13 Nature Conservation

13.1 Introduction

The ecological values of the study area are characterised in this chapter with biodiversity values determined for areas potentially impacted by the McArthur River Mine Phase 3 Development Project (the Project). Focus is on significant species and habitats. Potential impacts are identified and mitigation strategies provided. Objectives are to:

- determine the species composition and habitats of terrestrial and aquatic fauna of the McArthur River area through a combination of literature review, review of current monitoring programs and field assessment
- identify the known or likely presence of threatened flora and fauna species and sensitive ecological communities in the area
- provide assessment of the Project's impacts on flora, terrestrial and aquatic fauna, and matters of conservation significance
- develop strategies to minimise and manage potentially adverse ecological impacts.

13.2 Study Approach

Existing data on flora and terrestrial and aquatic fauna (especially for fish and riparian birds) for the McArthur River Mine (MRM) area are particularly robust in terms of species inventory and catalogue of threatened species, resulting from numerous environmental studies, as well as current and ongoing monitoring surveys. Research undertaken to date includes:

- database searches to determine lists of species known to occur, or potentially occurring in the area, particularly with reference to species of conservation significance
- literature reviews to obtain background or historical information on the biodiversity of the area
- summary review of several ongoing terrestrial and aquatic fauna monitoring programs currently in place at MRM
- field verification surveys incorporating quantitative and opportunistic sampling in the proposed Project expansion areas and an assessment of fauna habitats and current conditions.

An assessment of potential impacts on flora and terrestrial and aquatic fauna was undertaken based on the findings of the above studies.

13.2.1 Study area

The Project is within the Gulf Fall and Uplands (GFU) bioregion (Baker *et al.*, 2005), covering an area of 111,783 km^2 within the Northern Territory and a small portion within Queensland. Currently 8.4 % of this bioregion is reserved or protected in the Northern Territory.

The Gulf Fall and Uplands bioregion comprises undulating terrain with scattered low, steep hills on Proterozoic and Palaeozoic sedimentary rocks, often overlain by lateritised Tertiary material. Soils are mostly skeletal or shallow sands. Two types of woodland predominate vegetation: Darwin stringybark (*Eucalyptus tetrodonta*) and variable-barked bloodwood (*Corymbia dichromophloia*) with spinifex understorey and northern box (*Eucalyptus tectifica*) with tussock grass understorey (Baker *et al.*, 2005).

There are two major project components that, without mitigation, have the potential to affect the terrestrial flora, fauna and aquatic fauna of the Project site:

- expansion of the North Overburden Emplacement Facility (OEF), including several small water retention dams, in an area of mainly low open woodland to shrubland
- expansion of the existing open pit inside the existing bund area and placement of Non-Acid Forming (NAF) overburden in the area between the existing bund wall, the McArthur River Channel and Barney Creek. Included in this area are some upland woodland communities, lowland woodland, areas of riparian woodland and riparian corridor along the old channel of the McArthur River and Barney Creek

The conversion of a new water management dam to a Tailings Storage Facility (TSF), Cell 4, which will be joined to the western side of the existing TSF facility, will be used to store Project tailings from 2032 as current capacity is utilised. This new water management dam, that is being designed and constructed to facilitate future use as a TSF, is currently being considered under the annual Mining Management Plan process pursuant to Section 40 of the *Mining Management Act 2001*. This dam is required for water management purposes for current operations, independent of the Project.

Other Project components, such as the expansion of the existing accommodation village, upgrade and expansion of the power station and upgrading of the processing plant are considered unlikely to have significant additional impacts on flora and terrestrial and aquatic fauna.

13.2.2 Relevant legislation

13.2.2.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of the environment, especially matters of National Environmental Significance (MNES), and is administered by the Commonwealth Department of the Sustainability, Environment, Water, Population and Communities (SEWPAC). The Act is designed to provide for the conservation of biodiversity through the protection of threatened species and ecological communities, migratory, marine and other protected species listed under the EPBC Act. In general, the EPBC Act regulates national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places.

As a result of a referral submitted to SEWPAC, the Project is not considered a 'controlled action' under the EPBC Act (Determination 2011/5904) and no further assessment is required by SEWPAC.

13.2.2.2 Environmental Assessment Act 1982

The Northern Territory *Environmental Assessment Act 1982* (EA Act) administered by the Northern Territory Department of Natural Resources, Environment, The Arts and Sport (NRETAS), provides for the impact assessment process under which major development projects are controlled. The primary purpose of the assessment process is to provide for appropriate examination of proposed new projects which may cause significant environmental impact. The legislation defines 'environment' to mean all aspects of the surroundings of man including the physical, biological, economic, cultural and social aspects.

13.2.2.3 Territory Parks and Wildlife Conservation Act 2000

The *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act), which provides for the creation of parks and reserves, their management, conservation and sustainable utilisation of wildlife, is administered by NRETAS.

Species that are considered to be threatened are listed under the TPWC Act. Species listed as threatened are managed so as to promote an increase or maintenance in population numbers. This is achieved through a number of measures, including the protection of threatened species habitat and scientific programs such as captive breeding and propagation.

Under the TPWC Act, threatened species are listed as:

- vulnerable species
- endangered species
- critically endangered species
- extinct in the wild species
- extinct species.

13.2.2.4 NT Fisheries Act 1988

The *Northern Territory Fisheries Act 1988* (Fisheries Act), which has been created to manage aquatic resources in a sustainable manner, looks at management of single species and at ecosystems as a whole. The Act is administered by the Department of Resources - Primary Industry and Fisheries Resources (DR-PIFR).

13.2.2.5 NT Weeds Management Act 2001

The Northern Territory *Weeds Management Act 2001* (WM Act) lists species of exotic plants that are environmental weeds and regulates control measures and responsibilities. This Act aims to prevent the spread of weeds within, from, and into the Northern Territory and ensure that weed management is an integral component of land management.

13.3 Aquatic Fauna

MRM currently undertakes an aquatic ecology monitoring program in response to recommendations by the Northern Territory Government in its approval of the 2005 underground to open pit expansion and to commitments made by MRM through that environmental impact assessment process. As studies are ongoing and data collected are current, no additional studies specific to the Project were conducted. Results presented below are based on these existing datasets.

13.3.1 Habitat description

The McArthur River system is a component of the Gulf drainage division. It has an overall catchment area of some 20,000 km^2 including three major tributaries: Glyde River, Kilgour River and Batten Creek. With the exception of some spring-fed tributaries, particularly in the sandstone ranges, most of the flow in the McArthur River system comes from wet season rains. Often the McArthur River ceases to flow during dry seasons and most stretches (including reaches near the Project's mine area) dry to a series of large isolated pools. During the wet season, the McArthur River can be extremely turbid when in flood, carrying high silt loads. Apart from the sandstone ranges in the headwaters of the Glyde and Kilgour Rivers, much of the course of the McArthur River traverses open woodland plains country which is heavily grazed by cattle.

Downstream of the Project's mine area, the McArthur River flows through open woodland country in the Narwinbi Aboriginal Land. The tidal limit is reached a few kilometres upstream of Borroloola. Downstream of Borroloola, the McArthur River forms an extensive estuary complex which enters the sea opposite the Sir Edward Pellew Islands.

13.3.1.1 McArthur River main channel

Aquatic habitats along the McArthur River in the region of the Project's mine site include deep, permanent refuge pools with dense fringing vegetation, relatively shallow sandy sections and rock bars.

The major permanent refuge pools in the area are Eight Mile Waterhole (about 8 km upstream of the Project's mine area) and Djirrinmini (Jirinmini) Waterhole. Eight Mile Waterhole is the largest permanent waterhole in the area, being some 5 km in length, up to 200 metres (m) wide in some areas and up to 5 m deep. Fringing vegetation is generally fairly sparse and narrow, consisting typically of *Melaleuca argentea*, *Eucalyptus camaldulensis*, *Casuarina cunninghamiana* and sparse *Pandanus aquaticus*. Permanent waterholes are the most important aquatic habitats in the region as they act as dry season refuge habitat for aquatic species.

Downstream of Djirrinmini Waterhole and through the Project's mine area (except the McArthur River Channel), the river flows through a deeply incised channel. The channel has a benched profile, with an inner width of about 15 m. The river flows through this narrow channel for most of the year, although it dries completely at the end of most dry seasons. The total width of the greater channel is about 40 m and in many areas there are one or more braided overflow channels running parallel to the main river. Along the main channel the river flows swiftly over sandy substrate and is relatively shallow (about 1-2 m following the wet season). Aquatic vegetation is either sparse or not present. The channel is fringed by tall riverine forest, a habitat used as a transit zone for migrating aquatic fauna.

Numerous rock bars and shallow riffle habitats occur along the river, especially at either end of the larger waterholes. These shallow habitats are important resting and feeding sites for migrating fauna and are also an important habitat for aquatic macroinvertebrates. Some fish species, such as small gudgeons and gobies have a preference for these habitats.

13.3.1.2 Surprise Creek and Barney Creek

Surprise and Barney Creeks, which traverse dry, open woodland and generally have a stony or muddy substrate with a sparse fringing vegetation community dominated by *Casuarina cunninghamiana,* offer important aquatic habitat, preferred by some species over the main river habitats. Detailed habitat descriptions of many sites in this system are presented in Hanley (1993).

13.3.1.3 Glyde River

The Glyde River is a tributary of the McArthur River, with the confluence being 5 km downstream of the Project's mine area. For much of its length, the Glyde River flows through a rugged series of sandstone gorges of the Bukalara Range. The river channel ranges from steep, narrow-sided rock ravines (10 m wide, 10 m deep) in the upper reaches, to gorges about 90 m wide and 50 m deep in the lower areas, where the river bed is extremely sandy. In the dry season, the river bed contracts to a series of permanent waterholes.

The river has a seasonal character, with high flow rates observed in the wet season, when the river may flood up to 25 m above base flow within the gorge. Even in the upper gorges, flood levels 10 m to 15 m above usual depth have been observed. Permanent waterholes are fringed with a narrow band of riverine forest dominated by *Melaleuca argentea*, *Acacia* spp. and some rainforest species to a height of 15 m. The understorey is covered by a dense matting of creepers and non-perennial weeds, especially Wild passionfruit (*Passiflora foetida*). Aquatic vegetation is generally sparse, although *Blyxa* sp. and *Chara* sp. are common in some isolated pools, and patches of the lily *Nymphoides* sp. are present in some areas.

13.3.2 Fish monitoring

Aquatic surveys of the McArthur River area were first initiated by Mount Isa Mines, which commissioned a study of the aquatic fauna (mainly fish) of the river near the mine site in 1975 (Midgley, 1975). Additional fish surveys were also carried out in the region following requests by the Northern Territory Government, including within the McArthur River and adjacent streams (Midgley, 1982; 1994).

General surveys of aquatic fauna (fish and macroinvertebrates) were conducted in the MRM area for the original 1992 EIA process (Hollingsworth Dames and Moore, 1992a); and again for the 2005 EIA process (URS/MRM, 2005). A Northern Territory Museum survey of the fish and macroinvertebrates of Barney and Surprise Creeks was undertaken in 1993 (Hanley, 1993).

A commitment of the 2006 Public Environmental Report (PER) was to undertake a more comprehensive survey of the aquatic fauna of the McArthur River area, with particular reference to Freshwater Sawfish (*Pristis microdon*) populations. This survey was completed in 2006 (RPS, Bowman, Bishaw and Gorham, 2006). Additional aquatic studies have included preparation of a Freshwater Sawfish management plan (Indo-Pacific Environmental, 2009b); investigation of the Glyde River area for suitability as a potential biodiversity offset (Indo-Pacific Environmental, 2007b); and investigation of metals and lead isotopes in fish (Indo-Pacific Environmental, 2009d). Subsequent to these surveys, regular semi-annual monitoring of fish has been undertaken and is ongoing (Indo-Pacific Environmental, 2006a; 2007; 2008; 2009a; 2009b; 2010a; 2010b; 2011). Objectives of the fish monitoring program are to:

- monitor fish populations in permanent and semi-permanent pools
- monitor populations of the freshwater sawfish, a Vulnerable species (EPBC Act)
- monitor fish diversity in temporary or semi-permanent pools and riffles
- monitor heavy metal levels in aquatic biota
- monitor fish passage success through the McArthur River Channel by:
    - implementing a tagging program of key fish species
    - assessing temporal migration patterns of the fish within the river and determining habitat associations and the utilisation of the Channel
    - sampling of key sites within the Channel as well as both upstream and downstream.

These surveys have yielded a total of 47 fish species recorded from freshwaters of the McArthur River, including tidal freshwaters downstream of MRM. Of these, 27 are considered freshwater species (i.e. breed in freshwater) and 20 species can be regarded as estuarine vagrants. Fish monitoring sites are shown in Figure 13-1.

13.3.2.1 Fish monitoring methods

The biannual sampling regime of the monitoring program has been modified since 2006 to investigate the functionality of the McArthur River Channel and how the rehabilitation of the aquatic habitat in the channel has progressed. Since 2009 a greater sampling effort has aimed to investigate:

- suitability of the aquatic habitat in the channel for fish by comparing the suite of species present in the channel to that occurring in naturally vegetated reaches immediately above and below
- use of the channel as a thoroughfare for fish through additional netting and expansion of the existing tagging program
- effectiveness of large woody debris piles placed in the channel in April 2010 as habitat for fish.

Fish survey sites selected for the monitoring program were identified at those locations where water was likely to remain throughout the year and where access to the river was available. Annual survey sites include those as far upstream as Bessie Springs, as far downstream as below Burketown Crossing and main channel and tributary sites (in particular Surprise and Barney Creeks). Several sites have also been surveyed for fish in the Glyde River as part of an investigation into its suitability as a biodiversity offset in 2007 (Indo-Pacific Environmental, 2007b). Implementation of the 'Sampling Procedure for Metal and Lead Isotope Analysis in Fish and Macroinvertebrates' (Indo-Pacific Environmental, 2009e) in 2009 has led to fish being monitored further upstream at Top Crossing, about 60 km upstream of MRM.

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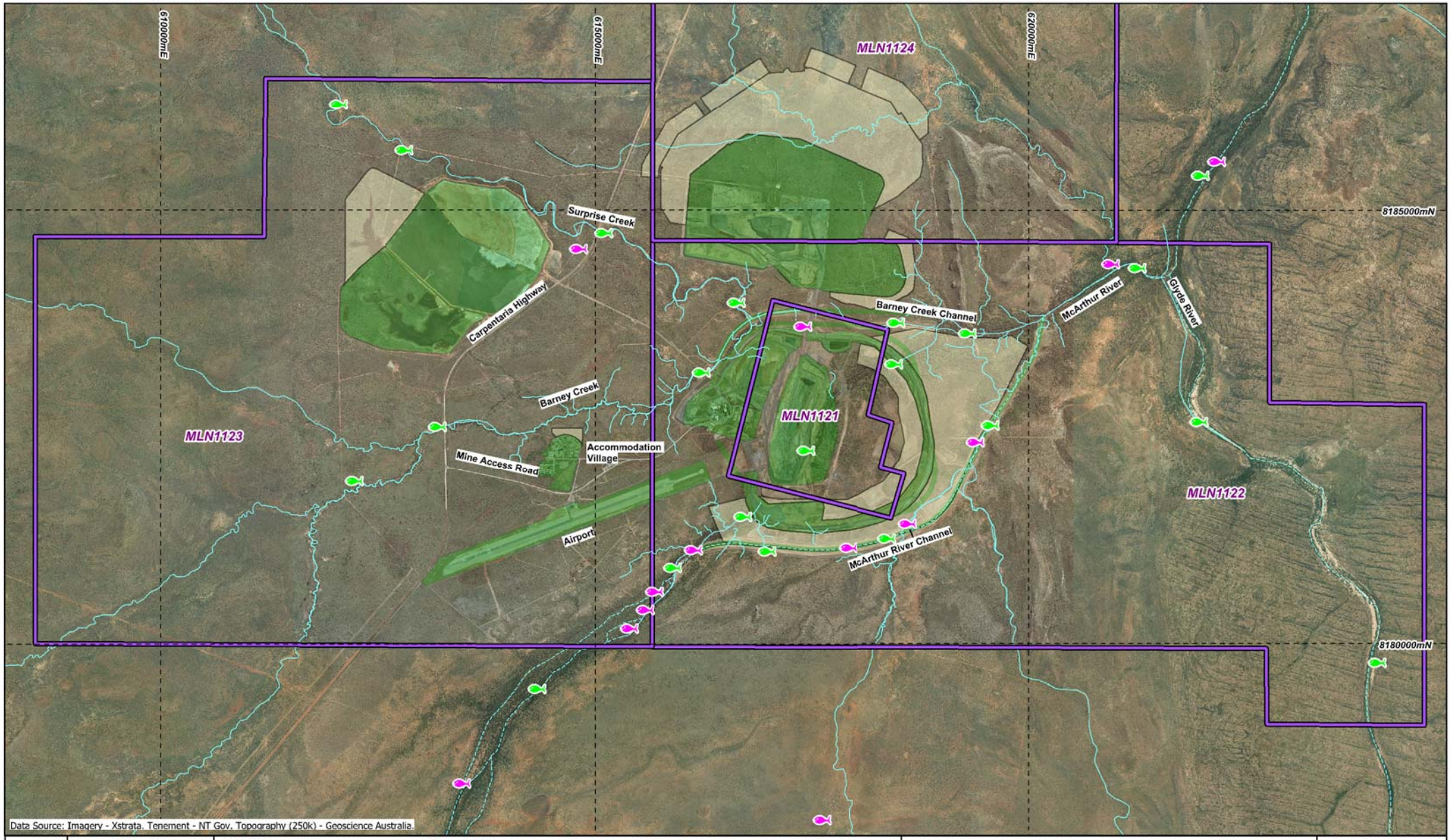

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LEGEND

Project tenement

Sample Type

Fish Monitoring Sites

Macroinvertebrate Monitoring Sites

McArthur River Mine
Phase 3 Development Project

Location of fish and macroinvertebrate monitoring sites

14/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 13 - 1

Sampling for fish occurs annually in the early dry (as soon as sites become accessible after the wet season) and late dry seasons. Fish community structure in the McArthur River is examined using a variety a methods that aim to avoid mortality of fish at all times, including fyke, seine and gill nets, electrofishing equipment, visual survey and line fishing techniques.

Fyke nets are one of the techniques used to monitor the movement of fish through the channel and additionally, to compare the diversity of fish present in the channel to those occurring in naturally vegetated stretches immediately upstream and downstream. Sampling generally occurs at three sites within the river channel and at two sites above and below the channel in each season. Fyke nets are a funnelling net. Two nets are deployed at each sampling site - one facing upstream and the other downstream. The mouth of the net is held open by a rigid aluminium frame, which is secured to the bottom with the use of a star picket. The wings of each net are then strung to the nearest bank or held in place with a picket driven into the bed - an arrangement acting to channel fish into the mouth of the net.

As fish move into the funnel, suspended screens prevent fish exiting the nets. In order to minimise the risk of drowning amphibians and aquatic reptiles the end of the net (the cod end) is tied up above the water line.

Electrofishing is also conducted at the majority of fyke net sites to capture a full suite of species present at the sampling site. This sampling tool is also used to sample fish occurring in large woody debris piles in the channel for comparison to the fish occurring on bare bank and for the collection of samples for metal analysis. Electrofishing is conducted using a Smith Root LR-24 backpack electrofisher and a small scoop net. Transects of variable but known length are electrofished at each sampling site and a fish per metre abundance calculated. Stunned fish are kept, allowed to revive in an aerated tub of freshly-collected water prior to being identified, measured and released.

Gill nets are utilised at long-term monitoring sites, including below and above the Burketown Crossing, Djirrinmini Waterhole, and Eight Mile Waterhole, with the aim of assessing the distribution of Freshwater Sawfish and larger bony fish. Gill nets were utilised in Bessie Spring until 2009. However because of the lack of captures and the distance upstream, it was potentially not suitable habitat for Freshwater Sawfish. Gill nets are a maximum of 40 m long, and comprised of two sinking monofilament panels each 20 m long, and of 100 mm and 150 mm stretched mesh, respectively. For safety reasons, gill nets are generally utilised during daylight hours. Most sampling sites are remote, have large on-water transiting distances with numerous in-water hazards and are inhabited by both estuarine and freshwater crocodiles, which are more active and more frequently captured at night. Furthermore, by-catch mortality is higher at night.

Tagging of bony fish has been conducted since 2007. The main aim of the tagging program is to investigate the passage of fish through the channel, with a number of species being tagged. Several MRM employees residing in the township of Borroloola have been trained in tagging procedures and equipped with tagging kits for use on Barramundi (*Lates calcarifer*). All tagged fish are entered into a tagging database maintained by MRM. Fish are tagged with individually numbered 40 mm (PDX) or 100 mm (PDS) dart tags (Hallprint fish tags), which are dull in colour to reduce the likelihood of detection by predatory species. Tags are generally placed near the origin of the second dorsal fin. In 2010 the MRM tagging program partnered with a recently instigated tagging program in the lower reaches of the McArthur River coordinated by Infofish as part of a population assessment of Barramundi.

In the case of cartilaginous fish, such as Freshwater Sawfish and Bull Sharks (*Carcharhinus leucas*), a cattle style tag, supplied by the DR-PIFR, is placed in the dorsal fin of captured individuals prior to release. Each tag carries an individual number and contact details for Fisheries. Information such as capture location, size and sex of individuals tagged is forwarded to Fisheries and contribute to the Northern Territory Shark Tagging Program. A genetic sample (small amount of tissue removed from the fin prior to applying the tag) is also preserved in DMSO (dimethyl sulfoxide) and forwarded to DR-PIFR for inclusion in their database.

13.3.2.2 Fish monitoring results

A total of 47 species of fish have been recorded from freshwaters of the McArthur River. Thirty two species of fish have been recorded from non-tidal waters, with the additional 15 species known from tidally influenced freshwaters in the vicinity of Burketown Crossing (Appendix D8). Twenty-seven species of fish are considered to be freshwater species, i.e. capable of breeding in freshwater. Three elasmobranch species have been also been recorded, with Freshwater Whiprays (*Himantura dalyensis* -formerly known as *H. chaophraya*) and Bull Sharks being recorded from tidal and freshwaters, and Freshwater Sawfish which has been captured as far upstream as Eight Mile Waterhole. A total of 28 records (including 19 captures) of Freshwater Sawfish have been collected between March 2006 and June 2011. None of the fish species recorded from the McArthur River system is restricted in range or specialised to a particular habitat. Most species are common and widespread across northern Australia.

Approximately 1,200 fish have been tagged with a PDS or PDX dart tag since 2007. Thirty two recaptures have been recorded with a vast majority (29) being Freshwater Catfish (*Neoarius paucus*). Recaptures of all individuals of this species near their site of first capture suggest strong site fidelity occurs. Several individuals have been recaptured up to three times over successive years. Three Barramundi have also been recaptured. Two Barramundi tagged upstream of MRM were recaptured in later years near the mouth of the McArthur River, indicating movement downstream through the channel.

Baseline sampling conducted between 2006 and 2008 (i.e. prior to the opening of the McArthur River Channel) indicated Splendid Rainbow Fish (*Melanotaenia splendida inornata*) to be the most abundant species occurring in the McArthur River during both the early and late dry seasons. Spangled Perch (*Leiopotherapon unicolor*), Macleay's Glassfish (*Ambassis maclaeyi*), Muller's Glassfish (*Ambassis mulleri*), Barred Grunter (*Amniataba percoides*) and Flathead Goby (*Glossogobius giurus*) were also captured in high abundances between 2006 and 2008. These species were also well represented in the original McArthur River channel designated for realignment, with a total 29 species (21 freshwater) of fish known from that section and waterholes immediately upstream. Statistical comparison of survey site species data over those years indicated relative stability in the suite of species present within each sample site in each season and year, as well as the occurrence of a comparable suite of species between sample sites in the vicinity of the mine.

In contrast to pre-channel data on the McArthur River, sampling after the opening of the channel (2009 and 2010) indicated that a depauperate suite of species existed within the channel with both diversity and abundance of fishes being far lower than those present in the original channel (i.e. 17 species of fish in the channel compared with 29 species prior to realignment) and in naturally vegetated sections above and below the channel. Of particular concern was the lack of small prey species including Splendid Rainbow Fish (the most abundant species in the river) and the very high abundances and larger sizes of aggressive piscivorous species, including Mouth Almighty (*Glossamia aprion*) and Barred Grunter. Reduced diversity was attributed to the lack of suitable habitat for fishes (e.g. no woody debris or rock benthos), high level of predation in the channel and reduced water quality (including elevated water temperatures and light attenuation).

Introduction of large woody debris was considered to be a vitally important rehabilitation strategy for aquatic habitats within the channel. Large woody debris not only provides habitat and protection for smaller (prey) species but encourages the deposition of river sediments. Sandy deposited (as opposed to rocky) benthos favours a number of species occurring in the McArthur River. Numerous piles of large woody debris were introduced into the channel at 35 locations in June 2010. Despite being in place for only a few months the effectiveness of the large woody debris as fish habitat was assessed in September 2010 by comparing the fish abundance at woody debris piles to those occurring along areas of open bank with limited habitat structure (i.e. typical of the channel prior to commencement of this program). Significantly higher species diversity and abundance was found to be occurring at woody debris sites as opposed to bare bank (Figure 13-1). Mouth Almighty, Sooty Grunter (*Hephaestus fuliginosus*) and Seven-spot Archerfish (*Toxotes chatareus*) were recorded only from woody debris sites. Other species, including Spangled Perch, Barred Grunter and Splendid Rainbow Fish, were also recorded at much higher abundances at woody debris than open bank sites. The presence of Splendid Rainbow Fish was notable as this was the first time the species had been detected in the channel since its construction, despite being the most commonly encountered fish species in the

McArthur River. The introduction of woody debris into the channel will continue annually as part of the ongoing rehabilitation strategy.

A survey conducted in 2011 (Indo-Pacific Environmental, 2011) found greater diversity and abundances of fish species within the Surprise and Barney Creek systems in proximity to the Project site when compared to previous surveys.

13.3.3 Macroinvertebrate monitoring

A number of studies have documented the macroinvertebrates of the McArthur River in sampling associated with the development of MRM. Pre-mine and establishment phase surveys were commenced by Midgley (1975), with aquatic surveys throughout the McArthur and Glyde River systems, including sites within and downstream of the Project's mine area. The initial surveys focussed on freshwater fish and include records of molluscs and crustacean species. Dames and Moore (1977) completed a study of the freshwater biota of the McArthur River system, sampling a total of eleven sites throughout the catchment, including areas upstream and downstream of MRM, Barney Creek, and the Glyde River. Hollingsworth Dames and Moore (1992) sampled four aquatic sites in the vicinity of the MRM mine site, including the McArthur River and Surprise and Barney Creeks. Macroinvertebrates, crustaceans and molluscs were sampled as a component of these surveys. Hanley (1993) sampled freshwater fish and macroinvertebrates at sites on Barney and Surprise Creeks within the Project area.

During assessments for MRM's 2005 Draft EIS conducted between 2002 and2003, 12 additional macroinvertebrate sites were sampled on the main McArthur River channel and on the Glyde River (URS/MRM, 2005). Subsequent surveys were undertaken at a number of sites during the construction of the McArthur River Channel and open pit bund protection walls, commencing in the late dry season of 2008 (Indo-Pacific Environmental, 2008). These surveys followed AUSRIVAS sampling protocols and included five sites on the main channel of the McArthur River (Indo-Pacific Environmental, 2008) (Figure 13-1).

Monitoring of aquatic macroinvertebrates of the McArthur River main channel commenced at five sites in April and May 2007 and during the late dry season 2007 (Indo-Pacific Environmental, 2008). Following consultation with DR-PIFR the program was expanded to incorporate an expanded number of sites commencing in the wet season recessional flow period between April and May 2008. Sampling was repeated in the 2009, 2010 and 2011 recessional flow periods. Sampling for the program is limited to one seasonal sample per year as per the AUSRIVAS protocol (Lamche, 2007).

Objectives of the macroinvertebrate monitoring program include:

- collation of baseline data on the distribution and abundance of aquatic macroinvertebrates in selected habitats within the McArthur River and associated tributaries
- monitoring of aquatic macroinvertebrates following commencement of the operational phase of the McArthur River and Barney Creek Channel
- collection of surface water and fluvial sediment data at macroinvertebrate sampling sites
- collation of environmental variable data at macroinvertebrate sites
- analysis of macroinvertebrate data to provide comparison between treatments (exposed, channel and reference sites).

13.3.3.1 Macroinvertebrate monitoring methods

The value of aquatic macroinvertebrates in monitoring the condition of instream conditions and water quality has long been recognised. The rationale behind the use of aquatic macroinvertebrates in biological monitoring is based on the fact that the results can have greater ecological meaning than physico-chemical measurements, unless contamination or disturbance of waterways is so severe that the implications of chemical results for the ecology of the river are obvious (Halse *et al.*, 2007). Macroinvertebrates have been

chosen as indicator organisms as they are ubiquitous, have a relatively well-known taxonomy and are easily sampled (Halse *et al.*, 2007).

The optimum sampling period in the Northern Territory wet/dry tropics is four to six weeks following the cessation of wet season storm flushing events, enabling macroinvertebrates to recolonise stream habitats following flood disturbance (Lamche, 2007). Sampling is generally conducted earlier on minor tributaries (Surprise and Barney Creeks) and later on larger tributaries (Glyde River and McArthur River).

Macroinvertebrate sampling sites selected within the context of the local tributaries, mine operations and facilities and channels were designed to sample reference sites, channel sites and sites potentially influenced by a gradient of contaminant concentrations relating to mine operations. The main study area is located on the McArthur River and associated tributaries from the Kilgour River confluence (20 km upstream of the channel) to the lower McArthur River (approximately 9 km upstream of Borroloola). A number of off-stream reference sites are located outside this area on Leila Creek, Amelia Creek, the Glyde River, Wearyan River and Robinson River.

A number of additional reference sites have been added during the course of the program in an effort to locate suitable reference sites in catchments removed from mining operations. Three sites in the open pit area were not sampled after 2008 following the construction of the bund and operation of the McArthur River Channel, as these sites were no longer accessible or did not support surface water.

The sites include:

- three potentially exposed sites and one upstream reference site on Surprise Creek upstream of the Barney Creek confluence
- one site on Barney Creek above the Barney Creek Channel and one site on the Barney Creek Channel
- one site on the McArthur River below the Barney Creek Channel and between the McArthur River inlet and outlet
- three sites on the McArthur River Channel
- three sites on the McArthur River below the McArthur River Channel
- three sites on the McArthur River above the McArthur River Channel
- five reference sites on the Glyde River and associated tributaries.

In the Northern Territory, AUSRIVAS models have been developed for the Darwin - Daly region (Lamche, 2007) however there are no models available for the eastern section of the Northern Territory. As such DR-PIFR has recommended that sampling and laboratory processing be conducted following established AUSRIVAS protocols, while data analysis should employ traditional methods for the assessment of site conditions and comparison of sites. In this program most aspects of sampling and laboratory processing closely followed established Northern Territory protocols (Lamche, 2007) with reference to Lloyd and Cook (2002) for sampling of riffle habitats.

At each site a range of standard surface water, fluvial sediment, spatial and habitat variables were measured during sampling. Environmental variables were measured to assess the extent of the potential impacts mining activities were having on surface water, sediments and natural habitat factors, as well as to enable interpretation of differences in macroinvertebrate assemblages between sites.

The methodology generally follows Northern Territory AUSRIVAS protocols (Lamche, 2007). Sampling methods for riffle habitats follow Queensland Department of Natural Resources and Mines protocols (QDNRM, 2001). During 2010, macroinvertebrate samples were collected at riffle and edge habitats. Site variable data collected at each site included edge and riffle habitat characteristics, 100 m reach substrate, riparian vegetation and stream morphology and 100 m reach water quality observations and disturbance

measures. Field water sampling included pH, dissolved oxygen, turbidity, water temperature and salinity. Water and fluvial sediment samples were collected for laboratory analysis, with test parameters including pH, electrical conductivity, sulphates (SO_4) and metals including Cadmium (Ca), Nickel (Ni), Copper (Cu), Lead (Pb) and Zinc (Zn). Fluvial sediment samples were collected and analysed for a range of metals including cadmium, copper, lead and zinc.

Each macroinvertebrate sample is collected using a 250 micron mesh net with an opening of 350 mm at the base. The length of habitat sampled is 10 m per habitat sample and samples are collected on separate lengths of habitat if a contiguous 10 m length is not present. Samples are collected at edge habitats at all sites and at riffle habitats if they are present at a site. Field and laboratory processing of macroinvertebrate samples generally follows the Northern Territory AUSRIVAS manual (Lamche, 2007).

Macroinvertebrates are identified in accordance with the AUSRIVAS family level methodology described in Lamche (2007). The main focus of the analysis is identification to family level for analysis purposes. However macroinvertebrates are identified to lower taxonomic levels or species types where possible. Analysis of the macroinvertebrate data is conducted using multivariate routines in PRIMER 6 (Plymouth Routines in Multivariate Ecological Research) (Clarke and Gorley, 2006) and PERMANOVA+ for PRIMER (Anderson *et al.*, 2008).

13.3.3.2 Macroinvertebrate monitoring results

Combined results of family-level taxa recorded at each site during the macroinvertebrate sampling program is presented in Appendix D8. Key results from analysis of the macroinvertebrate data undertaken for the project up to 2010 are described in the following section.

Aquatic macroinvertebrate taxa numbers from edge habitats were lowest at exposed sites on Surprise Creek and Barney Creek downstream of MRM's processing areas and the TSF and at reconstructed sites on the channels. There was a general increase in taxa numbers indicating recovery at downstream reference sites.

Analysis indicates that during some sampling periods a number of surface water variables, (Cu and log Pb), habitat variables (percentage vegetation cover 100 m reach) and spatial variables (latitude) had a significant relationship with the macroinvertebrate species derived multivariate data ($p<0.05$). Percentage vegetation cover (100 m reach) alone accounted for 22% of the variability in the data and was the most important variable.

During 2009, macroinvertebrate communities at riffles within the McArthur River Channel were found to be similar to those at reference sites. This indicates that riffle habitats within the channel have been rapidly colonised by macroinvertebrates following commencement of operation of the channel, despite the absence of habitat features such as riparian vegetation.

Site groups with the highest dissimilarity levels for riffle habitat macroinvertebrates were reference sites and exposed sites, indicating that elevated levels of contaminants and degraded water quality had a greater influence on riffle macroinvertebrates than the disturbance and habitat changes at channel sites.

Riffle habitats at exposed sites on Surprise Creek and Barney Creek Channel held lower biodiversity and fewer individuals compared to both reference and McArthur River Channel sites. Major variables explaining the distribution of macroinvertebrate biodiversity at riffle sites were pH, log turbidity, electrical conductivity (EC), arsenic in surface water (As SW), zinc in surface water (Zn SW) and percentage cobble (riffle habitat).

There is evidence of a gradient of elevated metals, sulphate and other parameters associated with the Surprise/Barney Creek system. Sampling conducted in 2008-2010 has shown negative impacts on aquatic biota (macroinvertebrates) associated with elevated levels of metals, sulphate and other water chemistry parameters within Surprise and Barney Creeks.

Impacts on macroinvertebrate communities are illustrated by significant negative correlations between macroinvertebrate taxa numbers in response to increasing levels of key variables (e.g. Cu, Pb, SO_4). These relationships were less pronounced but still significant during the 2009 and 2010 recessional flow period,

possibly due in part to improved seasonal flow conditions and reduced effects of evapoconcentration of pollutants (Indo-Pacific Environmental, 2009; 2010).

Statistically significant negative correlations exist between macroinvertebrate community diversity and surface water metals (e.g. Pb), indicating adverse impacts on biota in receiving waters. The correlation between taxa numbers and percentage silt/clay at edge habitats was also negative, indicating the impacts of excessive deposition of fine sediment and general disturbance on aquatic macroinvertebrates.

Surveys in 2008-2010 revealed macroinvertebrate communities within the channel edge sites were small in comparison to reference sites and this was related to the absence of riparian vegetation and stream morphology factors. The correlation between edge habitat taxa numbers and riparian vegetation parameters (percentage vegetation cover 100 m reach and percentage vegetation cover edge) were positive, with sites with higher percentages of vegetation cover recording higher numbers of macroinvertebrate taxa. Riparian vegetation condition is clearly important to the condition of in-stream macroinvertebrate populations in edge habitats.

Riffle sites on exposed sections of Surprise Creek and the Barney Creek Channel had macroinvertebrate communities that were significantly less diverse compared with reference sites or McArthur River Channel sites. Riffle sites within the McArthur River have been rapidly colonised by macroinvertebrates and are not significantly different to reference sites on the basis of macroinvertebrate abundance data.

13.3.4 Aquatic reptiles

Aquatic reptiles have not been formally surveyed as part of the monitoring program to date. However, researchers conducting the surveys have informally recorded two crocodiles, three freshwater turtles and one file snake species in the McArthur and Glyde river systems (Table 13-1). Data on aquatic reptiles captured during the biannual surveys of fish has been collected since 2010 (Indo-Pacific Environmental, 2010).

Freshwater crocodiles (*Crocodylus johnstoni*) are common in the McArthur and Glyde river systems. They occur in all habitats, including the ephemeral streams of Surprise and Barney Creeks and are most abundant in sandy refuge pools along the Glyde River. Steep sandy banks, which are common along the Glyde River gorge, offer suitable nesting habitat for this species.

Although estuarine crocodiles (*Crocodylus porosus*) occur in the lower reaches of the McArthur River, there are no documented records from the area near the Project's mine. Anecdotal reports indicate that individual crocodiles are occasionally sighted at Eight Mile Waterhole.

The Gulf snapping-turtle (*Elseya lavarackorum*) (EPBC Act - Endangered) is a large short necked turtle restricted to several large river systems of the southern gulf, from the Roper River NT across to the Nicholson River, Queensland. See Section 13.3.5.2 for details of this species on site.

Surveys in April 2003 found two Arafura file snakes (*Acrochordus arafurae*) at two locations within the river channel area in shallow sandy habitats. Although widespread, this tropical species had not previously been recorded in the Project's mine area.

Table 13-1 Aquatic Reptiles of the McArthur and Glyde Rivers

Common Name	Scientific Name
Freshwater crocodile	*Crocodylus johnstoni*
Estuarine crocodile	*Crocodylus porosus*
Worrell's turtle	*Emydura subglobosa worrelli*

Table 13-1 Aquatic Reptiles of the McArthur and Glyde Rivers (cont)

Common Name	Scientific Name
Gulf snapping-turtle	*Elseya "lavarackorum"* – Endangered, EPBC Act.
Northern longneck turtle	*Chelodina rugosa*
Arafura file snake	*Acrochordus arafurae*

13.3.5 Threatened aquatic fauna

13.3.5.1 Freshwater Sawfish (*Pristis microdon*)

The Freshwater Sawfish is currently listed as vulnerable (EPBC Act and TPWC Act) and as endangered by the International Union for the Conservation of Nature (IUCN). The Freshwater Sawfish is known from several rivers across northern Australia including the Fitzroy, Durack and Ord Rivers (Western Australia), the Adelaide, Victoria, Daly and McArthur Rivers (Northern Territory), and the Gilbert, Mitchell, Norman and Leichhardt Rivers (Queensland). Outside Australia, it is known from New Guinea, Indonesia and may possibly exist in India (Last and Stevens, 1994; Pogonoski *et al.,* 2002; Stirrat and Larson, 2002). Recent surveys of freshwater elasmobranchs in northern Australia recorded the species from the Robinson, Wearyan, McArthur, Roper, Adelaide, Daly and Victoria Rivers in the Northern Territory, and in the Fitzroy and Robinson Rivers in Western Australia. The survey also recorded the species in northern Queensland. The species was caught several hundred kilometres upstream from the coast in the Roper and Fitzroy Rivers, and the Fitzroy River (Western Australia) was found to be a stronghold for this species in Australia (Thorburn *et al*., 2004).

In Australia, Freshwater Sawfish appear to be confined to freshwater drainages and the upper reaches of estuaries in northern Australian waters. They prefer slightly alkaline waters, and are known to breed in freshwater. Freshwater Sawfish prefer sandy or muddy substrates away from riparian vegetation and feed on slow-moving shoaling fish, molluscs and small crustaceans which are swept out of the sand and mud by the saw (Pogonoski *et. al*., 2002).

The main threat to this species has been identified as gill net fishing to which it is particularly susceptible. As the McArthur River was closed to commercial fishing in 2002, gill netting in this area is no longer considered a threat. The species is also occasionally taken by recreational line anglers. MRM has erected signs around the McArthur River system making anglers aware that the sawfish is a threatened species that if caught, must be released.

A total of 28 records (including 19 captures) of Freshwater Sawfish have been collected during the biannual sampling of fish for MRM between March 2006 and June 2011. With the exception of a 2,050 mm individual captured in June 2011, most have been small and between one and two years of age. A single recapture has been recorded during the study - an individual captured in waters above the Burketown Crossing in September 2009 and recaptured one year later in the same area, had grown approximately 550 mm.

Capture data for Freshwater Sawfish suggest that the recruitment of juveniles is related to the magnitude and duration of the wet season (i.e. greater numbers are encountered after large wet seasons). Sustained waters of a long wet season facilitate upstream recruitment by providing increased depth, (reducing obstruction by barriers including rock bars, sand bars and barrages) and extending the time available for upstream migration.

13.3.5.2 Gulf Snapping-Turtle (*Elseya lavarackorum*)

The Gulf snapping-turtle (EPBC Act - Endangered; TPWC Act - least concern) is a large short-necked turtle originally described from fossil specimens found at Riversleigh, Queensland, which is now known to be an

extant species (Thomson *et al.*, 1997). It occurs in several large river systems of the southern gulf including the Roper, Limmen Bight, Robinson and Calvert Rivers in the NT, across to the Nicholson River in Queensland (Wilson and Swan, 2010). However, this distribution may not be correct, with recent research that suggests this species is confined to the Nicholson River drainage system in Queensland and that *Elseya* turtles from the McArthur River are currently referrable to the more widespread *E. dentata* taxa (Georges and Merrin, 2008; Georges and Thomson, 2010). However, with records of an *Elseya* sp. from the Gulf region east of the MacArthur River that corresponds to neither *E. dentata* nor *E. lavarackorum*, it is possible that the *Elseya* known from the McArthur River are either *E. lavarackorum* or an undescribed species (AWC, 2009).

During the course of regular fish monitoring surveys at McArthur River in 2007, eight individuals of a large *Elseya* sp., most likely *Elseya lavarackorum*, were captured incidentally by gill netting at a location in the lower Glyde River. All specimens were released. Despite a significant effort of netting for fish at various locations in the main channel of the McArthur River and in other areas, no other records of this turtle have been made despite other turtle species (e.g. *Emydura worrelli*) regularly being captured.

13.3.6 Potential impacts on aquatic fauna

Without the implementation of effective mitigation strategies, a number of Project components have the potential to degrade downstream aquatic habitats through release of contaminated runoff or increased sedimentation. These components include the expansion of the mine and associated infrastructure area, as well as the TSF and OEFs.

Monitoring of tissue samples as part of ongoing macroinvertebrate sampling shows bioaccumulation of heavy metals within the tissues of macroinvertebrates within the region of MRM's mine site. This bioaccumulation may be due to the high background levels of heavy metals that naturally occur in mineralised areas.

Elevated sulphate levels in the surface waters of Surprise and Barney Creeks in the vicinity of the MRM may affect biodiversity in these systems. Recent monitoring of fish diversity and abundance show there are still high numbers of resilient species within these systems (Indo-Pacific Environmental, 2011).

The biodiversity in the McArthur River may potentially be affected if the riparian vegetation between the channel and the OEF is not established effectively.

To mitigate potential impacts from any containment overflow on the receiving waters, the management and monitoring strategies detailed in Section 13.3.7 and 13.3.8 will be implemented. Deterioration of downstream aquatic habitats due to impacts on water quality will also be mitigated by implementation of these strategies. Previous hydrological modelling has shown that negligible deleterious water quality impacts are expected downstream. While no Project impacts are expected on the Port McArthur Tidal Wetlands at the mouth of the McArthur River, located 60-100 km downstream of the mine, localised impacts in the vicinity of the Project's mine site could potentially occur if appropriate mitigation strategies are not implemented effectively.

13.3.7 Management of aquatic fauna

The old McArthur River channel, both upstream and downstream of the current bund wall, remains operational as a functioning ecosystem, with some relevance for the maintenance of aquatic fauna diversity and as a terrestrial fauna refuge and corridor. Where practicable, development of these two areas will be delayed until riparian ecosystem functionality of the surrounding channel has been enhanced.

Encroachment of the South and East OEF area within close proximity of Barney Creek and the McArthur River Channel may potentially impact on terrestrial and aquatic ecology, as well as a potential to impact on rehabilitation efforts. In order to retain these areas as functioning ecosystems and avoid impacts on aquatic biodiversity, buffer zones in excess of 70 m will be maintained between the OEF/ bund and waterways.

When the East OEF is established, banks will be stabilised by increased planting of the McArthur River Channel batters, direct seeding and planting of established trees to help prevent excessive erosion due to

elevated flow rates and provide slow back-waters to aid upstream fish migration. Building additional baffling on the western channel wall to reduce erosion will be implemented if erosion appears.

Appropriate water management infrastructure will be incorporated into the expanded North OEF to prevent flow of contaminants into the McArthur River via drainage lines entering below the channel.

Coarse woody debris will be retained as habitat piles adjacent to, and within the channel to provide refugia, disrupt stream flow rates and provide heterogeneity of habitats.

As part of the continuing management of the McArthur River Channel that was required as part of the underground to open pit conversion, results from the aquatic monitoring program will be regularly assessed and, if necessary, changes to the management of the realigned channel made to alleviate adverse effects.

Mineral salt depositions on the banks of Surprise and Barney Creeks (and anywhere else such deposits are recorded) will be analysed and monitored to aid assessing the potential impacts that elevated sulphate levels pose to the McArthur River system.

13.3.8 Recommendations for monitoring of aquatic fauna

Development of the East and South OEFs will result in disturbance of the two old McArthur River channel areas. Should ecological values within the old channel areas exist immediately prior to disturbance of this area, surveys of aquatic fauna will be undertaken to identify their relevance as dry season refugia and wet season resting areas, as well as to inform the management of the potential impacts of this Project component.

Heavy metal monitoring including both macroinvertebrates and fish species will continue to be undertaken as per the current monitoring program (EES, 2010).

Due to the presence of elevated sulphate levels both within surface waters and deposited along banks of Surprise and Barney Creeks, monitoring of fish abundance and diversity in these systems will be incorporated into the ongoing monitoring program.

Riparian bird and aquatic ecology monitoring will continue to provide a mechanism for the detection and management of potential impacts on biodiversity from the Project.

13.4 Terrestrial Fauna

Terrestrial fauna potentially affected by the Project is described in this section. Data from database searches, literature reviews, current monitoring programs and general field surveys have been used to describe the species composition and habitats of terrestrial vertebrate fauna in the wider McArthur River area and in the proposed Project expansion areas. Large amounts of existing current data were available and were related directly to locations within or adjacent to the Project area. Much of the area was already in a disturbed state (URS, 2011). For these reasons, it was concluded that primary data collection was generally not required to the same level as a 'greenfield' site where no previous baseline data existed, but that fauna surveys to verify previous data were required. Locations of fauna survey sites are presented in Figure 13-2.

A fauna survey incorporating the main vertebrate fauna trapping program was undertaken between 30 May and 6 June 2011. Four systematic survey sites were sampled within the study area, including two sites in the proposed North OEF expansion area and two sites in the East OEF area. Additional sites were also sampled opportunistically. Other survey components, including site inspections, incidental observations and remote bat echolocation detection were undertaken between 30 May and 23 June 2011.

13.4.1 Previous studies

Existing reports and publications on the fauna of the McArthur River were reviewed. The combined dataset from these records was compiled into an overall species list for the site. Where records were directly applicable to the proposed project, these were highlighted for high relevance. These included records from areas within, or in close proximity to areas affected by the proposed project, and also records from areas with

identical habitat to those in the proposed expansion area. All sites previously sampled for fauna or aquatic fauna on, or near the proposed expansion area, were identified and mapped, and the level of search effort recorded.

Fauna surveys conducted in and around MRM on numerous occasions since the 1970's broadly fall into two categories:

- surveys conducted specifically to support environmental management of the mining operations, such as for EIA investigations
- surveys conducted by Government or private groups for purposes other than mining related assessment.

A series of wide-ranging surveys for terrestrial fauna in the Lower McArthur River Region were conducted by CSIRO during the 1970's (CSIRO, 1976). Mount Isa Mines financed studies, ranging across many areas of the Borroloola region, not limited to the Mineral Lease area. Historical data was used in the study, but site-specific records were not identified in the final report.

Following Northern Territory Government recommendations arising from the 1992 EIA process, an additional fauna study of the MRM area and surrounds was conducted (Ecostudy, 1992). A frog survey of the MRM mine area was also conducted in 1992 (Tyler, 1992).

General surveys of terrestrial fauna were conducted in MRM's mine area for the original 1992 EIA process (Hollingsworth Dames and Moore, 1992a); and again for the 2005 EIA process (URS/MRM, 2005). The focus of these surveys was to assess areas not well covered by the previous fauna studies, especially the McArthur River Channel, the open pit area and the OEF area. Additional surveys covering all areas of the project were also conducted as part of the subsequent PER required for the 2005 EIA process.

Following on from commitments made in the 2005 EIA process, Xstrata Zinc initiated studies to set up a biodiversity offset program to compensate for the environmental impacts of the mining operation. The program involved identification of several candidate sites on McArthur River Station, with a preferred option (the Glyde/Lower McArthur) eventually being settled upon (Xstrata Zinc, 2011). The proposal for this program has been submitted to the Northern Territory Government and is currently under review. As part of this work, field surveys were conducted in the Glyde River area for threatened species.

A full list of species, comprising 258 species recorded to date, was included in the 2005 EIA process (URS/MRM, 2005a). Many of these species however, occur in habitats which will remain undisturbed by the Project, particularly the sandstone ranges and plateaux east of the development.

Surveys of the area not related to MRM have mainly targeted threatened species, particularly the Carpentarian grasswren (*Amytornis dorotheae*) (TPWC Act - Endangered). The typical locality for this species is the Glyde River, near the Project's mine site, and for many years up to the late 1980's, it was regularly visited by birdwatchers. An NT Government consultancy (Martin and McKean, 1986) which surveyed the area for the grasswren in 1986 is believed to be the last time the species has been recorded in that area. Sites in the MRM area were surveyed for grasswrens in 2005 as part of a Masters study (Perry 2005; Perry *et al.* 2011), in 2007 as part of the biodiversity offsets program (URS, 2007a) and in 2008-2009 by Birds Australia (Harrington *et al.*, 2009), but the species was not detected in the area during these surveys.

Many of the previous studies report fauna observations made at sites that could be potentially impacted by the Project, or in nearby areas of identical habitat. These include the following studies:

- Ecostudy (1992) – two sites in the TSF area; one site in the river upstream of the expansion area
- Hollingsworth Dames and Moore (1992) – two sites sampled along McArthur River upstream of pit in expansion area
- Dames and Moore (2003) – two sites (F6 and F7) in area of the original OEF; two sites (F4 and F5) along McArthur River in existing MRM mining area; general observations in the TSF area.

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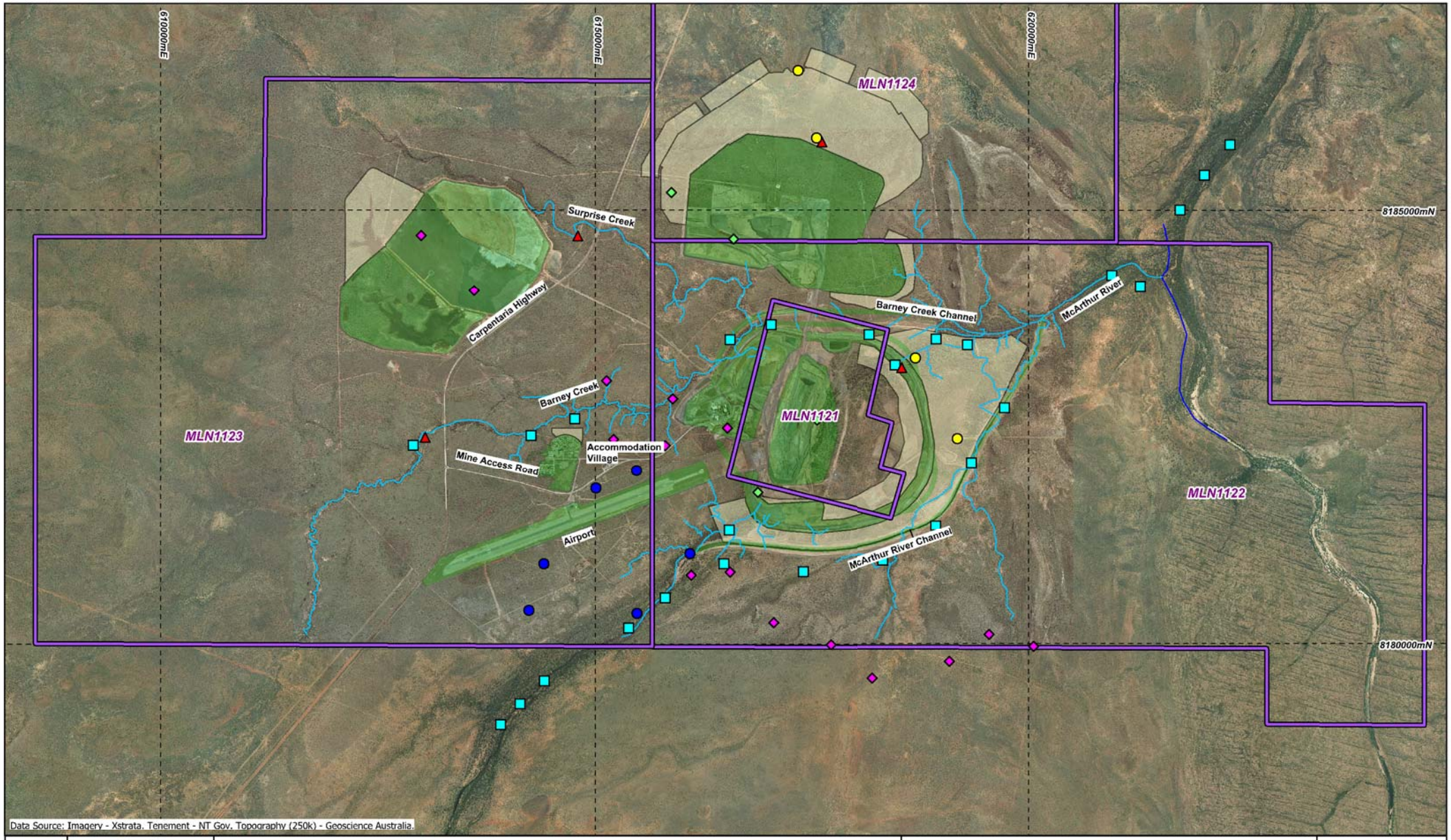

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LEGEND

Project tenement

Sample Type

- Fauna Survey Sites 2011
- Bat Trapping Site
- Riparian Bird Monitoring Sites
- Ecological Study Sites 1992
- Fauna Survey Sites 2002/2003
- Ecology Sites 1992
- Hollingworth Dames & Moore Sites 1992

McArthur River Mine Phase 3 Development Project

Location of fauna survey and monitoring sites

14/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 13 - 2

13.4.2 Database searches

Data on the fauna of the McArthur River region were gathered from a number of recent and historical datasets. Searches were conducted on two Northern Territory Government and one Commonwealth Government databases to obtain information on species lists, conservation values and threatened species potentially occurring in the Project area. The following searches were conducted:

- Northern Territory Fauna Atlas - for a species list and conservation attributes for the rectangular area surrounding MRM was conducted with a top left coordinate of 53 K 610000 8188000 and a bottom right coordinate of 53 K 620000 8176000. This database was accessed on 19 April 2011 (NRETAS, 2011)
- Northern Territory National Resource Management (NRM) Infonet site for environmental data, including species lists, was conducted for the McArthur River area using the coordinates $16^0$22' to $16^0$28' and $136^0$01' to $136^0$09' which represents an area of about 178 km^2 surrounding the mine. This database was accessed on 14 June 2011 (NRM, 2011)
- Commonwealth Government's EPBC Protected Matters Search Tool for the block surrounding MRM mine area (coordinates 136.03008 -16.38679, 136.12371 -16.38631, 136.12433 -16.49477, 136.03065 -16.49526, 136.03008 -16.38679), for the potential presence of EPBC listed threatened species (SEWPAC, 2011a).

The Northern Territory Fauna Atlas search returned fauna records for 19 amphibian, 39 reptile, 139 bird and 18 mammal species (Appendix D8). Records cover a wide area around the Project's mine site and it is likely that many of these species do not occur within the Project area. These records come from Northern Territory Museum specimens, as well as Atlas records from private and Government surveys in the area. It is likely that many of these records are duplicated from surveys previously conducted as part of previous EIA process investigations. The search results include detailed location coordinates for each species record, and the conservation status (TPWC Act and EPBC Act) for each species. From these data, locations of listed threatened or migratory species sightings within or near the Project area were extracted.

The Northern Territory NRM Infonet database provided data, including that from nearby blocks, so the search results cover a greater area than that specified in the coordinates. Search results indicated a total of 24 frog, 80 reptile, 245 bird and 33 mammal species in the region, although some of these species would not be expected in the Project area due to habitat limitations. The report also identified 16 species regarded as threatened under TPWC Act or EPBC Act as potentially occurring in the region.

The EPBC Protected Matters Search Tool results indicated six threatened and 14 migratory species listed under the EPBC Act as having potential to occur within the area (Table 13-2).

This chapter describes the recent and ongoing terrestrial fauna field investigations undertaken at McArthur River in response to recommendations by the NT Government in its approval of the 2006 PER for the Phase 2 Expansion of the mine and commitments undertaken by Xstrata as part of that process (EMS, 2008; 2009a; 2010a; 2010b).

13.4.3 Riparian bird monitoring

As a component of approvals for the McArthur River Channel, a commitment was included in the PER and Sustainable Development Mining Management Plan (MMP) to conduct a riparian bird monitoring program. The objective of the program is to monitor riparian birds in the vicinity of MRM and to assess the progress of rehabilitation works in the vicinity of the channel works for Barney Creek and the McArthur River (Figure 13-2). A key requirement of the expansion approval was the restoration of a functioning riparian corridor that can provide for the dispersal and movement of riparian birds and other wildlife between habitats up and downstream of the channel. The monitoring program focused on riparian birds, and in particular on two key riparian indicator species - the buff-sided robin (*Poecilodryas cerviniventris*) and the purple-crowned fairy-wren (*Malurus coronatus macgillivrayi*) - species chosen as indicators due to their known strong habitat association with riparian forest and woodland habitats.

The riparian bird monitoring program commenced in 2006 included bi-annual sampling conducted in the late wet season/early dry season and late dry season. Each seasonal survey included:

- seasonal monitoring of riparian bird communities at the sample sites established during the late dry season 2006
- assessment of seasonal changes in the abundance and distribution of the riparian bird assemblage and riparian habitat specialist species
- supplementary colour banding of riparian birds and riparian indicator species
- assessment of movements of colour banded birds during seasonal riparian bird monitoring.

13.4.3.1 Study area and sample sites

Twenty-six riparian bird monitoring sites were established in November 2006 on the McArthur River, McArthur River Channel and Barney Creek. Each site included a lower bank (riverine/stream corridor) and adjacent higher bank (floodplain) plot area to sample riparian forest/woodland and adjacent riparian woodland/low open woodland habitat (56 survey plots). During the course of the monitoring program a number of sites have been added or relocated due to refinement of the monitoring methodology and to accommodate on-going clearing and mining activities within the study area. The following monitoring sites have been established (refer to Figure 13-2):

- riparian vegetation on the McArthur River upstream of the open pit area and river channel (5 sites, 10 survey plots)
- riparian vegetation on the McArthur River downstream of the open pit area and river channel (5 sites, 10 survey plots)
- riparian vegetation on the McArthur River between the inlet and outlet and adjacent to, or within the bunds protecting the open pit area (6 sites, 12 survey plots). These sites may have been impacted by the diversion of water from the existing McArthur River channel and the proximity of mining activity. An additional site (PIT 6) was added in April 2008 due to the loss of an existing site (PIT 2) as the river channel construction activities progressed
- McArthur River Channel (rehabilitation or riparian restoration area) (6 sites, 12 survey plots). These sites represent a restoration treatment within the McArthur River Channel where the restoration of the riparian corridor is to be undertaken. Monitoring of higher bank reference survey plots was commenced in April 2007 (6 survey plots)
- Barney Creek riparian corridor and channel. Three sites (6 survey plots) are located on Barney Creek upstream of the re-alignment (reference) and three sites (6 survey plots) are located on the channel of Barney Creek (riparian restoration). Monitoring of higher bank survey plots was commenced in April 2007. Survey sites were re-organised during 2007 following the clearing of vegetation, construction of the bund wall and channel. An additional site (BC6) was added in November 2007.

13.4.3.2 Methods

Riparian birds were sampled by searching established 100 x 200 m plots for 20 minutes, recording all birds seen or heard within the designated area. Timed area searches were repeated four times per season in lower bank riparian plots and twice per season in higher bank floodplain plots (total 6 x 20 minute timed area surveys per site per seasonal sample). During each survey standard habitat data were collated at survey plots.

Monitoring commitments for the colour-banding component of the riparian bird monitoring program included:

- maintenance of a base population of uniquely colour-banded buff-sided robins and purple-crowned fairy-wrens to enable monitoring of bird movements and home range areas

- conducting treatment colour banding of additional riparian bird species to enable assessment of movements of these birds between banding sites and other areas
- continuation of seasonal monitoring of riparian bird communities incorporating observations/re-sightings of colour banded birds
- identification of relevant information relating to seasonal or other movements of colour banded riparian birds, home range areas and habitat associations of riparian indicator species.

13.4.3.3 Results

Since the commencement of riparian bird monitoring in November 2006, ten seasonal surveys of riparian birds have been conducted incorporating 1,656 20 minute / 2 hectare (ha) searches across 56 sites, with 55,086 bird observations documented. A total of 141 bird species have been recorded within survey plots, and 172 bird species have been recorded from the wider McArthur River Station riparian habitat and adjacent floodplain habitats in the vicinity of the Project area. During the course of the riparian bird monitoring program feedback has been provided to MRM regarding rehabilitation planning, management of riparian fauna, fencing and management of ecological issues within restoration areas. A list of bird species recorded at each site is presented in Appendix D8.

During the course of the colour banding component of the study (between August 2007 and June 2011) 200 purple-crowned fairy-wrens were captured and individually colour marked, with 27 recaptures and 331 re-sighting records. During the same period 33 buff-sided robins have been individually colour marked with 73 re-sightings recorded. Two hundred and thirty one birds of other species have been captured and banded during the program.

A number of changes in the composition and abundance of riparian and woodland bird species has been recorded across the seasonal samples undertaken between November 2006 and May 2010. Some changes are evident in the bird populations present at some rehabilitation sites (e.g. Barney Creek BC5) as regenerating vegetation becomes established. However, there is little or no regenerating vegetation present at most sites on the McArthur River Channel and as a consequence bird communities at these sites remain species poor.

Analysis of habitat data indicate that bird species diversity is positively correlated with indicators based on canopy cover, condition and vegetation structure, with higher quality sites as measured by riparian condition supporting higher numbers of bird species. Minimal change in species composition has occurred over time at many rehabilitation sites. Condition scores and other measures of habitat quality remain low.

Buff-sided robin and purple-crowned fairy-wren have not been detected in core restoration areas during the monitoring period (between 2007 and 2011) and observations of banded birds have not detected any movements up and downstream of the McArthur River Channel. None of the marked purple-crowned fairy-wrens remaining within the open pit bund walls has been observed to move out of the open pit area into adjacent remnant habitat.

A notable finding of the riparian bird monitoring program is an apparent increase in abundance of purple-crowned fairy-wren within the cattle exclusion fence between the channel inlet and the southern bund, particularly in higher bank riparian woodland habitat. This increase has occurred concurrent with an expansion of cane grass distribution in this area and suggests that while some cattle are still present in this area the fencing is reducing the overall impact of cattle grazing in the riparian woodland. It is likely that this effect is also occurring within the area below the northern bund and outlet at the downstream end of the channel. Research at other sites has found that cattle grazing can have a significant impact on purple-crowned fairy-wren abundance, in particular by impacting dense stands of cane grass that are preferred nesting and foraging habitats. Establishment of an expanding population of small birds between the channel inlet and outlet is highly desirable, as these areas will eventually provide a potential source population to colonise rehabilitation areas on the McArthur River Channel and Barney Creek Channel as suitable habitat develops.

13.4.4 Project fauna survey of expansion areas

13.4.4.1 Study approach

Objectives of the field investigation were to:

- collect primary quantitative data only from sites/habitats where previous surveys were under-represented, or using methods not previously applied
- collect primary observational data from areas directly affected by the Project
- undertake semi-quantitative visual inspection of sites and habitats in the proposed expansion areas to identify and understand potential impacts from the Project and to develop management strategies
- undertake targeted surveys to identify the presence of any threatened species and their occurrence in the Project area.

13.4.5 Fauna survey sites

Four systematic survey sites sampled within the Project area included two sites in the proposed North OEF expansion area and two sites in the South and East OEF expansion area. Opportunistic sampling conducted both day and night at an additional site near the TSF area also used remote bat echolocation detection. Locations of the sampling sites are shown in Figure 13-2.

13.4.5.1 North OEF

The North OEF area is a generally flat cracking soil plain dominated primarily by lowland woodland communities. Vegetation is dominated by *Bauhina cunninghamii* and *Eucalyptus microtheca* with *Excoecaria parvifolia* along the stream lines. There is a sparse mid-stratum, and an understory of grasses. In some areas, treeless grasslands predominate. A small ephemeral stream line draining the area to the north offers refuge to fauna, especially frogs. Drying pools present in some areas attract nomadic birds such as finches. Few tall trees are suitable as denning sites or for hollow-nesting bird species. Ground cover is generally sparse, with fallen branches and termitaria providing the only cover for terrestrial fauna. Generally, terrestrial fauna in this area rely on burrows along the stream lines or cracks in the soil for refuge sites. Parts of this area have been largely excluded from cattle due to fencing. In fenced areas the native grass understory is prolific and grassland bird species are common.

13.4.5.2 South and East OEF

The open pit and East OEF area outside the bund has a high diversity of fauna habitats. The old channel of the McArthur River is a well-vegetated functioning riparian system. A riparian corridor of woodland to open forest is dominated by *Melaleuca argentea* and *Casuarina cunninghamiana*, with a fringing band of *Barringtonia acutangula* along the water's edge. Permanent water is currently present along the channel although this may be reduced as ongoing approved mining activities draw down the water table. At present the water offers habitat for aquatic fauna such as turtles, crocodiles and frogs. Tall riparian vegetation offers refuge, feeding and nesting habitat for a range of bird species such as parrots and honeyeaters, as well as for more specialised species such as purple-crowned fairy wrens.

A riverine woodland community occurs on either side of the old McArthur River bed along the high banks. Ground cover is generally dense cane grass. Exclusion of cattle in this area has meant expansion in native cane grass cover in most areas, which has benefited many species, including the vulnerable purple-crowned fairy wren (URS 2011).

The remainder of this area is a Coolibah-dominated lowland woodland community, which is subject to seasonal flooding, possibly increased due to flows being redirected by the river channel. There was evidence during the field surveys that most of this area had been inundated by between 4-20 m of floodwaters during

the 2011 wet season. In areas adjacent to the channel, sand deposition had smothered vegetation up to 200 m inland of the channel.

Two small rock outcrops are present in this area rising to 25 m above the surrounding areas. Sparse vegetation, with a few individual *Ficus* spp. provide refuge for terrestrial fauna in flood conditions, though are probably too small to support any specialist rock-dwelling species.

13.4.5.3 Tailings storage facility

This area is a low-lying plain of lowland woodland communities dominated by *Corymbia terminalis* and *Eucalyptus chlorophylla*.

13.4.6 Survey methods

A vertebrate fauna trapping program was undertaken between 30 May and 6 June 2011. Other survey components, including site inspections, incidental observations and remote bat echolocation detection, were undertaken between 30 May and 23 June 2011.

Standard biological survey techniques were used during field surveys, including a number of live capture/release trapping techniques, standard and general observational (birds and mammals), habitat searches (reptiles and amphibians), as well as indirect methods to detect the presence of terrestrial fauna.

Fauna sampling at standard sites followed the standard methodology for inventory and monitoring as outlined by the Northern Territory Government (DIPE, 2002). Each standard site is a 50 m x 50 m trapping quadrat. Observational surveys and searches (e.g. reptile searches, bird surveys) were conducted within a one ha search area centred on the trapping grid. At each site, frogs, reptiles, birds and mammals were surveyed using a combination of trapping, observational survey and active search techniques. A number of additional sampling methods were used including hair tubes, funnel traps, remote overnight ultrasonic bat detection, remote cameras and remote audio recordings.

Additional surveys were conducted outside the main standard fauna sites to assess the presence of threatened fauna species in the wider project area. Habitat data for fauna sites was collected at each site following standard procedure and data forms (DIPE, 2002).

13.4.6.1 Elliott trapping for small mammals

Twenty three traps (20 Elliott 'A' type and 3 Elliott 'B' type) were set approximately 8 m apart around the perimeter of the 50 m x 50 m quadrat, with five type "A" traps along each side and the type "B" traps on three corners. Traps were baited with a peanut butter, honey and oat mixture and left open for three nights. Traps were checked daily in the morning and afternoon.

13.4.6.2 Wire cage trapping

One wire cage trap was set on a corner of each quadrat. Traps were baited with apple and the Elliot trapping mixture and left open for three nights. Traps were checked daily in the morning and afternoon.

13.4.6.3 Pitfall trapping

Pitfall traps were used to capture frogs, reptile and small mammals. At each site four 20 L pitfall buckets were set along a 10 m drift fence. Pitfall lines were left open for three nights. Traps were checked daily in the morning and afternoon.

13.4.6.4 Hair tubes for small to medium-sized mammals

Five ground-mounted hair tubes were set approximately 10 m apart along a transect within the trapping quadrat at each site. The hair tubes were baited with a honey, peanut butter and oat mixture and left on site for 16 nights.

13.4.6.5 Funnel traps

Two reptile funnel traps were place along each of the four pit trapping drift fences at each site. The traps were unbaited. They were left active for three days and were checked daily in the morning and afternoon.

13.4.6.6 Diurnal bird counts

Eight 10 minute/one hectare timed area diurnal bird counts were undertaken at each systematic site within representative habitat (80 minutes per site, total 320 minutes across four sites). Bird counts involved walking through a habitat area for 10 minutes recording all bird species seen or heard within the broad habitat type. Birds were recorded as incidental sightings if seen adjacent to the sample plot, or overflying the site, but not using habitats with the plot. Bird counts were conducted between 6:00am to 9:00am or in the late afternoon (2:00pm to 5:00pm). Birds observed incidentally during time spent within habitats or sites were recorded as incidental records.

13.4.6.7 Diurnal searches

Four 10 minute active diurnal searches were conducted at each systematic site within the one hectare plot. Active searching involved recording all individuals (small mammals, reptiles, amphibians) found active or sheltering underneath or within fallen woody debris, rocks, litter and peeling bark. Active searches were undertaken between 8:30am and 2:00pm.

13.4.6.8 Nocturnal searches

Four 10 minute active nocturnal searches were undertaken at each systematic site within the one hectare plot. Active searches involved the use of headlamps and spotlights to record all individuals (small mammals, reptiles and amphibians) found active on the ground or in trees, or underneath fallen debris, rocks, litter and peeling bark. Frogs heard calling at each site were also recorded during this time.

13.4.6.9 Spotlighting survey and call playback

A spotlighting census involved an observer within the study area with a 50 watt spotlight for a total of 40 minutes per systematic site. The spotlight survey was undertaken in the area within, and adjacent to the one hectare quadrat. The spotlight survey included a two minute broadcast of calls of selected species, including masked owl and barking owl, with a two minute gap between each call to listen for call responses and scan the area with the spotlight.

13.4.6.10 Ultrasonic microbat call detection

Ultrasonic microbat call detection was used to sample microchiropteran bats. Ultrasonic call detection was conducted at each systematic site for five nights of remote sampling using Anabat CF ZCAIM systems, commencing at dusk with effective sampling for approximately 11.5 hours per night. Additional incidental hand held Anabat recordings were collected during the spotlight survey period at each site (40 minutes per systematic site). Overnight remote sampling was also conducted at the MRM accommodation village (four nights) and two hours of hand-held recordings were compiled at the TSF.

13.4.6.11 Remote camera

A remote camera with a motion and heat trigger activation was placed at each site for a total of five nights. Cameras were placed on trees and the area in front of the camera was baited with standard trap bait.

13.4.6.12 Harp trapping for microbats

Harp traps were used to capture low flying microchiropteran bats. Where suitable sites were available, harp traps were set on systematic sites. However harp trapping was not undertaken at some sites due to an absence of suitable flyways or suitable trapping sites. Harp trapping was undertaken at sites 2 and 4 (Figure 13-2) and traps were also set on Surprise Creek (north of the TSF) and Barney Creek (south of the TSF). Traps were set for six nights at each site for a total of 24 harp trap nights.

13.4.6.13 Vehicle spotlighting

Vehicle spotlighting was conducted opportunistically along the margins of the study area and while driving between survey sites at night.

13.4.6.14 Scat collection, tracks and signs

Searches were conducted for predator and non-predator scats during diurnal searches. Searches for scats suitable for analysis were undertaken during surveys and other time spent on site. Tracks and other signs noted during the survey were inspected and identified.

13.4.6.15 Remote Audio Recording

A remote audio recorder was set at each systematic site to record birds and nocturnal animals over a three day period. Each recorder was set to record at three time periods each day to cover early morning, early evening and nocturnal sampling periods, including 6:30 am to 9:00 am, 6:00 pm to 8:00 pm and 11:00pm to 12:00 am.

13.4.7 Fauna survey results

The 2011 survey recorded 10 frog, 15 reptile, 20 mammal and 77 bird species within the three main project component areas (Appendix D8). Results include data from both the systematic site surveys and from general observations through the area. All species recorded during the 2011 survey and the expansion areas of the Project in which they were observed are listed in Appendix D8. Detailed results of the various trapping/observation programs are presented in Appendix D8.

Pitfall trapping caught 21 frogs from three species, three skinks from two species, and two small mammals of one species. Funnel trapping caught 15 frogs from four species, five skinks from three species, and a single snake. No captures were made in the Elliot and cage trapping program.

Active searches located 53 frogs from eight species, 20 lizards from three species, and individuals from two snake species. Hair funnels recorded a single species of mammal. Seventy-seven bird species were observed within the study area at standard survey sites during the current survey.

Two hundred and one microchiropteran bats comprising seven species were trapped at four sites across 24 harp trap nights. A large percentage of captures were made on Surprise Creek near the northern TSF margin (183 captures) as the trapping site was in close proximity to a roost site. The most commonly trapped species was the northern cave bat (*Vespadelus caurinus*), while the large-footed myotis (*Myotis adversus*) and hoary wattled bat (*Chalinolobus nigrogriseus*) were also common. A number of species that were trapped during the survey have not been previously recorded in the vicinity of the mine site, including the orange leaf-nosed bat (*Rhinonicteris aurantia*), northern long-eared bat (*Nyctophilus arnhemensis*) and hoary wattled bat.

Nine species of microchiropteran bats were recorded by echolocation call detection using Anabat detectors. Commonly detected species included the northern freetail bat (*Chaerephon jobensis*), northern cave bat, Gould's wattled bat (*Chalinolobus gouldii*) and hoary wattle bat. A number of long-eared bats (*Nyctophilus* sp.) were recorded but these cannot be identified to species-level using the Anabat system.

13.4.8 Terrestrial fauna species summary

A total of 24 frog, 62 reptile, 189 bird and 32 mammal species have been recorded within the Project area across all surveys. A breakdown of species found in each of the three major expansion area component sites during the field surveys gives 89 vertebrate species in the North OEF areas, 75 species in the South and East OEF area and 59 in the TSF area. These figures are not indicative of biodiversity in each area due to differences in search effort: for example in the TSF area where no systematic trapping was undertaken. However, the numbers of species in each area does suggest fewer terrestrial vertebrates in the South and East OEF area compared to the North OEF area. The East OEF area is subject to regular flooding, which may prevent terrestrial mammals and reptiles from establishing permanent populations. The East OEF had higher

numbers of frogs due to moist conditions created by the dense vegetation and proximity to permanent water. Terrestrial small mammals were absent, and reptiles were generally represented by semi-aquatic species or arboreal species such as lizards of the genera *Gehyra* and *Cryptoblepharus*.

A number of pest animals and domestic stock species are present in the area. These include the cane toad (*Rhinella marina*), and mammal species such as donkey, pig and cattle. Presence of the latter species is due to the area being an active cattle station.

13.4.9 Species of conservation significance

The status of threatened species was assessed with regard to Northern Territory and Commonwealth listings under the EPBC Act and TPWC Act.

A search of the EPBC Act Protected Matters database identified six threatened species of national conservation significance as being potentially present, or that their habitat is likely to occur, in the Project area. They include three bird species, one mammal species, one reptile species and one fish species (Table 13-2). In addition to the Commonwealth listed threatened species, 15 migratory species have been identified as potentially occurring in the area (Table 13-3).

Species of conservation significance listed under the TPWC Act and known to occur in the Project area were determined from previous surveys and the present fauna survey results (Appendix D8). Additionally, the Northern Territory Fauna Atlas search for the McArthur River area identified three bird and two reptile species of conservation significance as present in the area. These records are from actual observations and include locality coordinates.

Threatened species known or expected in the McArthur River area are listed in Table 13-2. The current status and occurrence of threatened terrestrial fauna species in the McArthur River area is discussed in the following sections. Several of the species known to occur, or potentially occurring in the McArthur River area, are affected by proposed TPWC Act legislation changes. Amendments to species listings under the TPWC Act that are not presently legislated have been taken into consideration in the following sections.

Table 13-2 Threatened species known or potential in the McArthur River area

Common Name	Scientific Name	TPWC Act *+	EPBC Act *
Fishes			
Freshwater Sawfish	*Pristis microdon*	VU	VU
Reptiles			
Gulf snapping-turtle	*Elseya lavarackorum*	LC	EN
Merten's water monitor	*Varanus mertensi*	VU	.
yellow-spotted monitor	*Varanus panoptes*	VU	.
Birds			
emu	*Dromaius novaehollandiae*	VU (NT)	.
Australian painted snipe	*Rostratula australis*	VU	VU

Table 13-2 Threatened species known or potential in the McArthur River area (cont)

Common Name	Scientific Name	TPWC Act *+	EPBC Act *
purple-crowned fairy-wren (eastern subsp.)	*Malurus coronatus macgillivrayi*	VU (NT)	-
grey falcon	*Falco hypoleucos*	NT (VU)	-
red goshawk	*Erythrotriorchis radiatus*	VU	VU
Australian bustard	*Ardeotis australis*	VU LC)	.
masked owl	*Tyto novaehollandiae kimberli*	VU	VU
Carpentarian grasswren	*Amytornis dorotheae*	EN	.
Gouldian finch	*Erythrura gouldiae*	EN (VU)	EN
Mammals			
northern quoll	*Dasyurus hallucatus*	CR	EN

* V = Vulnerable; EN = Endangered; CR = Critically Endangered; LC = Least Concern; NT = Near Threatened
+ Status in brackets indicates proposed new status under current NT Threatened Species revision.

13.4.9.1 Carpentarian Grasswren (*Amytornis dorotheae*)

The Carpentarian grasswren (TPWC Act - Endangered) inhabits the rugged, spinifex-covered sandstone hills and plateaux of the southern Gulf of Carpentaria. It has been recorded in the region from Nathan River Station (NT) to the Mt. Isa/Gunpowder area of Queensland (Lewis, 2006). This species was well known from the Glyde River area near MRM, as this site is the type of locality where specimens were first collected in 1914. The species was observed many times at this site up until the mid-1980's (Martin and McKean, 1986). Since then, Carpentarian grasswrens have been discovered at more accessible locations and bird observers no longer visit the Glyde River to see this bird. The bird has not been seen regularly in the McArthur River region since the mid-1990's (Perry, 2005). Intensive surveys were undertaken in the Glyde River area in 2007 (URS, 2007) and the general McArthur River – Borroloola area in 2009 (Harrington *et al.*, 2009) but no observations were recorded. Perry (2005 and 2011) undertook surveys of all previously known Carpentarian grasswren locations in 2005, but also failed to locate the species in the Borroloola area. The most recent published record of this species in the region was from Caranbirini Waterhole in 2006 (Howes, 2006). Based on these recent survey results, the continued survival of this species in the McArthur River area is uncertain. The most likely cause of the decline of this species is cited as uncontrolled burning in the sandstone ranges (Lewis, 2006; Perry, 2005).

The Northern Territory Fauna Atlas lists a 1980 record of the Carpentarian grasswren from a locality near Surprise Creek (S16.41855 E136.08119). However, since numerous other species are listed under the same coordinates, it is most likely that the observer used a single coordinate for all observations made in the area, rather than the recorded locality being accurate for that species.

The sandstone and spinifex range habitat to which this species is specialised does not occur on or near any of the Project expansion areas. The closest areas of potential habitat are on the Bukalara Range, several

kilometres to the north-east and east of the Project area. Therefore, even if this species persisted in these areas, it is unlikely that the Project would impact negatively on these populations.

13.4.9.2 Gouldian Finch (Erythrura gouldiae)

The Gouldian finch (TPWC Act and EPBC Act - Endangered; TPWC Act proposed revision to Vulnerable) is a small, brightly coloured bird endemic to the savannah landscapes of northern Australia. Once widespread and common, it is now confined to a few widely scattered areas. Gouldian finches seasonally occupy two different landscape components. During the dry season and late wet season they inhabit wooded hillsides dominated by a group of Eucalypts known as 'snappy gums'. In the wet season they move out across lowland drainage areas where they feed on a variety of native grasses. Gouldian finches appear to be threatened by a parasitic air sac mite, trapping for the bird trade, pastoral practices and changing fire regimes (Palmer and Woinarski, 2006). There is recent evidence (several sightings in new areas) that Gouldian finch populations have recently stabilised and may be increasing. For these reasons, the NT Government review of Threatened Species is recommending a status change from Endangered to Vulnerable (NRETAS, 2011).

There are recent records for the Gouldian finch from the Borroloola area and at Caranbirini Waterhole (NRETAS 2009). Additionally there is anecdotal evidence from MRM security workers of Gouldian finch sightings on the Carpentaria Highway near the TSF area during mid-2008. These observations were made by persons familiar with the species and are believed to be genuine (URS, 2011). Investigations of these areas later in the 2008 dry season failed to locate any birds, however seeding grasses that were present earlier in the dry season had subsequently been burned and no finches were located. There are also recent records of this species on Pungalina Station, 100 km to the east of McArthur River (AWC, 2009). Given the nomadic nature of this species and the recent observations, there is a likelihood that it could occasionally visit areas covered by the Project.

13.4.9.3 Northern Quoll (Dasyurus hallucatus)

The northern quoll (TPWC Act - Critically Endangered; EPBC Act - Endangered) is a medium-sized marsupial carnivore. It is distributed across northern Australia, but is in decline. Recently the species has suffered a dramatic decline due to the spread of the cane toad, as quolls are thought to be particularly vulnerable to toad poisoning (Woinarski, 2006b).

There are historical records of this species from the McArthur River area. Scats and dens were found on Barney Hill in 1992 (Ecostudy, 1992) and in the Glyde River area in 2002 (URS/MRM, 2005). No direct evidence of this species has been recorded in the area since then.

13.4.9.4 Merten's Water Monitor (*Varanus mertensi*)

Merten's water monitor (TPWC Act - Vulnerable) is a semi-aquatic species which occurs across tropical Australia. The primary threatening process for this species is due to poisoning from the introduced cane toad. The species has suffered a marked decline in areas where cane toads have invaded (Ward *et al.*, 2006a). Merten's water monitor has been widely reported in the McArthur River area, and is still known to be present despite the cane toad threat. A large specimen was recorded in the TSF area in June 2011 (Plate 13-1).

Plate 13-1 Merten's water monitor at the TSF area, June 2011

13.4.9.5 Yellow-spotted Monitor (Varanus panoptes)

The yellow-spotted monitor (TPWC Act - Vulnerable) is a large ground-dwelling monitor found across the tropical savannahs of northern Australia. As with Merten's water monitor, this species is under threat due to poisoning from the introduced cane toad (Ward *et al.*, 2006b). This species has been observed in the area of McArthur River mine on numerous occasions, generally in grassland, floodplain and riparian woodland habitats. It is likely to be present in the North, South and East OEF and TSF areas where suitable habitat exists.

13.4.9.6 Emu (Dromaius novaehollandiae)

The emu (TWPC Act - Vulnerable; proposed revision to Near Threatened) is a large and well-known flightless bird distributed across the Australian mainland. There has been a documented decline in this species in the NT, possibly associated with high frequencies of fires (Taylor and Woinarski, 2006). The NT Government review of Threatened Species is recommending a status change from Vulnerable to Near Threatened for this species, based on evidence that the decline has been poorly quantified, and that there are stable populations in central Australia (NRETAS, 2011). Emus are present, but uncommon in the McArthur River area. Recent observations have been in the area to the east of the McArthur River Channel in open grassland and low open woodland. There may be occasional occurrences on the Project expansion areas, but these sites are not considered important habitats for this species.

13.4.9.7 Australian Painted Snipe (*Rostratula australis*)

The Australian painted snipe (TPWC Act and EPBC Act - Vulnerable) is a wader approximately 250 mm in length. This species is inconspicuous and occurs solitarily or in only small parties. The painted snipe is more common in eastern Australia, but there are some records from the Northern Territory, including the Borroloola area. The Australian painted snipe occurs in shallow, vegetated, freshwater swamps, claypans or inundated grassland (including temporary wetlands). A decline in this species in the Northern Territory has been attributed to cattle grazing (Taylor *et al*., 2006).

Despite a significant level of bird survey effort in the McArthur River area since 2006, this species has not been recorded in the area. It is also absent from previous survey records. There is a possibility that the species could occasionally traverse the area. An unidentified snipe was flushed from reeds on the McArthur River Channel in 2008, however the species could not be determined (P. Barden, pers. obs.).

13.4.9.8 Red Goshawk (Erythrotriorchis radiatus)

The red goshawk (TPWC Act and EPBC Act - Vulnerable) is a large, reddish brown species of hawk which occurs across northern Australia, from Broome in Western Australia, to south-east Queensland. Its preferred habitat is tall Eucalyptus forest and riparian forests, such as paperbarks. It builds a conspicuous stick nest in riparian forest usually close to a watercourse. Threatening processes for this species include land clearing for agriculture, illegal egg collecting, shooting and fire (Woinarski, 2006b).

There was a sighting of this species made in riparian habitat along Barney Creek during a 1992 fauna survey (Ecostudy, 1992). However, since that time, no further sightings have been made in the area even though intensive long-term monitoring of riparian birds has been undertaken since 2006. It is considered unlikely that this species nests within, or is a regular visitor to the MRM area.

13.4.9.9 Australian Bustard (*Ardeotis australis*)

The Australian bustard (TPWC Act - Vulnerable; proposed revision to Least Concern) is Australia's heaviest flying bird. It is widespread and generally scarce in the Northern Territory. Bustards inhabit grassland, low shrubland and woodland habitats. There have been reported widespread declines in this species throughout its range due to a variety of factors including predation, altered fire regimes, hunting, disturbance, habitat alteration, pesticides and grazing (Ziembicki, 2006). The Northern Territory Government review of Threatened Species is recommending a status change from Vulnerable to Least Concern for this species, based on a national review that indicated the population to be relatively stable in northern Australia (NRETAS, 2011).

Australian bustards are commonly observed around the MRM area in all open habitats. They were regularly sighted in all areas of the Project expansion during the June 2011 field surveys (Plate 13-2). It is likely that this species has benefitted from cattle exclusion wherein there is regrowth of native grassland habitats.

Plate 13-2 Australian bustards on the TSF bund wall, June 2011

13.4.9.10 Masked Owl (Tyto novaehollandiae kimberli)

The masked owl (TPWC Act and EPBC Act - Vulnerable) is a large, dark owl species. The subspecies *T. n. kimberli* is distributed across the Northern Territory, a distribution which has been construed from very few records of the species. This species occurs mainly in tall Eucalyptus forest and also roosts in monsoon rainforest. There is a likelihood that the masked owl is in decline, with contributing factors being a broad scale reduction in medium sized mammals (the primary prey item) due to changed burning regimes (Woinarski and Ward, 2006).

The Northern Territory Fauna Atlas contains one record of a masked owl from 1977, located two kilometres east of MRM's mine site. Extensive bird surveys in the area since then, including specific call playback for this species, have not yielded any further records. It is considered unlikely that this species is currently present in the area.

13.4.9.11 Grey Falcon (Falco hypoleucos)

The grey falcon (TPWC Act - Near Threatened; proposed revision to Vulnerable) is sparsely distributed across large areas of arid and semi-arid Australia. As a recent national assessment has concluded that the population is fewer than 1,000 mature individuals, the Northern Territory Government Review of Threatened Species has recommended placement in the Vulnerable category (NRETAS, 2011).

The grey falcon inhabits inland timbered plains and tree-lined watercourses. Identified threats include overgrazing, habitat loss in marginal farming areas, and loss of large nest trees (Garnett and Crowley, 2000). Grey falcons have been observed at McArthur River incidentally during the course of the riparian bird monitoring surveys. Sightings have been made at two sites along the McArthur River approximately three kilometres downstream of MRM's mine site (Appendix D8).

13.4.9.12 Purple-crowned Fairy-wren (Malurus coronatus macgillivrayi)

The purple-crowned fairy-wren (eastern subspecies) (TPWC Act - Vulnerable; proposed revision to Near Threatened) is a small, sedentary bird restricted to riverine fringes, creeks and lakes where there are pandanus or paperbark thickets, tall canegrass, or other dense low cover. This subspecies occurs in the southern gulf region of the Northern Territory across to adjacent areas of Queensland (Pizzey and Knight 2002). This subspecies has been erroneously classified as Vulnerable under Northern Territory legislation due to a mistaken transposing of another subspecies in the gazettal. Amendment to the classification is proposed in the Northern Territory Government Review of Threatened Species (NRETAS, 2011) and the status downgraded to Near Threatened.

This species is found along the McArthur River and Barney Creek in the Project area and a monitoring program is in effect (see Appendix D8).

13.4.9.13 Migratory and marine species

Species listed as Migratory or Marine under the EPBC Act which occur, or may occur in the Project area are listed inTable 13-3. There are no data to suggest that the Project area supports important habitat (DEWHA, 2009) for any listed migratory or marine species.

Table 13-3 Migratory and marine species of the MRM area

Common Name	Scientific Name	EPBC Classification	Occurrence in MRM area
great egret	*Ardea modesta*	Migratory Marine Bird Migratory Wetlands Species Listed Marine Species	Regular visitor in low numbers to wetland and riverine environments.
cattle egret	*Ardea ibis*	Migratory Marine Bird Migratory Wetlands Species Listed Marine Species	Regular visitor in low numbers in cleared areas around cattle.
Gouldian finch	*Erythrura gouldiae*	Migratory Terrestrial Species	Occasional visitor
white-bellied sea-eagle	*Haliaeetus leucogaster*	Migratory Terrestrial Species Listed Marine Species	Occasionally forages along McArthur River main channel.
rainbow bee-eater	*Merops ornatus*	Migratory Terrestrial Species Listed Marine Species	Common aerial species.
buff-sided robin	*Poecilodryas cerviniventris*	Migratory Terrestrial Species	Resident in riparian forest along McArthur River.
common sandpiper	*Actitis hypoleucos*	Migratory Wetlands Species	common sandpiper
sharp-tailed sandpiper	*Calidris acuminata*	Migratory Wetlands Species Listed Marine Species	Occasionally present in small numbers in channel area.
marsh sandpiper	*Tringa stagnatilis*	Migratory Wetlands Species Listed Marine Species	Occasionally present in small numbers in channel area.
common greenshank	*Tringa nebularia*	Migratory Wetlands Species Listed Marine Species	Occasionally present in small numbers in channel area.
Oriental plover	*Charadrius veredus*	Migratory Wetlands Species Listed Marine Species	Infrequent visitor to marshes and river bank habitats.
Oriental pratincole	*Glareola maldivarum*	Migratory Wetlands Species Listed Marine Species	Infrequent visitor to open grassy areas.
magpie goose	*Anseranas semipalmata*	Listed Marine Species	Occasional visitor in small numbers to wetland areas including TSF area

Table 13-3 Migratory and marine species of the MRM area (cont)

Common Name	Scientific Name	EPBC Classification	Occurrence in MRM area
freshwater crocodile	*Crocodylus johnstoni*	Listed Marine Species	Common along McArthur River and Surprise/Barney Creeks.
estuarine crocodile	*Crocodylus porosus*	Migratory Marine Species Listed Marine Species	Occasional reports from McArthur River near mine site. Populations in lower McArthur River area.

13.4.10 Project impacts on terrestrial fauna

Primary impacts from the Project expansion areas on terrestrial fauna are direct habitat removal and impedance to habitat restoration along the McArthur River Channel.

Terrestrial fauna species occurring in the North OEF area are common and wide-ranging forms, with no species restricted to the open woodland habitat in the area. Threatened species including yellow-spotted monitors and Australian bustard occur in this area and emu may occasionally be present. The Project will remove a minor amount of habitat for these species leaving large areas of similar habitat available in the region.

Habitats in the South and East OEF area are the most complex and diverse of the proposed expansion areas. This area has riverine/aquatic habitats, tall riparian forest, upper bank habitats, floodplains and small rocky outcrops. Existing riparian forest along the old McArthur River channel and Barney Creek is intact and a functioning ecosystem. It provides roosting, feeding and refuge habitat for a range of species. Threatened purple-crowned fairy wrens and Merten's water monitors are specialised inhabitants of riparian habitats. Riparian areas act as important refuge sites from which terrestrial riparian fauna species may recolonise restoration areas on the McArthur River and Barney Creek channels. Habitat connectivity may be reduced when the OEF is developed in the south and east channels. Should successful enhancement of the ecological value of the channel not occur through rehabilitation, purple-crowned fairy wrens and Merten's water monitors may be negatively impacted by the reduction of habitat connectivity as a result of the proposed South and East OEF expansion. Establishment of adequate revegetation along the channel will serve as an alternative riparian corridor. As yet, the revegetation on the channel is inadequate to provide this ecological function. Where practicable, development of the South and East OEF within the old McArthur River Channel will be delayed to allow sufficient time for the ecological value of the channel to be enhanced.

MRM made commitments in the 2005 EIA process and subsequent 2006 PER to rehabilitate the McArthur River Channel and restore it to a functioning riparian ecosystem. These works are ongoing. This involves rehabilitating not only the in-stream and bankside habitats, but extends approximately 20 m into the adjacent natural vegetation. The development of the South and East OEF may affect habitat rehabilitation through potential edge effects due to the proximity of the OEF to the rehabilitation area.

Cattle exclusion fencing in the North, South and East OEF areas has improved wildlife habitat. Although the fencing program has not entirely excluded cattle from these areas, numbers present are low enough to cause minimal impact and regrowth of native grasses has expanded. In the low woodland areas of the North OEF, cattle exclusion has resulted in enhanced grassland habitat ideal for threatened species such as the Australian bustard. In the South and East OEF areas the expansion of cane grass habitat due to cattle exclusion has resulted in increased habitat availability for the threatened purple-crowned fairy wren, a species that represents an important indicator of riparian habitat quality.

A number of bat roost sites are within the broader Project area, including sites within road culverts and bridges, sandstone caves and crevices in the nearby Bukalara Range and in large riparian trees (mainly river

red gum *Eucalyptus camaldulensis*) on the old McArthur River channel. In some cases the latter sites support colonies of 200 to 300 bats and at least one long term colony of northern freetail bats (*Chaerephon jobensis*) is present within a large river red gum on the old McArthur River channel within the East OEF component of the Project.

13.4.11 Management

Development of the South and East OEFs in proximity to Barney Creek and the McArthur River Channel has the potential to impact on rehabilitation activities. The Independent Monitor audit of the MRM revegetation notes a high level of risk of failure to re-establish vegetation along the McArthur River Channel. Without appropriate mitigation and management this risk may be compounded by encroaching on the revegetation site by the South and East OEFs. To maximise success of rehabilitation of the McArthur River Channel, where practicable, these areas will be avoided and buffer zones in excess of 70 m will be established and maintained according to best practice management (URS, 2005; EES, 2010; NRETAS, 2010).

The old McArthur River channel, both upstream and downstream of the current bund wall, is a functioning ecosystem that provides a terrestrial fauna refuge and corridor. Where practicable, development of these two areas will be delayed, until the ecological value of the channel has been enhanced through revegetation activities. At present there is no functioning riparian vegetation corridor along the channel.

Clearing of vegetation for the OEF areas is to be staged over four years. Monitoring of riparian birds, aquatic fauna and other species of conservation significance will occur as clearing progresses.

Impacts of staged clearing will be monitored within revegetation sites to allow mitigation of any impacts on successful rehabilitation, particularly along the McArthur River Channel.

Fauna spotter-catchers will be engaged to move in front of clearing areas to remove wildlife. Hollow-bearing trees will be identified and marked prior to any clearing to allow appropriate management. Clearing actions will be outlined in a pre-clearing survey and report to be undertaken by a suitably qualified ecologist.

More intensive, species-diverse revegetation of the main channel is necessary to create a functioning riparian system along the channel (EES, 2010). A pest animal management plan should be implemented to control vertebrate pest animals on and adjacent to the Project site. Included in this plan should be species-specific management and, where practicable, eradication methods for terrestrial vertebrate pest animals on site in accordance with best practice. The plan is envisaged to include horses, pigs, donkeys, and unmanaged cattle.

Encroachment of the east OEF area within close proximity to Barney Creek and the McArthur River Channel is likely to have negative impacts on terrestrial fauna. Buffer zones of at least 70 m from these landscape features will be maintained and kept free of cattle (NRETAS, 2010).

Where practicable, cleared vegetation will be placed as coarse mulch and debris on revegetation sites. Suitable logs will be placed on the ground in rehabilitation sites to provide habitat and ground-layer complexity. Some larger logs will be used within the river channel for aquatic habitat and environmental flow regulation.

Increased planting and seeding of the channel batters and planting of established local provenance trees along and adjacent to the channel will be undertaken. By establishing dense, structurally complex vegetation, impacts on riparian fauna and the effects of habitat continuity reduction will be minimised. Revegetation will be conducted in accordance with MRM's revegetation strategy.

The feasibility of a program to relocate populations of purple-crowned fairy-wrens and buff-sided robins from within the pit area and the two old McArthur River channel sites will be investigated by suitably qualified ecologists. These populations have been subject to long-term monitoring and without appropriate management (relocation/ reestablishment of alternative habitat areas) would be significantly impacted by the Project.

Increasing the cattle exclusion areas along the McArthur River channel and expanding these into woodland habitats will mitigate removal of habitat for purple-crowned fairy wrens, Australian bustards, Merten's water

monitors and other threatened species. The high biodiversity values and environmental benefits of the cattle-free areas are already demonstrated in the area. A proposed biodiversity offset program submitted to the Northern Territory Government for the 2005 EIA process (Xstrata Zinc, 2011) includes a cattle exclusion zone surrounding the McArthur River from the mine site downstream to the McArthur River Station boundary.

Fencing will be rapidly maintained following each wet season to minimise potential for cattle to enter the exclusion areas (EES, 2010).

13.4.12 Monitoring

Monitoring of rehabilitation sites and the McArthur River Channel revegetation will be undertaken on a continuing basis to facilitate the management of potential impacts on rehabilitation. Monitoring will be undertaken by suitably qualified ecologists. Should the option to increase cattle exclusion areas be adopted as a management strategy, a monitoring program to assess the success of habitat improvement and fauna communities, including threatened species and indicator species, will be established.

Continuation of the current riparian bird program will require some modifications to capture any potential additional impacts of the Project. MRM will continue monitoring of riparian bird fauna.

Cultural Significance

During the 2005 impact assessment process, three members of the local community, two Traditional Owners and one Senior Custodian, were asked if any of the animals, fish or reptiles at the mine site had cultural significance. They reported that there are no animals at the mine site currently used by the local community. Furthermore, there are no animals with any cultural or spiritual significance nor are there any that are used for making materials or artefacts (URS, 2005).

13.5 Flora

Previous comprehensive surveys of flora across the wider project area (i.e. the MRM Mineral Leases and the adjacent Glyde River area) were conducted in February and April 2003 for the 2005 EIA process (URS, 2005). The 2003 surveys provided detailed information on flora from 54 study sites sampled in accordance with standard NRETAS survey methodology (i.e. floristic and cover data recorded within 20 × 20 m quadrats). The 2003 surveys built on baseline data from a number of other previous flora surveys and monitoring projects within the MRM Mineral Lease. Locations of previous flora survey sites are presented in Figure 13-3. Surveys in 2011 conducted over three days between the 28-30 of May 2011, involved field assessment of terrestrial flora and verification of existing vegetation mapping within the Project area.

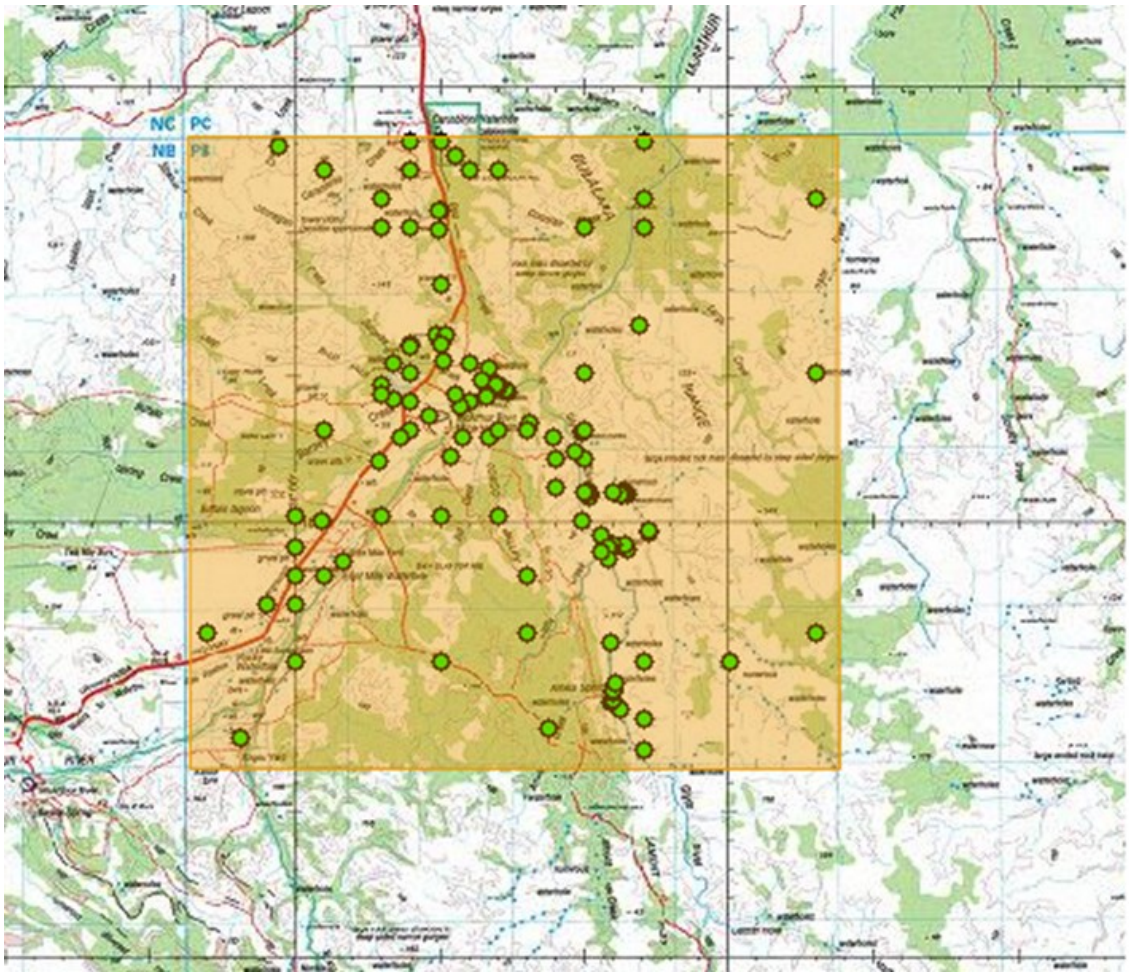

Figure 13-3 Location of all previous survey sites in the area MRM

Study plots were used at key locations to identify plant communities in areas proposed for the Project's mining operations. Prior to fieldwork, a desktop review of existing information identified priority flora species and communities for assessment during field surveys. Habitats potentially supporting species of conservation significance were targeted to assess species occurrence and important ecological systems were assessed in relation to potential environmental impacts. Plant species in study plots were recorded, as well as opportunistic records outside of study plots, to comprehensively record the species within the Project area (Figure 13-4).

13.5.1 Vegetation communities

Vegetation communities in the 706 ha area to be cleared for the Project are accurately represented in previous mapping of the mining lease (Figure 13-5). The Project is sited within four vegetation communities and will impact on two lowland Eucalypt-dominated woodland communities (Inland Bloodwood and Coolibah /Atalaya /Bauhinia open woodland) and two riverine communities (Table 13-4). Multivariate analysis of 16 flora study sites surveyed for the Project verified the presence of four distinct vegetation communities in the Project area. A total of 123 plant species were recorded during the three day field survey in May 2011, including 30 species not recorded during the 2003 surveys. Overall, during the 2005 and 2011 surveys 381 species were recorded from the wider MRM survey area (Appendix D7).

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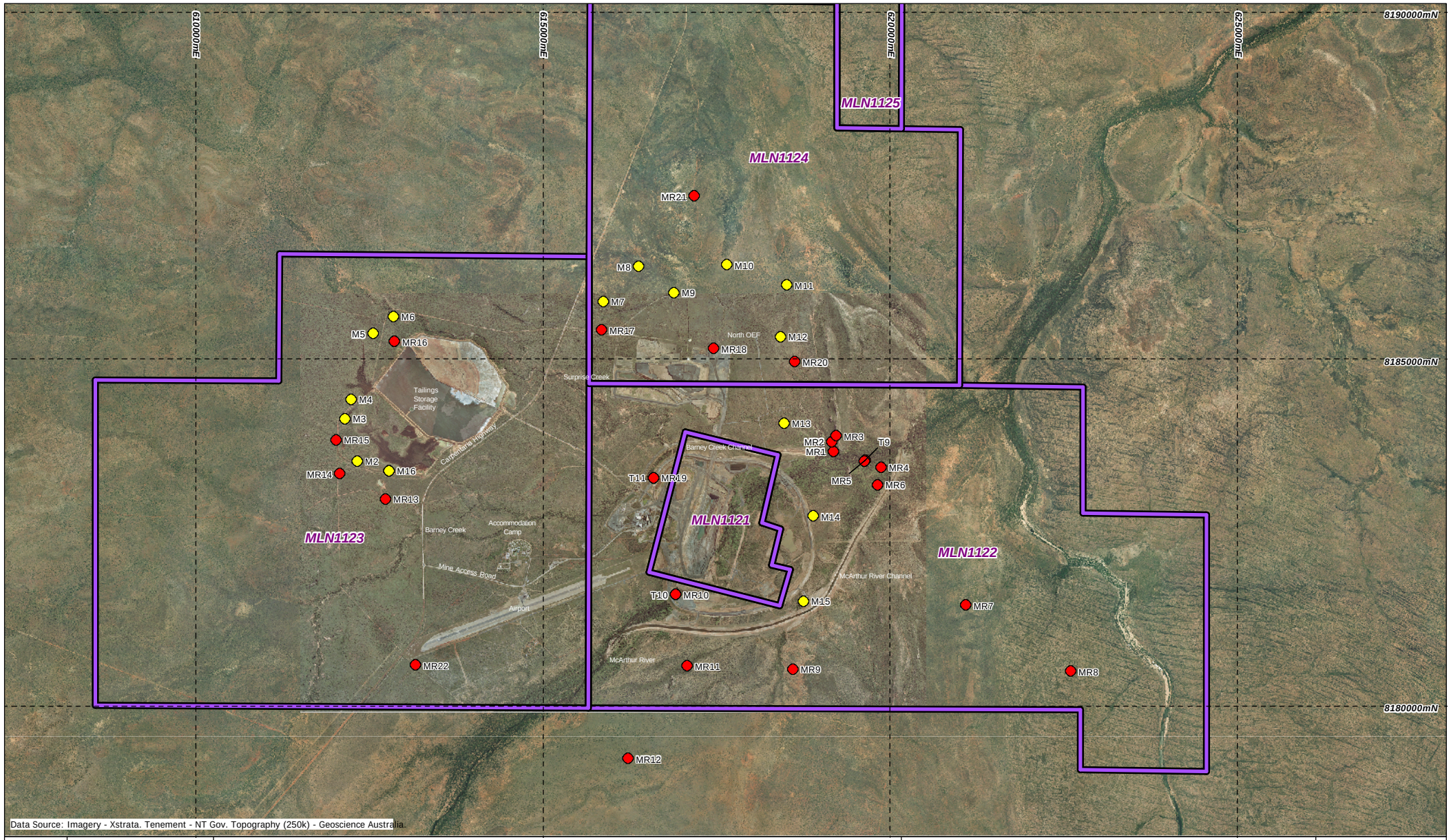

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Kilometres
Scale: 1:75,000 (A4)

LEGEND

Project tenement

Sample Type

2003 survey

2011 survey

McArthur River Mine
Phase 3 Development Project

Location of survey transects and flora sites for 2011 survey

19/01/2011

Datum: GDA94
Projection: MGA53

FIGURE 13 - 4

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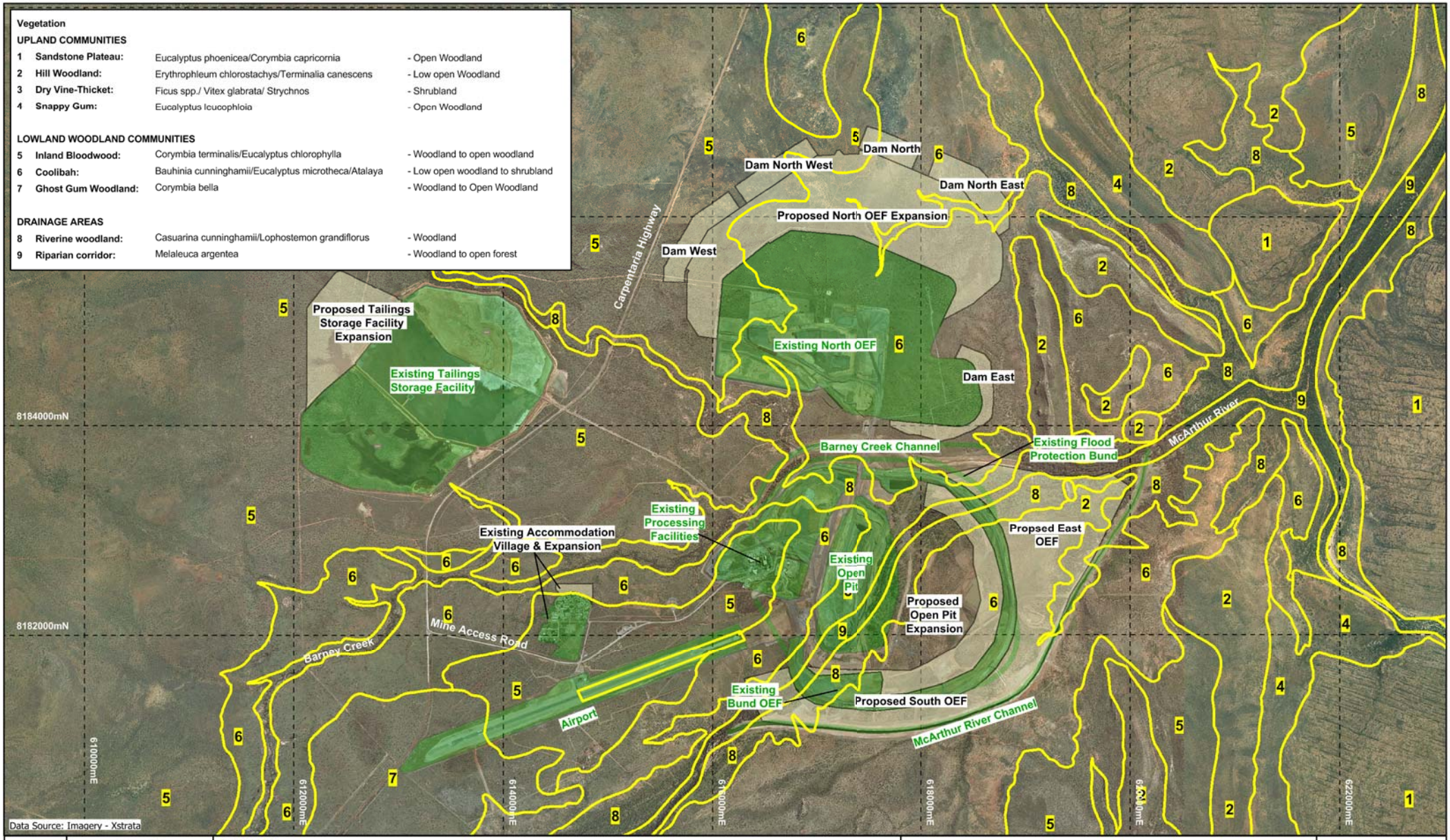

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Scale: 1:40,000 (A4)

LEGEND

- Existing Infrastructure
- Proposed Infrastructure
- Mine Roads
- Vegetation Boundary

McArthur River Mine
Phase 3 Development Project

Vegetation Map of MRM

05/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 13 - 5

Table 13-4 Summary of the nine vegetation communities and their dominant species identified during previous mapping of the wider survey area (after URS, 2005)

Map Unit	Project	Vegetation Community and Description
Upland Communities		
1	No impact. Outside Project area	Sandstone Plateau *Eucalyptus phoenicea/Corymbia capricornia* Open Woodland Eucalypt community in rugged sandstone plateaux areas east of the project area and at Glyde River.
2	No impact. Outside Project area	Hill Woodland *Erythrophleum chlorostachys/Terminalia canescens* Low open Woodland Mixed species on rocky hills e.g. Mt Stubbs, Emu Hill, with *E. chlorostachys* and *T. canescens*.
3	No impact. Outside Project area	Dry Vine-Thicket *Ficus spp./ Vitex glabrata/ Strychnos* Shrubland Scree slopes and riparian areas with Ficus spp., Pouteria sericea, Vitex glabrata and Strychnos lucida.
4	No impact. Outside Project area	Snappy Gum Open Woodland *Eucalyptus leucophloia* low open woodland on low ridges of ranges to east of the project area.
Lowland Woodland Communities		
5	TSF and accommodation village	Inland Bloodwood *Corymbia terminalis/Eucalyptus chlorophylla* Woodland to open woodland Extensive woodlands on lowland plains bordering the McArthur. *C. terminalis* dominan but varies with changes in drainage favouring *E. chlorophylla* and *E. tectifica* - either singly or as co-dominants.
6	North OEF and open pit expansion	Coolibah Bauhinia cunninghamii/Eucalyptus microtheca/Atalaya hemiglauca Low open woodland to shrubland Low open community on poorly drained floodplain areas with cracking clays. Extensive areas to east and west of McArthur River. Dominance varies locally between Bauhinia, Atalaya hemiglauca and Coolibah (Eucalyptus microtheca) with Gutta Percha (Excoecaria parvifolia) in drainage areas.
7	No impact. Outside Project area	Ghost Gum Woodland Corymbia bella Woodland to Open Woodland A distinctive community with sparse Ghost Gum (Corymbia bella) dominant in upper stratum to 10m.

Table 13-4 Summary of the nine vegetation communities and their dominant species identified during previous mapping of the wider survey area (after URS, 2005) (cont)

Map Unit	Project	Vegetation Community and Description
Drainage Areas		
8	North OEF and open open pit expansion	Riverine woodland *Casuarina cunninghamii/Lophostemon grandiflorus* Woodland to open woodland Variable community typically forming narrow linear bands on smaller tributary creeks (e.g. Barney and Surprise). Dominant species include *Casuarina cunninghamii*, *Eucalyptus camaldulensis* with *Terminalia bursarina, Excoecaria parvifolia* and *Lophostemon grandiflorus* .
9	East OEF and open pit expansion	Riparian corridor *Melaleuca argentea* Woodland to open forest Larger drainage lines with dense tree layer (8 to 23m) and mid-stratum of riparian species (2 to 6m), with terraced banks and sandy levees. The species characteristic of this unit is *Melaleuca argentea.* Sub-dominants include *Casuarina cunninghamii* and *Nauclea orientalis* with *Barringtonia acutangula.*

The proposed TSF will be situated within the Inland Bloodwood community. The open pit expansion and the North and East OEF, are mainly sited in Coolibah/Atalaya/Bauhinia open woodland. These communities are bordered in some areas by riverine woodland on tributary creeks and riparian open forest vegetation fringing the original McArthur River channel. Expansion of the open pit and construction of the East OEF will require clearing of some remnant riparian corridor vegetation, now bypassed by the McArthur River Channel (Table 13-5).

Table 13-5 Areas of proposed vegetation clearing for the Project

Description	Area (ha)
Open pit	65
East/South OEF	150
North OEF	485
Camp/Admin	6
Total	**706**

13.5.1.1 Inland Bloodwood

The Inland Bloodwood community occurs extensively on lowland plains to the west of the McArthur River. Located on well-drained soils in flat to gently undulating country this community generally intergrades with Coolibah open woodland community, particularly toward the drainage areas. The major floristic structure is shown in Table 13-6. The TSF Cell 4 is located entirely within the Inland Bloodwood community and potentially has a 73 ha footprint (managed under the *Mining Management Act* process).

Table 13-6 Dominant flora of the Inland Bloodwood vegetation community

Stratum	Relative Dominance	Scientific Name	Common Name
Canopy	Dominant	*Corymbia terminalis*	Inland Bloodwood
	Occasional	*Eucalyptus chlorophylla*	
	Occasional	*Eucalyptus tectifica*	Darwin Box
Understorey	Occasional	*Bauhinia cunninghamii*	
Shrub Layer	Dominant	*Terminalia canescens*	
	Associated	*Atalaya hemiglauca*	Whitewood
	Occasional	*Petalostigma pubescens*	Quinine Bush
Groundcover	Dominant	*Chrysopogon fallax*	Golden Beard Grass
	Dominant	*Heteropogon contortus*	Black Spear Grass
	Associated	*Dodonaea oxyptera*	

The Inland Bloodwood community is dominated by *Corymbia terminalis* with co-dominant species *Eucalyptus chlorophylla* and *Eucalyptus tectifica.* Common canopy species include *Erythrophleum chlorostachys* and *Corymbia confertiflora.* Dominance varies continually throughout this community in response to local variations in soil properties and drainage. For example, *Eucalyptus chlorophylla* may be locally dominant near the TSF and patches of *Corymbia grandiflora* north-west of the Project's mine site. The vegetation structure also varies from open woodland to woodland with minor areas of shrubland generally associated with seasonal waterlogging.

Beneath the generally open canopy, low tree species include *Bauhinia cuninghamii*, *Atalaya* spp. over a moderate to dense shrub layer of *Terminalia canescens* and *Acacia* spp. with a grassy layer of *Heteropogon contortus* and *Chrysopogon fallax* (Plate 13-3). Other canopy trees include *C. confertiflora* and *E. tectifica* with other sparse understory species including Quinine Bush *Petalostigma pubescens*, *Hakea arborescens* and *Dodonaea oxyptera*. Canopy cover of the upper stratum is approximately 11% with an average height of 6 m. Average mid-stratum height was 3.1 m with 20% cover, with grasses and subshrubs to 88% cover occupying the ground layer to a height of 0.6 m.

Plate 13-3 Inland Bloodwood community

No threatened plant species were recorded within the Inland Bloodwood community in the Project area.

Disturbance to the Inland Bloodwood community within the Project area will mainly be required for upgrading the TSF with minor clearing in other areas for expansion of the accommodation village and construction in the north and north-eastern sections of the North OEF.

Overall, the condition of Inland Bloodwood in the Project area is healthy. Intact stands of this community are abundant in the region and it is unlikely that disturbance within the Project area will significantly impact on the regional occurrence of this community.

Weed species including *Cenchrus edicellatum*, *Xanthium strumarium, Stylosanthes hamata, S. scabra* and *Passiflora foetida* were observed in disturbed areas around the TSF. Of these weed species, only *Xanthium strumarium* is currently listed as a Class B species. Impacts of grazing were evident throughout this community.

13.5.1.2 Coolibah

The Coolibah community (or *Eucalyptus microtheca/ Bauhinia cunninghamii/ Atalaya hemiglauca* vegetation type) is located on poorly drained floodplain soils with cracking clays. Extensive areas of this community occur to the east and west of the McArthur River. Almost the entire North OEF is located within Coolibah open woodland and it is the most extensive community within the proposed East OEF between the main bund wall and the McArthur River Channel.

Coolibah open woodland is generally dominated by *Eucalyptus microtheca* which forms a sparse, open canopy, generally above a sparse to mid-dense shrub layer of *Bauhinia cunninghamii* and/or *Acacia farnesiana*. Dominance varies locally between *E. microtheca*, *Bauhinia cunninghamii* and *Atalaya hemiglauca* in response to subtle changes in soils and drainage. In different areas within the Project area, each species may form almost single-species stands, becoming co-dominant or sub-dominant in others. Minor drainage lines in this community typically support stands of *Excoecaria parvifolia* trees with occasional *E. microtheca* (Table 13-7).

Table 13-7 Dominant flora of Coolibah open woodland vegetation community

Stratum	Relative Dominance	Scientific Name	Common Name
Canopy	Dominant	*Eucalyptus microtheca*	Coolibah
	Dominant	*Bauhinia cunninghamii*	Bauhinia
	Dominant	*Atalaya hemiglauca*	Whitewood
	Occasional	*Excoecaria parvifolia*	Gutta Percha
Understorey	Dominant	*Bauhinia cunninghamii*	Bauhinia
	Occasional	*Atalaya hemiglauca*	
Shrub Layer	Dominant	*Acacia farnesiana*	Needlebush
	Associated	*Carissa lanceolata*	Conker Berry
Groundcover	Dominant	*Brachyachne convergens*	
	Associated	*Eulalia aurea*	Silky Browntop

Upper stratum canopy cover is approximately 6% with an average height of 5.7 m and mid-stratum cover is 26 % with average ground cover of 82%. *Acacia farnesiana* and *Carissa lanceolata* are common low tree and shrub species within this vegetation community. Areas of black soil grassland tend to be interspersed with shrubland and low open woodland in this community (Plate 13-4). The ground layer typically comprises dense grasses and sedges including species such as *Brachyachne convergens* and *Eulalia aurea*. Ground layer species also include grasses such as *Iseilema macrantherum* with dense perennial forbs such as *Flemingia pauciflora,* with sedges to 20% cover.

Plate 13-4 Coolibah community

No plant species of conservation significance were found within this vegetation community. Dense grass cover is a characteristic of seasonally saturated clay soils in this community. The estimated total disturbance of the Coolibah Open Woodland within the Project area is over 500 ha, which includes an area exceeding 400 ha in the North OEF and over 100 ha in the East OEF (refer to Table 13-5 for areas of vegetation clearance and Figure 13-5 for vegetation community location and proposed Project infrastructure). Overall, the condition of Coolibah open woodland in the Project area is healthy. Intact stands of this community are abundant in the region and it is unlikely that disturbance within the Project area will significantly impact on the regional occurrence or viability of this community.

Three weed species, *Sida acuta, Stylosanthes hamata* and *Malvastrum americanum* were observed within Coolibah open woodland. These species are restricted to small areas and are a minor component of the vegetative ground cover. *Malvastrum americanum*, for example, only occurs on the fringes of minor drainage basins within the proposed North OEF expansion.

13.5.1.3 Riverine woodland

The Riverine woodland community generally occurs within linear corridors fringing the major tributary creeks within the Project area, particularly Surprise Creek and Barney Creek (Plate 13-5). Characterised by variable species composition, a number of tree species are dominant in this community including *Lophostemon grandiflorus, Casuarina cunninghamiana, Terminalia bursarina* and *Excoecaria parvifolia*. Common secondary trees include *Terminalia platyphylla, Eucalyptus microtheca, E. camaldulensis* and *Corymbia bella*. Mid-stratum low trees and shrubs included *Planchonia careya, Hakea arborescens* and *Acacia* spp. Upper stratum canopy cover is 30% with an average height of 10 m (Table 13-8). Average height of the mid-stratum is 3 m with 50% cover. The ground layer is dynamic, being exposed to annual disturbance from flooding and is generally well vegetated with 100% cover of grasses and forbs with variable species composition.

Table 13-8 Dominant flora of the riverine woodland vegetation community

Stratum	Relative Dominance	Scientific Name	Common Name
Canopy	Dominant	*Lophostemon grandiflorus*	Swamp box
	Occasional	*Casuarina cunninghamii*	

Table 13-8 Dominant flora of the riverine woodland vegetation community (cont)

Stratum	Relative Dominance	Scientific Name	Common Name
	Occasional	*Eucalyptus camaldulensis*	River Red Gum
Understorey	Occasional	*Excoecaria parvifolia*	Gutta Percha
Shrub Layer	Dominant	*Terminalia bursarina*	
	Associated	*Helicteres isora*	
	Occasional	*Acacia spp.*	
Groundcover	Dominant	*Urochloa reptans*	

No threatened plant species were found within the riverine woodland community. Disturbance of the riverine woodland community will occur during expansion of the North OEF where a drainage line will be affected. Remnant riverine woodland fringing the old McArthur River channel (now bypassed by the 5 km long McArthur River Channel) will be cleared for construction of the East OEF (Figure 13-5). The condition of riverine woodland in the Project area is healthy.

Plate 13-5 Riverine woodland along Surprise Creek

The northern embankment of the TSF Cell 1 impinges upon this community at Surprise Creek, where in some places the creek is less than 50 m from the TSF dam wall. Other areas of Riverine woodland have been cleared along the Barney Creek Channel during works required around the open pit area.

A number of weed species occur in this habitat which experiences seasonal disturbance due to flooding, erosion and sediment deposition. Weeds included *Hyptis suaveolens, Xanthium strumarium* and *Sida* spp..

13.5.1.4 Riparian corridor

The riparian corridor community is located on seasonally flooded banks and over-flow channels of larger drainage lines such as the McArthur River. This community forms a dense linear corridor of trees 8-23 m high and 85% canopy cover on terraced banks and sandy levees fringing the McArthur River.

Melaleuca argentea is the characteristic riparian specie with subdominants including *Casuarina cunninghamiana, Eucalyptus camaldulensis* and *Nauclea orientalis.* Upper banks, sandy levees and overflow channels support *Eucalyptus bella, E. microtheca* and *Terminalia platyphylla.* The understorey layer is relatively species poor, 5 m tall and 65% cover mainly comprising *Barringtonia acutangula, Pandanus aquaticus* and *Ficus* spp. (Table 13-9).

The ground layer is typically dense, tall grasses (*Chionachne cyathopoda* and *Mnesithea rottboelioides)* to 100% cover and 1.5 m high (Plate 13-6). The noxious weed *Xanthium strumarium* forms dense patches in some areas, amongst other weeds including interspersed *Parkinsonia aculeata*, *Alternanthera dentata* and *Passiflora foetida.* Other environmental weeds such as *Clitorea ternatea, Cenchrus pedicellatum* and *Stachytarpheta* spp. occur in this community, particularly in areas subject to regular disturbance from seasonal flooding.

Table 13-9 Dominant flora of the Riparian corridor vegetation community

Stratum	Relative Dominance	Scientific Name	Common Name
Canopy	Dominant	*Melaleuca argentea*	Silver Paperbark
	Occasional	*Corymbia bella*	Ghost Gum
	Occasional	*Nauclea orientalis*	Leichardt Tree
Understorey	Occasional	*Ficus racemosa*	
Shrub Layer	Dominant	*Barringtonia acutangula*	Freshwater Mangrove
	Associated	*Terminalia platyphylla*	
	Occasional	*Flueggia virosa*	
Groundcover	Dominant	*Alternanthera dentata*	

Plate 13-6 Riparian corridor community along the McArthur River

No threatened plant species were found in the riparian corridor community. A five kilometre stretch of riparian corridor habitat has previously been disturbed during construction of the Project's open pit and McArthur River Channel. Several small, disjunct areas of remnant riparian corridor vegetation now remain close to the main bund around the open pit, and within the area designated for the South and East OEF. Overall, the condition of riparian corridor vegetation in the Project area is healthy. However, in the absence of regular seasonal scouring due to the McArthur River Channel, weeds have proliferated in river bank areas truncated by the channel. Grazing and impacts from feral animals have also led to habitat degradation in this community.

Numerous weed species, including a weed of national significance (*Parkinsonia aculeata*) and several Class B species (*Xanthium strumarium, Stachytarpheta* spp.) were observed in this habitat. *Alternanthera dentata* was abundant, forming the dominant ground cover in some areas.

13.5.2 Weeds

Previous surveys recorded 18 weed species within the wider MRM survey area including three declared Class B noxious weeds (WM Act) (Table 13-10). One Class A species (to be eradicated) occurs within the Mineral Lease but was not observed during this survey. In all, a total of 26 species have been recorded and the current survey recorded eight new species within the three proposed Project expansion areas (Table 13-10).

Table 13-10 Weed species recorded within the wider project area and their classification

Weed species	Common name	Classification (Weeds Management Act, 2001)	Wider Project area (2003 surveys)	Project area (2011 surveys)
Aerva javanica		—		•
Alternanthera dentata		—		•
Bidens bipinnata	cobbler's peg	—	•	•
Chionachne hubbardiana		—	•	
Cenchrus pedicellatum	mission grass	—		•
Clitorea ternatea	butterfly pea	—	•	•
Corchorus olitorius		—	•	
Digitaria bicornis		—	•	
Echinochloa colona	barnyard grass	—	•	
Eragrostis amabilis		—	•	
Heliotropium indicum		—	•	
Hyptis suaveolens	horehound	Class B	•	•
Martynia annua	devil's claw	Class A		
Malvastrum americanum		—		•
Mitracarpus hirtus	Berrimah weed, white eye	—	•	•
Parkinsonia aculeata	parkinsonia, Jerusalem thorn	Class B	•	•
Passiflora foetida	wild passionfruit	—	•	•
Physalis minima	wild Gooseberry	—	•	
Portulaca pilosa		—	•	
Scoparia dulcis		—	•	•

Table 13-10 Weed species recorded within the wider project area and their classification (cont)

Weed species	Common name	Classification (Weeds Management Act, 2001)	Wider Project area (2003 surveys)	Project area (2011 surveys)
Sida acuta	spinyhead sida	Class B		•
Stachytarpheta spp.	snakeweed	Class B		•
Stylosanthes hamata	verano	—	•	•
Stylosanthes scabra		—		•
Trianthema portulacastrum	giant pig weed	—	•	
Tridax procumbens	Singapore daisy	—		•
Urochloa mosambicensis		—		•
Xanthium strumarium [=Xanthium occidentale]	Noogoora burr	Class B	•	•
		Total	18	18

Weed distribution and abundance in riverine areas vary in response to the scouring effect of wet season flooding, evident by the dense growth of weeds along sections of the McArthur River cut off by the channel. Extensive disturbance associated with the McArthur River Channel and Barney Creek Channel poses significant challenges for weed control and management.

Weed control is conducted by MRM in association with the Katherine Weed Management Branch with the last major control effort conducted in October 2010. Ongoing and integrated weed management is necessary as weeds are continually introduced from upstream of the Project site, where they are prevalent. MRM has a comprehensive weed management plan for the mine site and surrounding area, which is reviewed every three years. The plan identifies both high priority weed species including one Class A noxious weed (to be eradicated) and several Class B species (growth and spread to be controlled). The primary species identified for control are *Martynia annua* (Class A), *Hyptis suaveolens, Jatropha gossypifolia, Parkinsonia aculeata* and *Xanthium strumarium* (Class B). Individual strategies to remove and control each of these five species within the project area are described in the weed management plan (MRM, 2003).

Within the Mineral Lease area *Parkinsonia aculeata* occurs only as scattered plants which are actively targeted in MRM's weed management program. Infestations of *Martynia annua,* mainly occur outside the mining lease, on the southern site of the river close to the old McArthur River station where they are targeted by aerial spraying by helicopter. *Xanthium strumarium* occurs in dense thickets in riverine habitats on the McArthur River, on tributary creeks and in depressions. *Hyptis suaveolens* and *Aerva javanicus* have similar patterns of distribution, favouring disturbed areas. *Cenchrus pedicellatum*, not recorded in previous surveys has established dense stands around mining infrastructure. These five species represent the most serious environmental weeds in the Project area.

13.5.3 Threatened flora

A search of the Northern Territory Herbarium (IUCN, Holtze), NRETAS databases and SEWPAC's EPBC Act Protected Matters databases revealed no records of threatened species from within the Project area, nor within a search area of 20 km surrounding the mine.

There are few plant species with significant conservation values in the region surrounding the Project's mine area. Twenty four threatened plant species are listed for the Gulf Coastal Bioregion, which encompasses the Project area, comprising only 2.6% of threatened bioregional species in the Northern Territory (Connors, Woirnarski and Oliver, 1996). This figure is relatively low, in comparison with the Top End Coastal bioregion with 163 threatened species (representing 8.6% of threatened species).

Given the lack of suitable habitat (e.g. sandstone, vine-thicket and riverine) and the level of previous disturbance (from mining, grazing and feral animals), the presence of undetected threatened plant species within the Project area is unlikely. None of the 183 plant species recorded during this survey, nor any of the 381 species observed during both the 2003 and 2011 surveys, has significant declared IUCN threat codes (i.e. endangered or vulnerable) (Table 13-11).

Table 13-11 Characteristics of Near-threatened and Data deficient flora species recorded from the surrounding region, noting habitat and classification under Commonwealth and Northern Territory legislation

Species Identification		Conservation Status		Present within the Project area
Scientific Name	**Habitat**	**EPBC Act**	**NT PWC Act**	
Calytrix mimiana	sandstone plateau	not listed	near threatened	not detected
Ophioglossum gramineum	sandstone plateau	not listed	near threatened	not detected
Astrebla lappacea	black soil plain	not listed	data deficient	not detected
Dicarpidium monoicum	sandstone plateau	not listed	data deficient	not detected
Hibiscus setulosis	sandstone plateau, vine thicket	not listed	data deficient	not detected
Nephrolepis arida	moist crevices, Glyde River gorge	not listed	data deficient	not detected
Portulaca oligosperma	sandstone plateau	not listed	data deficient	not detected
Rothia indica spp. australis	sandy soils, riverine corridor	not listed	data deficient	not detected

Source: Northern Territory Herbarium

In previous surveys which covered a larger project area, one species, a tiny fern *Ophioglossum gramineam* which is listed as near-threatened (one of the lower risk IUCN categories), was recorded in the sandstone plateau environment in which it is has a wide but sparse distribution. *Calytrix mimiana* is another near-threatened species from the sandstone plateau habitat which is known from outside the MRM area, closer to Caranbirini waterhole. However, these species do not occur within the current Project area. Similarly, of the eight species regarded as data deficient (i.e. poorly known species with a lower IUCN threat code than near-threatened), and nine species recognised as endemic to the Northern Territory, none is likely to be affected by the Project: either their habitats do not occur within the Project area, or in the case of data deficient species *Astrebla lappacea* (from black soil plain) and *Rothia indica* spp. *australis* (from riverine corridor on sandy soils), neither species is restricted to the Project area. Of the 73 species collected from the Project area during the May 2011 survey for identification by the Northern Territory Herbarium, none was of conservation significance - i.e. listed as threatened under EPBC Act or TPWC Act.

13.5.3.1 Conservation of riverine communities

Riverine communities, although having no formal conservation status, are ecologically important due to their significance as a resource and habitat for fauna and their functional role as corridors through a largely arid landscape. Riparian vegetation and closed forests typically associated with waterways and wetlands are considered sensitive and significant vegetation communities of importance in maintaining water quality and biodiversity protection (NRETAS, 2010). Riverine communities and natural wetland habitats occur downstream and upstream of the project area and *Melaleuca* habitats such as these are referred to as sensitive and significant vegetation communities in the *Northern Territory Planning Scheme* (NTPS, 2007). It is recommended in Clause 8.1 of the NTPS that the native vegetation in drainage lines, wetlands and watercourses should not be cleared (NTPS, 2007). If clearing vegetation in these habitats is unavoidable, the Northern Territory Government *Land Clearing Guidelines* will be considered when developing mitigation measures, where required (NRETAS, 2010).

13.5.4 Project impacts on flora

Without appropriate mitigation and management, land clearing and mining activities associated with the Project may increase soil erosion, inadvertently causing downstream silting, sedimentation or contamination of riverine habitats and waterholes.

Without appropriate mitigation and management, acid rock drainage (ARD) from the North OEF may impact on adjacent riparian vegetation communities and downstream habitats, particularly freshwater aquatic flora.

Surprise Creek, which flows into Barney Creek and then the McArthur River, plays an important role in dilution of contaminants. However, if ARD from the expanded North OEF is not controlled this may have cumulative downstream impacts.

High wet season rainfall and the incidence of cyclones may create potential for erosion of the TSF capping which could potentially expose tailings to the environment. Modelling based on trials will be undertaken to confirm the final TSF capping layer, which is discussed more in Appendix E1 – Tailings Storage Facility Management Plan.

Activities associated with the Project have the potential to introduce new weed species and spread weeds within and around the Project area. Without appropriate management, these activities may lead to habitat degradation, loss of habitat for fauna, increased fire risk, reduced accessibility, loss of biodiversity, and exclusion of native flora species.

13.5.5 Management of impacts

Native vegetation removal will be conducted only after the areas to be cleared have been clearly delineated and identified to equipment operators and supervisors. Appropriate buffer zones, erosion and sediment control structures will be put in place.

Buffer areas in excess of 70 m will be retained between new mining facilities and drainage lines that are to remain functional. The McArthur River Channel represents a riparian corridor, although it is not yet revegetated to an adequate level to provide ecosystem function.

Where practicable, final landforms will be contoured to resemble the original local topography to include hill slopes and rocky drainage lines. This will provide a structure to facilitate the establishment of a variety of habitat types.

Revegetation of the main McArthur River Channel will continue and a diversity of plants will be established in conjunction with intensified revegetation efforts. Important species to include in riparian revegetation efforts are *Melaleuca argentea*, *Casuarina cunninghamiana*, *Barringtonia acutangula*, *Pandanus* and canegrass.

Weed control will be monitored and the existing weed control plan adhered to, including areas upstream and downstream of the channel. Weeds will be monitored on an annual basis by a suitably qualified person.

Buffer zones around riparian vegetation of the channel will be mapped and maintained and designed to prevent development of the southern and eastern OEF impeding revegetation of the channel.

Tailings dams, when capped, will be adequately contoured to allow effective drainage of the surface and prevent rill erosion (which can potentially expose tailings and can contribute to sedimentation and pollution of drainage lines). Consolidation of the TSF surface through adequate capping and rehabilitation is fundamentally important to reduce impacts on terrestrial and aquatic flora ecosystems, particularly over the longer term, following mine closure.

Monitoring of ARD will continue throughout the life of the Project and after mine closure, to avoid potential pollution of the McArthur River and its tributaries and therefore impacts on riparian and aquatic flora.

Cultural Significance

During the 2005 impact assessment process, three members of the local community, two Traditional Owners and one Senior Custodian, were asked if any of the flora at the mine site had cultural significance. While one person reported that a local plant (root vegetable similar to a carrot) has historically been used as food, it is not present on the mine site nor is it currently used. There are no local plants that have been used for medicinal or spiritual significance nor are there any that are used for making materials or artefacts (URS, 2005).