunities for local community members, in particular local Indigenous persons.

**Potential Business Opportunities**

Traditional Owners, councils, local businesses and service providers expressed the view that they wish to take advantage of potential business opportunities available through the Project. Viable and sustainable businesses are desired, leading to positive outcomes for Traditional Owners and local communities. A particular emphasis was placed on potential opportunities related to land and coastal management, timber harvesting, civil construction, contract mining, eco-tourism services, training and development, seed collection and rehabilitation, cultural heritage management and general goods and services.

The construction and operations of the Project will provide employment and a range of business opportunities. Opportunities to reduce local dependency on one business supplier are seen as desirable.

Metro Mining will encourage local business opportunities, particularly Indigenous business opportunities, and look for ways to form partnerships that provide good social and economic outcomes.

**Transport and Site Access Issues**

General queries were raised regarding the transport associated with the Project and how this would impact on existing infrastructure. Once it was established that access would predominantly be via airstrip and barge, with limited road access and no current plans to use or upgrade any of the
existing roads in the region, there were few issues identified. The slight additional increase in flights, given that the majority of FIFO flights for employees would be directly to the Skardon River airstrip, was not a significant concern to the local stakeholders.

Metro Mining commits to maintaining at least the existing access controls, with potentially more stringent controls being required to limit access to the mining operations that may also reduce access concerns for sensitive environmental and cultural areas. Access for recreational fishing and Traditional Owners to the Skardon River and the existing bush camping, at the mouth of the river, will not be impacted, except for potentially diverting the existing access track away from the mining operations. In the Skardon River itself, the barge loading facility will extend between approximately 5 – 10 m into the Skardon River, still allowing at least 20 m of free access to the river for recreational purposes.

**Exclusion of the Community**

The Traditional Owners and the existing freehold land owners both raised concerns with not knowing what would be happening on their land during operations or being able to confirm if Metro Mining was complying with the agreed conditions.

Access to the site for Traditional Owners parties will be established and implemented through the relevant Cultural Heritage Management Plan. As part of the CHMP development Metro Mining and the relevant Indigenous parties will develop agreed protocols that will facilitate how access to the site is arranged and undertaken. The protocols will be inclusive in nature and will ensure appropriate site health and safety protocols are adhered to.

Regular stakeholder communications covering updates on the Project will be undertaken as part of the Stakeholder Engagement Plan (SEP). It is also proposed to hold an annual ‘open day’ for relevant stakeholders where information and a site visit will be provided.

**Disruption to Community Cohesion**

Law and order and alcohol control were issues raised during consultation. These issues have the potential to cause deterioration in community cohesion and are inter-related with other issues raised such as domestic violence, child safety, health and safety and youth crime.

The usual issues of interaction between workers and the community, and alcohol consumption at the workers camp leading to community impacts are made largely irrelevant for the Project considering the long distances from the regional townships, and with access predominantly via air and barge.

Another issue raised as part of community cohesion was the impact of FIFO rosters on both the employees, and their families located in the chosen base. Some stakeholders were concerned that a two week on, and one week off roster may cause negative impacts on employees, with some anecdotal evidence suggesting an elevated risk of high stress levels, depression, binge drinking, recreational drug use and relationship break-ups. These would potentially decrease the community values and cohesion.

Given the extremely limited opportunity for interaction between the mining operations and the surrounding communities, the potential to negatively impact on community cohesion is considered to be low.

A study undertaken with Western Australia FIFO mining employees, *The Effects of Fly-in/Fly-out Commute Arrangements and Extended Working Hours on the Stress, Lifestyle, Relationship and Health*
Characteristics of Western Australian Mining Employees and their Partners (Clifford, 2009), found that:

‘FIFO and extended working hours had negative impacts on employees’ work satisfaction and FIFO was frequently reported to be disruptive to employees’ and partners’ lifestyle, in the long-term. However, FIFO and extended working hours did not lead to poor quality relationships, high stress levels or poor health, on average in the long-term; there were generally no significant differences in these characteristics between FIFO and Daily Commute (DC) employees, or between the FIFO sample and the wider community.’

The report concluded that:

‘In conclusion, the project results largely dispute anecdotal evidence as FIFO employees and partners were generally no more likely to have high stress levels, poor relationship quality or poor health behaviours than DC employees or community samples. There was however a small proportion who found the working arrangements particularly stressful.’

A study undertaken by Beach and Cliff (2003), found it was the disparity between work and family time that was the major problem with FIFO rosters, such that even lengthy rosters that had equal work to home ratios were sustainable (i.e. 28 days on, 28 days off), but that the greater the work to home ratio, the less sustainable the roster for employees.

Beach and Cliff (2003) found that employee turnover at mines using the 14/7 pattern varied between 13% and 28%, with most being at the higher end of the range. The best performing site using a 14/7 roster (13% turnover) demonstrates that management at that mine had, in large part, offset the difficulties associated with the 14/7. The obvious difference at this mine was not financial incentives, but the commitment of management to develop and maintain a positive organisational culture that benefited all employees.

Metro Mining considers the FIFO roster to be a significant factor in employee satisfaction and will look for opportunities to develop a roster that will be sustainable for the majority of employees.

**Demographic Changes**

The Project is not predicted to cause any significant increase in local community populations as the aim is to employ as many local people as possible (i.e. those that already live in the towns). Where local employees are not possible, people will reside in one of the larger regional communities e.g. Cairns.

As an example, Cairns currently has a population of over 150,000, therefore even if a worst case scenario of every single employee being based out of Cairns, and every employee being part of a four person family, an additional 420 people may be located in Cairns, which is approximately a 0.25% increase in the population.

**Cumulative Impacts**

A number of stakeholder groups raised concerns regarding significant duplication of infrastructure and services, particularly between this Project and the proposed SRM. Should both of these proceed, cumulative social and environmental impacts will arise. It is anticipated that Metro Mining will work in conjunction with Gulf Alumina to avoid such potential impacts.
7.5 Management and Mitigation Measures

A range of mitigation strategies are proposed both to enhance the positive social impacts and mitigate the negative social impacts arising from the development and operation of the Project. The management and mitigation measures described below are those that Metro Mining has control over and does not refer to matters that are the responsibility of government agencies and other parties. The following management plans will also influence the management of potential social impacts and opportunities:

- Cultural Heritage Management Plan (CHMP);
- Stakeholder Engagement Plan (SEP); and
- Emergency Response Plan (ERP).

7.5.1 Cultural Heritage Management

Indigenous cultural heritage management is important to both the Ankamuthi People and the Cape York Group #1, who are the recognised Native Title Claimants, together with OMAC as the freehold land owners.

Metro Mining has undertaken appropriate steps to identify the correct Aboriginal parties in accordance with the ACH Act. The Right to Negotiate (RTN) process is now well advanced with both the Ankamuthi People and the Cape York Group #1. Metro Mining currently has CHMPs in place covering exploration activities on site and on successful completion of the RTN processes the management processes and procedures in the existing CHMPs will be amended to reflect the transition from exploration to mining. The CHMPs will be active throughout the life of the Project and will incorporate the outcomes of monitoring, survey and fieldwork, analysis and consultation.

In parallel, Metro Mining is developing a new Land Access Agreement with OMAC as the owners of the freehold titles that the Project MLA overlays. This new agreement will also be updated in consultation with OMAC to reflect the transition from exploration to mining.

The CHMPs and Land Access Agreement will be finalised prior to any construction commencing on site.

7.5.2 Workforce Management

Metro Mining is developing workforce management strategies and will continue to do so as project planning and engagement with stakeholders’ progresses.

The mine site is remote from any town or settlement. The nearest town is Mapoon, population 300, which is over 300 km by road and is accessible only to 4WD vehicles. All positions within the Project will require the incumbent to reside on site during their working roster, in the accommodation provided by Metro Mining.

The composition of the workforce and the source of workers will not be known until recruitment commences. Recruitment will; however, be focussed on residents in the local area with preference given to Traditional Owners and local Indigenous people, followed by other residents from the Northern Cape York area. Although not yet final Metro Mining expects at least 25% of the workforce to be from the groups mentioned above by 2021.
In developing the employment strategy, Metro Mining is working with relevant stakeholders to ensure realistic targets are set and these targets are met.

**Workforce Accommodation**

A fully catered workers accommodation facility will be located at the mine site for employees and contractors. The accommodation village will offer a high level of amenity, which will contribute to a healthy workforce. Ensuring adequate access to exercise and other recreational facilities, along with modern communication facilities, will also contribute to the health and social wellbeing of workers.

**Construction, Operation and Decommissioning Phases**

Recruitment and management of the workforce during all phases of the Project will largely be the responsibility of contractors and subcontractors appointed to undertake various components of the Project. The contracting strategy requires contractors to have recruitment and training programs in place, along with a local and Indigenous employment policy.

**Workplace Health and Wellbeing**

Metro Mining has comprehensive, risk based health and safety plans which comply with the MR Act and WHS Act. These plans are focussed on the physical safety of workers while onsite. Equally as important is general health and wellbeing of workers. If workers are not physically and mentally healthy they are less able to perform their duties, they can be fatigued, distracted by issues in the home and become unsafe in the workplace.

There is considerable debate in regard to mining operations that engage FIFO workers, including the impacts on health and wellbeing. Metro Mining is taking a proactive approach to the health and wellbeing of employees through a number of strategies and programs including:

- An Induction Program which outlines expectations and includes education and awareness of fitness for work requirements to maintain a strong focus on health and safety and a high level of awareness of personal responsibilities for health and safety;
- Provision of health, fitness and recreational facilities and ensuring healthy choices are available within the accommodation village dining area;
- Requirements in relation to safe work practices and fitness for work, including fatigue, drugs and alcohol education and testing programs; and
- Education regarding both the challenges and opportunities being a FIFO worker presents. This will include encouragement and support for staff to gain advice in relation to financial planning, and to get involved in mining support groups such as mining family matters www.miningfm.com.au and FIFO families www.fifofamilies.com.au.

**Workforce Behaviour**

Workforce behaviour will be managed in a proactive way by setting clear expectations of anticipated behaviour through the development and implementation a Code of Conduct for workers which will be presented to the workforce in the induction process. The clear expectations of contractors and employees will be identified through determining the environment and appropriate behaviours Metro Mining wishes to create and promote onsite and in the accommodation camp. These behaviours will then be developed into the Code of Conduct.

The code of conduct will include (as a minimum):
Equal opportunity in the workplace;

Tolerance of and respect for race, gender, religious views, political views and sexual preferences;

General behaviour, including aggressive and threatening behaviour;

Behaviour when travelling between the place of residence and the accommodation camp;

Use of facilities and services and respect for property of Metro Mining and individuals;

Zero tolerance of alcohol when in the workplace;

Responsible consumption of alcohol within the accommodation camp and when off-shift;

Zero tolerance of illegal drugs in the workplace and the accommodation camp;

Possession of guns and other weapons; and

Compliance with all Metro Mining policies, for example, health, safety, environmental, cultural heritage, and quality control.

The code of conduct will be explained to workers in inductions and there will be an ongoing program to maintain awareness of requirements and encourage worker commitment to establishing a positive culture at the mine and accommodation village. Employment agreements will include consequences for not following the code of conduct.

Contractors will also be required to manage workforce behaviour in accordance with Metro Mining standards and requirements.

7.5.3 Procurement

Metro Mining will advertise for goods and services in the region, giving preference to local contractors when they are able to meet the tendering requirements and are competitive with other suppliers. Preference will favour, in order of priority, suppliers from: (i) the Mapoon and Weipa area, (ii) Cape York Region/North Queensland, (iii) the rest of Queensland, and (iv) elsewhere in Australia.

7.5.4 Community Engagement

Metro Mining will develop a CEP for the Project. The objectives of the CEP will be to:

- Identify stakeholders and their values, concerns and issues;
- Develop a consultation process that can be integrated into the community with minimal disturbance and which provides a foundation for long-term relationships between Metro Mining and the community that is based on trust and mutual respect;
- Provide factual information about the Project and ensure all stakeholders understand any potential benefits and/or impacts;
- Ensure community feedback mechanisms are in place to maximise opportunities for community input into the Project during the environmental approval process, and for the life of the Project; and
- Work with stakeholders to develop agreed outcomes and solutions to issues, where practicable.
Metro Mining and its subsidiary Cape Alumina Ltd have been active in the Cape York region since 2008 and have established informal communication processes with many of the stakeholders. Informal communication will continue to occur; however, for the specific purposes of the Project, there were a number of formal communication and engagement activities undertaken as detailed in Table 7-5.

### Table 7-5 Formal communication and engagement activities as of June 2015

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Website Update</strong></td>
<td></td>
</tr>
<tr>
<td>Metro Mining website updated with information regarding the Project</td>
<td>Jan 2015</td>
</tr>
<tr>
<td><strong>Meetings</strong></td>
<td></td>
</tr>
<tr>
<td>Mr Billy Gordon, MP. Queensland member for Cook</td>
<td>6 March 2015</td>
</tr>
<tr>
<td>Hon Anthony Lynham, MP. Queensland Minister DNRM</td>
<td>7 April 2015</td>
</tr>
<tr>
<td>Hon Warren Entsch, MP. Federal member for Leichhardt</td>
<td>27 April 2015</td>
</tr>
<tr>
<td>Hon Mark Bailey MP. Queensland Minister for Ports</td>
<td>11 May 2015</td>
</tr>
<tr>
<td>Hon Curtis Pitt MP. Queensland Treasurer, Minister for Aboriginal and Torres Strait Islander Partnerships</td>
<td>26 June 2015</td>
</tr>
<tr>
<td><strong>Email Presentation</strong></td>
<td></td>
</tr>
<tr>
<td>Federal Minister for Indigenous Affairs - Senator the Hon Nigel Scullion</td>
<td>April 2015</td>
</tr>
<tr>
<td><strong>Meetings and Project Updates</strong></td>
<td></td>
</tr>
<tr>
<td>Ankamuthi People (or their legal representation)</td>
<td>January 2015, April 2015, June 2015, July 2015</td>
</tr>
<tr>
<td>DEHP – Brisbane Office</td>
<td>Feb 2015, Mar 2015</td>
</tr>
<tr>
<td>DotE – Canberra Office</td>
<td>Sep 2014, Mar 2015</td>
</tr>
<tr>
<td>Cooktown Shire Council</td>
<td>Apr 2015</td>
</tr>
<tr>
<td>Cairns Regional Council</td>
<td>Apr 2015</td>
</tr>
<tr>
<td>Cape York Sustainable Futures / Tourism Cape York</td>
<td>Apr 2015</td>
</tr>
<tr>
<td>Cairns Chamber of Commerce</td>
<td>Apr 2015</td>
</tr>
<tr>
<td>Mapoon Aboriginal Council</td>
<td>April 2015</td>
</tr>
<tr>
<td>My Pathways Weipa Office</td>
<td>May 2015</td>
</tr>
<tr>
<td>Old Mapoon Aboriginal Corporation (OMAC)</td>
<td>Feb 2015, May 2015, June 2015</td>
</tr>
<tr>
<td>Mapoon Land and Sea Rangers</td>
<td>June 2015</td>
</tr>
<tr>
<td>Department of the Prime Minister and Cabinet – Cairns Office</td>
<td>Apr 2015</td>
</tr>
<tr>
<td>Weipa Police</td>
<td>Apr 2015</td>
</tr>
</tbody>
</table>
In addition to the above meetings, Metro Mining has sent out electronic updates of the Project to the following stakeholders:

- Department of Local Government, Community Recovery and Resilience;
- Cairns Airport;
- Cairns Public Safety Business Agency – Rural Fire Brigade and Emergency Services;
- Western Cape Chamber of Commerce;
- Weipa Town Office;
- Queensland Health;
- Gulf of Carpentaria Fishing Association; and
- Regional Development Australia – Canberra Office.

### 7.5.5 Stakeholder Engagement

Metro Mining will prepare a SEP prior to construction to ensure Project stakeholders have access to the relevant information, are able to voice their concerns and suggestions in relation to the Project and its impacts, and participate as valued partners in the development and operation of the mine.

The SEP will ensure the continuity of engagement with key stakeholders, including Traditional Owners and OMAC, and provide mechanisms to seek further information, provide feedback and raise concerns related to the Project.

In response to concerns raised regarding duplication of infrastructure between Metro Mining and Gulf Alumina, Metro Mining has been actively seeking agreement on a combined approach to existing and proposed infrastructure, where this is feasible, but at the time of lodging this document no agreement had been reached with Gulf Alumina.

The infrastructure that has been identified includes:

- Skardon River airstrip;
- Accommodation camp;
- Haul roads; and
- Port facilities.

### 7.5.6 Emergency Response

Consultation with relevant government departments, including the Department of Community Safety, Queensland Fire and Rescue Service, Queensland Police Service and Queensland Ambulance Service, will be undertaken to develop an ERP. The ERP will be developed to ensure that the potential consequence of emergency situations are minimised as far as possible. The Project will have an on-site contact for state emergency services to contact in the event of an emergency situation.
7.6 Qualitative Risk Assessment

A qualitative risk assessment associated with potential social and community impacts is summarised in Table 7-6. An analysis of initial risk, without mitigation, was considered for each potential impact. The residual risk considers the mitigation and management measures developed for potential social impacts, and put forward in this assessment.

Table 7-6 Qualitative risk assessment – social and engagement

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Initial Consequence</th>
<th>Initial Likelihood</th>
<th>Initial Risk</th>
<th>Management and Mitigation Measures</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport and site access</td>
<td>Moderate</td>
<td>Unlikely</td>
<td>Medium</td>
<td>▪ Maintain existing access controls</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ Implement more stringent controls, where required, to limit access to the mining operations to reduce access concerns to sensitive environmental and cultural areas</td>
<td></td>
</tr>
<tr>
<td>Exclusion of the community</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Implement the SEP</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ Regularly update stakeholders regarding the Project status</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ Hold an annual 'open day' for relevant stakeholders where information and a site visit will be provided</td>
<td></td>
</tr>
<tr>
<td>Disruption to community cohesion</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Develop and maintain a positive organisational culture that benefits all employees</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ Develop a roster that will be sustainable for the majority of employees</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ Develop and implement a CHMP and SEP</td>
<td></td>
</tr>
<tr>
<td>Demographic changes</td>
<td>Moderate</td>
<td>Unlikely</td>
<td>Medium</td>
<td>▪ Employ local people where possible (i.e. those that already live in the towns) or those that live in larger regional communities e.g. Cairns</td>
<td>Low</td>
</tr>
<tr>
<td>Duplication of infrastructure and services</td>
<td>Minor</td>
<td>Possible</td>
<td>Medium</td>
<td>▪ Work in conjunction with Gulf Alumina</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ Develop and implement an ERP</td>
<td></td>
</tr>
</tbody>
</table>
7.7 Summary

The Project’s main cultural and social area of influence is the local communities of Mapoon, Weipa, the broader Cook Shire Regional Council and the lands associated with the Traditional Owners. The development of the Project will create employment and business opportunities within this region, contributing to higher income levels and help sustain population growth. This growth is, and will continue to be, the necessary stimulus for improved infrastructure and services in the region.

Sustainable employment creation is key to regional economic development, and in securing genuine community support for new developments. Metro Mining is focussed on maximising this opportunity for the local people. To this end, Metro Mining is committed to working collaboratively with community stakeholders and government agencies, including relevant councils, the Chamber of Commerce, Traditional Owners, OMAC and various educational institutions to enhance education, training and employment for local Indigenous people and community residents, and support the ongoing development of emerging and existing businesses.

The social impact assessment for the Project, given the current social environment, has concluded that the Project will have impacts that are manageable via the implementation of a CHMP, SEP and ERP.

7.8 Commitments

Metro Mining’s commitments, in relation to the Project’s social and engagement impacts are provided in Table 7-7.

Table 7-7 Commitments – social and engagement

<table>
<thead>
<tr>
<th>Reference</th>
<th>Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE1</td>
<td>Implement a Stakeholder Engagement Plan that will include a Code of Conduct to enhance relationships between employees, contractors and the local community, and ensure stakeholder issues are recorded and responded to.</td>
</tr>
<tr>
<td>SE2</td>
<td>Implement a Cultural Heritage Management Plan and induct employees to ensure they are familiar with local Indigenous cultures and values.</td>
</tr>
<tr>
<td>SE3</td>
<td>Work with Gulf Alumina to avoid unnecessary disturbance and address stakeholder concerns.</td>
</tr>
<tr>
<td>SE4</td>
<td>Develop Emergency Response Plans prior to construction.</td>
</tr>
<tr>
<td>SE5</td>
<td>Encourage local and Indigenous employment.</td>
</tr>
<tr>
<td>SE6</td>
<td>Regular engagement with the Ankamuthi people and OMAC and implement participation strategies to effectively communicate and promote Indigenous employment and contracting opportunities.</td>
</tr>
<tr>
<td>SE7</td>
<td>Implement a ‘buy local’ initiative to priorities local purchasing.</td>
</tr>
</tbody>
</table>
Section 8  Draft Environmental Authority

Conditions

The following are proposed conditions for the Project Environmental Authority.

These proposed conditions will be further developed and finalised in consultation with DEHP during the evaluation and consideration of the information provided through this environmental impact assessment.

Schedule A - General

(A1) This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.

(A2) In carrying out the mining activity authorised by this environmental authority, the holder of this environmental authority must comply with layout described in Section XXX or other approved plans following detailed design.

(A3) The holder of this environmental authority must:

a) Install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority;

b) Maintain such measures, plant and equipment in a proper and efficient condition;

c) Operate such measures, plant and equipment in a proper and efficient manner; and

d) Ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.

Monitoring

(A4) Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than 5 years.

Financial assurance

(A5) The activity must not be carried out until the environmental authority holder has given financial assurance to the administering authority as security for compliance with this environmental authority and any costs or expenses, or likely costs or expenses, mentioned in section 298 of the Act.

(A6) The amount of financial assurance must be reviewed by the holder of this environmental authority when a plan of operations is amended or replaced or the authority is amended.

Risk management

(A7) The holder of this environmental authority must develop and implement a risk management system for mining activities which mirrors the content requirement of the Standard for Risk Management (ISO31000:2009), or the latest edition of an Australian standard for risk management, to the extent relevant to environmental management, by <<Insert date 3 months from date of issue>>
Notification of emergencies, incidents and exceptions

(A8) The holder of this environmental authority must notify the administering authority by written notification within 24 hours, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority.

(A9) Within 10 business days following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following:

a) Results and interpretation of any samples taken and analysed;
b) Outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and
c) Proposed actions to prevent a recurrence of the emergency or incident.

Complaints

(A10) The holder of this environmental authority must record all environmental complaints received about the mining activities including:

a) Name, address and contact number for of the complainant;
b) Time and date of complaint;
c) Reasons for the complaint;
d) Investigations undertaken;
e) Conclusions formed;
f) Actions taken to resolve the complaint;
g) Any abatement measures implemented; and
h) Person responsible for resolving the complaint.

(A11) The holder of this environmental authority must, when requested by the administering authority, undertake relevant specified monitoring within a reasonable timeframe nominated or agreed to by the administering authority to investigate any complaint of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority within 10 business days of completion of the investigation, or no later than 10 business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

Third-party reporting

(A12) The holder of this environmental authority must:

a) Within 1 year of the commencement of this environmental authority, obtain from an appropriately qualified person a report on compliance with the conditions of this environmental authority;
b) Obtain further such reports at regular intervals, not exceeding 3 yearly intervals, from the completion of the report referred to above; and
c) Provide each report to the administering authority within 90 days of its completion.

(A13) Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must:
a) Comply with the amended or changed standard, policy or guideline within 2 years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation; and

b) Until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

End of conditions for Schedule A

Schedule B - Air

Dust and Particulate Matter Monitoring

(B1) The release of dust, noxious or offensive odour or any other airborne contaminants resulting from the mining activities must not cause unauthorised environmental harm at any sensitive place or commercial place.

(B2) The holder of this EA must ensure that the transportation (including shipping) of bulk materials from the mining lease, leave the mining lease with appropriate load preparation to minimise the spillage and/or loss of particulate matter and/or windblown dust during transport.

(B3) In the event of a complaint made to the administering authority (which in the opinion of an authorised officer is considered neither frivolous nor vexatious) about airborne contaminants generated in carrying out the authorised activity in the Bauxite Hills Project area, monitoring will be undertaken to determine must not exceed if the following levels have been exceeded when measured at the relative any sensitive or commercial place:

a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air Determination of particulate matter Deposited matter Gravimetric method; and

b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time*, when monitored in accordance with the most recent version of the relevant Australian Standard for measuring 10 micrometres (PM10) suspended. (*5 days exceedance allowed each year including natural causes).

(B4) If monitoring indicates the airborne contaminants specified in Condition (B2) have been exceeded, the holder of this environmental authority must compare the results of the impacted site to that of the nominated reference monitoring site. If the level of airborne contaminants at the impacted site does not exceed the reference monitoring site, then no action is to be taken and the contaminants will be regarded as not having been generated in the carrying out of the authorised activity.

Light

(B5) In the event of a complaint about light emissions from any mining activity that, after investigation is in the opinion of an authorised person causing a nuisance at a sensitive place, the administering authority may request the holder of this EA to take appropriate action to mitigate the nuisance and the holder must take appropriate action (e.g. by screening or directing the light away from the sensitive place) within a time set by the administering authority.

End of conditions for Schedule B
Schedule C - Waste Management

(C1) General inert construction waste must only be disposed of into the Project inert waste disposal trench facility identified in Figure <to be finalised after consultation with DEHP>.

(C2) Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.

(C3) The holder of this environmental authority may burn vegetation cleared in the course of carrying out extraction activities provided the activity does not cause environmental harm at any sensitive place or commercial place.

Acid Sulphate Soils

(C4) Treat and manage acid sulphate soils in accordance with the latest edition of the Queensland Acid Sulfate Soil Technical Manual.

End of conditions for Schedule C

Schedule D - Noise

Noise limits

General Conditions

(D1) Noise from mining activities must not cause a nuisance to any sensitive receptor as defined in the EPP (Noise).

(D2) Noise monitoring will be undertaken on a complaint based basis.

(D3) In the event of a complaint made to the administering authority (which is neither frivolous or vexatious) about noise generated in carrying out the licensed activity and the noise is unauthorised noise and is considered by the administering authority to be an unreasonable noise, monitoring will be undertaken to determine the noise levels and source and to confirm that it is no longer an unreasonable noise.

(D4) When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint related to noise (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) at any sensitive or commercial place, and the results must be notified within 14 days to the administering authority following receipt of final monitoring report.

End of conditions for Schedule D

Schedule E - Groundwater

(E1) All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.

(E2) Groundwater quality and levels must be monitored at the locations and frequencies defined in Table 8-1 Groundwater monitoring locations and frequency for the parameters outlined.
Table 8-1 Groundwater monitoring locations and frequency

<table>
<thead>
<tr>
<th>Monitoring Point</th>
<th>Location</th>
<th>Parameters</th>
<th>Monitoring Frequency</th>
<th>Trigger values</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBA</td>
<td>TBA</td>
<td>pH, Electrical Conductivity, Total Dissolved Solids, Total Phosphorus, Total Nitrogen, Ammonia, Aluminium, Copper, Lead, Iron, Zinc, Mercury</td>
<td>TBA</td>
<td>Final trigger values are proposed using the 80th percentile of the baseline data set. Interim trigger values using the current 80th percentile from the existing baseline data are proposed</td>
</tr>
<tr>
<td>TBA</td>
<td>TBA</td>
<td>TBA</td>
<td>TBA</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Exceedance Investigation

(E3) If quality characteristics of groundwater from compliance bores identified in Table XXXX – Groundwater monitoring locations and frequency exceed any of the trigger levels stated, the holder of this environmental authority must complete an investigation in accordance with the ANZECC and ARMCANZ 2000.

Bore construction and maintenance and decommissioning.

(E5) The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimizes impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.

End of conditions for Schedule E

Schedule F - Water

Contaminant Release

(F1) Contaminants that will, or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.

Receiving Environment Monitoring and Contaminant Trigger Levels

(F2) The quality of the receiving waters must be monitored at the locations specified in Table 8-2 - Receiving water upstream background sites and downstream monitoring points for each quality characteristic and at the monitoring frequency stated in Table 8-3 - Receiving waters contaminant trigger levels.

Table 8-2 Receiving waters upstream background sites and downstream monitoring points

<table>
<thead>
<tr>
<th>Monitoring Point</th>
<th>Receiving waters location description</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skardon River</td>
<td>TBA</td>
<td>TBA</td>
<td>TBA</td>
</tr>
<tr>
<td>Downstream monitoring points</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skardon River</td>
<td>TBA</td>
<td>TBA</td>
<td>TBA</td>
</tr>
</tbody>
</table>
### Table 8-3 Receiving water contaminant trigger levels

<table>
<thead>
<tr>
<th>Quality Characteristics</th>
<th>Trigger Level</th>
<th>Monitoring Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>TBA</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Electrical Conductivity</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Suspended solids</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Sulfate (SO(_{4}^{2-}))</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Nitrate</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorous</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Aluminium</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C6-C9)</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>Petroleum hydrocarbons (C10-C36)</td>
<td>TBA</td>
<td></td>
</tr>
</tbody>
</table>

All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.

(F3) If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in Table 8-3 - Receiving waters contaminant trigger levels during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and:

a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or

b) where the downstream results exceed the upstream results complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining:
   i. Details of the investigations carried out
   ii. Actions taken to prevent environmental harm

(F4) All determinations of water quality and biological monitoring must be performed by an appropriately qualified person.
Receiving Environment Monitoring Program (REMP)

(F5) The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity.

This must include monitoring the effects of the mine on the receiving environment periodically under natural flow conditions. For the purposes of the REMP, the receiving environment is the waters of the Skardon River and connected or surrounding waterways within XX (for example, X km) downstream of the release. The REMP should encompass any sensitive receiving waters such as swamps (e.g. Bigfoot Swamp) or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.

(F6) A REMP Design Document that addresses the requirements of the REMP must be prepared and made available to the administering authority upon request.

(F7) A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and made available on request to the administering authority. This must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.

Water reuse

(F8) Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).

Annual Water Monitoring Reporting

(F9) The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format:

a) the date on which the sample was taken;
b) the time at which the sample was taken;
c) the monitoring point at which the sample was taken;
d) the measured or estimated daily quantity of mine affected water released from all release points;
e) the release flow rate at the time of sampling for each release point;
f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; and
g) Water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.

Temporary Interference with waterways

(F10) Destroying native vegetation, excavating, or placing fill in a watercourse, lake or spring necessary for and associated with mining operations must be undertaken in accordance with Department of Natural Resources and Mines (or its successor) Guideline – Activities in a Watercourse, Lake or Spring associated with Mining Activities.
**Water Management Plan**

(F11) A Water Management Plan must be developed by an appropriately qualified person and implemented.

**Stormwater and Water sediment controls**

(F12) An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimize erosion and the release of sediment to receiving waters and contamination of stormwater.

(F13) Stormwater, other than mine affected water, is permitted to be released to waters from:

a) Erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition F12; and

b) Water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with condition F11, for the purpose of ensuring water does not become mine affected water.

**End of conditions for Schedule F**

**Schedule G – Sewage Treatment**

(G1) Treated sewage effluent is permitted to be released to land as long as the treated effluent is in compliance with the release limits stated in Table 8-4 Contaminant release limits to land.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Unit</th>
<th>Release limit</th>
<th>Limit type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 day Biochemical oxygen demand (BOD) 1</td>
<td>mg/L</td>
<td>20</td>
<td>Maximum</td>
<td>Monthly</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>mg/L</td>
<td>30</td>
<td>Maximum</td>
<td>Monthly</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>mg/L</td>
<td>30</td>
<td>Maximum</td>
<td>Monthly</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg/L</td>
<td>15</td>
<td>Maximum</td>
<td>Monthly</td>
</tr>
<tr>
<td>E-coli</td>
<td>Organisms/100ml</td>
<td>1,000</td>
<td>Maximum</td>
<td>Monthly</td>
</tr>
<tr>
<td>pH</td>
<td>pH units</td>
<td>6.0 – 9.0.</td>
<td>Range</td>
<td>Monthly</td>
</tr>
</tbody>
</table>

(G2) Treated sewage effluent may only be released to land in accordance with the conditions of this approval at the following locations:

a) Within the nominated area(s) identified in Schedule XX—Figure XXX (sewage treatment plant and effluent disposal); and

b) Other land for the purpose of dust suppression and/or firefighting and / or composting.

(G3) The application of treated effluent to land must be carried out in a manner such that:

a) Vegetation is not damaged;

b) There is no surface ponding of effluent; and

c) There is no run-off of effluent.

(G4) If areas irrigated with effluent are accessible to employees or the general public, prominent signage must be provided advising that effluent is present and care should be taken to avoid consuming or otherwise coming into unprotected contact with the effluent.
(G5) All sewage effluent released to land must be monitored at the frequency and for the parameters specified in Table 8.7 - Contaminant release limits to land.

(G6) The daily volume of effluent release to land must be measured and records kept of the volumes of effluent released.

(G7) A minimum area of <<to be agreed with DEHP>> of land, excluding any necessary buffer zones, must be utilised for the irrigation and/or beneficial reuse of treated sewage effluent.

**Schedule H – Land and rehabilitation**

(H1) Land disturbed by mining must be rehabilitated in accordance with Table 8-5- Rehabilitation Requirements.

**Table 8-5 Rehabilitation requirements**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Outcome</th>
<th>Objective</th>
<th>Completion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Community and future generations left with no residual liability for site rehabilitation or maintenance.</td>
<td>To ensure that progressive rehabilitation and site decommissioning leave the area safe, fit for purpose, and non-polluting.</td>
<td>Government acceptance of mine completion report which demonstrates achievement of all completion criteria.</td>
</tr>
<tr>
<td>All site components</td>
<td>Habitat areas supporting native biodiversity.</td>
<td>To enhance the EVs of remnant native vegetation and habitat.</td>
<td>Ecological monitoring determines adequate native plant growth and habitat quality.</td>
</tr>
<tr>
<td>Undisturbed land</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native vegetation and habitat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undisturbed land</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Cut pits</td>
<td>Access to the pit areas is restricted as necessary, subject to the landowner’s requirements for access and cultural purposes. Geotechnical stability has been confirmed. Habitat areas supporting native biodiversity.</td>
<td>Post mine land use is native bushland, where practical. Erosion rate is managed to levels that do not compromise post mine land use. Safety risk to people and fauna is managed.</td>
<td>Access to the pit areas is restricted as necessary, subject to the landowner’s requirements for access and cultural purposes. Geotechnical stability has been assessed. Land is suitable for environmental land uses.</td>
</tr>
<tr>
<td>Mine Infrastructure Areas (MIA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration offices</td>
<td>All infrastructure removed6.</td>
<td>To leave the MIA in a condition fit for environmental land use.</td>
<td>Audit of domain against final closure plan to confirm the administration offices and related infrastructure do not remain on site.</td>
</tr>
<tr>
<td>Sewage, water treatment plant</td>
<td>All infrastructure removed6; no pollution.</td>
<td>To leave the MIA in a condition fit for environmental land use.</td>
<td>Audit of domain against final closure plan to confirm the sewage and water treatment infrastructure does not remain on site.</td>
</tr>
<tr>
<td>Workshops and fuel farm area</td>
<td>All infrastructure removed6; no pollution.</td>
<td>To leave the MIA in a condition fit for environmental land use.</td>
<td>Audit of domain against final closure plan to confirm the infrastructure does not remain on site and any contamination has been appropriately managed.</td>
</tr>
</tbody>
</table>

6 All infrastructure, except that specifically requested to remain following consultation with post-mining land owners / Traditional Owners, and with approval of the relevant regulator.
### Conveyors and barge loading facilities

**Outcome:** All infrastructure removed.

**Objective:** To leave the site in a condition fit for environmental land use.

**Completion criteria:** Audit of domain against final closure plan to confirm the infrastructure does not remain on site. Any infrastructure retained within the river is left safe to mitigate potential navigation risks.

### Access tracks

**Internal access tracks**

**Outcome:** Access tracks rehabilitated unless required for end land use by post-mine landowner.

**Objective:** To leave tracks in a condition fit for environmental land use.

**Completion criteria:** Audit shows all internal access track infrastructure, no longer required, is decommissioned and rehabilitated.

### Water storage and management dams

**Dams**

**Outcome:** All dam structures remaining in place are stable and safe for humans and wildlife.

**Objective:** To leave dam structures in a condition fit for environmental land use.

**Completion criteria:** Audit confirms the structural stability and safety of remaining dam structures.

**Erosion control**

**Outcome:** All erosion control structures for channelling or dispersing water are functional, stable and safe.

**Objective:** To ensure that erosion at former mine areas is minimised.

**Completion criteria:** Geotechnical assessment shows that all retained erosion control structures are functional, stable and safe.

### (H2) Rehabilitation must commence progressively in accordance with the plan of operations.

### Contaminated Land

### (H3) Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use.

### (H4) Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under condition H1.

### (H5) Minimise the potential for contamination of land by hazardous contaminants.

### Biodiversity offsets

### (H6) The holder of this environmental authority must provide an offset for impacts on applicable state significant biodiversity values, in accordance with Queensland Biodiversity Offset Policy. The biodiversity offset must be consistent with the requirements for an offset as identified in the Biodiversity Offset Strategy (as per condition H7) and must be provided:

a) Prior to impacting on state significant biodiversity values; or

b) Where a land based offset is to be provided, within 12 months of the later of either of the following:

i. The date of issue of this environmental authority; or

ii. The relevant stage identified in the Biodiversity Offset Strategy submitted under condition H7; or
c) Where an offset payment is to be provided, within four months of the later of either of the following:
   i. The date of issue of this environmental authority; or
   ii. The relevant stage identified in the Biodiversity Offset Strategy submitted under condition H7; or G7, A Biodiversity Offset Strategy must be developed and submitted to the administering authority within either 30 days, or a lesser period agreed to by the administering authority, prior to impacting on the applicable state significant biodiversity values.

(H7) A Biodiversity Offset Strategy must be developed and submitted to the administering authority within either 30 days, or a lesser period agreed to by the administering authority, prior to impacting on the applicable state significant biodiversity values.

End of conditions for Schedule H
## Section 9  Glossary

### Table 9-1 Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiotic</td>
<td>Physical rather than biological, not derived from living organisms.</td>
</tr>
<tr>
<td>Anthropogenic</td>
<td>Originating from human activity.</td>
</tr>
<tr>
<td>Attenuation</td>
<td>A general term used to indicate the reduction of noise or vibration, by whatever method or for whatever reason, and the amount in decibels, by which it is reduced.</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Variety of all life forms on earth - the different plants, animals and micro-organisms and the ecosystems of which they are a part.</td>
</tr>
<tr>
<td>Carbon dioxide equivalent</td>
<td>A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (expressed as CO₂-e).</td>
</tr>
<tr>
<td>Clean water</td>
<td>Surface runoff from catchments undisturbed or relatively undisturbed by mining activities.</td>
</tr>
<tr>
<td>Consequence</td>
<td>How much harm the impact could have, how many people in could affect and the duration of the harm.</td>
</tr>
<tr>
<td>Conservation significance</td>
<td>Communities of conservation significance listed as critically endangered or endangered under the EPBC Act.</td>
</tr>
<tr>
<td>Contaminated water</td>
<td>Surface runoff and underground mine water production which could potentially contain hydrocarbons, salts or other chemical contaminants.</td>
</tr>
<tr>
<td>Conveyor</td>
<td>Mechanical handling equipment (which may include a belt, chain or shaker) used to move ore or other materials from one location to another.</td>
</tr>
<tr>
<td>Critical incident</td>
<td>An incident that:</td>
</tr>
<tr>
<td></td>
<td>- Causes death or permanent injury to a person;</td>
</tr>
<tr>
<td></td>
<td>- Incident requiring emergency medical response;</td>
</tr>
<tr>
<td></td>
<td>- Causes significant property damage;</td>
</tr>
<tr>
<td></td>
<td>- Is likely to give rise to public comment;</td>
</tr>
<tr>
<td></td>
<td>- Is likely to result in legal proceedings against the Client; and</td>
</tr>
<tr>
<td></td>
<td>- Is a near miss with the potential to cause any of the above.</td>
</tr>
<tr>
<td>DG Class</td>
<td>Dangerous Goods class means the hazard class of the dangerous goods as stated in the Australian Dangerous Goods Code ADG Code.</td>
</tr>
<tr>
<td>Direct economic impacts</td>
<td>Refers to impacts associated directly with an increase in expenditure within an economy.</td>
</tr>
<tr>
<td>Dirty water</td>
<td>Surface runoff from disturbed catchments such as the active mine area and ROM and product coal stockpiles, all of which could contain sediments.</td>
</tr>
<tr>
<td>Dust</td>
<td>Generic term used to describe fine particles that are suspended in the atmosphere. The term is nonspecific with respect to the size, shape and chemical composition of the particles.</td>
</tr>
<tr>
<td>Ecosystem functions</td>
<td>Refers to the habitat, biological or system properties or processes of ecosystems. Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, for ecosystem functions (as described in Costanza et al., 1997).</td>
</tr>
<tr>
<td>Embodied energy</td>
<td>Energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery.</td>
</tr>
<tr>
<td>Emergency</td>
<td>An event, actual or imminent, which endangers or threatens to endanger life, property or the environment, and which requires a significant and coordinated response.</td>
</tr>
<tr>
<td>Emissions</td>
<td>Release of a substance (usually a gas) into the atmosphere.</td>
</tr>
<tr>
<td>Environmental dam</td>
<td>Contain water captured onsite from overland flow and run-off from within the Project area.</td>
</tr>
<tr>
<td>Ephemeral</td>
<td>Brief or short-lived. This term is generally used to describe watercourses that only flow intermittently throughout periods of heavy rainfall.</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>Flow-on / indirect economic impacts</td>
<td>Flow-on (or indirect) economic impacts refer to impacts throughout an economy induced by a direct increase in expenditure.</td>
</tr>
<tr>
<td>Fluorinated gases</td>
<td>Powerful synthetic greenhouse gases such as are emitted from a variety of industrial processes.</td>
</tr>
<tr>
<td>Fugitive dust</td>
<td>Dust derived from a mixture of not easily defined sources. Mine dust is commonly derived from such non-point sources such as vehicular traffic on unpaved roads, materials transport and handling.</td>
</tr>
<tr>
<td>Gilgai microrelief</td>
<td>Natural soil feature associated with non-rigid soils (sometimes termed cracking clays or Vertosols). Gilgai consist of mounds and depressions, sometimes separated by an almost planar ground surface.</td>
</tr>
<tr>
<td>Global warming potential</td>
<td>Measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.</td>
</tr>
<tr>
<td>Greenhouse gas</td>
<td>Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.</td>
</tr>
<tr>
<td>Gross Domestic / State / Regional Product</td>
<td>Represents the market value of all final goods and services produced within the Australian / State / regional economy during a given period of time.</td>
</tr>
<tr>
<td>Gross value added</td>
<td>Measurement of the contribution to the economy of each individual producer, industry or sector, based on the net activity at each stage of production. Gross value added only measures the additional value added at each stage of production, and as such is considered a true measure of economic activity.</td>
</tr>
<tr>
<td>Haul Roads</td>
<td>Roads used to transport extracted materials by truck around a mine site.</td>
</tr>
<tr>
<td>Hazard</td>
<td>Something with the potential to cause harm. This can include hazardous substances, plant and equipment, work processes or other aspects of the surrounding environment.</td>
</tr>
<tr>
<td>Herpetofauna</td>
<td>Amphibians (including frogs, toads, salamanders and newts) and reptiles (including snakes, lizards, turtles, crocodilians).</td>
</tr>
<tr>
<td>High value regrowth</td>
<td>High value regrowth is mature native vegetation that has not been cleared since 31 December 1989, is not currently recognised as remnant vegetation and appears on a map certified by the Chief Executive of DNRM.</td>
</tr>
<tr>
<td>Household</td>
<td>The ABS defines a household as one or more persons, at least one of whom is at least 15 years of age, usually resident in the same private dwelling.</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.</td>
</tr>
<tr>
<td>Hydrochlorofluorocarbons</td>
<td>Compounds containing hydrogen, fluorine, chlorine, and carbon atoms. Although ozone depleting substances, they are less potent at destroying stratospheric ozone than chlorofluorocarbons.</td>
</tr>
<tr>
<td>Incident</td>
<td>An unplanned event that causes or could have caused injury or damage to personnel or property and:</td>
</tr>
<tr>
<td></td>
<td>▪ Involves an employee of company in the course of their employment;</td>
</tr>
<tr>
<td></td>
<td>▪ Involves an employee of a Consultant or Subcontractor working on behalf of company;</td>
</tr>
<tr>
<td></td>
<td>▪ Occurs at a place under the control of company, or a Subcontractor while engaged in activities related to the works; or</td>
</tr>
<tr>
<td></td>
<td>▪ Involves operation of the Client’s or company property, plant, or equipment.</td>
</tr>
<tr>
<td>Industry output</td>
<td>Measurement of the contribution to the economy of each producer, industry or sector based on the gross sales throughout the whole economy. As a gross measurement, industry output includes the purchase of goods and services consumed in the production process, and as such “double counts” the contribution of these goods and services.</td>
</tr>
<tr>
<td>Input-output modelling</td>
<td>An economic modelling technique that estimates the level of economic activity associated with an economic stimulus.</td>
</tr>
<tr>
<td>Kilowatt hour</td>
<td>Measure of electrical energy equivalent to a power consumption of one thousand watts for one hour.</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>$L_{10}$ (Level)</td>
<td>Level that is equal to or exceeded for 10% of the time interval considered in the absence of the noise under investigation. The $L_{10}$ is considered to be representative of road traffic noise. The A-weighted background level is denoted as $L_{A90}$.</td>
</tr>
<tr>
<td>$L_{A90,T}$</td>
<td>Background A-weighted sound pressure level.</td>
</tr>
<tr>
<td>$L_{A90,T}$</td>
<td>A-weighted sound pressure level, obtained using time weighting F and arithmetically averaging the lowest levels of the ambient sound pressure level, during time interval ‘T’.</td>
</tr>
<tr>
<td>Labour force</td>
<td>The labour supply available for the production of economic goods and services in a given period. Labour force is the most widely used measure of the economically active population.</td>
</tr>
<tr>
<td>$L_{A90,T}$</td>
<td>Time–average A-weighted sound pressure level.</td>
</tr>
<tr>
<td>$L_{A90,T}$</td>
<td>A-weighted sound pressure level, obtained using time-weighting F, and arithmetically averaging the maximum levels of the noise under investigation, during time interval ‘T’ and adding adjustments for tonality and impulsiveness</td>
</tr>
<tr>
<td>$L_{A90,T}$</td>
<td>Maximum A-weighted sound pressure level, obtained by arithmetically averaging of the maximum levels of the noise under investigation</td>
</tr>
<tr>
<td>$L_{A90,T}$</td>
<td>Minimum A-weighted sound pressure level, obtained by arithmetic averaging of the minimum levels of the noise under investigation</td>
</tr>
<tr>
<td>Likelihood</td>
<td>The chance or probability of an event resulting in an impact occurring.</td>
</tr>
<tr>
<td>Local Government Area</td>
<td>A geographical area under the responsibility of an incorporated local government council.</td>
</tr>
<tr>
<td>Lucustrine</td>
<td>Relating to or associated with lakes.</td>
</tr>
<tr>
<td>Major Accident Event</td>
<td>Sudden occurrence (including a major emission, loss of containment, fire, explosion or release of energy) leading to serious danger or harm to persons, property, both the built or natural environment, whether immediately or delayed.</td>
</tr>
</tbody>
</table>
| Matters of National Environmental Significance (MNES) | Under the EPBC Act, there are eight listed MNES; six of these apply to the Project:  
1. World Heritage properties (sections 12 and 15A);  
2. National Heritage places (sections 15B and 15C);  
3. Listed threatened species and communities (Sections 18 and 18A);  
4. Listed migratory species (Sections 20 and 20A);  
5. Commonwealth marine areas (sections 23 and 24A); and  
<p>| Max $L_{pa,T}$ | A-weighted maximum instantaneous sound pressure level, obtained using time weighting F. |
| Methane | A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 25 times that of carbon dioxide (CO$_2$). |
| Mitigate / Mitigation | The act of lessening in intensity, to prevent or make less severe. |
| Nitrogen oxides (NO$_x$) | Generic term for mono-nitrogen oxides nitric oxide (NO) and nitrogen dioxide (NO$_2$). In air quality, the term means total concentration of NO and NO$_2$. |
| Noise descriptor | A measure of noise used to define a specific characteristic of noise, e.g. average energy, variation (maximum and minimum) and annoyance. Noise descriptors are based on measurements of the sound pressure level. |
| Noise limit | A maximum or minimum value imposed on a noise index e.g. a legal purpose. |
| Nuisance dust | Dust which reduces environmental amenity without necessarily resulting in material environmental harm. Nuisance dust generally comprises particles greater than 10 micrograms. |
| Offsetting | Anything that balances, counteracts, or compensates for something else; providing compensation. For example carbon offsetting is the process of reducing greenhouse gas emissions by purchasing credits from others through emissions reductions projects, or carbon trading schemes. |</p>
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open cut mining</td>
<td>Mining carried out on, by excavating, the Earth’s surface for the purpose of extracting ore/coal, but does not include underground mining</td>
</tr>
<tr>
<td>Organic</td>
<td>Relating to or derived from living matter. Comprised of carbon.</td>
</tr>
<tr>
<td>Overburden</td>
<td>Material of any nature that overlies a deposit of useful materials, ores or coal - especially those deposits mined from the surface by open cuts</td>
</tr>
<tr>
<td>Ozone (O₃)</td>
<td>A triatomic form of oxygen is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (photochemical smog).</td>
</tr>
<tr>
<td>Packaging Group</td>
<td>Assigned to dangerous goods (other than Class 1, 2 and 7) according to the degree of risk the goods present (PGI – great danger; PGII – medium danger; and PGIII – minor danger).</td>
</tr>
<tr>
<td>Percentage point</td>
<td>Percentage points are the unit for the arithmetic difference between two percentages (e.g. the difference between 3% and 4% is one percentage point).</td>
</tr>
<tr>
<td>Real wage impact</td>
<td>Measurement of the change in wages and salaries as a result of a project over and above impacts on inflation.</td>
</tr>
<tr>
<td>Residual risk</td>
<td>The likelihood that a harmful consequence might result when exposed to the hazard with the effective implementation of the proposed mitigation measures.</td>
</tr>
<tr>
<td>Scalping</td>
<td>Scalping refers to removing the largest size particles, relative to other particle’s sizes. Scalping also clean the incoming material from foreign body contamination and unwanted oversized material.</td>
</tr>
<tr>
<td>Skills shortage</td>
<td>An economic condition in which there are insufficient qualified candidates (employees) to fill available positions.</td>
</tr>
</tbody>
</table>
| Social housing | Funded by the Queensland Government, social housing comprises:  
  - Department-managed housing through public housing (including Aboriginal and Torres Strait Islander housing); and  
  - Community-managed housing through funded community and local government housing providers that deliver long term community housing and time-limited transitional housing. |
<p>| Social Impact Assessment | The process of analysing and managing intended and unintended consequences of planned interventions (projects or policies) and any social change processes invoked by those interventions, to bring about a more sustainable and equitable biophysical and human environment. |
| Sound power | The sound energy radiated per unit of time by a sound source, measured in watts. |
| Sound propagation | The transfer of sound from one point to another. |
| Stakeholder | A person or organisation with an interest or stake in a project. |
| Steady state operations | Refers to a state in which operational activity does not change substantially over time. |
| Study area | Covers all the land required for the proposed Project and the immediate surrounding areas. |
| Sustainability | Using, conserving and enhancing the community’s resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased. |
| Tonnes of carbon dioxide equivalent | Concentration of CO₂ that will cause the same level of radiative forcing as a given type and concentration of GHG. This unit standardizes the GHG effect of the 6 GHGs considered of great anthropogenic contribution under the Kyoto Protocol. |
| Topography | Arrangement of the natural and artificial physical features of an area. |</p>
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN Numbers</td>
<td>Four-digit numbers that identify hazardous substances and articles (such as explosives, flammable liquids, toxic substances, etc.) in the framework of international transport. UN numbers range from UN0001 to approximately UN3500 and are assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods. They are published as part of their <em>Recommendations on the Transport of Dangerous Goods</em>.</td>
</tr>
<tr>
<td>Unmitigated Risk</td>
<td>The likelihood that a harmful consequence might result when exposed to the hazard without implementation of the proposed mitigation measures.</td>
</tr>
<tr>
<td>Value chain / supply chain</td>
<td>Refers to the chain of interlinked value-adding processes and activities that convert inputs into outputs.</td>
</tr>
<tr>
<td>Velocity</td>
<td>A vector quantity that specifies the time derivative of displacement.</td>
</tr>
<tr>
<td>Vibration</td>
<td>Oscillating motion of matter about a fixed equilibrium position</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Inability to withstand the effects of a hostile environment</td>
</tr>
<tr>
<td>Workforce</td>
<td>The ABS defines anyone aged 15 years and over and either employed or unemployed (but looking for work) in the week prior to the Census Night as part of the workforce. Those people not in the workforce are aged 15 years and above and usually studying on a full-time basis, retired or are either physically or mentally incapacitated and therefore unable to undertake work.</td>
</tr>
</tbody>
</table>
Section 10  Acronyms, Abbreviations and Measurement Units

Acronyms and abbreviations used in this document are tabulated in Table 10-1.

Table 10-1 Acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D</td>
<td>Two dimensional</td>
</tr>
<tr>
<td>3D</td>
<td>Three dimensional</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACH Act</td>
<td>Aboriginal Cultural Heritage Act 2003</td>
</tr>
<tr>
<td>ADG Code</td>
<td>Australian Code for the Transport of Dangerous Goods by Road and Rail</td>
</tr>
<tr>
<td>ADWG</td>
<td>Australian Drinking Water Guidelines</td>
</tr>
<tr>
<td>AFC</td>
<td>Anti-fouling coating</td>
</tr>
<tr>
<td>AHC</td>
<td>Australian Heritage Council</td>
</tr>
<tr>
<td>AHC Act</td>
<td>Australian Heritage Council Act 2003</td>
</tr>
<tr>
<td>AHD</td>
<td>Australian Height Datum</td>
</tr>
<tr>
<td>AHS</td>
<td>Australian Hydrographic Service</td>
</tr>
<tr>
<td>Air NEPM</td>
<td>National Environment Protection (Ambient Air Quality) Measure</td>
</tr>
<tr>
<td>AMSA</td>
<td>Australian Maritime Safety Authority</td>
</tr>
<tr>
<td>ARI</td>
<td>Average Recurrence Interval</td>
</tr>
<tr>
<td>AS/NZS</td>
<td>Australian Standard and New Zealand Standards</td>
</tr>
<tr>
<td>ASRIS</td>
<td>Australian Soil Resource Information System</td>
</tr>
<tr>
<td>ASS</td>
<td>Acid Sulfate Soil</td>
</tr>
<tr>
<td>ATSIHP Act</td>
<td>Aboriginal and Torres Strait Islander Heritage Protection Act 1994</td>
</tr>
<tr>
<td>AWBM</td>
<td>Australian Water Balance Model</td>
</tr>
<tr>
<td>BH1</td>
<td>Bauxite Hills mining area 1</td>
</tr>
<tr>
<td>BH6</td>
<td>Bauxite Hills mining area 6</td>
</tr>
<tr>
<td>BoM</td>
<td>Bureau of Meteorology</td>
</tr>
<tr>
<td>BPA</td>
<td>Biodiversity Planning Assessment</td>
</tr>
<tr>
<td>BWM Convention</td>
<td>International Convention for the Control and Management of Ships’ Ballast Water and Sediments 2004</td>
</tr>
<tr>
<td>CAMBA</td>
<td>China-Australia Migratory Birds Agreement</td>
</tr>
<tr>
<td>CAT</td>
<td>Caterpillar</td>
</tr>
<tr>
<td>CDFM</td>
<td>Cumulative Deviation from the Mean</td>
</tr>
<tr>
<td>CEC</td>
<td>Cation exchange capacity</td>
</tr>
<tr>
<td>CHMP</td>
<td>Cultural Heritage Management Plan</td>
</tr>
<tr>
<td>CLR</td>
<td>Contaminated Land Register</td>
</tr>
<tr>
<td>CO₂-e</td>
<td>Carbon Dioxide Equivalent</td>
</tr>
<tr>
<td>COLREGs</td>
<td>Convention on the International Regulations for Preventing Collisions at Sea 1972</td>
</tr>
<tr>
<td>CPM Act</td>
<td>Coastal Protection and Management Act 1995</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>Cwlth</td>
<td>Commonwealth</td>
</tr>
<tr>
<td>CYFP</td>
<td>Cape York Fire Program</td>
</tr>
<tr>
<td>CSYSF</td>
<td>Cape York Sustainable Futures</td>
</tr>
<tr>
<td>DC</td>
<td>Daily commute</td>
</tr>
<tr>
<td>DEEDI</td>
<td>Department of Employment, Economic Development and Innovation</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>DEHP</td>
<td>Department of Environment and Heritage Protection</td>
</tr>
<tr>
<td>DERM</td>
<td>Department of Environment and Resource Management (former)</td>
</tr>
<tr>
<td>DIWA</td>
<td>Directory of Important Wetlands in Australia</td>
</tr>
<tr>
<td>DNRM</td>
<td>Department of Natural Resources and Mines</td>
</tr>
<tr>
<td>DoA</td>
<td>Department of Agriculture</td>
</tr>
<tr>
<td>DotE</td>
<td>Department of the Environment</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Primary Industries</td>
</tr>
<tr>
<td>DSDIP</td>
<td>Department of State Development, Infrastructure and Planning</td>
</tr>
<tr>
<td>DSO</td>
<td>Direct shipping of ore</td>
</tr>
<tr>
<td>DTMR</td>
<td>Department of Transport and Main Roads</td>
</tr>
<tr>
<td>DTW</td>
<td>Depth to water below ground level</td>
</tr>
<tr>
<td>EA</td>
<td>Environmental Authority</td>
</tr>
<tr>
<td>EET</td>
<td>Emission Estimation Techniques</td>
</tr>
<tr>
<td>EEZ</td>
<td>Exclusive Economic Zone</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
</tr>
<tr>
<td>EMP</td>
<td>Environmental Management Program</td>
</tr>
<tr>
<td>EMR</td>
<td>Environmental Management Register</td>
</tr>
<tr>
<td>EMS</td>
<td>Environmental Management System</td>
</tr>
<tr>
<td>ENSO</td>
<td>El Nino Southern Oscillation</td>
</tr>
<tr>
<td>EO Act</td>
<td>Environmental Offsets Act 2014</td>
</tr>
<tr>
<td>EO Policy</td>
<td>Queensland Environmental Offsets Policy 2014</td>
</tr>
<tr>
<td>EO Regulation</td>
<td>Environmental Offsets Regulation 2014</td>
</tr>
<tr>
<td>EP Act</td>
<td>Environmental Protection Act 1994</td>
</tr>
<tr>
<td>EPBC Act</td>
<td>Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)</td>
</tr>
<tr>
<td>EPBC Offset Policy</td>
<td>Environment Protect and Biodiversity Conservation Act 1999 Environmental Offsets Policy</td>
</tr>
<tr>
<td>EPBC Regulation</td>
<td>Environment Protection and Biodiversity Conservation Regulation 2000</td>
</tr>
<tr>
<td>EPM</td>
<td>Exploration Permit for Minerals</td>
</tr>
<tr>
<td>EPP (Air)</td>
<td>Environmental Protection (Air) Policy 2008</td>
</tr>
<tr>
<td>EPP (Noise)</td>
<td>Environmental Protection (Noise) Policy 2008</td>
</tr>
<tr>
<td>EPP (Water)</td>
<td>Environmental Protection (Water) Policy 2009</td>
</tr>
<tr>
<td>EP Regulation</td>
<td>Environmental Protection Regulation 2008</td>
</tr>
<tr>
<td>ERA</td>
<td>Environmentally Relevant Activity</td>
</tr>
<tr>
<td>ERP</td>
<td>Emergency Response Plan</td>
</tr>
<tr>
<td>ESA</td>
<td>Environmentally Sensitive Area</td>
</tr>
<tr>
<td>ESCP</td>
<td>Erosion and Sediment Control Plan</td>
</tr>
<tr>
<td>ESD</td>
<td>Ecologically Sustainable Development</td>
</tr>
<tr>
<td>ESP</td>
<td>Exchangeable Sodium Percentage</td>
</tr>
<tr>
<td>EV</td>
<td>Environmental value</td>
</tr>
<tr>
<td>EVNT</td>
<td>Endangered, Vulnerable and Near Threatened</td>
</tr>
<tr>
<td>FFA</td>
<td>Flood frequency analysis</td>
</tr>
<tr>
<td>FIFO</td>
<td>Fly-in Fly-out</td>
</tr>
<tr>
<td>Fisheries Act</td>
<td>Fisheries Act 1994</td>
</tr>
<tr>
<td>FNQ</td>
<td>Far North Queensland</td>
</tr>
<tr>
<td>FTE</td>
<td>Full-Time Equivalent</td>
</tr>
<tr>
<td>GAB</td>
<td>Great Artesian Basin</td>
</tr>
<tr>
<td>GAB WRP</td>
<td>Water Resource (Great Artesian Basin) Plan 2006</td>
</tr>
<tr>
<td>GDE</td>
<td>Groundwater Dependant Ecosystem</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>GOMP</td>
<td>General Operational Management Plan</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Position System</td>
</tr>
<tr>
<td>GRP</td>
<td>Gross Regional Product</td>
</tr>
<tr>
<td>GWL</td>
<td>Groundwater levels above datum</td>
</tr>
<tr>
<td>HAT</td>
<td>Highest astronomical tide</td>
</tr>
<tr>
<td>HAZOP</td>
<td>Hazard and Operability Assessment</td>
</tr>
<tr>
<td>HFO</td>
<td>Heavy fuel oil</td>
</tr>
<tr>
<td>HP</td>
<td>Horsepower</td>
</tr>
<tr>
<td>HSU</td>
<td>Hydrostratigraphic units</td>
</tr>
<tr>
<td>IECA</td>
<td>International Erosion Control Association</td>
</tr>
<tr>
<td>IMDG</td>
<td>International Maritime Dangerous Goods</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>IMS</td>
<td>Invasive marine species</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>JAMBA</td>
<td>Japan-Australia Migratory Birds Agreement</td>
</tr>
<tr>
<td>JSA</td>
<td>Job safety analysis</td>
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<td>K</td>
<td>Potassium</td>
</tr>
<tr>
<td>Land Act</td>
<td>Land Act 1994</td>
</tr>
<tr>
<td>Land Protection Act</td>
<td>Land Protection (Pest and Stock Route Management) Act 2002</td>
</tr>
<tr>
<td>LiDAR</td>
<td>Laser Illuminated Detection and Ranging</td>
</tr>
<tr>
<td>LOR</td>
<td>Limit of reporting</td>
</tr>
<tr>
<td>LPS</td>
<td>Low pressure sodium</td>
</tr>
<tr>
<td>MARPOL</td>
<td>International Convention for the Prevention of Pollution from Ships</td>
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<tr>
<td>Mg</td>
<td>Magnesium</td>
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<tr>
<td>MIA</td>
<td>Mining Infrastructure Area</td>
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<td>MLA</td>
<td>Mining Lease Application(s)</td>
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<tr>
<td>MNES</td>
<td>Matters of National Environmental Significance</td>
</tr>
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<td>MR Act</td>
<td>Mineral Resources Act 1989</td>
</tr>
<tr>
<td>MSES</td>
<td>Matters of State Environmental Significance</td>
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<tr>
<td>MSQ</td>
<td>Maritime Safety Queensland</td>
</tr>
<tr>
<td>MQSH Act</td>
<td>Mining and Quarrying Safety Health Act 1999</td>
</tr>
<tr>
<td>NATA</td>
<td>National Association of Testing Authority</td>
</tr>
<tr>
<td>Native Title Act</td>
<td>Native Title Act 1993</td>
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<tr>
<td>NC Act</td>
<td>Nature Conservation Act 1992</td>
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<tr>
<td>NGER Act</td>
<td>National Greenhouse and Energy Reporting Act 2007</td>
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<tr>
<td>NATA</td>
<td>National Association of Testing Authorities</td>
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<td>NCWR</td>
<td>Nature Conservation (Wildlife) Regulation 2006</td>
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<td>NEPM</td>
<td>National Environment Protection Measure</td>
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<tr>
<td>NGA</td>
<td>National Greenhouse Accounts</td>
</tr>
<tr>
<td>NHMRC and NRMMC</td>
<td>National Health and Medical Research Council and National Resource Management Ministerial Council</td>
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<td>NM</td>
<td>Nautical miles</td>
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<tr>
<td>NOHSC</td>
<td>National Guidelines for Occupational Health and Safety Competency</td>
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<tr>
<td>NOx</td>
<td>Nitrogen Oxide</td>
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<td>NPI</td>
<td>National Pollutant Inventory</td>
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<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>NTQ Act</td>
<td>National Trust of Queensland Act 1963</td>
</tr>
<tr>
<td>OESR</td>
<td>Office of Economic and Statistical Research</td>
</tr>
<tr>
<td>OGV</td>
<td>Ocean going vessel</td>
</tr>
<tr>
<td>OMAC</td>
<td>Old Mapoon Aboriginal Corporation</td>
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<tr>
<td>PaCE</td>
<td>Ports and Coastal Environment</td>
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</table>
**Acronym** | **Description**
--- | ---
PDR | Peninsula Development Road
PET | Plecopteran, ephemeropteran and trichopteran
PHA | Preliminary Hazard Analysis
PMP | Probable Maximum Precipitation
PPE | Personal Protective Equipment
QASSTM | Queensland Acid Sulfate Soil Technical Manual
QCCAP | Queensland Coastal Contingency Action Plan
QH Act | Queensland Heritage Act 1992
QWQG | Queensland Water Quality Guidelines 2009
RE | Regional Ecosystem
REMP | Receiving Environment Monitoring Program
ROKAMBA | Republic of Korea-Australia Migratory Birds Agreement
ROM | Run of Mine
RPI Act | Regional Planning Interests Act 2014
RTN | Right to Negotiate
SDPWO Act | State Development and Public Works Organisation Act 1971
SDS | Safety Data Sheet
SEP | Stakeholder Engagement Plan
SoE | South of Embley
SOPs | Standard Operating Procedures
SP Act | Sustainable Planning Act 2009
SPP | State Planning Policy
SRP | Skardon River Project
SWL | Sound power level(s)
TAPM | The Air Pollution Model
TEC | Threatened Ecological Community
TI Act | Transport Infrastructure Act 1994
TSS | Total Suspended Solids
VM Act | Vegetation Management Act 1999
VM Regulation | Vegetation Management Regulation 2012
VOCs | Volatile Organic Compound(s)
Waste Act | Waste Reduction and Recycling Act 2011
Water Act | Water Act 2000
WHS Act | Work, Health and Safety Act 2011
WHO | World Health Organisation
WQO | Water Quality Objectives

Measurement units used in this document are tabulated in Table 10-2.

**Table 10-2 Units**

<table>
<thead>
<tr>
<th>Units</th>
<th>Description</th>
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<tbody>
<tr>
<td>/ha/yr</td>
<td>per hectare per year</td>
</tr>
<tr>
<td>°C</td>
<td>degrees Celsius</td>
</tr>
<tr>
<td>μm</td>
<td>micron (metre x 10^-6)</td>
</tr>
<tr>
<td>μg/l</td>
<td>microgram(s) per litre</td>
</tr>
<tr>
<td>µg/m³</td>
<td>microgram(s) per cubic metre</td>
</tr>
<tr>
<td>μs/cm</td>
<td>microsiemens per centimetre</td>
</tr>
<tr>
<td>bg/l</td>
<td>below ground level</td>
</tr>
<tr>
<td>cm</td>
<td>centimetre(s)</td>
</tr>
<tr>
<td>dB(A)</td>
<td>A-weighted sound pressure level</td>
</tr>
<tr>
<td>Units</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>dB(Z)</td>
<td>Z-weighted (linear) sound pressure level</td>
</tr>
<tr>
<td>EC</td>
<td>electrical conductivity</td>
</tr>
<tr>
<td>GL/yr</td>
<td>gigalitre(s) per year</td>
</tr>
<tr>
<td>ha</td>
<td>hectare(s)</td>
</tr>
<tr>
<td>Hz</td>
<td>hertz (unit of frequency)</td>
</tr>
<tr>
<td>km</td>
<td>kilometres</td>
</tr>
<tr>
<td>kHz</td>
<td>kilohertz</td>
</tr>
<tr>
<td>km/h</td>
<td>kilometre(s) per hour</td>
</tr>
<tr>
<td>km²</td>
<td>square kilometre(s)</td>
</tr>
<tr>
<td>knts</td>
<td>knots</td>
</tr>
<tr>
<td>l</td>
<td>litre(s)</td>
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<tr>
<td>L/s</td>
<td>litre(s) per second</td>
</tr>
<tr>
<td>m/d</td>
<td>metre(s) per day</td>
</tr>
<tr>
<td>m/s</td>
<td>metre(s) per second</td>
</tr>
<tr>
<td>m²/d</td>
<td>square metre(s) per day</td>
</tr>
<tr>
<td>m³</td>
<td>cubic metre(s)</td>
</tr>
<tr>
<td>m³/s</td>
<td>cubic metre(s) per second</td>
</tr>
<tr>
<td>mAHHD</td>
<td>metre(s) above the Australian Height Datum</td>
</tr>
<tr>
<td>mbgl</td>
<td>metre(s) below ground level</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligram(s) per litre</td>
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<tr>
<td>mg/m²/day</td>
<td>milligram(s) per square metre per day</td>
</tr>
<tr>
<td>ML/yr</td>
<td>megalitre(s) per year</td>
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<td>ML/d</td>
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<tr>
<td>mm</td>
<td>millimetre(s)</td>
</tr>
<tr>
<td>Mt</td>
<td>million tonne(s)</td>
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<tr>
<td>Mtpa</td>
<td>millions tonne(s) per annum</td>
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<tr>
<td>MW</td>
<td>megawatt(s)</td>
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<td>NTU</td>
<td>Nephelometric Turbidity Unit</td>
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<tr>
<td>PM_{10}</td>
<td>particulate matter less than 10 microns in size</td>
</tr>
<tr>
<td>PM_{2.5}</td>
<td>particulate matter less than 2.5 microns in size</td>
</tr>
<tr>
<td>tpa</td>
<td>tonnes per annum</td>
</tr>
<tr>
<td>t/hr</td>
<td>tonne(s) per hour</td>
</tr>
<tr>
<td>TSP</td>
<td>Total Suspended Particulates (matter with a diameter up to 50 microns)</td>
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</tbody>
</table>
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**SECTION 2 – DESCRIPTION OF THE PROJECT**


SRK 2014a, Skardon river shallow hydrogeology report, Report prepared for Gulf Alumina Ltd.


**SECTION 5 – REHABILITATION AND MINE CLOSURE**


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Climate


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**Landscape and Visual Amenity**


**Marine Ecology**


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Quinn, R 1992, *Fisheries Resources of the Moreton Bay Region*, Queensland Fish Management Authority.


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**Terrestrial Ecology**


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Queensland Version 2.1. Department of Environment and Resource Management (DERM), Biodiversity and Ecosystem Sciences, Brisbane.


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**Groundwater**


**Air Quality**


**Noise**

AECOM Australia Pty Ltd . (2013). *Air Quality impact Assessment*. Brisbane: AECOM Australia Pty Ltd.


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Waste

Indigenous Cultural Heritage


**Non-Indigenous Cultural Heritage**


**Economic**


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Department of Transport and Main Roads (DTMR) 2006a, *Guidelines for Assessment of Road Impacts for Development*, Department of Main Roads, Brisbane.

DTMR 2006b, *Road Planning and Design Manual*, Department of Main Roads, Brisbane.

**Transport (Shipping)**


**Hazards and Safety**


**Social and Engagement**


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