# 3. Environmental Context

This chapter (where information concerning the terrestrial environment is largely taken from Low (2001)) describes the broad environmental and social context within which the project will be developed. More specific details of site conditions are presented in Chapter 7.

The project area is a modified natural landscape that has varying levels of disturbance from previous exploration and mining-related activities. The main areas of disturbance are in and around the Browns test pit, along the Rum Jungle Road and the old borrow material areas in the central and southern parts of the project area (Figure 3.1).

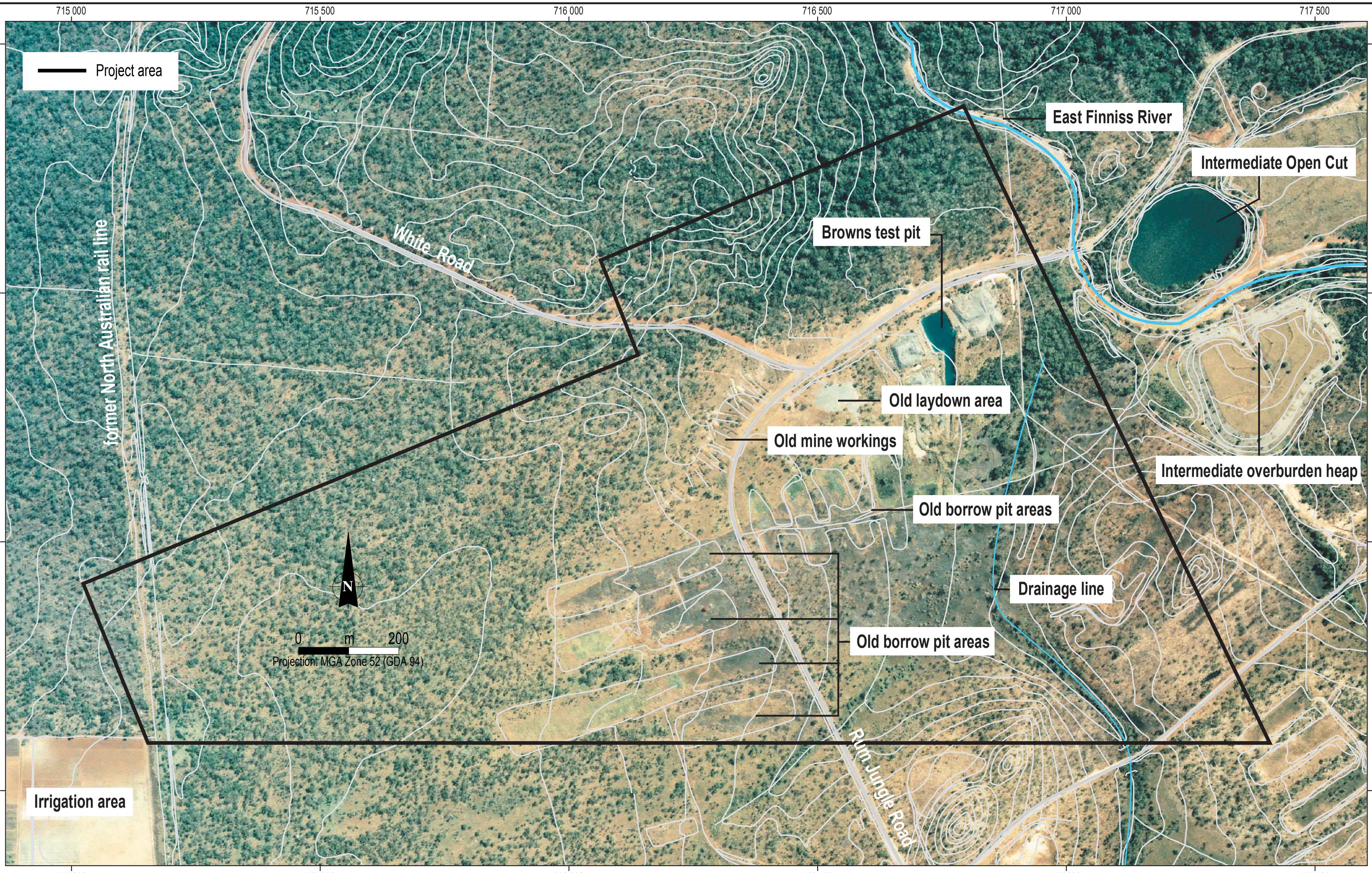
## 3.1 Terrestrial Environment

### 3.1.1 Climate

Batchelor has a monsoonal climate with distinct wet and dry seasons. The Australian Bureau of Meteorology maintains several weather stations in the region, but the longest data record (over 60 years) is available from Darwin Airport, where the average annual rainfall is 1,714 mm, with an average monthly rainfall ranging from 423 mm (January) to 1.4 mm (July). The highest average monthly temperature at Darwin Airport is 29.3˚C (November) and the lowest is 24.9˚C (July) (BoM, 2005).

In the project area, monitoring of rainfall, temperature, solar radiation and wind speed and direction was undertaken from 11 July 2000 to 7 February 2003. Within this period, most of the rainfall occurred during the wet season, i.e., December to March, and very little rainfall was recorded over the dry season; this is consistent with the rainfall pattern recorded at Darwin Airport (Figure 3.2) and reflects the monsoonal climate in the top end of the Northern Territory. The relatively high rainfall during the wet season consists of isolated showers and storms with prolonged periods of cyclonic depressions, particularly in the latter half of the wet season.

Average daily temperatures at the site differed by about 4°C between the cooler months of the dry season and other times of the year, with the highest average monthly temperature being 28.5°C (October and November) and the lowest being 23.5°C (July) (see Figure 3.2). Winds showed significant seasonal trends (Figure 3.3). During the dry season, winds were predominantly from the east-southeast and southeast. Wet season winds were predominantly from the west and west-southwest. The dry season wind pattern is consistent with that recorded at Darwin, although the wet season pattern for Darwin has a less dominant westerly wind than recorded on site. Wind speed data showed that there is a high proportion of calm periods, i.e., 30% of the 12-month period from July 2000 to July 2001, where the wind speed was less than 0.5 m/s.




Source: AMDAD.

| Job No: 836 | Compass Resources NL | Project area aerial photograph and topography | Figure No: 3.1 |
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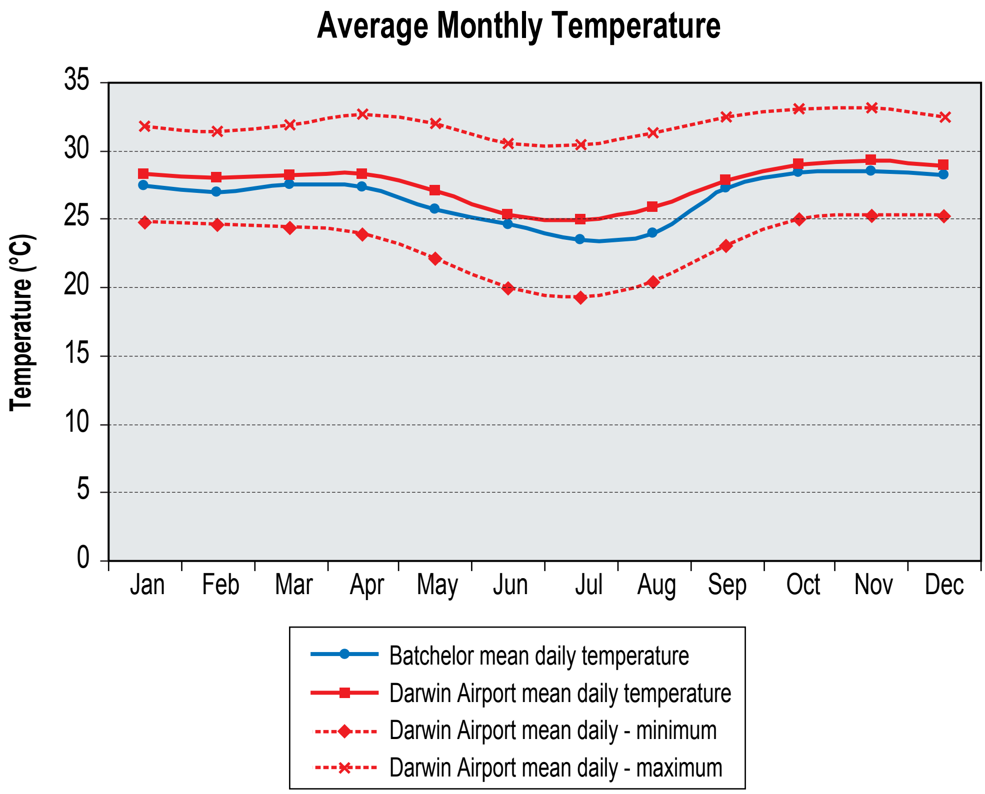


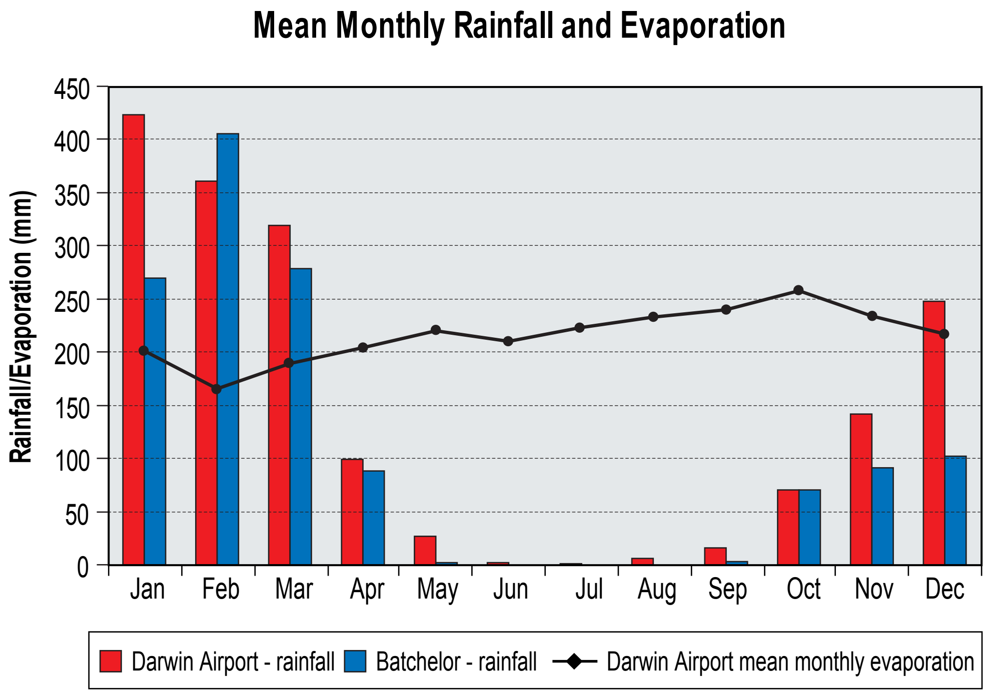


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| Job No: 836 | Compass Resources NL | Temperature, rainfall and evaporation | Figure No: 3.2 |
| File No: 836_08_F3.02_HB | Browns Oxide Project | | |


Source: Compass meteorological station (11 July 2000 to 10 July 2001).

| enesar peopleandplace | Job No: 836 | Compass Resources NL | Annual and seasonal wind roses | Figure No: 3.3 |
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### 3.1.2 Landscape and Land Systems

The general area around Batchelor is on the north slope of the Pine Creek Geosyncline and can be described primarily as a peneplain of gently undulating land interspaced by plains. Small hills are usually less than 150 m above the surrounding plains. Christian and Stewart (1953) (as cited in Low (2001)) broadly described the land systems of the region, and the project area lies in the northern part of 'elevated backbone country'. Land systems (or elements thereof) that occur in the region are Batchelor, Cullen, Finniss and Brocks Creek Ridge land systems, the main characteristics of which are shown in Table 3.1.

**Table 3.1 Characteristics of land systems in the region**

| Land System | Extent within Region | Geology | Geomorphology | Main Soils | Main Plant Communities[1] |
|---|---|---|---|---|---|
| Batchelor | Large | Strongly folded slates, quartzites | Mostly hills, some undulating and flat country | Mostly stony soils, yellow podsolic soils, lateritic soils and acid alluvial soils | Tall mixed open forest, patches of grassland on flats |
| Brocks Creek Ridge | Small | Strongly folded slates, quartzites | Sharp north–south ridges and hills | Rock outcrops and skeletal soils | Deciduous open forest and mixed open forest |
| Cullen | Large | Granite | Mixed and undulating hills | Rocky skeletal soils, granitic yellow podsolic soils, granitic lateritic podsol | Deciduous open forest, mixed open forest or scrubby open forests |
| Finniss | Small | Quaternary flood plain alluvia with considerable areas of metamorphics | Flats liable to flooding intermixed with hills and undulating country | Acidic alluvial soils, gravelly yellow podsolic soils and skeletal soils | Grassland on flats, mixed open forest on remainder |

[1] Along drainage lines, parts of the mixed open forest may be classed as riparian rain forest.

### 3.1.3 Geology and Geomorphology

The project area is in the northwestern part of the Pine Creek Geosyncline where lower Proterozoic sedimentary rocks were deposited over the Archaean Rum Jungle and Waterhouse granitic complexes (Davy, 1975 as cited in Low, 2001). Regionally, the Pine Creek Geosyncline is composed of sandstones and mudstones, with minor tuffaceous intervals, accumulated in a single basin up to 14 km in thickness (Needham et al., 1980 as cited in Low, 2001). In the project area, the sedimentation is typically transgressive, beginning with older reworked granitic conglomerates and arkoses (the Crater Formation) followed by a massive carbonate sequence (the Coomalie Dolomite). Local faulting appears to have repeated these two lower formations. Overlying the Coomalie Dolomite and hosting the base metal deposits of the area is the Whites Formation, a grey to black carbonaceous shale. These lowermost rocks are then overlain by the slates, sandstones, quartzites and metamorphic rocks of Pine Creek Geosyncline.

The area has been geologically stable since Precambrian time. Sedimentation and erosion during the Tertiary and Quaternary have been major factors influencing the topographic form of the area.

The Browns Oxide Project area lies in the Northern Lateritic Plains Geomorphological Unit marked by lateritic soils formed on rocks of the Brocks Creek Group. Although the area has high rainfall, erosion has generally been retarded by the relative lack of relief and the high permeability of the soils.

### 3.1.4 Soils

The soils of the region are generally nutrient poor, except in the river valleys which usually flood during the wet season and tend to be acidic. The topography and soils of the Coomalie area are generally regarded as being highly erodible (DLPE, 2000). Christian and Stewart (1953) (as cited in Low, 2001) have described the soils of the region at a broad scale and these are presented in Table 3.1. More detailed studies of smaller areas (e.g., Wood and Sivertsen, 1984 (as cited in Low, 2001) describe soils in relation to land systems of regions north and south of the Batchelor area. Lateritic massive soils and gravelly yellow podzols dominate the higher grounds while light textured 'acid' alluvial soils and heavy grey pedocals occur in the lowlands (Davison and van Groenou, 1986 (as cited in Low, 2001).

Conclusions from the monitoring studies of the Rum Jungle site that is adjacent to the project site indicate that erosion is a localised problem and is not widespread (Kraatz, 1998 (as cited in Low, 2001).

### 3.1.5 Fire

The current practice at the Browns Oxide Project area is to undertake limited burning of seasonal grasses in areas where drilling is proposed (at times as permitted by the local fire regulations). This is undertaken as soon as practical after the wet season, in still weather, to minimise the intensity of the fire. It is, however, not an irregular event for wild fire to travel cross-country and burn other sections of the project area, with intense fires typically occurring late in the dry season. The source and path of such fires vary considerably and their origin is generally unknown.

## 3.2 Aquatic Environment

A considerable amount of biological and water quality monitoring has been undertaken in the Finniss River system as part of the Rum Jungle Rehabilitation Project. A summary of the monitoring programs undertaken, and the results of those assessments, are presented in Appendix 2.

### 3.2.1 Drainage and Hydrology

The project area is about 70 km inland from Fog Bay in the Timor Sea and is mostly drained by the East Branch of the Finniss River, i.e., the East Finniss River, which is one of the smaller catchments in the northwest of the Northern Territory. The catchment area of the entire Finniss River system is 9,532 $km^2$ (NGIS, 2004) (Figure 3.4). The river runs for approximately 140 km from the project site to enter the sea at Fog Bay via a wide, swampy, mangrove mudflat estuary.

The East Finniss River generally has no flow in the latter part of the dry season, i.e., from July to November, when the river becomes a series of discontinuous permanent and semi-permanent waterholes and billabongs. In the wet season, flood events are superimposed on a base flow. Very intense storms result in flood peaks with rapid run off down streams that have become broad, deeply incised flood-water channels which can discharge large quantities of water in a very short period of time.

### 3.2.2 Water Quality

The water quality of the East Finniss River is heavily influenced by long-term acid rock drainage (ARD) from the former Rum Jungle Mine, which is located adjacent to the Brown Oxide Project site (see Figure 1.1). Some discussion about the legacies of this mine, which provide the context for the proposed project, is therefore appropriate.

The Rum Jungle Mine, which operated between 1954 and 1971, was one of Australia's first uranium mines, but also produced copper and small amounts of nickel and lead. Generation of ARD ($pH<3$ and elevated levels of copper, zinc, nickel, cobalt, manganese, aluminium and iron) from the site, particularly the waste rock dumps, has caused severe adverse impacts on water quality in the East Finniss River and, to a lesser extent, the Finniss River.

In the early 1980s, the Northern Territory and Commonwealth governments agreed to undertake the Rum Jungle Rehabilitation Project, where the main objective was to reduce water infiltration rates into the waste rock dumps to less than 5% of incident rainfall (thereby reducing the oxidation rate of pyrite and the rate at which pollutants were transported to the environment and, specifically, to reduce copper and zinc loadings to the East Finniss River by 70% and manganese loading by 56%)[1]. The waste rock dumps were therefore capped with a three-layer cover between 1983 and 1986. The water infiltration target was met for the first 10 years following cover placement, representing a 10-fold reduction over rates measured prior to rehabilitation. However, there is now evidence that the covers are failing since infiltration rates have increased to 5 to 10% of incident rainfall (Bennett, 2002). As a result, pollutant loads from the waste rock dumps may increase over the next 20 to 30 years to levels that represent about 30 to 50% of loads prior to rehabilitation (Bennett, 2002).

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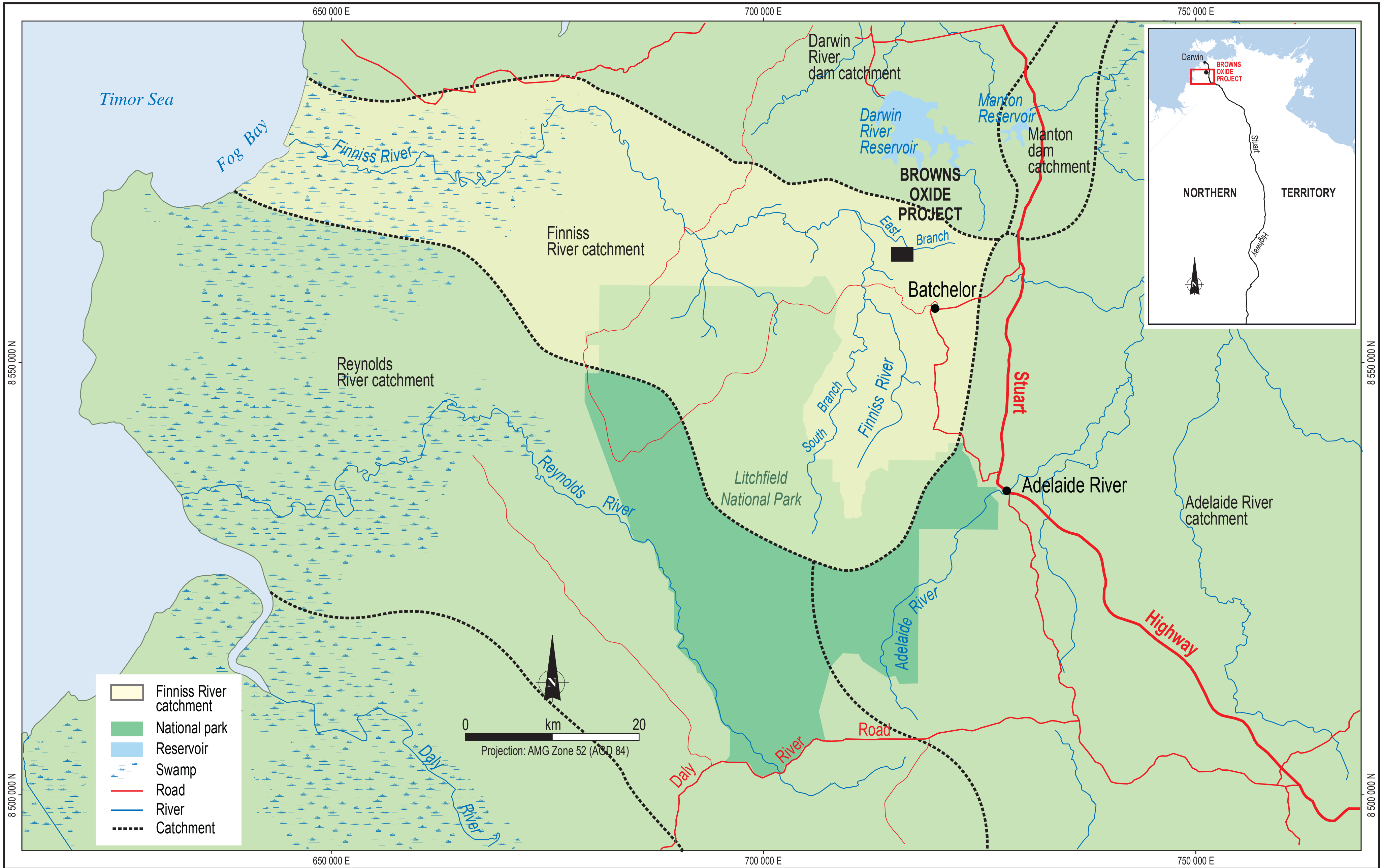
[1] Other objectives included: reducing public health hazards by reducing radiation levels at the site; reducing pollution in Rum Jungle pits (Whites and Intermediate); and aesthetic improvements.




| Job No: 836 | Compass Resources NL | Catchment areas | Figure No: 3.4 |
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| File No: 836_08_F3.04_HB | Browns Oxide Project | | |

The rehabilitation project also involved treatment of pit water (via lime addition) and diversion of the East Finniss River to its original path through Whites and Intermediate pits[1] during wet season flows. This annual flushing of the pits during the wet season is designed to prevent build up of acidity and heavy metals. The design restricts contaminant discharges to the East Finniss River until after base flow is established, thereby maximising available dilution. Flows from the pits also cease earlier than flow in the river as low recessional flows are confined to the diversion channel.

### 3.2.3 Aquatic Ecology

The aquatic ecology of the Finniss River system has similarly been adversely affected by ARD from Rum Jungle. Prior to rehabilitation of the Rum Jungle site, very few fish survived at low-flow conditions in the 10-km section of the East Finniss River downstream of the mine, where concentrations of copper and zinc measured in the water were 55 and 44 mg/L, respectively (Jeffree and Twining, 2000). An appreciable decline in fish diversity and abundance in the Finniss River also occurred for at least 15 km downstream of the confluence with the East Finniss River during dry season sampling (Jeffree, 2002). Fish kills occurring in the Finniss River during the first flush of the wet season (when moderate inflow from the East Finniss River coincided with low flows in the Finniss River) were thought to be responsible for the residual impacts on fish populations that were observed in dry season surveys (Jeffree et al., 2001).

Post-rehabilitation surveys in the Finniss River in 1992 and 1995 showed no statistically significant differences in fish diversity or abundance between impact sites, i.e., sites downstream of the confluence with the East Finniss River, and unimpacted sites, i.e., sites upstream of the East Finniss River confluence and downstream of the Florence Creek confluence (Jeffree et al., 2001). The recovery in the abundance and diversity of fish species in the impacted zone of the Finniss River is attributed to the reduction in metal loads and concentrations following remediation, although considerable contaminant loads are still being delivered from the East Finniss River (Jeffree, 2002).

Surveys during 1996 and 1997 found that fish kills continued to occur in the East Finniss River (Twining et al, 2002). However, up to seven species of fish have been recorded in the East Finniss River, indicating some ecological recovery post-remediation, although well short of the potential diversity of up to 18 fish species in similar habitats elsewhere in the Finniss River system (Twining et al, 2002).

Establishment of baseline conditions for the Browns Oxide Project is difficult since the existing environment is in a state of flux and the extent of possible recovery is unknown. It is also possible that, without any further activity on the site, the ecological health of the Finniss River system may again deteriorate due to ongoing failure of the Rum Jungle Mine waste rock dump cover systems.

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[1] Water quality in Whites Open Cut, particularly in deeper waters, is seriously degraded being of low pH and containing copper concentrations of up to 60 mg/L. Intermediate Open Cut is relatively unpolluted, except in the mixed upper layer during the early wet season when contaminated overflow water from Whites Open Cut flows through the pit (Lawton, 1998a).

### 3.2.4 Groundwater

Good supplies of groundwater (more than 5.0 L/s) are generally available in the Batchelor area, with moderate groundwater prospects (up to 5.0 L/s) also being evident throughout the Coomalie region (DLPE, 2000). Groundwater is therefore the main water source in the region and is used for Batchelor's water supply.

The main aquifer is in the top of the Coomalie Dolomite, with water quality reflecting the dolomitic nature of the aquifer, i.e., elevated hardness and total dissolved solids concentrations that are largely due to carbonate (Yin Foo, 1996). The town's annual water consumption is 378 ML (DIPE, 2004), although there is considerable seasonal variability with increased usage in the dry season being attributed to high lawn and garden watering, college intake and increased tourism (Yin Foo, 1996).

The registered bore data for the project area and surrounds indicates 116 registered bores within a 3-km radius of the proposed mine. Of these, 15 appear to be production bores and 10 are located at the groundwater irrigation area (where crops such as mangos and vegetables are grown) located southwest of the mine (Appendix 3).

## 3.3 Socio-economic Environment

The Browns Oxide Project is located within the area administered by the Coomalie Community Government Council, where the council is responsible for ensuring that the area maintains its rural setting while allowing continued, appropriate development.

The Coomalie area was developed through construction of the overland telegraph line in 1872 and the associated discovery of gold, during which period Adelaide River became a convenient service and resting location. Prior to the Second World War, the area around Rum Jungle was the focus of agricultural enterprises. During the war, both Batchelor and Adelaide River were integral to military operations. Following the war, attention in the Coomalie area turned to mineral exploration.

In addition to its role as the commercial and civic centre of Coomalie, Batchelor is regarded as the 'gateway' to Litchfield National Park and thus receives a considerable share of the region's tourist market, with approximately 250,000 visitors to Batchelor each year mostly visiting Litchfield (and generally in the dry season). The smaller town of Adelaide River, located on the Stuart Highway approximately 23 km southeast of Batchelor, is also a popular stop for tourists.

In 2001 (the last census), the population of Batchelor was 727 (0.3% of the Northern Territory population), an increase of 12.7% from 1991. However, access to land and water resources is expected to constrain population growth. Batchelor is largely self-sufficient with respect to day-to-day commercial and community services needs, although residents travel to Coolalinga (approximately 50 km to the north) or to Darwin for specialist commercial and other services.

There were 250 employed persons in Bachelor in 2001 out of a labour force of 269 (i.e., 6.9% unemployment). Education is the largest employer followed by the hospitality industry while, as indicated above, tourism is also an important industry in the area.

Information available to date suggests that, in general, the local community supports the proposed project, although there are possible misperceptions associated with the Rum Jungle site and the earlier Browns Polymetallic (Sulfide) Project proposed in 2001, as well as a number of specific concerns (that are described in Chapter 6).

## 3.4 Aboriginal Groups

The original (and still the main) Aboriginal tribal groups of Coomalie are the Kungarakan and Awarai (Warai) people; a third group, the Maranunggu, were originally from the Daly River region but gravitated north over a number of years towards the Batchelor area (DLPE, 2000). Many other Aboriginal groups have resided (and in some cases still reside) in the area, such as the Muluk-Muluk, Wadgigan, Brinkin and Djerait groups (DLPE, 2000).

The project area is not subject to Native Title claims, being land granted to the Finniss River Aboriginal Land Trust under ALRA (*Aboriginal Land Rights (Northern Territory) Act 1976*).