

OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION SHORT-RANGE ENDEMIC FAUNA ASSESSMENT



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EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned to undertake a terrestrial biological assessment survey for BHP Billiton Iron Ore's proposed Outer Harbour Development and Goldsworthy Rail Duplication projects at Port Hedland, Western Australia. Infrastructure associated with the proposed Outer Harbour Development includes rail, stockyards, a transfer pad, conveyors and access roads. The proposed Goldsworthy Rail Duplication will include the construction of additional rail infrastructure adjacent to the existing Goldsworthy Rail.

As part of this biological assessment, surveys for short-range endemic (SRE) fauna were undertaken in two survey periods, July 2008 for the proposed Outer Harbour Development and October 2008 for the proposed Goldsworthy Rail Duplication.

An assessment and characterisation of habitat suitability for SRE fauna was undertaken for the Outer Harbour Development and Goldsworthy Rail Duplication project areas using a combination of desktop review and field surveys. Where suitable SRE habitat was identified, targeted searches for SRE fauna were undertaken.

The Outer Harbour Development project area was found to contain little habitat considered likely to result in short-range endemism amongst inhabiting invertebrate fauna. The potential SRE fauna habitats identified, and thus targeted, included Finucane Island (being isolated from the mainland) and rocky limestone outcrops on both the mainland and Finucane Island. Targeted searches for SRE fauna revealed the presence of various land snail species and a single species of the widely distributed Mygalomorphae trap door spider, *Aname mainae*, commonly referred to as the Black Wishbone Spider. All species recorded are widespread regionally, and are therefore not considered to be SRE fauna at the species level.

Clearing associated with the construction of the proposed transfer pad of the Outer Harbour Development will remove rocky limestone outcrops on Finucane Island which are not locally or regionally rare or restricted. No SRE fauna species and no invertebrates of conservation significance were recorded in the proposed disturbance envelope on Finucane Island. Therefore, the proposed Outer Harbour Development is considered highly unlikely to adversely impact on SRE fauna.

No prospective SRE fauna habitat was located within the Goldsworthy Rail Duplication project area. The project area was characterised by regionally widespread Spinifex plain in varying states of disturbance (e.g. rehabilitated, weed infested and recently burnt), with no landform features or dispersal barriers that may have otherwise lead to the formation of short-range endemism. Consequently, no targeted searches for SRE fauna were undertaken.

As a result of the two surveys, it was concluded that Finucane Island was likely to be the only area of potential SRE fauna habitat that could be impacted through construction of proposed infrastructure. Extensive foraging on Finucane Island failed to record SRE taxa, and thus it is concluded that the proposed Outer Harbour Development and associated infrastructure conveys no threat to SRE fauna.

1 INTRODUCTION

ENV.Australia Pty Ltd ('ENV') was commissioned to undertake terrestrial biological assessment surveys for BHP Billiton Iron Ore's proposed Outer Harbour Development and Goldsworthy Rail Duplication projects at Port Hedland Western Australia. These biological assessments include surveys of flora and vegetation, vertebrate fauna and short-range endemic ('SRE') fauna. This report documents the findings of the SRE fauna surveys undertaken by Phoenix Environmental Sciences Pty Ltd in July and October 2008. The surveys targeted potential SRE fauna habitats within the proposed Outer Harbour Development and Goldsworthy Rail Duplication project areas and, more specifically, within the proposed disturbance envelopes. The objectives of the surveys were to:

- identify potential SRE fauna habitat within the project areas;
- undertake field searches for SRE fauna within habitats identified as potentially supporting SRE fauna;
- identify and assess the significance of SRE fauna occurring and potentially occurring within the project areas;
- document potential SRE fauna occurring within the project areas; and
- undertake an impact assessment with reference to the proposed Outer Harbour Development and Goldsworthy Rail Duplication disturbance envelopes and any recorded SRE fauna.

1.1 SHORT-RANGE ENDEMIC FAUNA

Short-range endemic fauna are typically regarded as fauna occupying extremely restricted distributions (defined as an area less than 10 000 km²) (Harvey 2002). SRE fauna are usually arthropods, and very few vertebrate fauna qualify as true SRE fauna. The distribution of SRE fauna species is restricted due to their limited physical ability to disperse (e.g. lack of wings) and/or confinement to discontinuous habitat. As a result of limited dispersal opportunity, populations of SRE fauna species are characterised by little or no emigration and immigration.

In general, characteristics of SRE fauna include:

- poor powers of dispersal;
- confinement to discontinuous habitat;
- highly seasonal activity and climatic triggers;
- slow growth; and
- low fecundity.

1.2 LOCATION

The Outer Harbour Development project area lies west and south-west of the towns of Port Hedland and South Hedland and covers an area from Finucane Island to the decommissioned Boodarie Hot Briquette Iron (HBI) Plant and inland to the Newman to Port Hedland rail line in the south-east (Figure 1). The proposed Goldsworthy Rail Duplication project area lies to the south and south-west of Port Hedland and covers areas immediately adjacent to the existing Goldsworthy rail line and Newman to Port Hedland rail line (Figure 1).

1.3 PROPOSED INFRASTRUCTURE

The proposed Outer Harbour Development terrestrial infrastructure includes:

- three rail options, 2007 Rail Options A and B, and 2008 Rail Option C (the preferred rail option otherwise known as ‘the proposed Western Spur Railway’) which originate from the area of the decommissioned Boodarie HBI Plant and connect with the existing Newman to Port Hedland rail line;
- stockyards to the north of the decommissioned Boodarie HBI Plant;
- four car dumpers and associated conveyor tunnels within the area of the decommissioned Boodarie HBI Plant;
- a transfer pad on Finucane Island; and
- an infrastructure corridor (including conveyors, access roadway and utilities) from the stockyards to the transfer pad.

To allow for the location of potential construction laydown areas, a liberal disturbance envelope surrounds the above proposed infrastructure (Figure 2), although it is unlikely that this area will be disturbed in its entirety.

The proposed Goldsworthy Rail Duplication project will include the addition of rail infrastructure to sections of the existing Goldsworthy rail line. The exact location of this rail infrastructure is still uncertain. For this project, the disturbance envelope referred to in this report is equivalent to the Goldsworthy Rail Duplication project area.

1.4 PHYSICAL ENVIRONMENT

1.4.1 Climate

The Pilbara region has an arid-tropical climate with two distinct seasons, a hot summer from October to April and a mild winter from May to September. The Port Hedland area experiences a wide range of temperatures throughout the year, with an average temperature of 33.2°C. In summer, maximum temperatures may reach 48.2°C, whilst in winter, minimum temperatures may reach 3.2°C (Bureau of Meteorology 2008).

Rainfall in the Pilbara is often sporadic, and can occur year-round. Port Hedland has an average annual rainfall of 303.8mm (Figure 3). Summer rainfall is a result either of tropical storms or of tropical cyclones that cross the coast and move inland. Winter rainfall is generally lighter, and is the result of cold fronts moving across the State.

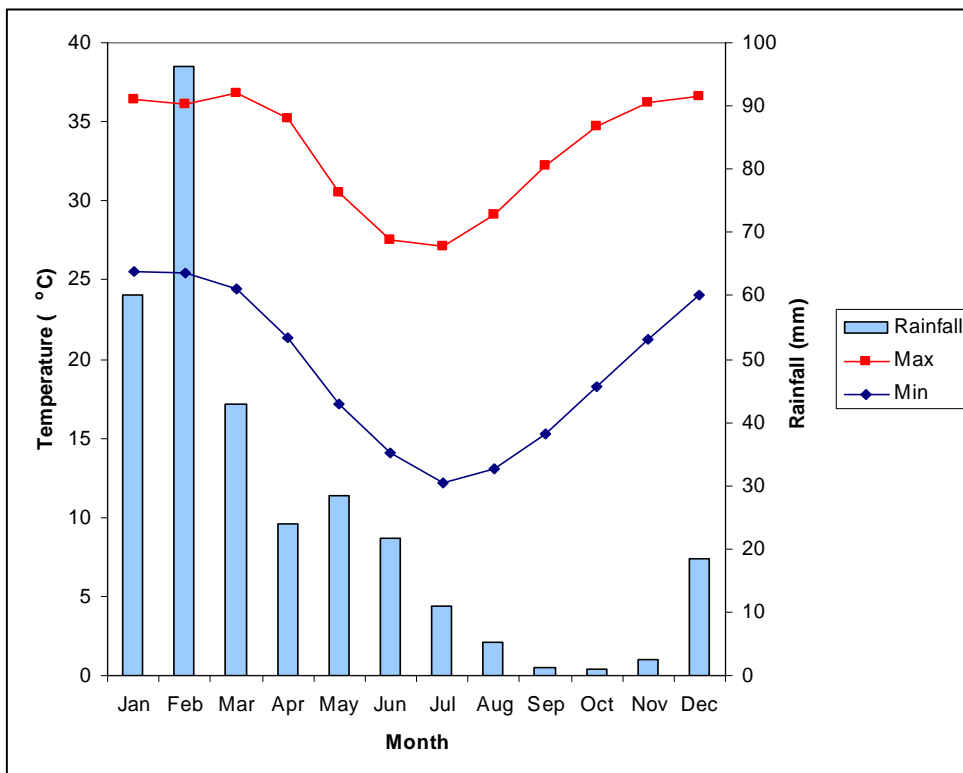


Figure 3: Average monthly rainfall and maximum and minimum temperatures for the Port Hedland area (Bureau of Meteorology 2008).

The Port Hedland area had received relatively low amounts of rainfall preceding the surveys, with only 60.2mm in the three months before the July 2008 survey and 0.4mm in the three months before the October Survey. The area received very little rainfall during the summer months as few cyclones crossed the WA coast in the 2007 – 2008 cyclone season (Bureau of Meteorology 2008). On average the area usually receives 273.8mm over January to June, however, only received 144.8mm for the same period in 2008.

1.4.2 Geology

The geology of the northern section of the Outer Harbour Development project area and the Goldsworthy Rail Duplication project was mapped as consisting of the following 11 units as per the Geological Survey of Western Australia (1983; Figure 4):

Qps: Silty sand, red-brown.

Qhs: Silty sand, red-brown.

Qhm:	Mud and silt.
Qc:	Clayey sand, abundant claypans.
Qf:	Flood-plain sediments.
Qs:	High-level sands.
Qhy:	Younger beach and dune shelly sand.
Qr:	Residual sand.
Qp:	Dune limestone.
Ql:	Lime-cemented beach conglomerate.
Qho:	Older dune shelly sand.

The geology of the southern section of the Outer Harbour Development project area was mapped as consisting of the following three units as per Geological Survey of Western Australia (2001; Figure 4):

Qaa:	Alluvial sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains.
Qaac:	Mixed floodplain deposits with numerous small claypans.
AgLpe:	Pegmatite; metamorphosed.

1.5 BIOLOGICAL ENVIRONMENT

1.5.1 Biogeography

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 85 bioregions based on major biological and geographical/geological attributes (Thackway & Cresswell 1995). These bioregions are subdivided into 404 subregions as part of a refinement of the IBRA framework (Department of Environment, Water, Heritage & the Arts 2005).

The Outer Harbour Development and Goldsworthy Rail Duplication project areas are located in the Pilbara bioregion and Roebourne subregion (Thackway & Cresswell 1995). Coastal areas in the subregion typically contain alluvial and colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *Acacia pyrifolia* and *Acacia inaequilatera*. The subregion also contains areas of Samphire, *Sporobolus* and mangal on marine alluvial flats and river deltas.

The Outer Harbour Development and Goldsworthy Rail Duplication project areas are located in the Abydos Plain, which forms part of the Fortescue Botanical

District in the Eremaean Botanical Province of Western Australia, as per Beard (1975).

1.5.2 Land Systems

Land system mapping is based on regional patterns in topography, soils and vegetation. The most recent land system mapping of the Pilbara bioregion was completed by van Vreeswyk *et al.* (2004). The mapping divides the Pilbara region into 102 land systems. The following three land systems are found within the Outer Harbour Development project area:

- Lit:** Littoral: Bare coastal mudflats with mangroves on seaward fringes, samphire flats, sandy islands, coastal dunes and beaches; forms 0.9% (1577 km²) of the Pilbara bioregion; and
- Mac:** Macrocy: Stoney plains and occasional tor fields based on granite supporting hard and soft Spinifex grasslands; forms 7.2% (13095 km²) of the Pilbara bioregion;
- Riv:** River: Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft Spinifex grasslands; forms 2.3 % (4088 km²) of the Pilbara bioregion; and
- Uar:** Uaroo: Broad sandy plains; supporting shrubby hard and soft Spinifex grasslands; forms 4.2% (7681 km²) of the Pilbara bioregion.

The Littoral and Uaroo land systems are found within the Goldsworthy Rail Duplication project area.

Beard Mapping

Beard (1975) broadly mapped the Outer Harbour Development and Goldsworthy Rail Duplication project areas as Spinifex with no shrubs or trees and Mangroves on Finucane Island, dwarf shrub steppe and grass savanna mixed with Spinifex near the decommissioned Boodarie HBI Plant and through the middle of the project area, and granite plains near the Newman to Port Hedland rail line in the south-east of the Outer Harbour Development project area. Beard (1975) mapped the area as containing six vegetation associations:

- t₁Hi:** Hummock grasslands, grass steppe; soft Spinifex;
- Mud:** Bare areas; mud flats;
- Mangroves:** Thicket; mangroves;
- a₁₈Zr.t₁Hi:** Hummock grasslands, dwarf-shrub steppe; *Acacia* over Spinifex;
- xGc/t₁Hi:** Mosaic: short bunch grassland – savanna/grass plain; and

A₂Sr.t₁Hi: Hummock grasslands, shrub steppe; kanji over soft Spinifex.

1.6 PREVIOUS SHORT-RANGE ENDEMIC FAUNA SURVEYS

A comprehensive and systematic field review by the Department of Environment and Conservation ('DEC') of Pilbara regional fauna (including invertebrates) has been undertaken (DEC Pilbara Biological Survey 2002-2007). However these surveys aimed to target the most common habitat types in the Pilbara and thus, did not consider the more limited habitat types which might contain SRE taxa. Many of the groups known to include SRE taxa were recorded in this Biological Survey which will shed light on species distributions, however this information is not yet available in a published form (J.Clarke pers.comm.).

In recent decades, a boom in large-scale regional resource development projects has resulted in a significant amount of site-specific biological survey work being carried out in the Pilbara, most undertaken for formal environmental approvals. Few of these biological surveys have focussed on SRE fauna. Within the Port Hedland region, surveys undertaken by Biota (2008, 2009) included non-intensive searches for SRE fauna species. Biota also collected invertebrates during the FMG rail corridor survey (Biota 2004) with the aim of identifying SRE fauna.

2 METHODOLOGY

2.1 BACKGROUND TO SURVEY METHODOLOGY

In the context of environmental impact assessment SRE fauna remain an important consideration. Any disturbance to SRE fauna habitat may result in loss of localised SRE fauna populations which can contribute to a loss in overall biodiversity at the population, species and genetic levels.

The SRE fauna surveys described in this report have been undertaken using methods that adhere to the principals and guidelines outlined in Environmental Protection Authority (EPA) *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002) and EPA *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

At the time of the surveys there were no formal guidelines on the sampling and surveying of short range endemic fauna species released from the EPA. A Guidance Statement regarding this was released in May 2009, *Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA 2009). The survey approach used in this SRE fauna assessment broadly reflects the approach recommended by the EPA.

The surveys targeted faunal groups known to contain SRE taxa within the Pilbara region (see Section 2.2) and the potential SRE fauna habitats within the Outer Harbour Development and Goldsworthy Rail Duplication project areas.

2.2 SURVEY APPROACH

The survey approach used to determine the presence of SRE fauna habitats and SRE fauna included:

- assessing the presence and extent of potential SRE fauna habitat within the project areas, including identifying landforms which may give rise to short-range endemism in terrestrial invertebrates (habitat assessment followed up with ground-truthing);
- assessing the condition of the remnant vegetation in the context of SRE fauna (field assessment);
- undertaking targeted searches for SRE fauna taxa within habitats identified as potentially SRE habitat; and
- undertaking targeted searches for SRE fauna within reference sites located in habitat considered unlikely to support SRE fauna to:
 - verify the absence of SRE fauna and confirm the status of non-SRE habitat; and

- confirm that taxa considered to be SRE fauna are indeed restricted in distribution or habitat confined.

2.3 IDENTIFICATION OF SHORT-RANGE ENDEMIC FAUNA HABITAT

SRE fauna are typically restricted to isolated or discontinuous habitat. Prior to any field work, aerial photography and geological maps (Geological Society of Western Australia (GSWA) 1983; 2001) for the area were reviewed to identify prospective habitat for SRE fauna. This review focused on identifying any locally and/or regionally restricted habitats within both the Outer Harbour Development and Goldsworthy Rail Duplication project areas as such habitats are the major factors driving short-range endemism in individual species.

Examples of habitats which are known to support SRE taxa include:

- oceanic islands;
- southern facing slopes of ranges;
- hilltops;
- gullies and gorges;
- granite / basalt rocky outcrops;
- limestone outcrops; and
- minor springs and seeps.

Potential SRE fauna habitats identified during the review were ground-truthed during the field surveys.

2.4 FIELD ASSESSMENT

2.4.1 Outer Harbour Development Project Area

The survey for the Outer Harbour Development project area was conducted in daylight hours from 3-5 July 2008. A reconnaissance of the survey area was undertaken to ground-truth potential SRE fauna habitat identified from aerial photographs and geological maps for the project area.

A total of 29 sample sites within potential SRE fauna habitats were surveyed, of which, three sites were located within the proposed disturbance envelope (see Figure 5). Eight reference sites were surveyed in habitat considered unlikely to support SRE fauna.

The location of each sample and reference site were recorded by GPS (Appendix A). Site descriptions, vegetation present and sampling activity were recorded at each sample and reference site (Appendix B). Approximately 25 hours of hand searching were undertaken at these sites, and a total search area of 62

500 m² was covered. Additional targeted searching was conducted on Finucane Island upon finding a Mygalomorphae spider burrow.

The survey collection methodology comprised active searches (foraging), blacklighting for scorpions, and the collection of leaf litter samples, where appropriate. The foraging included the systematic inspection of logs and larger debris, looking under the bark of larger tree species and the underside of larger rocks (limestone outcrops), and methodically searching amongst the leaf litter of shade-bearing tall shrubs and trees. A temporally and spatially standardised search approach was undertaken, whereby a 50 m x 50 m area was searched at each site for 60 minutes (30 minutes x two people). Leaf litter samples were taken from shaded sites where a sufficient accumulation of leaf litter was found. On the night of 4 July 2008 three hours were spent blacklight searching for scorpions on Finucane Island, within the proposed Outer Harbour Development disturbance envelope.

2.4.2 Goldsworthy Rail Duplication Project Area

The review of aerial photographs for the Goldsworthy Rail Duplication project area failed to identify areas / habitats considered likely to support SRE fauna species. Nonetheless, a site-based habitat assessment was undertaken in 12 daylight hours on the 17 October 2008 to confirm the absence of SRE fauna habitat within this project area. As the findings of the desktop review were confirmed during the field survey, no SRE fauna sample sites were established. The establishment of reference sites was not considered necessary as those searched in the Outer Harbour Development field survey in areas classed as non-SRE habitat revealed an absence of SRE fauna taxa. The locations and details of sites visited (but not searched for SRE fauna for the reasons above) within the proposed Goldsworthy Rail Duplication project area are presented in Appendices A and B, respectively.

2.5 TARGET TAXA

The survey targeted taxonomic groups in the Pilbara region known to include SRE fauna species, including (but not limited to):

- trap-door spiders (Mygalomorphae),
- non-marine snails (Mollusca),
- millipedes (Diplopoda)
- scorpions (Scorpionida);
- pseudoscorpions (Pseudoscorpionida); and
- slaters (Isopoda).

2.6 SORTING AND IDENTIFICATION

Specimens collected by foraging techniques were transported to Perth alive and then preserved in 100% ethanol. Each specimen was placed in a glass vial and labelled accordingly.

All leaf litter samples were processed using a Tulgren Funnel extraction system before being sieved (through 18 mm, 8 mm and 2 mm stacks) and sorted in Perth under a stereo dissecting microscope to ensure that no specimens escaped the extraction process.

One species of Mygalomorph spider was identified to genus level in the field before delivery to Professor Barbara Main (University of Western Australia) for identification to species level. Following each survey, mollusc specimens were delivered to Dr Shirley Slack-Smith (Western Australian Museum) for identification.

3 FAUNA SURVEY LIMITATIONS AND CONSTRAINTS

It is important to note the specific constraints and/or limitations imposed on individual surveys, as identified by the EPA under *Guidance Statement No.20* (EPA 2009). Constraints and/or limitations are often difficult to predict, as is the extent to which they influence survey outcomes. The survey constraints and limitations experienced during the SRE fauna surveys are detailed in Table 1.

Table 1: Constraints Associated with the SRE Fauna Surveys

Variable	Impact on Survey Outcomes
Experience levels/ Resources	<p>The zoologists who executed these surveys are practitioners suitably qualified in their respective fields:</p> <ul style="list-style-type: none"> • Mr Jarrad Clark – Senior Invertebrate Biologist • Mr Glen Murray - Zoologist • Mr Justin Freeman – Biologist <p>Professor Barbara York-Main, Dr Shirley Slack-Smith, Dr Mark Harvey and Mr Corey Whisson identified specimens to species level.</p>
Scope: Life Cycles / sampling methods / intensity	<p>As little is known of the specific biology and ecology of SRE fauna in the Pilbara, detection of species during field investigation could not account for the cryptic nature of species, enabling them to avoid detection.</p> <p>The July survey collected a wide range of invertebrates from taxonomic groups known to contain SRE fauna. The sampled habitat was selected after careful consideration of the habitat most suitable for SRE fauna.</p> <p>Given the lack of prospective SRE fauna habitat within the project areas other than that present on Finucane Island, 37 hours of diurnal sampling time is considered sufficient survey effort.</p>
Proportion of fauna recorded/ Completeness	<p>The lack of comparable data on SRE species, and the general lack of knowledge of their biology and distribution, means it is not possible to estimate the proportion of SRE fauna recorded. The survey was completed as planned.</p>
Sources of Information	<p>At the bioregion level, the Pilbara has been the subject of many targeted biological surveys, primarily for the resources sector. Within the Port Hedland area, few surveys (Biota 2004; 2008 and 2009) have included an SRE fauna component. The Biota (2004), (2008) and (2009) survey findings are not readily comparable to those of the current surveys as they were either based on opportunistic searches or were undertaken in different habitats.</p>
Timing, weather, season.	<p>The surveys were conducted after a long period of little or no rainfall (see Figure 3 for rainfall data). Optimal timing for SRE surveys in the Pilbara is November to April (EPA 2009) and generally within wet conditions. The lack of rainfall may influence the activity levels of target SRE fauna.</p>
Access problems	<p>Site access was restricted to areas with 4WD vehicle access. All areas of the potential SRE fauna habitat were accessible on foot.</p>

4 RESULTS

4.1 SHORT- RANGE ENDEMIC FAUNA HABITAT

A map showing potential areas of SRE fauna habitat (rocky limestone outcrops) was derived using a combination of visual observations made during the surveys and the corresponding mapped geological units (Ql, Qhy, Qho and Qp) for the Port Hedland area as per the Geological Survey of Western Australia (1983; 2001). The potential SRE fauna habitat in the Outer Harbour Development project area is mapped in Figure 6.

4.1.1 Outer Harbour Development Project Area

The habitat assessment for the Outer Harbour Development project area identified Finucane Island as a major potential SRE fauna habitat area as it is separated from the mainland which is likely to promote endemism amongst invertebrate fauna. A number of specific areas on Finucane Island were also identified as potential SRE fauna habitat and included rocky limestone outcrop habitat (most suitable for land snails and pseudoscorpions) extending along the northern coast of the island. The Outer Harbour Development transfer pad is proposed to be located within this rocky habitat on the eastern end of Finucane Island. However, this same habitat is very well represented, outside the proposed disturbance envelope (Figure 6).

The remainder of the island vegetation and geology is largely homogenous, being dominated by Buffel grass (*Cenchrus ciliaris*) and coastal Spinifex (*Triodia* sp.) over stable and unstable coastal dunes. In places, these two species coexist, but for the most part *Cenchrus ciliaris* is dominant. Mangroves fringe the southern side of the island along the bank of the estuary. This habitat is not expected to support SRE fauna, largely because SRE fauna are typically highly susceptible to desiccation and thus intertidal marine habitats with their high salt concentrations are not suitable habitats for such taxa. Further, this habitat is largely continuous and represented more broadly in local area, especially with respect to the isolated rocky outcrops.

Exposed limestone outcropping was also noted as occurring in locations between the decommissioned HBI Plant at Boodarie and the coastal mangrove flats on the mainland (but outside of the proposed Outer Harbour Development disturbance envelope). As with Finucane Island, it was determined that these rocky limestone outcrops were prospective SRE fauna habitats. Rock outcrops often constitute a disjunct habitat that supports short-range endemism amongst the invertebrate and vertebrate fauna for example granite outcrops in the southwest (Withers and Edward 1997). Targeted searches were thus undertaken at these areas (Figures 5a and 5b), with no restricted species being recorded. These sites acted as reference sites to those on Finucane Island. Coastal low-lying limestone outcrops are widespread in the region and the absence of any SRE species from within

these isolated outcrops during the targeted searches indicates that SRE fauna are unlikely to be present in such habitat on Finucane Island.

Limited potential SRE fauna habitat occurs over most of the mainland portion of the Outer Harbour Development project area, other than the limestone outcropping mentioned above. The remainder of the project area is comprised of broad Spinifex plain with pockets of *Acacia* shrublands and tidal mangrove flats; all broad scale habitats unsuitable for the formation of short-range endemism. However, a number of reference sites were surveyed from within Spinifex plains, a habitat identified as unlikely to support SRE.

4.1.2 Goldsworthy Rail Duplication Project Area

The Goldsworthy Rail Duplication project area consisted of an 80 m linear strip surrounding the Newman to Port Hedland Railway and a 60 m strip surrounding the existing Goldsworthy Railway. Aside from the railway there are existing access roads within the survey area which are highly disturbed. The survey area consists primarily of broadly distributed and generally degraded coastal Spinifex plain, which is homogenous in nature and lacks any geological or landscape features that might give rise to short-range endemism. Consequently, all sites were assessed as highly unlikely to contain SRE invertebrate fauna.

4.2 TAXA RECORDED IN THE PROJECT AREA

Targeted searches for SRE fauna within reference sites (i.e. sites established in non-SRE fauna habitat) did not locate any invertebrates from taxa known to support SRE fauna.

Targeted searches for SRE fauna within sample sites (i.e. those within potential SRE fauna habitat) concentrated on Finucane Island as this area was considered to be the most significant area of potential SRE habitat within the project area.

Invertebrates collected from eight sample sites (Figures 5a and 5b) were from four taxonomic groups known to contain SRE fauna:

- Mollusca;
- Acarina;
- Araneae (Araneomorphae and Mygalomorphae spiders); and
- Blattodea.

A summary of specimens collected is provided in Table 2, and a description of the sample sites is provided in Appendix B.

Table 2: Invertebrate Specimens Collected During the Short-range Endemic Fauna Survey

Site	Group	Quantity	Comments	Submitted for ID	Identification
FG03	Mollusca	2	Dead, shells only	No – Marine Snail	-
FG02	Mollusca	1 large 1 small	Large species, probably marine, with very thick shell	WAM (S.Slack-Smith)	<i>Pupoides lepidulus</i> (Adams & Angas 1864)
FG02	Mollusca	1	Small	WAM (S.Slack-Smith)	<i>Pupoides cf. contrarius</i> (EA Smith 1894)
FG04	Aranaea (Arenaeo-morph)	1	Very small species - dispersal by aerial means	No	-
FG04	Mollusca	3	-	WAM (S.Slack-Smith)	<i>Pupoides lepidulus</i> (Adams & Angas 1864)
FG21	Blattodea (Cockroaches)	1	Winged form capable of aerial dispersal	No	-
MYG01	Aranaea (Mygalomorphae)	1	2 adult female specimens caught (1 damaged)	UWA (B.Main) 1 specimen only	<i>Aname mainae</i>

As can be seen in Table 2, there were a number of taxa that were not formally identified. With regard to the spider (FG04) and cockroach (FG21) specimens, both were capable of aerial dispersal, which effectively disqualifies them as SRE taxa (one exception being certain midges which may be restricted to very narrow stretches of rivers and streams for example). Lastly, two snail specimens, collected from limestone outcrops, were not formally identified as they were considered to be of marine origin and thus not SRE taxa.

4.2.1 Mygalomorphae

Nemesiidae *Aname mainae* Raven 2000 (Mygalomorphae)

The Black Wishbone Spider (*Aname mainae*) was recorded on Finucane Island (see Plate 1), approximately 1.7 km south of the proposed disturbance envelope on the island (sites MYG1 - MGY6; Figure 5b). Six characteristic burrows were identified after six hours of searching Finucane Island and only two individuals were collected.



Plate 1: Black Wishbone Spider *Aname mainae* (female) collected on Finucane Island

Aname mainae was recorded from an area of mixed *Triodia* and Buffel Grass, but not from areas of homogenous *Triodia* or homogenous Buffel Grass, which may indicate that areas of greater structural complexity favour the species. A further six hours were spent searching for burrows to the north of the original records, from within the proposed disturbance envelope. Although suitable habitat was present, no spiders or spider burrows were located.

The previous known distribution of this species was across the western half of the continent, from South Australia, along the south coast of Western Australia, extending north into the coastal Midwest. Therefore this record represents a considerable range extension for the species. The accuracy of fauna distributions is dependent on the level of historical survey work. The fact that *A. mainae* has not been found in the area before may be an indicator of the level of previous survey work focussed on this taxon. Given the broad distribution of this species, it is not considered to be an SRE species.

Although the burrows were characteristic of the species, the two collected adult individuals were of unusual colour and smaller than adult specimens collected from the Midwest. These differences are most likely a response to the colour of local substrate on which they were recorded and, due to the relatively small size of their island environment (R. Raven pers. comm. August 2008), which can act to reduce the body size of Mygalomorphae spiders.

Professor Barbara Main (University of Western Australia) and Jarrad Clark (Phoenix Environmental Sciences) agree that the specimen belongs to *Aname*

mainae, although, given the distribution and colouration differentiation, it may be a sub-species.

4.2.2 Mollusca

A number of extant snail species were recorded in the survey. Most specimens were of marine origin, and were recorded from limestone outcrops on Finucane Island and north of the decommissioned Boodarie HBI Plant. All of the outcrops are ancient oceanic reefs. Thus these specimens were not reported on.

Three generally widespread terrestrial species were recorded, representing one family and two genera.

Pupoides lepidulus (Adams & Angas 1864)

Pupoides lepidulus was recorded at FG02 and FG04 from within the development envelope on Finucane Island. It is a small, narrow, dextrally coiled species with a geographic distribution similar to the sinistral *Pupoides contrarius*. *P. lepidulus* has been found from coastal areas between Shark Bay and Port Hedland, including one record from Cape Latouche-Treville (south-west of Broome). It has also been recorded from the Houtman Abrolhos Islands, South Murion Island and Barrow Island. A single inland record exists from Wyloo Station in the Pilbara (Solem 1986). Due to its widespread distribution, this species is not considered to be SRE taxa.

Pupoides cf. contrarius (EA Smith 1894)

The single broken juvenile shell collected from site FG02 within the disturbance envelope on Finucane Island most closely resembles *P. contrarius*.

Pupoides contrarius is one of the few sinistrally coiled species in this family. It has an apparently widespread coastal distribution, having been recorded from Shark Bay, Cy Creek (south of North West Cape), and Port Hedland and at Cape Latouch-Treville (south-west of Broome). This species has also been recorded from the Houtman Abrolhos Islands, Hermit Island (Montebello Islands) and Barrow Island (Solem 1986).

In his 1986 publication, Solem found two geographic size variations of *P. contrarius*, which he suggested may represent two species. This included a 'northern' group from the Onslow turnoff on the Great Northern Highway north to Port Hedland, including specimens north of Pardoo. Specimens of *P. contrarius* in this area were much larger than those of the 'southern' group, with a shell height range of 3.46-5.16 mm (mean 4.37 mm).

The 'southern' group, found from Shark Bay to Cape Range, including the Houtman Abrolhos Islands, was much smaller, with a shell height range of 2.94-4.64 mm (mean shell height 3.79 mm).

The specimens from this survey fit the known distribution and size range of *P. contrarius* in the 'northern' group and is not considered a SRE taxa.

Gastrocopta cf. mussoni Pilsbry

The two shells from this survey (FG03 within the disturbance envelope on Finucane Island) most closely agree with the species *Gastrocopta mussoni* Pilsbry, which exists in two forms, a cylindrical and an ovate form. The latter form was recorded from within the proposed disturbance envelope on Finucane Island in this survey.

Species of the genus *Gastrocopta* have tiny elongate shells with several barriers around the edge of their aperture. They are widely distributed through tropical and temperate areas of the world, and are diverse and widespread throughout Australia and therefore do not constitute SRE taxa.

G. mussoni has a widespread distribution centred on central Australia. It extends from the north of Western Australia into the north of the Northern Territory, northern and north-east Queensland, across to the mid-west coast of Western Australia and into South Australia. (This geographical distribution assumes that *Gastrocopta deserti* Pilsbry is a synonym.)

4.2.3 Scorpions

No whole scorpion specimens were recorded during the SRE fauna survey. However, blacklighting undertaken on Finucane Island revealed that scorpions are present on the island. Identification of scorpions was not possible as no live specimens were able to be recovered.

5 DISCUSSION

5.1 HABITAT ASSESSMENT

The habitat assessment undertaken for the proposed Outer Harbour Development project area identified a number of sites which may support SRE fauna. The field survey for the Goldsworthy Rail Duplication project area revealed an absence of potential SRE fauna habitat.

The inclusion of the reference sites into the Outer Harbour Development survey provided data that verified that SRE fauna were not present in habitat identified as unlikely to support SRE fauna and justified the decision not to undertake targeted searches for SRE fauna within the Goldsworthy Rail Duplication project area.

5.1.1 Outer Harbour Development Project Area

A number of areas on Finucane Island were identified as potential SRE fauna habitats, with the island being separated from the mainland which in itself encourages endemism. Rocky limestone outcrops located on the northern, ocean facing side of the island has the potential to harbour SRE species. This is due to this type of habitat being disjunct or separate from a continuous habitat and therefore increasing the chances of isolationism. The proposed transfer pad will impact upon a small area of this habitat. This rocky habitat occurs on the geological units Ql, Qhy, Qho and Qp (GSWA 1983), which occur elsewhere in the Port Hedland area (Figure 6), including near Boodarie landing.

The remainder of the Outer Harbour Development project area on both Finucane Island and the mainland contained habitats considered to be unsuitable for SRE fauna. The majority of Finucane Island includes largely homogenous vegetation, such as the introduced flora species *Cenchrus ciliaris* and coastal Spinifex on coastal dunes. The island is also highly modified because of stock grazing, which once took place on the island when it was part of a pastoral lease. Mangroves fringe the south of Finucane Island and the north of the mainland, while the mainland consisted mainly of broad spinifex plains with low *Acacia* shrublands.

5.1.2 Goldsworthy Rail Duplication Project Area

The Goldsworthy Rail Duplication project area was found to encompass broadly distributed and generally degraded, coastal Spinifex plain with no geological or landscape features that might promote short-range endemism in the invertebrate fauna.

Habitats that might give rise to short-range endemism, such as the southern facing slopes of ranges, hilltops, gullies and gorges, limestone and granitic outcrops, oceanic islands, springs or seeps and other 'island habitats', were not located within the project area. It was concluded that the likelihood of SRE taxa being present within the Goldsworthy Rail Duplication project area was extremely low based on the lack of SRE fauna habitat, and that searches of reference sites did

not locate any SRE fauna. Consequently, no targeted searches for SRE fauna were undertaken.

5.2 TAXA RECORDED IN THE OUTER HARBOUR DEVELOPMENT PROJECT AREA

None of the invertebrate taxa located within the Outer Harbour Development project area were determined to be SRE fauna.

The Mygalomorph species *Aname mainae* was recorded from a small area of the southern portion of Finucane island (outside the proposed disturbance envelope), and substantial survey effort did not locate further specimens in the proposed disturbance envelope. However, the family Nemesiidae (to which *Aname mainae* belongs) is rarely found in substantial numbers, unlike families such as Idiopidae, which are commonly found in clusters of up to 50 individuals in the Midwest and Southwest regions for example. As the habitat on Finucane Island is relatively homogenous (or at least basic in its complexity), it is expected that *Aname mainae* occurs broadly across the island in low densities.

It is possible that *Aname mainae* is present in the proposed disturbance envelope. However, it seems very unlikely given the survey effort and the outcomes. For instance, more than six hours of searching failed to locate any individuals on the proposed Outer Harbour Development transfer pad area on Finucane Island. Due to the relatively small area of proposed disturbance from the transfer pad, the sparse distribution of this species, and based on the outcomes of the survey effort, it is unlikely that *Aname mainae* individuals will be impacted by the Outer Harbour Development.

Three land snail species were recorded from within the disturbance envelope on Finucane Island. Again, these are species that have long been known to science and are known to have large regional distributions. For example *Pupoides contrarius* and *P. ledipulus* have coastal ranges that extend over 1800 km, having been recorded from Cape Latouche-Trevelle (south-west of Broome), south to the Houtman Abrolhos Islands; (Solem 1986); with *Pupoides lepidulus* has a single inland record at Wyloo Station (approximately 250km inland of Lake Macleod). Similarly, *Gastrocopta mussoni* has a wide distribution, being found across inland Australia, including northern parts of WA, northern parts of the Northern Territory, northern and north-eastern parts of Queensland and on the mid-west coast of WA, and there are a few records from South Australia (Pokryszko, 1996).

6 IMPACT ASSESSMENT AND CONCLUSIONS

6.1 IMPACT ASSESSMENT

As no SRE taxa were located within the proposed Outer Harbour Development or Goldsworthy Rail Duplication project areas, and no potential SRE habitat was located within the Goldsworthy Rail Duplication project area, potential impacts only apply to potential SRE habitat located within the proposed Outer Harbour Development project area. Hazards associated with the proposed Outer Harbour Development and the potential impacts that may result are summarised in Table 3.

Table 3: Potential Impacts on SRE Fauna habitats from Construction of the Proposed Outer Harbour Development

Hazard	Source	Potential Impact
Clearing and earthworks	Construction of the proposed transfer pad on Finucane Island.	<ul style="list-style-type: none"> Direct loss of potential SRE habitat will occur through clearing. Accidental clearing outside of the proposed disturbance envelope may also lead to loss of potential SRE habitat. Fragmentation of potential SRE habitat.
	Dust - deposition	<ul style="list-style-type: none"> Dust may result in deterioration in habitat quality and condition.
Accidental ignition from machinery and earthworks	Fire	<ul style="list-style-type: none"> Direct loss of potential SRE habitat outside of the proposed disturbance envelope may result.

Small areas of potential SRE habitat (rocky limestone outcrops), are likely to be impacted by construction of the proposed Transfer Pad on Finucane Island. However, the extent of impact will be insignificant as similar potential SRE habitat is well represented outside of the proposed disturbance envelope. Fragmentation of potential SRE habitat is unlikely to pose a significant issue as large areas of potential SRE habitat have already been disturbed through the construction of existing port operations on the island and access tracks. Dust deposition, fire and accidental clearing are also considered unlikely to pose a significant issue as these hazards may be avoided through the implementation of standard management practices.

Due to the small area of impact, it has been determined that should SRE occur on Finucane Island, only a small number of individuals may be lost during construction of the Outer Harbour Development infrastructure corridor and transfer pad. This impact is considered to be insignificant in a regional context.

6.2 CONCLUSION

Clearing associated with the construction of the proposed transfer pad of the Outer Harbour Development will remove rocky limestone outcrops on Finucane Island which are not locally or regionally rare or restricted. No SRE fauna species and no listed rare or Priority invertebrate species were recorded in the proposed disturbance envelope on Finucane Island. Therefore, the proposed Outer Harbour Development is considered highly unlikely to adversely impact on SRE fauna.

No prospective SRE fauna habitat was located within the Goldsworthy Rail Duplication project area. The project area was characterised by regionally widespread Spinifex plain in varying states of disturbance (e.g. rehabilitated, weed infested and fire scarred), with no landform features or dispersal barriers that may have otherwise lead to the formation of short-range endemism. Consequently, no targeted searches for SRE fauna were undertaken.

As a result of the two surveys, it was concluded that Finucane Island was likely to be the only area of potential SRE fauna habitat that could be impacted through construction of proposed infrastructure. Extensive foraging on Finucane Island failed to record SRE taxa, and thus it is concluded that the proposed Outer Harbour Development and associated infrastructure conveys no threat to SRE fauna.

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ('the report') has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed between the Client and ENV.Australia Pty Ltd (ENV) ('scope of services'). In some circumstances the scope of services may have been limited by factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied on data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or in part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, unavailable, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied on the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, express or implied, is made.

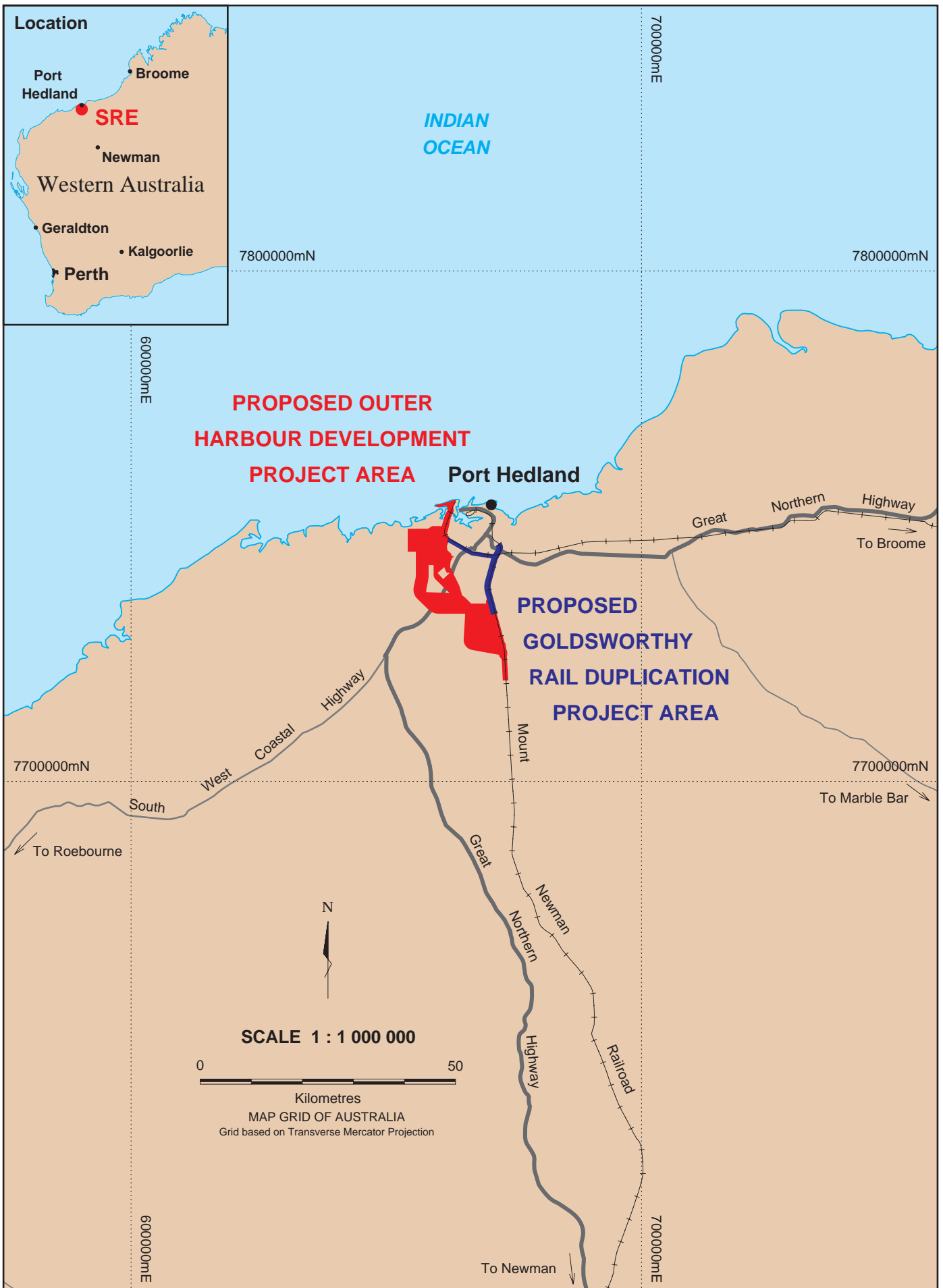
Report for Benefit of Client

The report has been prepared for the benefit of the Client and for no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including, without limitation, matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely on the report or the accuracy or completeness of any conclusions, and should make their own enquiries and obtain independent advice in relation to such matters.

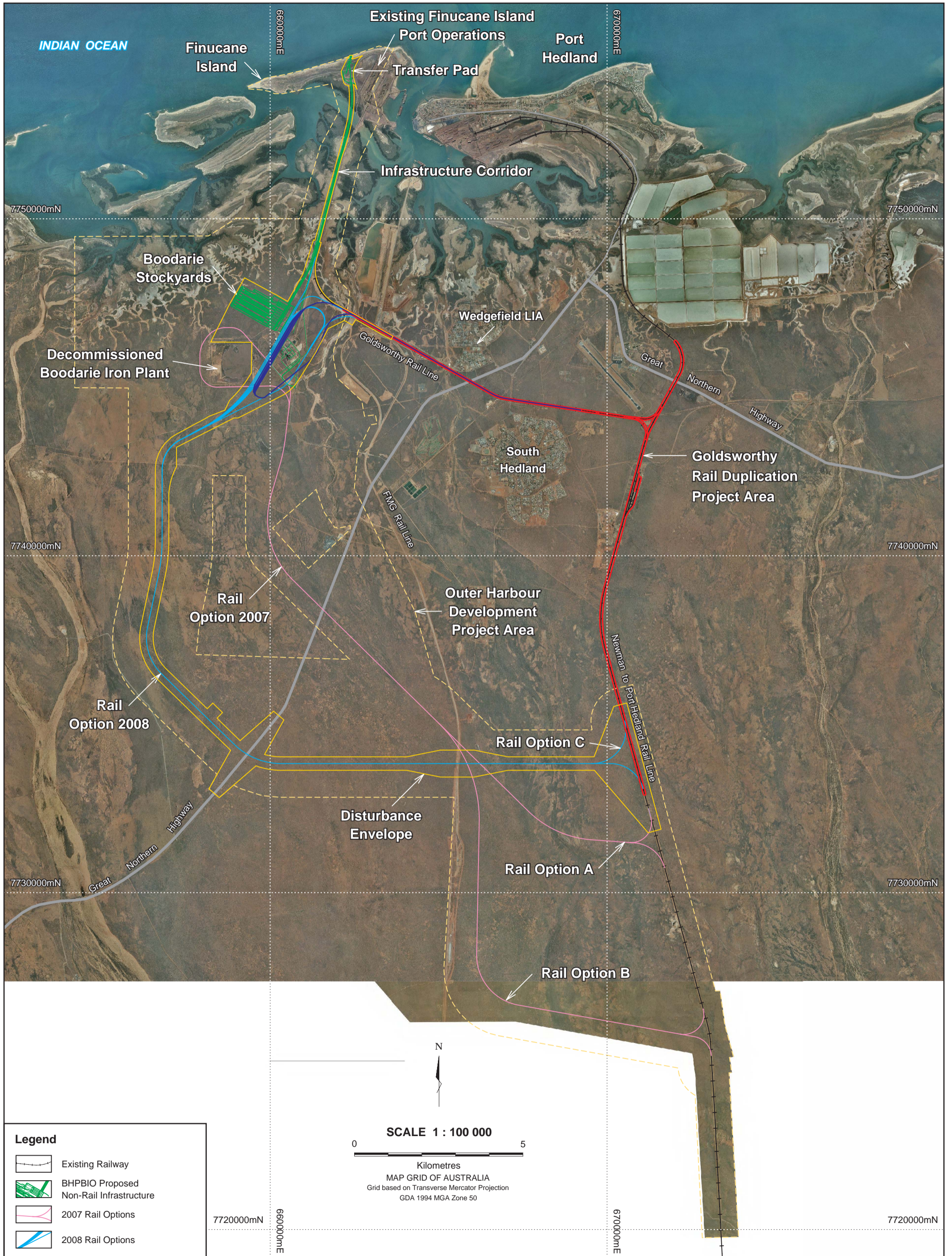
Other Limitations

ENV will not be liable to update or revise the report to take into account any events or circumstances occurring or becoming apparent after the date of the report, or facts becoming apparent or available after the date of the report.





FIGURES



	Client: BHP BILLITON PTY LTD	REGIONAL LOCATION	Date: 14 September 2009
	Project: OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION SHORT RANGE ENDEMIC ASSESSMENT 08.330		Scale: 1:1 Million
			Author: E.C. / S.C.
			Figure No. 1
		A4	Plan No. SRE-001



Legend

-  Existing Railway
-  BHPBIO Proposed Non-Rail Infrastructure
-  2007 Rail Options
-  2008 Rail Options

SCALE 1 : 100 000

0 5
Kilometres
MAP GRID OF AUSTRALIA
Grid based on Transverse Mercator Projection
GDA 1994 MGA Zone 50



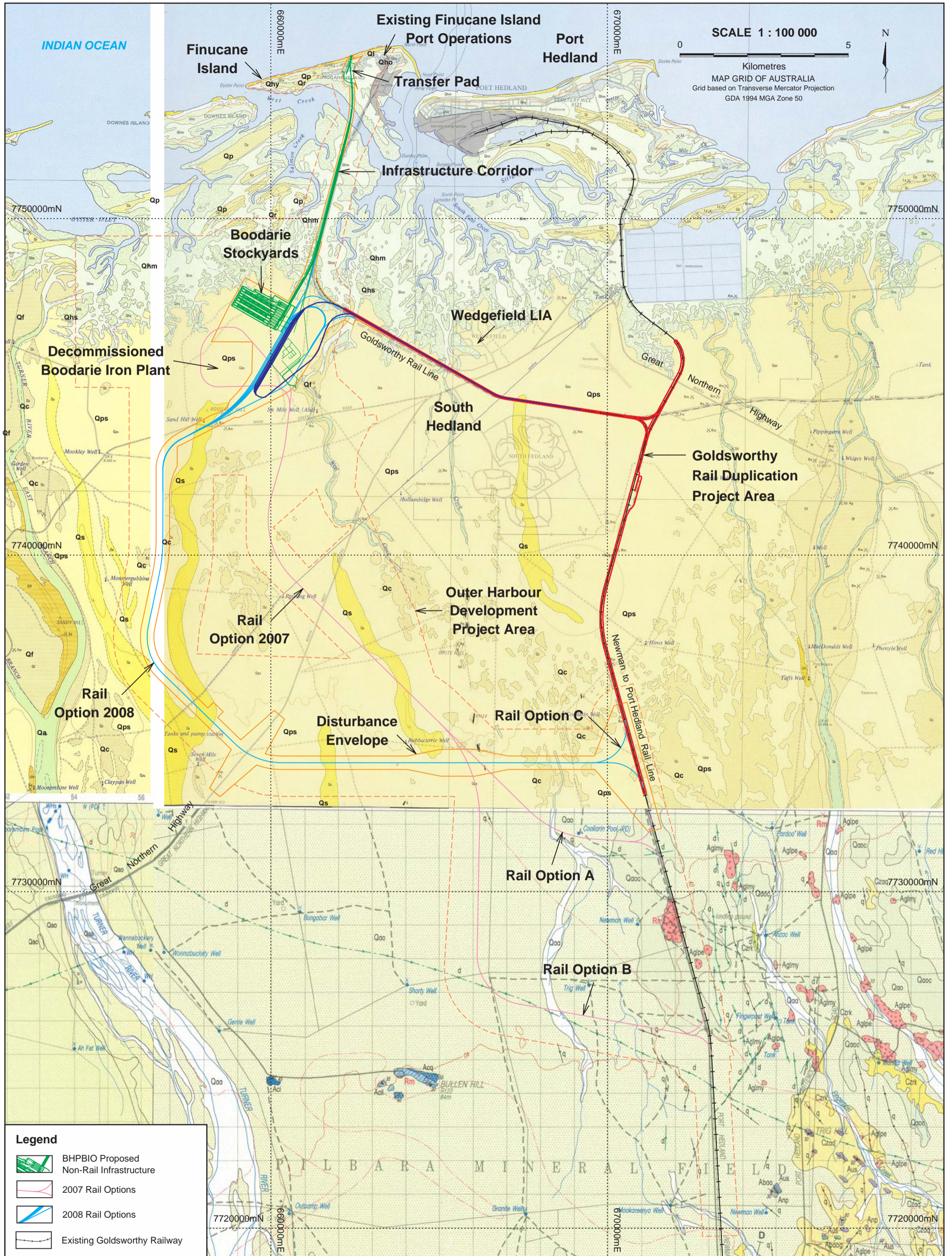
Author: M.Brown
Drawn: S.Coleman
Status:
Job Number: 08.216

Client: **BHP BILLITON PTY LTD**
Project: **OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION SHORT RANGE ENDEMIC ASSESSMENT**

**PROJECT AREA
PROPOSED INFRASTRUCTURE**

Date: 14 September 2009
Scale: 1:100 000
Figure No. **2**
Plan No. **SRE-006**

A3



Legend	
	BHPBIO Proposed Non-Rail Infrastructure
	2007 Rail Options
	2008 Rail Options
	Existing Goldsworthy Railway

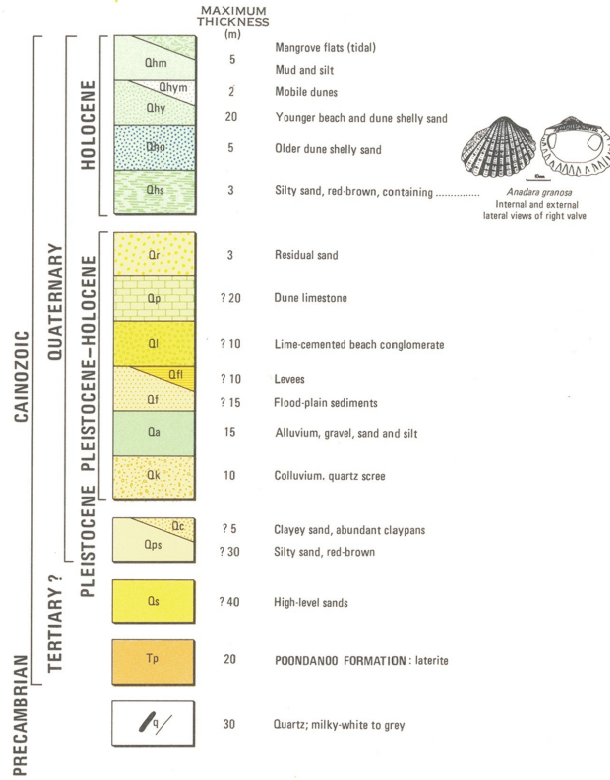
	Author: M.Brown
	Drawn: S.Coleman
	Status:
	Job Number: 08.216

Client: BHP BILLITON PTY LTD
Project: OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION SHORT RANGE ENDEMIC ASSESSMENT

REGIONAL GEOLOGY	
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Date: 15 September 2009
Scale: 1:100 000
Figure No. 4a
Plan No. SRE-004

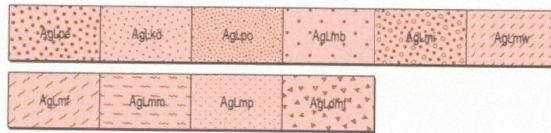
**1:50 000
Geology Legend
2557-2 (Boodarie)
2657-3 (Port Hedland)**



**1:100 000
Geology Legend
2556 (Yule)
2656 (Wallingara)**



- Qaa Alluvial sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains
- Qac Clay and silt in claypan deposits on floodplains
- Qao Alluvial sand, silt, and clay on floodplains
- Qooc Mixed floodplain deposits with numerous small claypans
- Qob Alluvial sand, silt, and clay in floodplains, with gllgal surface in areas of expansive clay
- Qw Sheetwash deposits — silt, sand, and pebbles on distal outwash fans; no defined drainage
- Qc Colluvium — sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits
- Qrg Quartzfeldspathic eluvial sand with quartz and rock fragments; overlying and derived from granitoid rock



- CARLINDI GRANITOID COMPLEX**
- AgLpe Pegmatite; metamorphosed
 - AgLkd KADGEWARRINA MONZOGRANITE: muscovite-biotite(-garnet) monzogranite; equigranular to weakly porphyritic; massive to weakly foliated; metamorphosed
 - AgLpo POOCATCHE MONZOGRANITE: muscovite-biotite monzogranite; seriate to porphyritic; massive to weakly foliated; locally abundant pegmatite; metamorphosed
 - AgLmb Fine- to coarse-grained muscovite-biotite monzogranite; massive to weakly foliated; metamorphosed
 - AgLmi MINNAMONICA MONZOGRANITE: porphyritic biotite(-muscovite) monzogranite; fine- to coarse-grained; quartz and K-feldspar phenocrysts; massive to weakly foliated; metamorphosed
 - AgLmw Biotite(-muscovite) monzogranite, equigranular to weakly K-feldspar porphyritic; locally highly leucocratic and ghost-banded; massive to weakly foliated; metamorphosed
 - AgLmf Biotite monzogranite, strongly foliated; seriate to K-feldspar porphyritic; related to AgLmp; metamorphosed
 - AgLmm Mylonitized monzogranite; related to AgLmp; metamorphosed
 - AgLmp Biotite monzogranite, porphyritic (K-feldspar) to seriate; massive to weakly foliated; locally strong flow-alignment; metamorphosed
 - AgLdmf Diorite, granodiorite, monzogranite, and abundant felsic to mafic inclusions and dykes, strongly foliated; metamorphosed



CLEAVERVILLE FORMATION

- AGlc Chert; metamorphosed
- AGlcw Chert; weakly banded, grey and white; metamorphosed
- AGli Banded iron-formation; locally includes banded quartz-magnetite-grunerite rock; metamorphosed
- AGls Metamorphosed, fine- to medium-grained wacke; locally interleaved with serpentine- and tremolite-rich schist and metamorphosed iron-formation and ferruginous siltstone



- As Sedimentary rock, undivided; metamorphosed
- Aci Banded iron-formation; locally includes banded quartz-magnetite-grunerite rock; metamorphosed
- Acil Banded iron-formation; strongly recrystallized and limonitized
- Aca Banded white and grey chert, and quartzite; local minor jaspillite and iron formation; locally includes banded quartz-grunerite rock; metamorphosed
- Anp Paragneiss; medium-grained, strongly recrystallized sedimentary rock



Client: **BHP BILLITON PTY LTD**

Project: **OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION SHORT RANGE ENDEMIC ASSESSMENT** 08.330

GEOLOGY LEGEND

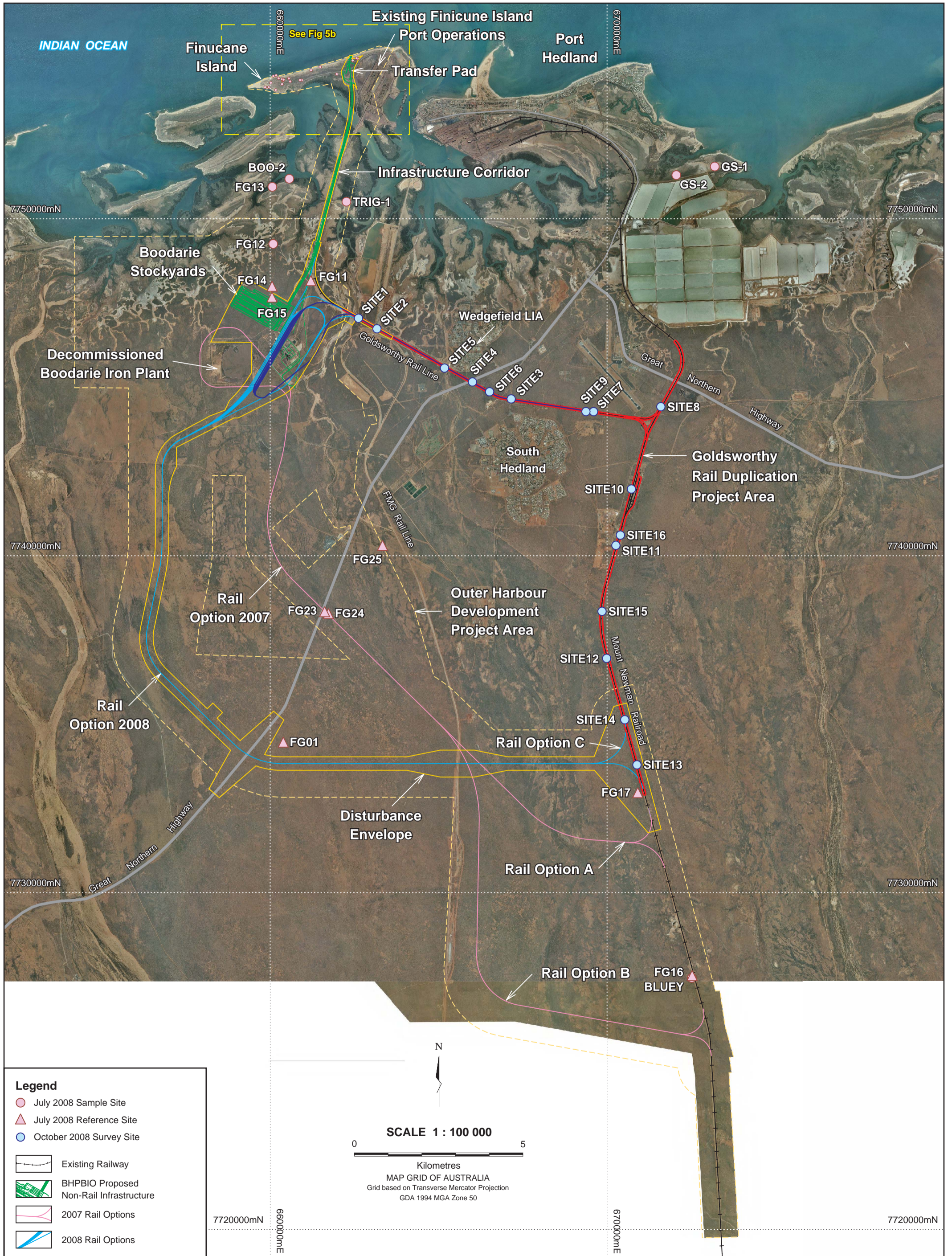
Date: 15 September 2009

Scale: NTS

Author: E.C. / S.C.

Figure No. **4b**

A4 Plan No. **SRE-007**



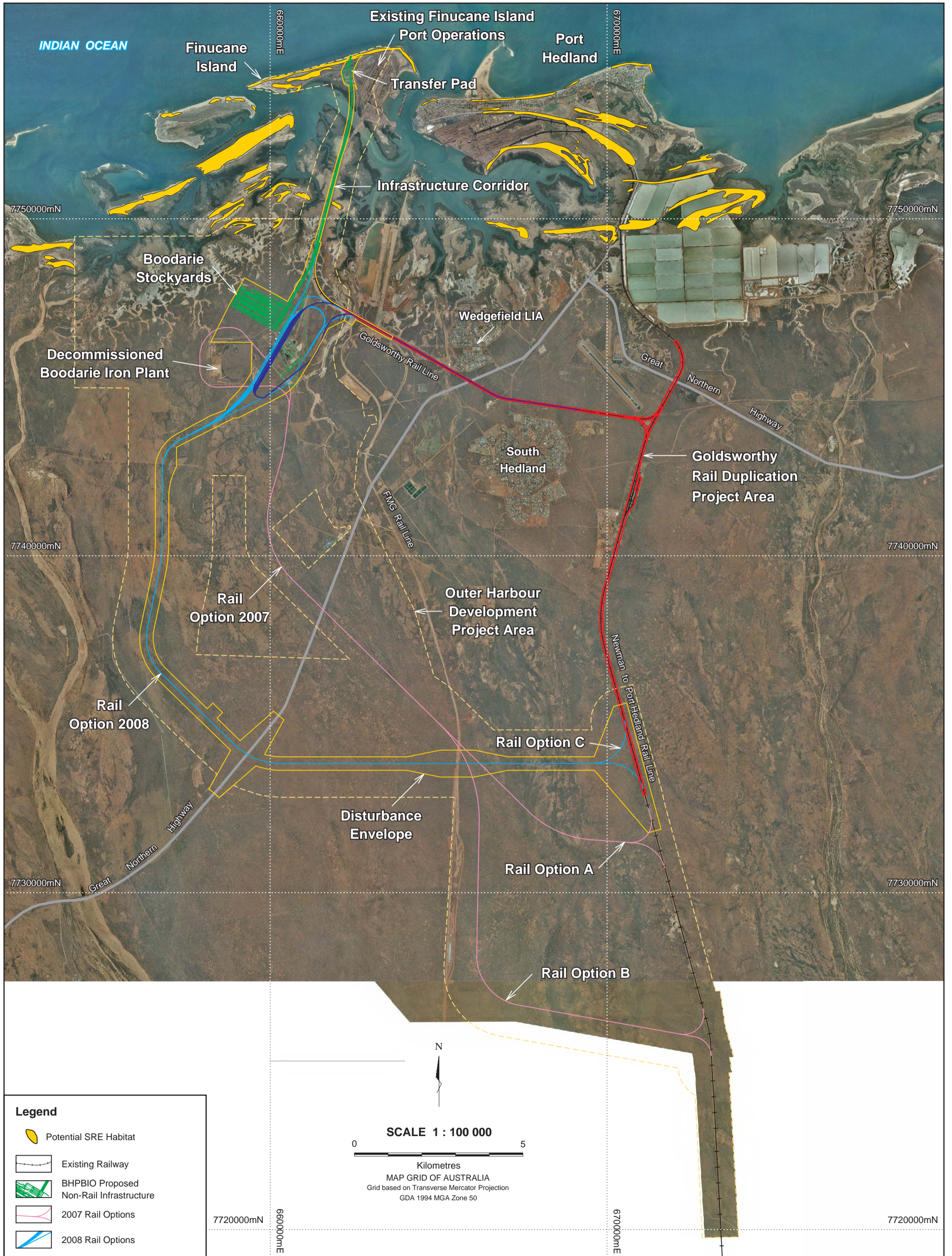


Legend
○ July 2008 Sample Sites

	Author: M.L. / S.C.	Client: BHP BILLITON PTY LTD
	Drawn: S.Coleman	Project: OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION
	Status:	SHORT RANGE ENDEMIC ASSESSMENT
	Job Number: 08.216	

SRE SAMPLING LOCATIONS FINUCANE ISLAND	
Date: 14 September 2009	
Scale: 1:20 000	
Figure No. 5b	
Plan No. SRE-003	

A4



- Legend**
- Potential SRE Habitat
 - Existing Railway
 - BHPBIO Proposed Non-Rail Infrastructure
 - 2007 Rail Options
 - 2008 Rail Options

SCALE 1 : 100 000

0 5

Kilometres

MAP GRID OF AUSTRALIA
Grid based on Transverse Mercator Projection
GDA 1994 MGA Zone 50



Author: M.Brown
 Drawn: S.Coleman
 Status:
 Job Number: 08.216

Client: **BHP BILLITON PTY LTD**
 Project: **OUTER HARBOUR DEVELOPMENT AND GOLDSWORTHY RAIL DUPLICATION SHORT RANGE ENDEMIC ASSESSMENT**

PROSPECTIVE SRE HABITAT

Date: 15 September 2009
 Scale: 1:100 000
 Figure No. **6**
 Plan No. **SRE-005**

APPENDIX A

SAMPLE REFERENCE AND SITE LOCATIONS

APPENDIX A1

JULY 2008 OUTER HARBOUR DEVELOPMENT SITE LOCATIONS

REFERENCE SITES

Site Name	Datum	
	WGS-84	
	Latitude	Longitude
FG01	-20.4821	118.5379
FG11	-20.3583	118.5445
FG14	-20.3599	118.5335
FG15	-20.3628	118.5335
FG16	-20.5436	118.6549
FG17	-20.4947	118.6389
FG23	-20.447	118.5493
FG24	-20.4475	118.5504
FG25	-20.4291	118.5656

SAMPLE SITES

Site Name	Datum	
	WGS-84	
	Latitude	Longitude
FG02	-20.2982	118.5572
FG03	-20.2981	118.5569
FG04	-20.2987	118.5558
FG05	-20.3043	118.536
FG06	-20.3037	118.5377
FG07	-20.3045	118.5381
FG08	-20.3037	118.5348
FG09	-20.3049	118.5326
FG10	-20.3024	118.5513

Site Name	Datum	
	WGS-84	
	Latitude	Longitude
FG12	-20.3481	118.5337
FG13	-20.3328	118.5333
FG18	-20.3068	118.534
FG19	-20.3061	118.532
FG20	-20.3061	118.531
FG21	-20.3041	118.5414
FG22	-20.3041	118.5409
MYG1	-20.304134	118.536
MYG2	-20.304042	118.5359
MYG3	-20.30389	118.5358
MYG4	-20.303984	118.5362
MYG5	-20.304014	118.5362
MYG6	-20.305258	118.5358
BLUEY	-20.5438	118.6548
BOO-2	-20.3306	118.5381
FIN-1	-20.3031	118.5333
FIN-1A	-20.3029	118.5341
FIN-2	-20.3005	118.5466
FIN-3	-20.3014	118.544
GS-1	-20.3262	118.659
GS-2	-20.3286	118.6481
TRIG-1-	-20.3366	118.5544
TRIG-2	-26.6563	118.6292

APPENDIX A2

OCTOBER 2008 GOLDSWORTHY RAIL DUPLICATION SITE LOCATIONS

Site	Date	Datum	Zone	Easting	Northing
SITE1	16/10/2008	WGS84	50K	662621	7747048
SITE2	16/10/2008	WGS84	50K	663170	7746735
SITE3	16/10/2008	WGS84	50K	667154	7744653
SITE4	16/10/2008	WGS84	50K	666005	7745157
SITE5	16/10/2008	WGS84	50K	665175	7745569
SITE6	16/10/2008	WGS84	50K	666513	7744865
SITE7	16/10/2008	WGS84	50K	669600	7744276
SITE8	16/10/2008	WGS84	50K	671596	7744423
SITE9	16/10/2008	WGS84	50K	669373	7744278
SITE10	16/10/2008	WGS84	50K	670722	7741978
SITE11	16/10/2008	WGS84	50K	670262	7740307
SITE12	16/10/2008	WGS84	50K	669987	7736953
SITE13	16/10/2008	WGS84	50K	670887	7733793
SITE14	16/10/2008	WGS84	50K	670526	7735132
SITE15	16/10/2008	WGS84	50K	669850	7738348
SITE16	16/10/2008	WGS84	50K	670395	7740611

APPENDIX B

DETAILS OF SAMPLE REFERENCE AND SITE LOCATIONS

APPENDIX B

DETAILS OF JULY 2008 SAMPLE AND REFERENCE SITES

DETAILS OF SHORT-RANGE ENDEMIC SITES AND SURVEY ACTIVITY

Site Name MYG 1-6 (Sample Site)
Date 3 July 2008
Habitat Type Foredune and limestone outcrop.
Leaf litter % 10
Shade % 10
Bare Earth % 50
Soil Type Sand
Soil Colour Grey
Comments Six mygalomorph burrows located.
Vegetation *Cenchrus ciliaris* and *Triodia* sp. between foredune
Description and limestone outcrop, < 100 m from coast.



Site Name FG01 (Reference Site)
Date 3 July 2008
Habitat Type Sand plain
Leaf litter % 15
Shade % 10
Bare Earth % 55
Soil Type Sandy loam
Soil Colour Red
Comments Leaf litter sample taken.
Vegetation Low *Eucalyptus* sp. over mixed shrubs over *Triodia*.
Description Some leaf litter under eucalypts, bare otherwise.



Site Name FG02-04 (Sample Site)
Date 3 July 2008
Habitat Type Grassland with very sparse shrub cover.
Leaf litter % 5
Shade % 10
Bare Earth % 60



Soil Type Sandy Loam
Soil Colour Red
Comments Leaf litter samples taken
Vegetation Description Very sparse pockets of low *Eucalyptus* sp. over sparse *Acacia* sp. (to 45 cm) over *Cenchrus ciliaris*.
Description Relatively thick leaf litter under *Acacia* sp. & *Eucalyptus* sp.

Site Name FG05 (Sample Site)
Date 3 July 2008
Habitat Type Limestone outcrop – old reef.

Leaf litter % 15
Shade % 10
Bare Earth % 20

Soil Type Coastal Sand
Soil Colour Grey

Comments Dug-out burrow – no Mygalomorphae recovered.
 Leaf litter sample taken

Vegetation Description Low *Acacia* spp. over *Cenchrus ciliaris* and *Triodia* sp.



Site Name FG06 (Sample Site)
Date 3 July 2008
Habitat Type Limestone outcrop – old reef.

Leaf litter % 15
Shade % 20
Bare Earth % 25

Soil Type Coastal Sands
Soil Colour Grey

Comments North of mygalomorph population. Leaf litter sample taken.

Vegetation Description *Cenchrus ciliaris* only.



Site Name FG07 (Sample Site)

Date 3 July 2008

Habitat Type Grassland

Leaf litter % 25

Shade % 25

Bare Earth % 35

Soil Type Sandy Loam

Soil Colour Red Brown

Comments Some good litter cover and shrub cover. Leaf litter sample taken.

Vegetation Description *Cenchrus ciliaris* and introduced herbs.



Site Name FG11(Reference Site)

Date 3 July 2008

Habitat Type Grassland with low, sparse shrubs.

Leaf litter % 25

Shade % 20

Bare Earth % 30

Soil Type Sand

Soil Colour Red

Comments Some good litter cover and shrub cover. Leaf litter sample taken.

Vegetation Description *Cenchrus ciliaris* and mixed introduced herbs over *Acacia* sp. shrubs.



Site Name FG12 (Sample Site)

Date 4 July 2008

Habitat Type Limestone outcrop.

Leaf litter % 20

Shade % 15

Bare Earth % 50

Soil Type Grey sands over sandy loam



Soil Colour Grey
Comments Leaf litter sample taken
Vegetation Description Low *Eucalyptus* sp. over *Acacia* sp. over *Triodia* sp.

Site Name FG13 (Sample Site)

Date 4 July 2008

Habitat Type Limestone outcrop.

Leaf litter % 5

Shade % 5

Bare Earth % 80

Soil Type Coastal grey brown sands

Soil Colour Grey / brown

Comments

Vegetation Description Banks of Mangrove inlet. Coastal *Triodia* sp. only.



Site Name FG14 (Reference Site)

Date 4 July 2008

Habitat Type *Triodia* sp. Grassland

Leaf litter % 80

Shade % 25

Bare Earth % 15

Soil Type Sandy loam

Soil Colour Red brown

Comments

Vegetation Description *Triodia* sp. grassland



Site Name FG15 (Reference Site)

Date 4 July 2008

Habitat Type *Triodia* sp. Grassland

Leaf litter % 20

Shade % 25

Bare Earth % 50



Soil Type Sandy Loam
Soil Colour Red orange
Comments No stones or pebbles, lots of log and stick debris
Vegetation *Acacia* sp. shrubs (>1.5 m) over mixed shrubs over
Description *Triodia* sp. Leaf litter sample taken.

Site Name FG16 (Reference Site)

Date 4 July 2008

Habitat Type *Triodia* sp. Grassland

Leaf litter % 50

Shade % 50

Bare Earth % 25

Soil Type Sandy clay loam

Soil Colour Red brown

Comments Granite soils/ rocks in sand and small granite boulder formation present. Some areas of cracking clays.

Vegetation Low *Acacia* sp. shrubland (50cm), with some to 5
Description m. *Grevillea* sp. Leaf litter sample taken.



Site Name FG17 (Reference Site)

Date 4 July 2008

Habitat Type *Triodia* sp. Grassland

Leaf litter % 10

Shade % 20

Bare Earth % 80

Soil Type Sandy loam

Soil Colour Red orange

Comments Leaf litter sample taken

Vegetation Low mixed *Acacia* sp. shrubland over *Triodia* sp.



Description

Site Name FG 18 – 20 (Sample Site)

Date 5 July 2008

Habitat Type Coastal Dune System

Leaf litter % 15

Shade % 25

Bare Earth % 75

Soil Type Sands

Soil Colour Grey brown

Comments Soft collapsible white/grey sands. Two Mygalomorphae burrows recorded. The spiders were not recovered because of collapsing sands. Very few other invertebrates seen.



Vegetation

Description

Site Name FG 21 – 22 (Sample Site)

Date 5 July 2008

Habitat Type Very sparse low Shrubland

Leaf litter % 50

Shade % 85

Bare Earth % 5

Soil Type Sandy loam

Soil Colour Red orange

Comments Leaf litter sample taken

Vegetation Description *Acacia* sp. over *Cenchrus ciliaris*.



Site Name FG 23 - 24 (Reference Site)

No Photo Available

Date 5 July 2008

Habitat Type Seasonally Damp Drainage Basin

Leaf litter % 40

Shade % 35

Bare Earth % 80

Soil Type Sandy clay loam

Soil Colour	Red orange	
Comments	Very occasionally inundated basin. Leaf litter to 4 cm in places. Leaf litter samples taken	
Vegetation Description	<i>Acacia</i> sp. (to 2 m) over sparse <i>Triodia</i> sp. "Riparian zone" more vegetated – with low <i>Acacia</i> sp. and mixed shrubs.	
<hr/>		
Site Name	FG 25 (Reference Site)	
Date	5 July 2008	
Habitat Type	Creek line 'riparian zone'	
Leaf litter %	60	
Shade %	80	
Bare Earth %	15	No Photo Available
Soil Type	Sandy clay loam	
Soil Colour	Red orange	
Comments	Relatively structurally complex site. Leaf litter sample taken	
Vegetation Description	Thick <i>Acacia</i> sp. shrubland (to 3 m) over mixed shrubs over <i>Triodia</i> sp. and mixed herbs.	

* Note that photos are representative of sites floristically and structurally but may not be actual site.

APPENDIX B2

DETAILS OF OCTOBER 2008 SAMPLING SITES

DETAILS OF SHORT-RANGE ENDEMIC SITES AND SURVEY ACTIVITY

Site Name	1
Date	16/10/2008
Habitat Type	Spinifex plain
Leaf litter %	0
Shade %	15
Bare Earth %	85
Soil Type	Sand
Soil Colour	Red orange
Comments	Regrowth on edge of access track, very poor SRE habitat, no SRE forming features present
Vegetation Description	Spinifex over mixed low shrubs and introduced species



Site Name	2
Date	16/10/2008
Habitat Type	Spinifex plain
Leaf litter %	0
Shade %	5
Bare Earth %	50
Soil Type	Sand
Soil Colour	Orange red
Comments	Highly damaged /degraded patchy, fragmented Spinifex. Unlikely SRE habitat, with no SRE forming features present
Vegetation Description	Spinifex and introduced species on edge of access track.



Site Name 3
Date 10/16/2008
Habitat Type Spinifex plain
Leaf litter % 10
Shade % 60
Bare Earth % 30
Soil Type Sand
Soil Colour Orange red
Comments Highly degraded and infested with introduced species. Unlikely SRE habitat, with no SRE forming features present

No Photo Available

Vegetation Description Mixed low shrubland over Spinifex

Site Name 4
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 5
Shade % 20
Bare Earth % 35
Soil Type Sand
Soil Colour Red orange
Comments Mixed low shrubland over Spinifex. Unlikely SRE habitat, with no SRE forming features present



Vegetation Description Mixed low shrubland over Spinifex

Site Name 5
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 0
Shade % 5
Bare Earth % 75
Soil Type Sand
Soil Colour Yellow brown



Comments Degraded by tracks and introduced weeds. Unlikely SRE habitat, with no SRE forming features present

Vegetation Description Mixed low sparse shrubland

Site Name 6
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 5
Shade % 80
Bare Earth % 10
Soil Type Sand
Soil Colour Orange red
Comments Disturbed and heavily infested with buffle grass. Unlikely SRE habitat, with no SRE forming features present



Vegetation Description Mixed low shrubs over Spinifex and buffle grass

Site Name 7
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 5
Shade % 50
Bare Earth % 50
Soil Type Sand
Soil Colour Orange red
Comments Thin degraded section between two tracks. Unlikely SRE habitat, with no SRE forming features present



Vegetation Description Mixed low shrubs over Spinifex and buffle grass

Site Name 8
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 5
Shade % 15
Bare Earth % 55
Soil Type Sand
Soil Colour Yellow brown
Comments Unlikely SRE habitat, with no SRE forming features present



Vegetation Description Mixed low shrubs over Spinifex and Buffle grass

Site Name 9
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 5
Shade % 15
Bare Earth % 60
Soil Type Sand
Soil Colour Yellow brown
Comments Unlikely SRE habitat, with no SRE forming features present



Vegetation Description mixed low shrubs over Spinifex and Buffle grass

Site Name 10
Date 16/10/2008
Habitat Type Spinifex plain
Leaf litter % 5
Shade % 20
Bare Earth % 55
Soil Type Sand
Soil Colour Orange brown



Comments *Acacia* sp. on roadside only real cover.
Unlikely SRE habitat, with no SRE forming features present

Vegetation Description Mixed low shrubs over Spinifex and Buffle grass

Site Name 11
Date 16/10/2008
Habitat Type *Acacia* sp. shrubland over mixed low shrubs and Spinifex
Leaf litter % 25
Shade % 75
Bare Earth % 25
Soil Type Sand
Soil Colour Orange red
Comments Unlikely SRE habitat, with no SRE forming features present




Vegetation Description *Acacia* sp. shrubland over mixed low shrubs and Spinifex


Site Name 12
Date 16/10/2008
Habitat Type Medium *Acacia* sp. shrubland
Leaf litter % 0
Shade % 0
Bare Earth % 100
Soil Type Sand
Soil Colour Orange red
Comments Burnt very recently. Unlikely SRE habitat, with no SRE forming features present




Vegetation Description Burnt *Acacia* sp. low shrubland over low mixed shrubs and Spinifex

Site Name 13
Date 16/10/2008

Habitat Type	Medium <i>Acacia</i> sp. shrubland over Spinifex	
Leaf litter %	20	
Shade %	65	
Bare Earth %	30	
Soil Type	Sand	
Soil Colour	Orange red	
Comments	Regrowth between two tracks. Unlikely SRE habitat, with no SRE forming features present	
Vegetation Description	<i>Acacia bivenosa</i> and <i>Ac. ancistrocarpa</i> over Spinifex	

Site Name	14	
Date	16/10/2008	
Habitat Type	Medium <i>Acacia</i> sp. shrubland	
Leaf litter %	0	
Shade %	0	
Bare Earth %	100	
Soil Type	Sand	
Soil Colour	Orange red	
Comments	Vast majority of shrubs dead. Unlikely SRE habitat, with no SRE forming features present	
Vegetation Description	Medium <i>Acacia</i> sp. shrubland over mixed low shrubs and Spinifex hummock grass	

Site Name	15	
Date	16/10/2008	
Habitat Type	Same as site 13	
Leaf litter %	5	
Shade %	15	
Bare Earth %	50	
Soil Type	Sand	
Soil Colour	Orange brown	

Comments Unlikely SRE habitat, with no SRE forming features present

Vegetation Description *Acacia bivenosa* and *Ac. ancistrocarpa* over Spinifex

Site Name 16

Date 16/10/2008

Habitat Type Low shrubland

Leaf litter % 15

Shade % 50

Bare Earth % 40

Soil Type Sand

Soil Colour Orange red

Comments Unlikely SRE habitat, with no SRE forming features present

Vegetation Description Mixed low shrubland over Spinifex

