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ROY HILL IRON ORE PTY LTD

Roy Hill Iron Ore Rail Route Selection Study

MCA Constraints and Route Selection

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SYNOPSIS

WorleyParsons Services Pty Ltd was commissioned by Roy Hill Iron Ore Pty Ltd (RHIO) to provide a constraint analysis for a rail route between their Roy Hill 1 Ore Mining Project to Port Hedland for iron ore export.

An integrated, multi criteria analysis approach (MCA) was adopted to identify suitable routes for the rail. The MCA involved consideration of environmental, social and engineering constraints in the decision-making process. Environmental, social and engineering criteria for route selection were developed by WorleyParsons and RHIO personnel.

The MCA consisted of three distinct rounds. In the first round, performance ratings were assigned to each criterion to identify routing preferences, as well as fatal flaws. Unsuitable areas were subsequently screened out using a geographic information system (GIS) database that allowed the multiple layers of environment, social and engineering information to be mapped and analysed against the selection criteria. The GIS database represents a 'table of maps' or 'map of tables' with each cell representing a 20 m x 20 m grid.

Round 2 utilised the GIS fatal flaw data from Round 1 as the input in to Quantm for the purpose of generating low cost rail alignments. These alignments avoid areas graded as environmentally, socially or engineering unfeasible (from Round 1). The termini for the Quantm model were the Roy Hill Mine and Boodarie Estate. Subsequently a more detailed assessment was undertaken of the short listed routes. The goal was to review constraints in the proposed infrastructure corridors and identify any required deviation outside the proposed alignments. Route attributes were summarised and potential constraints for the positioning of a rail route were identified.

In the third round, routes were ascribed a 'Sustainability Index' value. The dominance of each route was ranked based on the route feasibility, constructability, environmental and social constraint data. The resulting score for each route provides a ranking method between the routes.

A comparative Capital Cost (CAPEX) for each route was then determined to provide a financial measure against which the preferred route could be assessed. The CAPEX values for the routes were based on prices detailed in the *Estimate Basis Report* (RH_00-ES-REP-0001REV0).

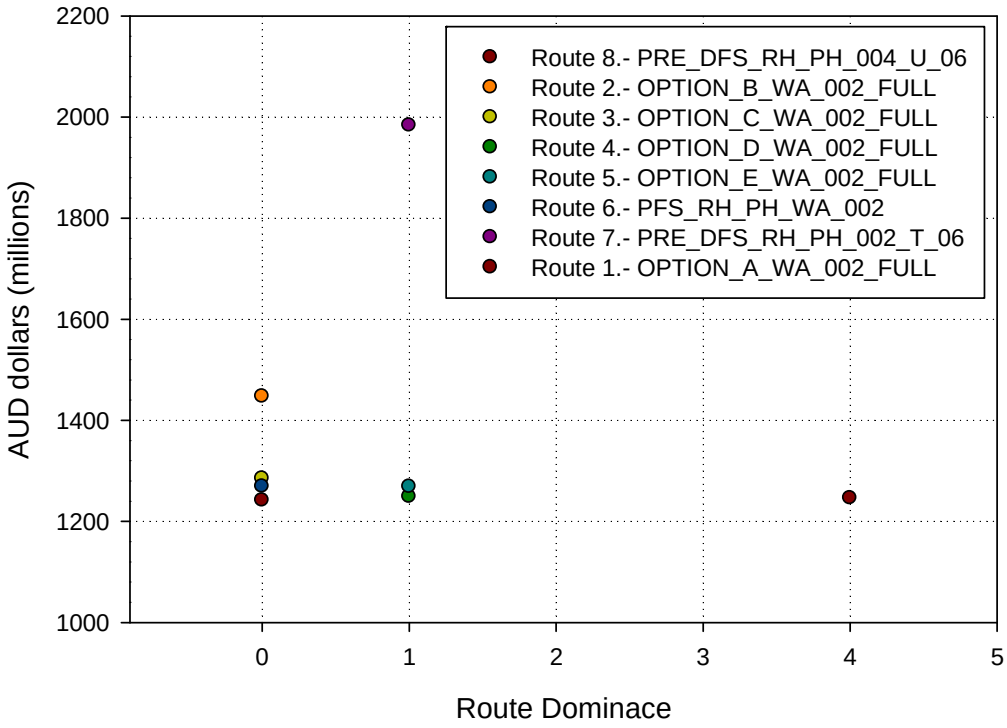
The composite result of the financial and non financial ranking process is shown below. The most preferred route can be defined as one with high dominance and low CAPEX values. The result from this study identified Route 1 – OPTION_A_WA_002_FULL as the most suitable. Cost aside, Routes 4, 5 and 7 would be suitable candidates as backup routes.

At the conclusion of Round 3 a sanity check for the outcomes was undertaken to check they make sense and are not accepted purely because the assessment says so. During this assessment it was

discovered that Route 6 had been screened out due to its larger construction footprint when compared to Route 1. Route 6 differed from Route 1 for only 20km of the alignment to avoid a known lease close to the Roy Hill Mine.

Based on this analysis Route 6 was considered a better route than Route 1.

Based on the knowledge to date it is recommended Route 6, form the basis of the EPA referral.



Suitability Index (CAPEX versus Route dominance)

The results of this study indicate preferred and potentially suitable routes for rail alignment. The study, has provided an overview of identified and known values for each route. A key finding is there is little differences between the options and all routes would prove viable.

RHIO adopted a conservative approach when applying rankings to attributes in an effort to identify a superior route through an already well studied area. This is evident in the ranking of National Heritage Sites, were RHIO objective was *to conserve significant cultural heritage sites.* RHIO ranked within

Woodstock art site as a fatal flaw, even though FMG proved it viable in their study. This approach by RHIO represents best practice in route selection.

A significant volume of baseline data and integrated decision-making process (MCA) were used. However, it must be reiterated that this is a high level, desktop study only. Should Roy Hill Iron Ore Pty Ltd (RHIO) wish to develop the route selection process further and validate the suitability and CAPEX of the routes, the preferred and backup routes should be the subject of detailed investigations, including on-ground field surveys to address the baseline data gaps and stakeholder and community consultation.

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PROJECT 301012-00928 - ROY HILL IRON ORE RAIL ROUTE SELECTION STUDY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	B Morna	P Mellor	N/A	05-May-09	N/A	
B	Issued for internal review	B Morna	P Mellor	M Pearson	07-AUG-09	N/A	

CONTENTS

Appendices

1. INTRODUCTION AND OBJECTIVES

WorleyParsons Services Pty Ltd was commissioned by Roy Hill Iron Ore Pty Ltd (RHIO) to provide a constraint analysis for a rail route between their Roy Hill mine site and Port Hedland for iron ore export.

The key outcome for this assessment will be determination of a suitable rail route based on this constraints analysis which will serve as a base for future investigations.

WorleyParsons developed a fit for purpose methodology for route selection however the individual stages followed previous route selection methodologies (Ad van Delft 1977, Mendoza & Macoun 1999 , Herath & Prato 2006). Environmental, social, logistic, economic and engineering limitations have been investigated to identify areas having low levels of overall constraint.

The scope of work is as follows;

- Undertake a literature review and identify environmental and social values (Appendix A);
- Collation and creation of regional GIS databases (Appendix C);
- The development and weighting of multi-criteria analysis including environmental, social and engineering and infrastructure criterion (Section 3);
- Formulation of a rail corridor identification model, with appropriate weightings allocated to environmental, social, and engineering criteria, and suitable buffers (Section 3);
- Application of the rail corridor identification model to the GIS data sets to produce maps showing the level of constraint (from least to most) for environmental factors, social factors and engineering factors (Section 3);
- Generation of a composite Environmental, Social and Engineering (ESE) constraints map (Section 3);
- Incorporation of fatal flaws into the Quantm engineering model for cost analysis (Section 4);
- Review routes and subsequently, conduct a more detailed assessment (Section 4);
- Provide a more detailed assessment of short listed routes, including the preparation of rail layouts for estimating CAPEX and the identification of optimal routes (Section 5); and
- Provide recommendations and identify gaps requiring further investigation.

1.1 Region of Interest

The study broadly screened an area stretching from Roy Hill mine site to Port Hedland (Figure 1) to identify constraints for the proposed routes in regard to environmental, social and engineering criteria.

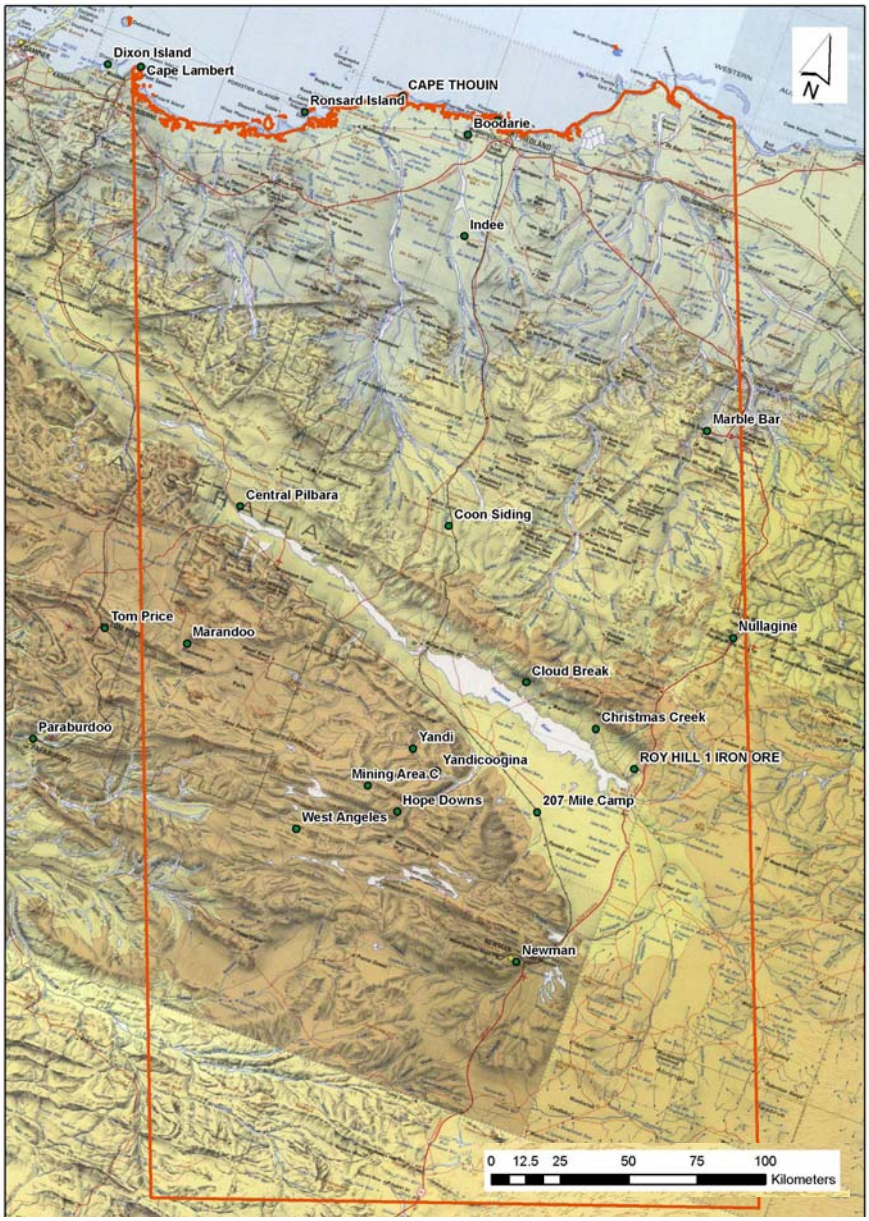


Figure 1 Region of Interest

2. RAIL ROUTE SELECTION METHODOLOGY

WorleyParsons initially undertook a literature review to identify environmental and social values within the region of interest (Appendix A).

The methodology for route selection required a staged approach leading from coarse screening of the region of interest, subsequent identification of suitable routes, and then location specific investigations as follows:

- Round One (Figure 2) – Multi-criteria analysis technique to screen out unsuitable areas and identify broadly suitable areas using a geographic information system database that allowed multiple layers of environment, social and engineering information to be mapped and analysed;

- Round Two (Figure 2) – Sanity check of GIS outputs, feed fatal flaws into Quantm and delineate eight least-constrained routes, and determine the environmental and social status of each selected route; and

- Round Three (Figure 2) – Route suitability index of economic judgment versus route feasibility.

The assessment process is presented as a flowchart in Figure 2. By following the process illustrated in Figure 2 a process can be presented to assess all routes within the area of interest, in a coarse then fine manner, whilst incorporating specialist opinions within RHIO and WorleyParsons.

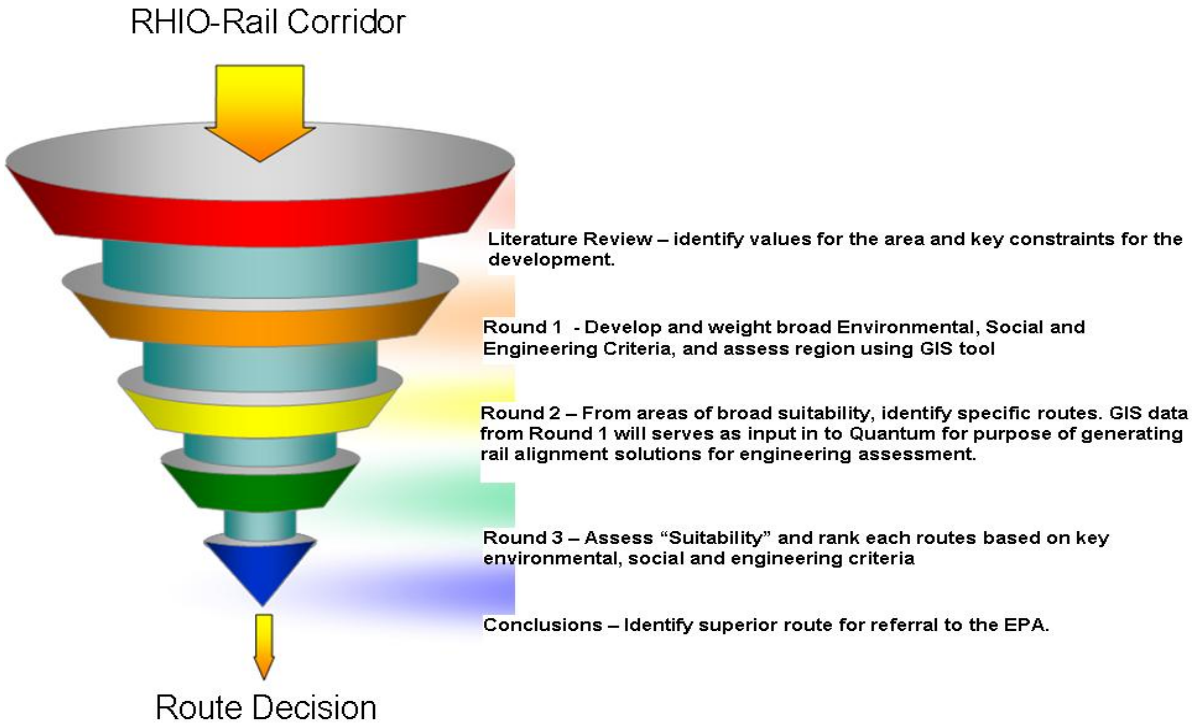


Figure 2 Rail Route Selection Process

2.1 Preferred Route Characteristics

A specific corridor was identified from the following directives:

- The alignment of the corridor should follow the most direct route;
- The rail line should traverse flat topography wherever possible;
- Proposed infrastructure should be within a land use compatible to a rail line wherever possible; and
- Residential buildings should be at least 500 m from the rail route to minimise noise impacts.

3. ROUND ONE: BROAD MULTI-CRITERIA ANALYSIS

WorleyParsons used a Multi-criteria Analysis (MCA) technique to screen out unsuitable areas and identify broadly suitable areas using a geographic information system database that allowed multiple layers of environment, social and engineering information to be mapped and analysed.

Multi-criteria analysis decision making is a type of decision analysis tool that is particularly applicable to cases where a single-criterion approach (such as cost-benefit analysis) falls short, especially where significant environmental and social impacts cannot be easily assigned monetary values. They are frequently used to compare positive and negative effects or values against a list of relevant criteria to determine preferred strategies or areas (Mendoza & Macoun 1999).

3.1 Background

Route selection is a process of determining potentially suitable locations for a given development or activity. This definition implies that numerous factors influence route selection, including those which are required by the development or activity itself (in a logistic or practical sense), and those which are inherent in the region being investigated (such as heritage and mining tenure).

There is a range of tools and methods available for identifying and selecting potential locations for a variety of infrastructure route selection. These can be considered to fall within three broad categories:

- The Opportunistic/Serendipitous;
  - Opportunistic/Serendipitous selection is characterised by locations being placed in a piece wise fashion, considering less desirable traits when the opportunity presents itself with little thought towards a greater location selection (Drew 2000).
- The Delphic/Judgmental;
  - The Delphic/Judgmental method is marked by selection of locations by a few people making rapid decisions to create a hierarchical list (Drew 2000).
- The Scientific/Analytic;
  - The Scientific Analytical approach to route selection uses existing spatial data and objective numerical techniques to evaluate a range of constraints and identify favourable areas.

For this round, Scientific Analytical-based spatial constraints have been employed using a Geographic Information System (GIS) database to determine potential development areas and areas of high constraint.

MCA are widely used for spatial decision-making in planning and design disciplines[1]. At a regional level, MCA provides a coarse planning assessment, identifying general areas which may encompass suitable routes. These areas then require detailed technical assessment to determine their suitability and to define specific routes within their broad boundaries.

The strength of multi-criteria analysis is the accountable manner in which unquantifiable and intangible factors (such as loss of amenity to a community or 'existence value' of wilderness i.e. clearing in an environmentally sensitive area) can be integrated with strictly measurable data. The reality of land use planning and environmental and social impact assessment is that decisions on these matters invariably include unquantifiable and intangible factors.

The selection and weightings of each criterion in the analyses remain subjective, but are clearly stated and debated by individuals with relevant expertise within a Delphic forum. As with all general planning tools and methods, there is still room for modification but, in general terms, it is considered that the model derived was suitable for the broad-scale identification of areas suitable for a rail route.

3.2 Methodology

3.2.1 Desktop Review

A review of publicly available data and reports was first undertaken to define the overall environmental and social characteristics of the region of interest (Figure 1). This study aimed to provide a summary of current knowledge and research undertaken in the area (Appendix A).

3.2.2 Information Sources

Information used in the course of the route selection study include spatial data in digital form as well as hardcopy maps and a variety of reports and published documents obtained from the grey

[1] McHarg first articulated the technique of thematically mapping spatial factors (in terms relevant to the study being conducted) and overlaying them, either selectively or in combination, to obtain an overview of the region. Historically, these multi-criteria analyses were limited to a small number of criteria for the simple reason that manual calculations and their spatial representation were time consuming and difficult to undertake, modify or repeat. Modern use of integrated, computerised mapping and database systems (GIS) enables the analysis of virtually unlimited numbers of criteria, and allocation of various weighting and priority systems. GIS technology has created a powerful analytical tool which has made route selection a more transparent, repeatable and thorough process, thereby improving the professional acceptability and usefulness of detailed route selection processes. It has enabled a wider range of information to be integrated and analysed, taking a greater number of influential factors into consideration.

literature. Some datasets required buffering or merging to contain the attributes necessary for the investigation. The principal references included:

- Department of Environment and Conservation;
- Western Australian Planning commission;
- International Union for Conservation of Nature (IUCN)
- Western Australia Land Information Authority (Landgate);
- National Native Title Tribunal;
- Aboriginal Sites Register (DIA)
- Department of Mines and Petroleum;
- Geoscience Australia; and
- Birds Australia.

3.2.3 Step 1 – Identify Evaluation Criteria

Evaluation criteria for suitability of a corridor for location of a rail route were identified by the WorleyParsons/RHIO project team in each of the following categories:

Environmental

- Native vegetation;
- Wetlands;
- Avifauna;
- Threatened fauna; and
- Conservation estate.

Social

- National Heritage (natural, historic and indigenous sites);
- Aesthetics;
- Land tenure;
- Native title; and
- Mining activities.

Engineering constraints

- Rivers and creeks;
- Roads; and
- Interference with infrastructure.

3.2.4 Step 2 – Data Review

The next step was to identify available data which could be used to represent the evaluation criteria identified in Step 1. For each data set, the accuracy and currency of the data was reviewed and is detailed in Appendices B and Appendix C. Evaluation criteria that could not be accurately represented in the Geographic Information System (GIS) model were rejected at this stage. Wherever possible, these criteria were carried forward to the Round 2 investigations.

3.2.5 Step 3 – Assign Performance Weightings

Performance ratings were developed by WorleyParsons and RHIO specialists. For each criterion, performance ratings were developed as follows:

- Fatal flaw (999) – completely unsuitable for further consideration (for example, residential area);
- Poorly suitable (100);
- Moderately suitable (50); and
- Highly suitable (1).

Values in brackets indicate performance weightings assigned to GIS attributes.

In determining performance ratings, the following issues were considered:

- Legislative requirements, for example, requirements to obtain permits to clear vegetation;
- Land use planning considerations and the need to maintain appropriate land uses and amenity; and
- Environmental values and sensitivities, and the need to protect ecosystems and species.

3.2.6 Step 4 – Weighting of Criteria

Multi Criteria Analysis requires consideration of the relative importance of each criterion compared to other criteria. A paired comparison method was selected for weighting of criteria (Stevens 1997). This approach requires each criterion to be compared to each other criteria to determine which of the two (paired) criteria is considered more important. By considering the

number of times any particular criteria is rated as more important than any other, the criteria can then be ranked as a set in terms of importance.

For this project, criteria were compared in the categories of environmental, social and engineering considerations. The paired comparison was undertaken by specialists selected from the project team who were considered able to provide environmental, social, and engineering expertise[2]. Weightings were normalised so that weightings were a percentage for each category. Results of the paired comparison for each set of criteria are presented in Table 14.

3.2.7 Step 5 – GIS Analysis

GIS analysis required data for each evaluation criterion to be compiled and analysed according to the performance ratings on a series of 20 m by 20 m grids across the study area[3]. Following this, the weightings were applied to each criterion and the overall score for each evaluation criterion in each grid calculated. The GIS model then compiled scores across all the evaluation criteria for each grid and identified areas that were more or less suitable for location of a rail route.

The Multi Criteria Analysis was performed using Esri's ArcGis Version 9.0. Datasets were sourced from a number of government departments/agencies (Section 3.2.2) and imported into ESRI shape files. All files were reprojected into GDA 94 (Zone 50) and an attribute field added in which a performance rating was assigned. Some datasets required more processing such as buffering and merging.

As a result, an overall sensitivity map was derived. The lower the score, the more attractive the route is for locating a rail route. This process is illustrated in Figure 3.

[2] As part of developing the evaluation criteria and associated weightings for the Multi Criteria Assessment (Round1), specialists from RHIO and WorleyParsons were assembled to workshop the route selection evaluation criteria. Evaluation criteria, which form the underlying assumptions for the route selection process, were discussed. The ratings and associated weightings were also discussed and broadly agreed,

[3] A 20 x 20 m grid was used to delineate suitable areas while capturing highly weighted constraints i.e. a river

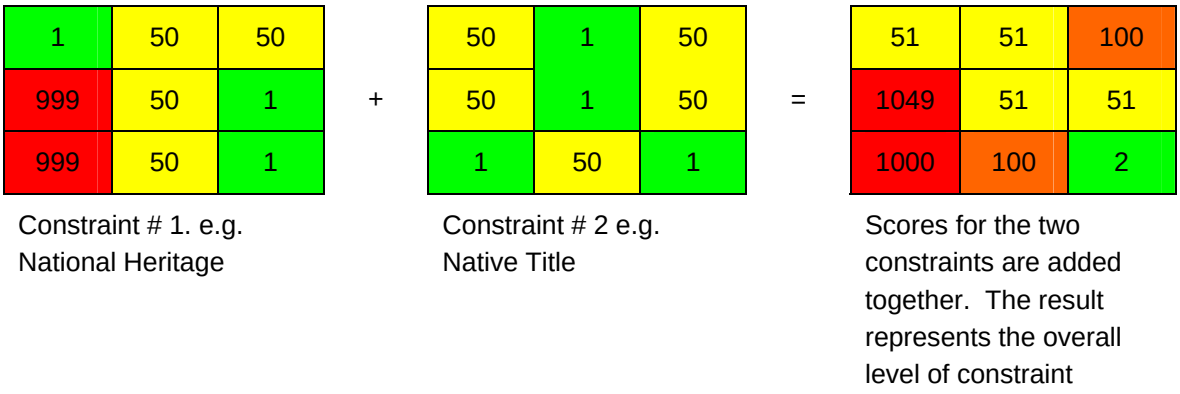


Figure 3 MCA methodology for construction of the weighted overlay

3.2.8 Limitations

While the Multi Criteria Analysis technique is a powerful tool for screening broad study areas, it must be noted that there are a number of limitations including:

- Inability to represent all of the critical aspects that determine suitability for development in a geographic format;
- Accuracy and currency of some data; and
- Coarseness of some of the assumptions that may be made in determining performance ratings and weightings for evaluation criteria.

Rounds 2 (Section 4) and 3 (Section 5) of the route selection process are intended to verify and validate the outputs of the GIS model, as well as incorporate additional considerations that could not be included in the model.

3.3 MCA Criteria for Route Selection

3.3.1 Environmental

NATIVE VEGETATION (TABLE 1)

Remnant native vegetation has significant value for conservation of individual species and biodiversity. Dominant communities have been mapped and assessed.

The categories of flora are:

- Declared Rare Flora (X) – Presumed Extinct Taxa. This category includes taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
- Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
- Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
- Priority Three – Poorly Known Taxa. This category includes taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
- Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years (Atkins, 2006).

Table 1: Native Vegetation

Objective	**To avoid clearing native vegetation and any impact on environmentally sensitive areas**
Fatal Flaw:	Route within 500 m of Declared Rare Flora (Extant Taxa)
	Route within 500 m of Declared Rare Flora (Presumed Extinct Taxa)
	Route within 500 m of Threatened Ecological Communities
Poor:	Route within 500 m of Priority 1 taxa
	Route within 500 m of Priority 2 taxa
Moderate:	Route within 500 m of Priority 3 taxa
	Route within 500 m of Priority 4 taxa
Good:	None of the above

WETLANDS (TABLE 2)

Ramsar wetlands are wetlands of international significance protected under the Convention on Wetlands, signed in Ramsar, Iran, in 1971, an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

The objective is to preserve all wetlands or minimise impacts. Values of wetland ecosystems include:

- Habitat for rare and endangered species and international migratory species;
- Presence of high levels of biodiversity;
- Removal of pollutants from surface waters;
- Stabilisation of coastal areas that might otherwise be subject to erosion;
- Recreation and aesthetic values; and
- Habitat for commercially important species, particularly fish.

The Fortescue Marshes (Figure 4) are listed as a Wetland of National Importance under the Directory of Important Wetlands of Australia (Environment Australia 2001) and is currently a high priority, proposed Ramsar Wetland[4]. The Fortescue Marshes meets the criteria for Ramsar nomination but nomination has been delayed subject to State funding for an Ecological Character Description and Management Plan, and then subsequent federal nomination. Although the Fortescue Marshes are not officially recognised as a Ramsar wetland they are nationally important and therefore any development in or near the wetlands will trigger the *EPBC Act* designed for protection of matters of national environmental significance. The MCA criteria for important wetlands are shown in Table 2 below.

[4] The Fortescue Marsh consists of Alluvial plains and river frontage. Extensive salt marsh, mulga-bunch grass, and short grass communities occur on alluvial plains in the east. Deeply incised gorge systems occur in the western (lower) part of the drainage. River gum woodlands fringe the drainage lines. It marks the northern limit of Mulga (Acacia aneura) in WA. An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of river gum and cadjeput Melaleuca woodlands. Episodically supports immense water-bird breeding.

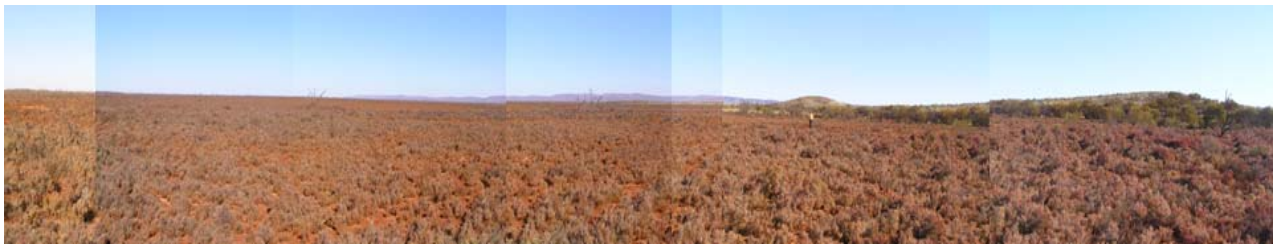


Figure 4 Panoramic of the Fortescue Marshes

Table 2: Wetlands

Objective	**To minimise and avoid an impact on wetlands**
Fatal Flaw:	Ramsar wetland
Poor:	The route is within Fortescue Marshes
Moderate:	The route is within a wetland
Good:	None of the above

AVIFAUNA (TABLE 3)

Important Bird Areas designated by Birds Australia were used to determine avifauna sites for this project. Birds Australia identified Important Bird Areas (IBAs) as sites of global conservation importance. To qualify as an IBA, the site must meet one of four global criteria used by BirdLife International. The criteria are:

- The site must regularly support a Critical or Endangered species or at least 10 pairs of a vulnerable species, as categorised by the IUCN Red List (Globally threatened species);
- The site forms one of a set protecting 'restricted-range species' (birds with a global range of <50,000 km^2);
- The site forms one of a set protecting all species restricted to a given biome. For this purpose, Australia has been divided into seven biomes using the paper by Hutchinson et al. (2005); and
- The site supports >1% of the world population of a waterbird (matching Ramsar Convention Criteria).

Table 3: Avifauna

Objective	To minimise the impact on avifauna
Fatal Flaw:	Route within 0-1 km of an Important Bird area
Poor:	Route is <10 km from an Important Bird area
Moderate:	Route is 10-25 km from an Important Bird area
Good	Route is >25 km from an Important Bird area

THREATENED FAUNA (TABLE 4)

Listed threatened species are matters of national environmental significance (protected matters) under the EPBC Act's assessment and approval provisions. The definition of a species under the *EPBC Act* includes sub-species and distinct populations that the Minister has determined to be species for the purposes of the Act. Threatened fauna may be listed in any one of the following categories as defined in Section 179 of the EPBC Act:

- Extinct;
- Extinct in the wild*;
- Critically endangered*;
- Endangered*;
- Vulnerable*; and
- Conservation dependent.

* Only species in those categories marked with an asterix are matters of national environmental significance (protected matters) under the EPBC Act.

Table 4: Threatened Fauna

Objective	Routes near threatened fauna are avoided
Fatal Flaw:	N/A
Poor:	Threatened fauna are <1 km from site
Moderate:	Threatened fauna are 1-2 km from site
Good	None of the above

CONSERVATION ESTATE (TABLE 5)

The Department of Environment and Conservation manages more than 26 million hectares (or nine per cent) of lands and waters in national parks, conservation parks and reserves, marine parks and reserves, regional parks, nature reserves, State forest and timber reserves.

Reserves are vested in the Conservation Commission of Western Australia and are managed in accordance with the *CALM Act* and Regulations, and the *Wildlife Conservation Act 1950*.

Table 5: Conservation Estate

Objective	**To avoid or minimise impacts on sites with legal conservation status and to minimise impact on land tenure**
Fatal Flaw:	Nature Reserve, National Park
Poor:	Proposed Addition to Nature Reserve
	Proposed addition to National Park
	State Forest
	Conservation Park
	Timber Reserve
Moderate:	Miscellaneous Reserve
	5(1)(g) Reserve
	5(1)(h) Reserve
	CALM Exec Body
	CALM Exec Body Freehold
Good:	None of the above/ infrastructure corridor

3.3.2 Social

NATIONAL HERITAGE (NATURAL, HISTORIC AND INDIGENOUS SITES) (TABLE 6)

The National Heritage List includes natural, historic and Indigenous places of outstanding heritage value.

The Commonwealth Heritage List comprises natural, Indigenous and historic heritage places on Commonwealth lands and waters or under Australian Government control.

The Register of the National Estate (RNE) will continue as a statutory register until February 2012. During this period the Minister for the Environment, Heritage and the Arts is required to continue considering the Register when making some decisions under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Register of the National Estate is a list of natural, Indigenous and historic heritage places throughout Australia. It was originally established under the *Australian Heritage Commission Act 1975*.

On 1 January 2004, a new national heritage system was established under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This led to the introduction of the National Heritage List, which was designed to recognise and protect places of outstanding heritage to the nation, and the Commonwealth Heritage List, which includes Commonwealth-owned or leased places of significant heritage value.

Once a heritage place is listed under the EPBC Act, special requirements come into force to ensure that the values of the place will be protected and conserved for future generations. The *EPBC Act* provides for the preparation of management plans which set out the significant heritage aspects of the place and how the values of the site will be managed.

Heritage Sites in the Register of the National Estate and Commonwealth Heritage List include:

- Aboriginal sites (including quarries, art sites, mythological sites);
- Historic Building;
- Wharf;
- Weir;
- Lighthouse;
- Jetty;
- Gaol Precincts;
- Homestead;
- Cemeteries;
- Monument;
- Memorials;
- Racecourse;
- Bridge;
- Pumping Station; and

- Army Camp.

Sites on the Register of the National Estate were not included if they were listed as:

- Removed from register;
- Rejected place; and
- Destroyed.

Table 6: National Heritage Sites

Objective	To conserve significant cultural heritage sites
Fatal Flaw:	Route is within Woodstock art site
	Route within Protected Areas
	Route is <50 m from a cemetery (indigenous or European), a burial ground, a lighthouse, memorial or historic building
Poor:	Route is <50 m from a known, significant cultural or heritage site (all of the above listed but not those included as a fatal flaw [cemeteries, burial grounds, lighthouses, memorials or historic buildings])
	Route is <50 m from an Aboriginal site listed by the Department of Indigenous Affairs
	Route is <500 m from an Aboriginal community
	Route is <500 m from Geoheritage site
Moderate:	Site is 50-100 m from a known, significant cultural or heritage site (all listed)
Good:	None of the above

AESTHETICS (TABLE 7)

Some sections of the proposed rail route may be visible to homesteads. The rail line and associated infrastructure may adversely affect the landscape character of some areas. The MCA criteria for aesthetics are shown in Table 7 below.

Table 7: Visual impact on surrounding area

Objective	The distance between residences and the corridor is within a reasonable distance
Fatal Flaw:	N/A
Poor:	Route is within 5 km from homestead
Moderate:	N/A
Good	None of the above

LAND TENURE (TABLE 8)

Certain tenures are likely to prelude the location of rail route. Increased land costs may also be associated with some land tenures. The MCA criteria for land tenure are shown in Table 8 below.

Table 8: Land Tenure

Objective	Impacts on land tenure are avoided or minimised
Fatal Flaw:	N/A
Poor:	Road
	Leasehold land, Strata Plan
	Freehold land
Moderate:	Reserved Crown land
	Crown Land
Good:	Vacant Crown land
	All other remaining areas

Native Title (Table 9)

Native Title is a set of rights and interests in relation to land or waters that are recognised under Australian law. Native Title parties have the right to negotiate future acts, for example involving the grant of a mining lease. Native Title mediation can be complex, costly and time-consuming; therefore it is seen as a constraint and has been included in the MCA (Table 9). Based on previous projects in the area some Native Title claimants have complex issues to resolve and have been ranked based on previous experiences by RHIO.

Table 9: Native Title

Objective	Reduce or minimised complexity native title issues
Fatal Flaw:	N/A
Poor:	Kariyarra People
	Njamal People
Moderate:	Palyku
	Nyiyaparli
	Martu Idja Banyjima People
	Innawonga and Bunjima People
Good	No claim on area

ACTIVE MINING SITES (TABLE 10)

Mining activities are likely to physically preclude location of a rail route due to surface or subsurface disturbance. Location of a rail route would preclude extraction of any underlying or nearby mineral resources effectively sterilising the area. Mining activities and mineral resources cannot be relocated.

Table 10: Mining Sites

Objective	Impact on mining and mineral exploration activities are not impacted on, mineral resources are not sterilised
Fatal Flaw:	<1 km from a mine site
Poor:	Within 5 km of a mine site
Moderate:	N/A
Good	> 5 km from a mine site

3.4 Engineering and Infrastructure

RIVERS AND CREEKS (TABLE 11)

Increased engineering and construction costs would likely be required for the rail line to cross creeks and rivers (Figure 5). Additional approvals may also be required for construction in such areas. The construction of the rail line could adversely impact the quality and integrity of rivers and creeks. This could occur through sedimentation and disturbance to banks and important riparian vegetation. The MCA criteria for rivers and creeks are shown in Table 11.

Figure 5 BHP rail crossing Yule River

Table 11: Rivers and Creeks

Objective	To minimise the number of river and creek crossings within the corridor
Fatal Flaw:	N/A
Poor:	Route is <200 m from a major river
Moderate:	Route is 200-300 m from a major river
Good	None of the above

ROAD (TABLE 12)

Crossing roads (Figure 6) would increase statutory approvals, engineering costs and timeframes associated with the project. The MCA criteria for road are shown in Table 12 below.

Figure 6 Railway crossings involve additional engineering and are considered a constraint

Table 12: Road

Objective	To minimise the number of road crossings and maintain a safe distance from road within the corridor
Fatal Flaw:	<100m to main road
Poor:	100 – 500 m from a main road
Moderate:	100 – 500 m form a secondary road
Good	Road is >500 m

INTERFERENCE WITH INFRASTRUCTURE (TABLE 13)

State agreements are contracts between the State and major project developers, ratified by the State Agreement Act. State agreements can only be changed by mutual consent, providing long term certainty over land tenure and approvals processes for developers.

The route must be located away from an operating mine to avoid land use conflicts, including potentially compromising the integrity of infrastructure due to subsidence or blasting associated with mining activities. Additionally, mines must be located away from construction activities to avoid sterilising future mineral resources as mineral resources cannot be relocated.

The rail line should be within a safe distance from existing and proposed railways in accordance to the *Railways Rail Safety Act 1998*.

Whilst being within competitors tenements is considered a constraint it is not considered a fatal flaw as FMG was able to set a precedent with BHP in 2008 (Figure 7).

Figure 7 FMG bridge crossing BHP line

Table 13: Interference with infrastructure

Objective	To minimise interference with infrastructure
Fatal Flaw:	Within a water body (e.g. dam)

Poor:	Within a third party State Agreement
	Within 1 km of an asbestos mine (current and abandoned)
	Within a third party mining\ mineral lease or proposed tenements
Moderate:	Within a RIO/FMG mining\mineral lease or proposed tenement
	Within a third party prospecting or exploration licences
	Within a third party retention licence
	Within a third party general purpose licence
	Within a third party miscellaneous licence
Good	Within the proposed RHIO State Agreement

Table 14 Results of the paired comparison Weightings for Environmental, Social and Engineering Criteria

		Native vegetation E1	Wetlands E2	Avifauna E3	Threatened fauna E4	Conservation Estate E5	National Heritage Sites (natural, historic and indigenous sites) S1	Aesthetics S2	Land tenure S3	Native title S4	Mining Activities S5	Rivers and creeks C1	Road C2	Interference with infrastructure C3	Count	Standardised Weighting	Category weighting
Native vegetation	E1		E2	E3	E4	E5	S1	E1	E1	E1	S5	C1	E1	E1	5	6.4	11.6
Wetlands	E2	E2		E2	E2	E2	E2	E2	E2	E2	S5	E2	E2	E2	11	14.1	25.6
Avifauna	E3	E3	E2		E3	E3	E3	E3	E3	E3	S5	E3	E3	E3	10	12.8	23.3
Threatened fauna	E4	E4	E2	E3		E4	E4	E4	E4	E4	S5	E4	E4	E4	9	11.5	20.9
Conservation Estate	E5	E5	E2	E3	E4		E5	E5	E5	E5	S5	E5	E5	E5	8	10.3	18.6
National Heritage Sites(natural, historic and indigenous sites)	S1	S1	E2	E3	E4	E5		S1	S1	S1	S5	S1	S1	S1	7	9.0	30.4
Aesthetics	S2	E1	E2	E3	E4	E5	S1		S3	S4	S5	C1	S2	C3	1	1.3	4.3
Land tenure	S3	E1	E2	E3	E4	E5	S1	S3		S3	S5	C1	C2	C3	2	2.6	8.7
Native title	S4	E1	E2	E3	E4	E5	S1	S4	S3		S5	C1	C2	C3	1	1.3	4.3
Mining Activities	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5		S5	S5	S5	12	15.4	52.2
Rivers and creeks	C1	C1	E2	E3	E4	E5	S1	C1	C1	C1	S5		C1	C1	6	7.7	50.0
Road	C2	E1	E2	E3	E4	E5	S1	S2	C2	C2	S5	C1		C3	2	2.6	16.7
Interference with infrastructure	C3	E1	E2	E3	E4	E5	S1	C3	C3	C3	S5	C1	C3		4	5.1	33.3
															78	100	

3.5 Multi Criteria Analysis Results

The Round 1 multi criteria analysis identified broad areas suitable for development of a rail route based on 20m by 20m grids. The main result was the generation of a composite Environmental, Social and Engineering (ESE – Figure 12) constraints map by overlaying Figure 9, Figure 10 and Figure 11 on each other to produce Figure 12. Orange-red areas reflect areas with the greatest level of constraint and have least suitability for development of a rail route. Such areas included cultural heritage, wetlands and conservation estate. Yellowish areas indicate a moderate level of constraint. Light green areas show moderately suitable areas and potentially suitable areas are displayed as dark green areas. Finally, the figure shows potentially suitable corridor for the rail route. Figure 8 illustrates this methodology. Notable features shown on these figures include:

- Environmental considerations substantially constrained were numerous rivers and creeks;
- Social constraints were the Black Range Dyke Section and Abydos-Woodstock Art Sites;
- Engineering constraints were road, rail and pipeline crossings;
- Numerous identified indigenous sites along the rail routes; and
- A few native title claimants.

A suitable corridor was delineated, which became the base for Round 2 of the Route Selection methodology (Figure 2).

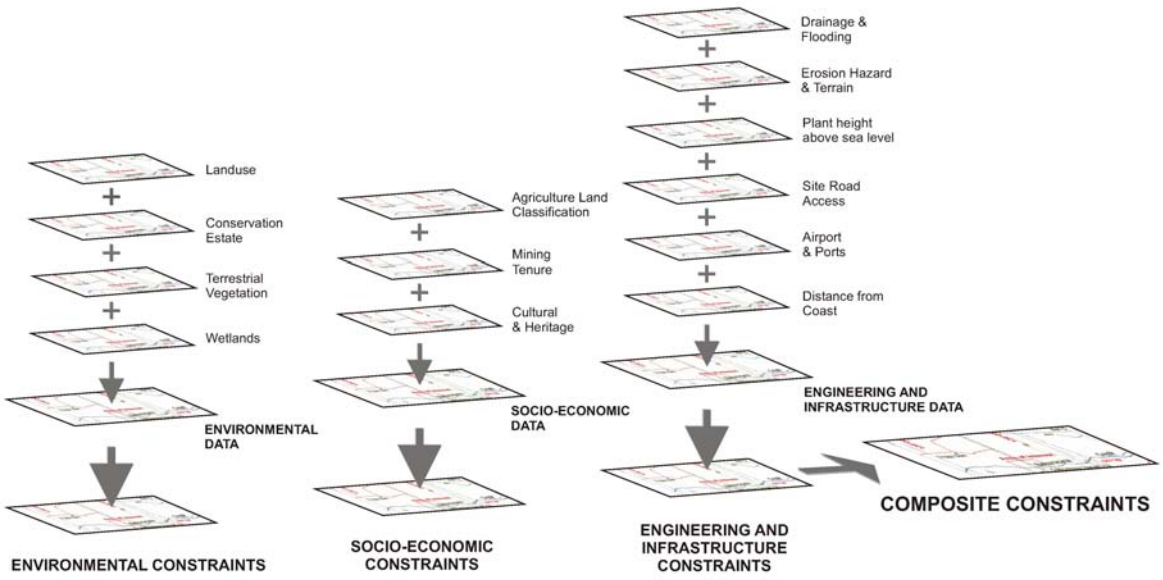
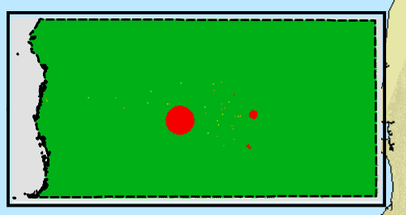


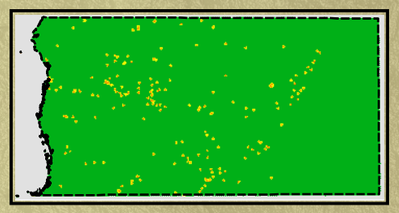
Figure 8 Example of procedure used to construct ESE weighted overlay

Figure 9 Environmental overlay

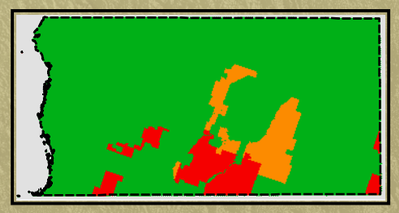


NATIVE VEGETATION

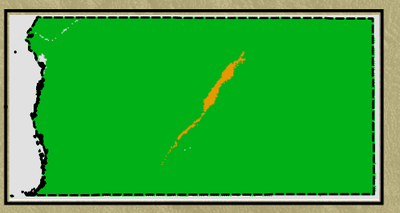
AVIFAUNA



THREATENED FAUNA



CONSERVATION ESTATE



WETALANDS

LEGEND
- MCA AREA OF INTEREST
- TOWNS & MINES
- BHPBIO RAILWAY
- FMG RAILWAY
- FUTURE HOPE DOWNS RAILWAY
- SEALED ROAD
- MAJOR UNSEALED ROAD
- CHICHESTER RANGE

ENVIRONMENTAL CONSTRAINTS VALUE
- MOST SUITABLE
- LEAST SUITABLE

Nullagine
Marble Bar
Christmas Creek
ROY HILL
Cloud Break
207 Mile Camp
Newman
Forfescue Marshes
PORT HEDLAND
Boodarie
Indee
Coon Siding
Yandicoogina
Weeli Wolli Spring Community
Yandi
Hope Downs
Mining Area C
CAPE THOUIN
TEC - Cracking Clays
Ronsard Island
Mungaroona Range Nature Reserve
TEC Coolibah Lignum Flats
West Angeles
Central Pilbara
Karijini National Park
Marandoo
Cape Lambert
Millstream-Chichester National Park
Dixon Island
Western Australia
N
0 10 20 40 60 80 100
Datum: GDA94, Projection: MGA94, Zone 50S (Kilometres)

ENVIRONMENTAL CONSTRAINTS: WEIGHTED OVERLAY

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REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING	REFERENCE DRAWING TITLE
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A	08-05-09	ISSUED FOR INTERNAL REVIEW	SS	DH					RH928-00-EN-DSK-0005	

SIZE A3 SCALE 1:1,450,000

OneWay to Zero Harm

WORLEYPARSONS PROJECT No. 301012-00928

WorleyParsons resources & energy

CUSTOMER: ROY HILL IRON ORE PTY LTD

ROY HILL 1 IRON ORE PROJECT
PRE-DFS RAIL STUDY

ENVIRONMENTAL CONSTRAINTS

DRG No FIGURE 9

REV B1

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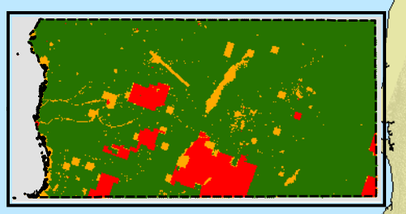
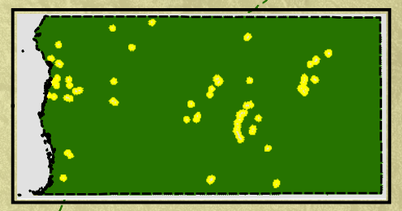
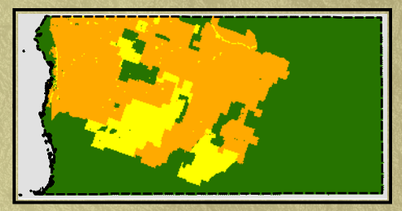
Figure 10 Social overlay



NATIONAL HERITAGE

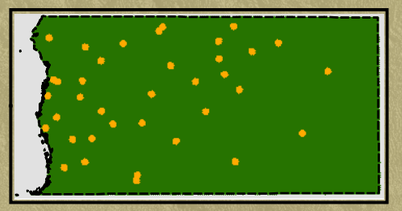


MINING ACTIVITIES



LAND TENURE

NATIVE TITLE



AESTHETICS/HOMESTEADS

LEGEND

- MCA AREA OF INTEREST
- TOWNS & MINES
- BHPBIO RAILWAY
- FMG RAILWAY
- SEALED ROAD
- MAJOR UNSEALED ROAD
- CHICHESTER RANGE

SOCIAL CONSTRAINTS

- MOST SUITABLE
- LEAST SUITABLE

Nullagine
Marble Bar
Christmas Creek
ROY HILL
Warrie
Black Range Dyke Section
Cloud Break
Hillside Outcamp
Fortescue Marshes
207 Mile Camp
Newman
PORT HEDLAND
Wallareenya
FMG KAR III 86-01
Woodstock Art Site
Boodarie
Indee
Coon Siding
WodE#2 Low Ground Site Complex
Yandicoogina
Yandi
CAPE THOUIN
Kangan
COWERIE WELL (Aboriginal Burial Site)
Hope Downs
Mining Area C
Ronsard Island
Mungaroona Range Nature Reserve
West Angeles
Central Pilbara
Karijini National Park
Marandoo
Cape Lambert
Millstream-Chichester National Park
Dixon Island
Western Australia

N

0 10 20 40 60 80 100

Datum: GDA94, Projection: MGA94, Zone 50S (Kilometres)

SOCIAL CONSTRAINTS: WEIGHTED OVERLAY

PRELIMINARY UNCHECKED

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A	08-05-09	ISSUED FOR INTERNAL REVIEW	SS	DH						RH928-00-EN-DSK-0006

SIZE A3 SCALE 1:1,450,000

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SOCIAL CONSTRAINTS

DRG No FIGURE 10 REV B1

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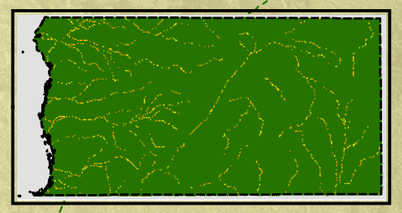
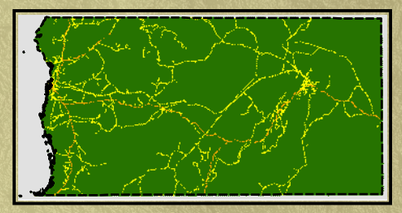
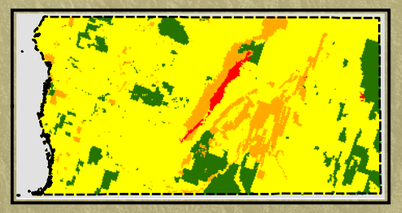
Figure 11 Engineering Data



MAJOR RIVERS



ROADS



INTERFERENCE INFRASTRUCTURE

LEGEND

- MCA AREA OF INTEREST
- TOWNS & MINES
- BHPBIO RAILWAY
- FMG RAILWAY
- SEALED ROAD
- MAJOR UNSEALED ROAD
- CHICHESTER RANGE

ENGINEERING CONSTRAINTS

- MOST SUITABLE
- -
- LEAST SUITABLE

N

Nullagine
Marble Bar
Christmas Creek
ROY HILL
State Agreements
Asbestos Mines
Cloud Break
207 Mile Camp
Newman
Fortescue Marshes
PORT HEDLAND
Mining Lease
Boodarie
Indee
Coon Siding
Mining Lease
Yandicoogina
State Agreements
CAPE THOUIN
Yandi
Hope Downs
Mining Area C
Ronsard Island
West Angeles
Central Pilbara
Marandoo
Cape Lambert
Dixon Island

0 10 20 40 60 80 100

Datum: GDA94, Projection: MGA94, Zone 50S (Kilometres)

ENGINEERING CONSTRAINTS: WEIGHTED OVERLAY

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A	08-05-09	ISSUED FOR INTERNAL REVIEW	SS	DH						RH928-00-EN-DSK-0007

SIZE A3 SCALE 1:1,450,000

OneWay to Zero Harm

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WorleyParsons resources & energy

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ROY HILL 1 IRON ORE PROJECT
PRE-DFS RAIL STUDY

ENGINEERING CONSTRAINTS

DRG No FIGURE 11

REV B1

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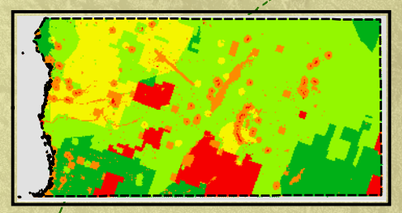
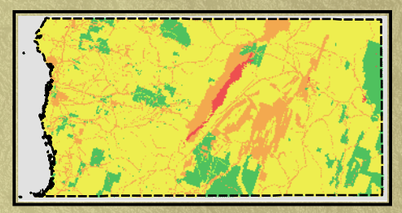
Figure 12 Final weighted overlay


SOCIAL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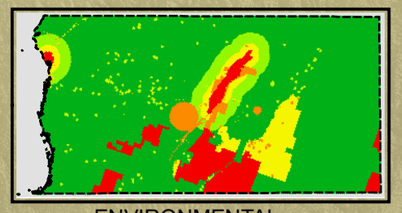
ENVIRONMENTAL

LEGEND
- MCA AREA OF INTEREST
- TOWNS & MINES
- BHPBIO RAILWAY
- FMG RAILWAY
- SEALED ROAD
- MAJOR UNSEALED ROAD
- CHICHESTER RANGE

COMBINED CONSTRAINTS VALUE
- MOST SUITABLE
- LEAST SUITABLE

N

Nullagine
Marble Bar
Christmas Creek
ROY HILL
Black Range Dyke Section
Cloud Break
Fortescue Marshes
207 Mile Camp
Newman
PORT HEDLAND
Boodarie
Indee
Woodstock Art Site
Coon Siding
WodE#2 Law Ground Site Complex
Yandicoogina
Weeli Wolli Spring Community
CAPE THOUIN
TEC - Cracking Clays
Yandi
Hope Downs
COWERIE WELL (Aboriginal Burial Site)
Mining Area C
Ronsard Island
Mungaroona Range Nature Reserve
TEC Coolibah Lignum Flats
West Angeles
Central Pilbara
Karijini National Park
Marandoo
Cape Lambert
Millstream-Chichester National Park
Dixon Island
Western Australia

0 10 20 40 60 80 100
Datum: GDA94, Projection: MGA94, Zone 50S (Kilometres)

SOCIAL,ENGINEERING AND ENVIRONMENTAL CONSTRAINTS: WEIGHTED OVERLAY

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A	08-05-09	ISSUED FOR INTERNAL REVIEW	SS	DH						RH928-00-EN-DSK-0008

SIZE A3 SCALE 1:1,450,000

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COMBINED CONSTRAINTS

DRG No FIGURE 12 REV B1

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4. ROUND 2: SPECIFIC ROUTE IDENTIFICATION

The objective of this Round 2 review is to identify specific routes within the study area used for the Round 1 review, which are likely to allow the development of a railway line.

GIS fatal flaw data from Round One serves as the input in to Quantm for the purpose of generating low cost rail alignments. These alignments avoid areas graded as environmentally, socially or engineering unfeasible.

4.1 Methodology

After the Round 1 assessment, Quantm's route optimisation technology streamlines the process of integrating the information that comes from the Round 1 database. Two termini were assigned for the analysis. The mine – E 795533.7 m, N 7514908.7 m; and port – E 656770.8 m, N 7738235.2 m MGA, zone 50.

The Quantm system simultaneously optimises the horizontal and vertical alignment to deliver a range of alternatives that meet the engineering, social, and environmental criteria defined by the team. Based on these criteria, the system investigates millions of routes for each scenario (various sets of constraints and costs) before delivering a range of alternatives to the team for consideration.

Using the Quantm system, multiple alternatives can be developed in a relatively short time for the team's consideration. The team inputs all relevant data using the front-end system Quantm Integrator. These data include terrain model (DEM or other elevation model), geology (location of various rock types and the cost of earthworks functions within them), design constraints and parameters (width, minimum curvatures, maximum grades, start and end points, etc.), physical constraints (locations of lakes, streams, urban centers, etc.), and environmental factors (fatal flaws from Round 1).

This information is then sent to the optimisation engine, Quantm Pathfinder (external party), which simultaneously considers all these factors and generates multiple alternatives. Quantm endeavors to meet the engineering and environmental criteria before optimising the alternatives on a cost basis. The speed and operation of the system support an iterative process whereby new constraints can be added to determine the location and cost impact of new avoidance zones or changes to engineering criteria. While cost drives the Quantm optimisation, it delivers a range of alternatives to enable the team, who has local knowledge and experience, to determine the best alternative.

Quantm results for rail alignment (eight routes) were exported to GIS for further MCA assessment in Round 2 (Quantitative constraints from Round 1 extracted for identified routes) and Round 3 (route suitability index of cost verse overall constraint).

4.2 Round 2 – Results

The outcome of the Quantm review resulted in eight route options. Subsequent to the identified Quantm routes, round two identified environmental/social constraints of each route, to assist in the overall assessment process.

For each route, a brief overview of the nature and scale of the proposed foot print and any key issues or potential impacts (environmental, social and engineering) were described. Initially GIS data (Round One) was extracted from each footprint. From this data, known and identified environmental/social values were assessed to quantify the primary impacts.

Potential environmental and social impacts to be considered in relation to rail route development can be categorised into nine groups: (1) water quality; (2) coastal hydrology; (3) sediment contamination; (4) marine and coastal ecology; (5) air quality; (6) noise and vibration; (7) waste management; (8) visual quality; and (9) socio-cultural impacts. The following assessment (Round 2 – Figure 3) has been inferred based on known and identified values. A detailed assessment of all these impacts is beyond the scope of this assessment.

The following routes were chosen from the Quantm software utilising the fatal flaws identified in the Round One assessment.

The lists of eight (8) rail route alignments are below:

Route 1. OPTION_A_WA_002_FULL

Route 2. OPTION_B_WA_002_FULL

Route 3. OPTION_C_WA_002_FULL

Route 4. OPTION_D_WA_002_FULL

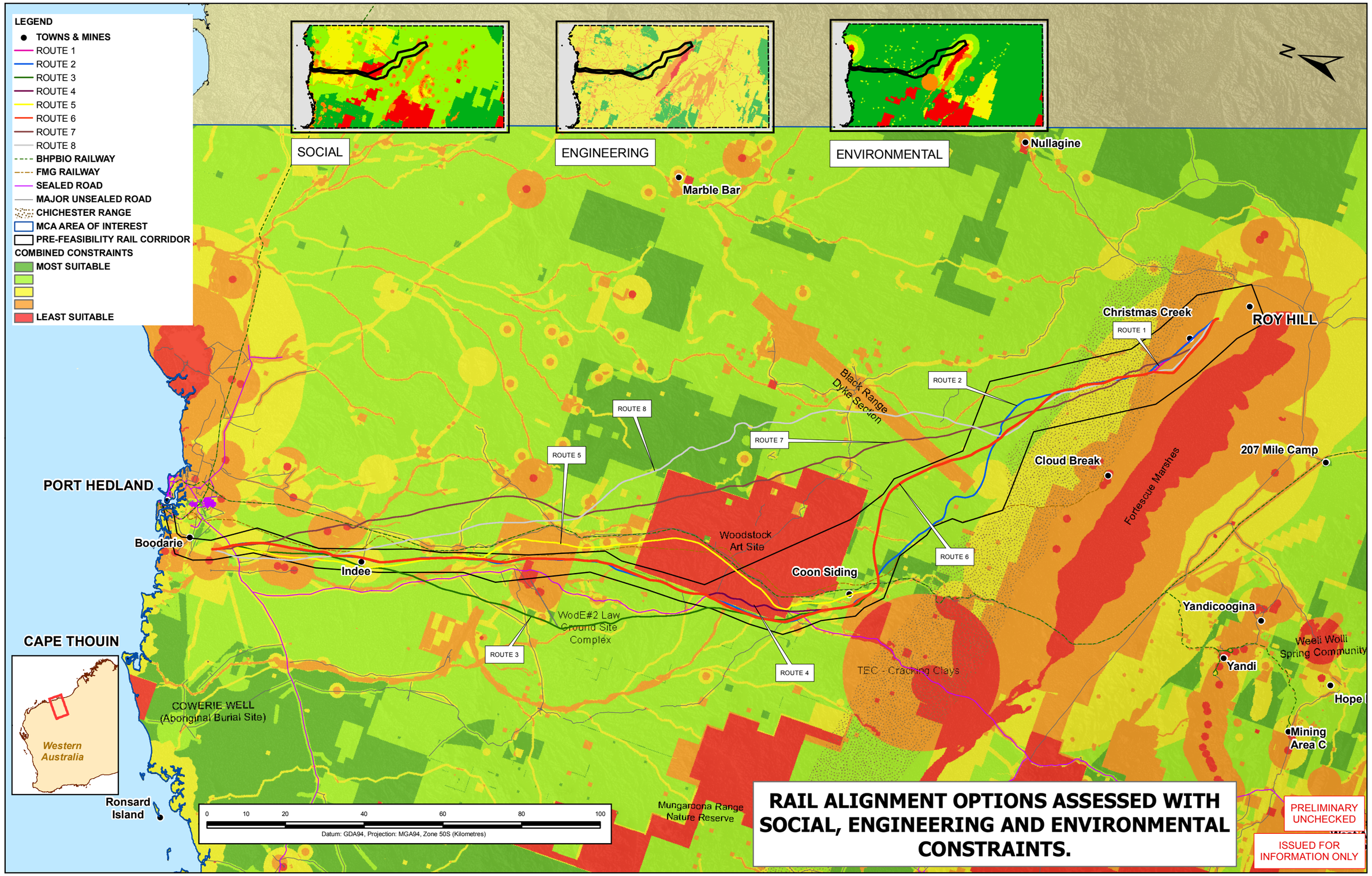
Route 5. OPTION_E_WA_002_FULL

Route 6. PFS_RH_PH_WA_002

Route 7. PRE_DFS_RH_PH_002_T_06

Route 8. PRE_DFS_RH_PH_004_U_06

Figure 13 Potential Rail Alignment Routes Identified from Quantm in the Round 2 Assessment



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A	29-05-09	ISSUED FOR INTERNAL REVIEW	SS	SD	SD	BK				RH928-70-RL-DSK-0001

SIZE A3 | SCALE 1:900,000

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WORLEYPARSONS PROJECT No. 301012-00928

WorleyParsons resources & energy

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PRE-DFS RAIL STUDY
RAIL ALIGNMENT ASSESSMENTS WITH CONSTRAINTS

DRG No FIGURE 13 | REV C1

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4.2.1 Route 1 – Option-A-WA-002-Full (Figure 14)

Figure 14 Oblique view of Route 1 – Option-A-WA-002-Full

The total length of the route is 297 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (206.2 km[5]). The remainder of the route traverses reserve land (89.4 km), freehold land (1.6 km) and road reserve (0.4 km). The route deviates to avoid the Abydos-Woodstock Reserves listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 1.

Route 1 passes through six Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 1 passes through the following:

- A Schedule 1 area (19 km);

[5] Values in brackets indicate length of the route intersecting a particular trait rather than chainage along the route.

- The Black Range Dyke Section (4 km). This site is listed on the Register of the National Estate for its heritage significance;
- Six DIA Aboriginal sites and Native Title claim area of the Kariyarra People, Palyku and Nyiyaparli ; and
- Five Priority 4 threatened fauna species, including birds and mammals, listed in the DEC database are within 2 km from the route, and two Priority 4 threatened fauna species (birds) listed in the DEC database are within 1 km from the route.

Table 15: General Description of Route 1 – Option-A-WA-002-Full

Within and adjacent to Route	Description
Total Route length	297 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 6 Aboriginal sites • Dambara Yambara (approx. 10 km) • Kulkakutjarra pool. (approx. 5 km) • Turner river (Tjirrlil) (approx. 1 km) • Yule river (Kakurka) (approx. 2 km) • Redmont access 1 (approx.1 km) • Tjilling creek (approx 3 km) • Black Range Dyke Section (4 km) listed on the Register of the National Estate
Aboriginal Communities	The route is approximately 3.5 km from the nearest Aboriginal community (Abydos Woodstock Group)
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 8.9 km from the route at its closest point

Within and adjacent to Route	Description
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is over ~8.9km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (19 km) No Threaten Ecological Community (TEC) within 1 km of the route
Land Tenure	Intersects the following State Agreement: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (25 km)
Land Use	• Freehold Land (1.6 km) • Leasehold Land (206.2 km) • Reserve (89.4 km) • Road Reserve (0.4 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Garden Creek • Christmas Creek • Cutinduna Creek • Gillam Creek • Yule River (**Figure 15**) • Western Shaw River (**Figure 15**)

Figure 15 Western Shaw River (left) and Yule River (right)

Within and adjacent to Route	Description
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD It also intersects with exploration licences, miscellaneous licences and general purpose leases
Road	The route intersects with the Great Northern Highway at three points
Rail	The route intersects with the FGM and BHP rail lines
Pipeline	The route intersects with one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd (**Figure 16**)

Figure 16 Epic Energy Pipeline

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database for matters of national environmental significance (NES) identified 6 threatened species and 11 migratory species that may occur within the Route 1 area. Table 16 summarises the *EPBC Act* status of the 6 threatened species.

Table 16 Matters of NES (Threatened Species) Route 1

Threatened Species	Status	Type of Presence
Birds		
Pezoporus occidentalis Night Parrot	Endangered	Species or species habitat likely to occur within area

Mammals		
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Macrotis lagotis Greater Bilby	Vulnerable	Species or species habitat may occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area

The listed migratory species that may occur within the study area include:

- 3 species of migratory birds;
- 5 species of migratory wetland birds; and
- 3 species of migratory marine birds.

The listed marine species which may also utilise the area include:

- 9 bird species

POTENTIAL IMPACTS

Route 1 is the fifth longest of the routes with a footprint of 297 km and has a smaller disturbance footprint than Routes 3, 4, 5 and 6.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and five threatened fauna are within 2 km of the route. Two bird species listed as DEC priorities and are within 1 km of the route. However, the majority of the route has been previously disturbed; therefore additional disturbance to threatened species habitat is likely to be limited.

The route intersects 4 km Black Range Dyke Section. This site is listed on the Register of the National Estate for its heritage significance.

The entire length of Route 1 is subject to Native Title claims by one Aboriginal group (*Kariyarra* People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through six registered Aboriginal sites which will require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act (AHA) 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey,

including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.2 Route 2 – OPTION_B_WA_002_FULL (Figure 17)

Figure 17 Oblique view of Route 2 – OPTION_B_WA_002_FULL

The total length of the route is 295 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (196.1 km). The remainder of the route traverses reserve land (90.4 km), freehold land (1.8 km) and road reserve (0.5 km). The route deviates from the easement to avoid the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 2.

Route 2 passes through seven Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 2 passes through the following:

- A Schedule 1 area (18 km);
- Seven DIA Aboriginal sites and Native Title claim area of the *Kariyarra* People, *Palyku and Nyiyaparli*; and

- Seven Priority 4 threatened fauna species including birds and mammals, listed in the DEC database are within 2 km from the route, and two Priority 4 threatened fauna species (birds) listed in the DEC database are within 1 km from the route.

Table 17: General Description of Route 2 – Option_B_WA_002_FULL

Within and adjacent to Route	Description
Total Route length	295 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 7 Aboriginal sites Dambara Yambara (approx. 10km) Kulkakutjarra pool. (approx. 5km) Turner river (Tjirrlil) (approx. 3km) Yule river (Kakurka) (approx. 1km) Redmont access 1 (approx. 1km) White springs (mrd) 06 (approx. 1km) Tjilling creek (approx 2km)
Aboriginal Communities	The route is approximately 3.3 km from the nearest Aboriginal community (Abydos Woodstock Group)
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5 km of the route
Aesthetics/Homesteads	Two homesteads (Indee and Hillside Outcamp)are within 5 km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 8.9 km from the route
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is ~8.9 km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (18 km) No Threatened Ecological Community (TEC) within 1 km of

Within and adjacent to Route	Description
	the route
Land Tenure	Intersects the following State Agreement: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (25 km)
Land Use	• Freehold Land (1.8 km) • Leasehold Land (196.1 km) • Reserve (90.4 km) • Road Reserve (0.5 km) • Vacant crown Land (7.2 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Christmas Creek • Cutinduna Creek • Gillam Creek • Western Shaw River
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD It also intersects with exploration licences, miscellaneous licences and general purpose leases
Road	The route intersects with the Great Northern Highway at three points
Rail	The route intersects with the FMG and BHP rail lines
Pipeline	The route intersects with one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified threatened species and 11 migratory species that may occur within the Route 2 area. The threatened, migratory and listed species identified in the Route 2 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 2 is the sixth longest of the routes with a footprint of 295 km and therefore has a smaller disturbance footprint than Routes 1, 3, 4, 5 and 6.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and seven threatened fauna are within 2 km of the route. Two bird species listed as DEC priorities are within 1 km of the route. However, the majority of the route has been previously disturbed; therefore additional disturbance to threatened species habitat is likely to be limited.

The entire length of Route 2 is subject to Native Title claims by one Aboriginal group (*Kariyarra* People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through seven registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.3 Route 3 –OPTION_C_WA_002_FULL (Figure 18)

Figure 18 Oblique view of Route 3 – OPTION_C_WA_002_FULL

The total length of the route is 300 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (197 km). The remainder of the route traverses reserve land (101 km), freehold land (0.08 km) road reserve (0.5 km) and vacant crown land (2 km). The route deviates from the easement to avoid the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 3.

Route 3 passes through seven Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 3 passes through the following:

- A Schedule 1 area (22 km);
- The Black Range Dyke Section (4 km). This site is listed on the Register of the National Estate for its heritage significance;
- Six DIA Aboriginal sites and Native Title claim areas of the, *Kariyarra* People, *Palyku and Nyiyaparli*; and

- Eight Priority 4 threatened fauna species including birds and four endangered mammals, listed in the DEC database are within 2 km from the route, and four Priority 4 threatened fauna species including birds and two endangered mammals, listed in the DEC database are within 1 km from the route.

Table 18: General Description of Route 3 – OPTION_C_WA_002_FULL

Within and adjacent to Route	Description
Total Route length	300 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 6 Aboriginal sites Port Hedland-white sprgs 05 (approx. 2km) Djindara Talu (approx. 2km) Kulkakutjarra pool. (approx. 7km) Turner river (Tjirrlil) (approx. 1km) Yule river (Kakurka) (approx. 1km) Redmont access 1 (approx. 1km) Route 3 passes through the Black Range Dyke Section (4 km) listed on the Register of the National Estate
Aboriginal Communities	The route is approximately 3.4 km from the nearest Aboriginal community (Abydos Woodstock Group)
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5 km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 6.2 km from the route
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is 6.2 km from the route
Direct disturbance to other areas of	Intersects a Schedule 1 area (22 km)

Within and adjacent to Route	Description
conservation significance.	No Threaten Ecological Community (TEC) within 1 km of the route
Land Tenure	Intersects the following State Agreement: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (27 km)
Land Use	• Freehold Land (0.08 km) • Leasehold Land (197 km) • Reserve (101 km) • Road Reserve (0.5 km) • Vacant crown Land (2 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Garden Creek • Christmas Creek • Cutinduna Creek • Yule River • Western Shaw River
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD It also intersects with exploration licences, miscellaneous licences and general purpose leases
Road	The route intersects with the Great Northern Highway at three points
Rail	The route intersects with the FMG and BHP rail lines
Pipeline	The route intersects with two pipelines. • Epic Energy (WA) One Pty Ltd

Within and adjacent to Route	Description
	• Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified 6 threatened species and 11 migratory species that may occur within the Route 3 area. The threatened, migratory and listed species identified in the Route 3 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 3 is the second longest of the routes with a footprint of 300 km and has a larger disturbance footprint than all the routes except Route 5.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and eight threatened fauna (including endangered mammal species) are within 2 km of the route. Two bird and two endangered mammal species listed as DEC priorities are within 1 km of the route.

The route intersects 4 km of the Black Range Dyke Section. This site is listed on the Register of the National Estate for its heritage significance.

The entire length of route 3 is subject to Native Title claims by one Aboriginal group (*Njamal* and *Palyku* People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through six registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.4 Route 4 – OPTION_D_WA_002_FULL (Figure 19)

Figure 19 Oblique view of Route 4 – OPTION_D_WA_002_FULL

The total length of the route is 298 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (208 km). The remainder of the route traverses reserve land (68 km), freehold land (1.1 km) and road reserve (21.7 km). The route intersects the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 4.

Route 4 passes through seven Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 4 passes through the following:

- A Schedule 1 area (19 km);
- The Black Range Dyke Section (4 km) and Abydos-Woodstock Art Sites (21 km). These sites are listed on the Register of the National Estate for its heritage significance;
- Seven DIA Aboriginal sites and Native Title claim area of *Kariyarra* People, *Palyku and Nyiyaparli*; and

- Eleven Priority 4 threatened fauna species including birds and mammals, listed in the DEC database are within 2 km from the route, and four Priority 4 threatened fauna species including birds, listed in the DEC database are within 1 km from the route.

Table 19: General Description of Route 4 – OPTION_D_WA_002_FULL

Within and adjacent to Route	Description
Total Route length	298 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 7 Aboriginal sites Dambara Yambara (approx. 11km) Kulkakutjarra pool (approx. 6km) Turner river (Tjirrlil) (approx. 1km) Yule river (Kakurka) (approx. 1km) Coonarrie creek mrd 1 (approx. 1km) Cunmagunna valley (approx.1km) Tjilling creek (approx. 2km) Route 4 passes through the Black Range Dyke Section (4 km) and Abydos-Woodstock Art Sites (21 km) listed on the Register of the National Estate
Aboriginal Communities	The route is approximately 3.3 km from the nearest Aboriginal community (Abydos Woodstock Group a point location with the reserve)
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5 km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 6.2 km from the route

Within and adjacent to Route	Description
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is 6.2 km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (19 km) No Threaten Ecological Community (TEC) within 1 km of the route
Land Tenure	Intersects the following State Agreement: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (27 km)
Land Use	• Freehold Land (1.1 km) • Leasehold Land (208 km) • Reserve (68 km) • Road Reserve (21.7 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Garden Creek • Christmas Creek • Cutinduna Creek • Gillam Creek • Yule River • Western Shaw River
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD It also intersects with exploration licences, miscellaneous licences and general purpose leases
Road	The route intersects with the Great Northern Highway at one point

Within and adjacent to Route	Description
Rail	The route intersects with the FMG and BHP rail lines
Pipeline	The route intersects with one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified 6 threatened species and 11 migratory species that may occur within the Route 4 area. The threatened, migratory and listed species identified in the Route 4 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 4 is the fourth longest of the routes with a footprint of 298 km and has a larger disturbance footprint than Routes 1, 2, 7 and 8.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and eleven threatened fauna are within 2 km of the route. Four bird species listed as DEC priorities are within 1 km of the route. However, the majority of the route has been previously disturbed; therefore additional disturbance to threatened species habitat is likely to be limited.

The route intersects 4 km of the Black Range Dyke Section and 21 km Abydos-Woodstock Art Sites. These sites are listed on the Register of the National Estate for its heritage significance. Abydos-Woodstock Art Sites was originally considered a fatal flaw in the specialist workshop undertaken by RHIO and WorleyParsons. However due to precinct being set with other infrastructure in the area and due to the Yandeyarra reserve (also an aboriginal reserve) on the western side of Abydos-Woodstock, it was included as a potential route albeit highly socially constrained.

The entire length of Route 4 is subject to Native Title claims by one Aboriginal group (*Palyku* People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through seven registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.5 Route 5 – OPTION_E_WA_002_FULL (Figure 20)

Figure 20 Oblique view of Route 5 – OPTION_E_WA_002_FULL

The total length of the route is 303 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (211.6 km). The remainder of the route traverses reserve land (44.2 km), freehold land (47 km) and road reserve (0.3 km). The route intersects the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 5.

Route 5 passes through seven Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 5 passes through the following:

- A Schedule 1 area (22 km);
- The Black Range Dyke Section (4 km) and Abydos-Woodstock Art Sites (43 km). These sites are listed on the Register of the National Estate for its heritage significance;
- Seven DIA Aboriginal sites and Native Title claim areas of the *Kariyarra* People, *Palyku and Nyiyaparli*; and
- Thirty six Priority 4 threatened fauna species including birds and eleven vulnerable mammals species, listed in the DEC database are within 2 km from the route, and four Priority 4

threatened fauna species including birds and eleven vulnerable mammals species, listed in the DEC database are within 1 km from the route.

Table 20: General Description of Route 5 – OPTION_E_WA_002_FULL

Within and adjacent to Route	Description
Total Route length	303 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 7 Aboriginal sites Kartangku Talu (approx. 11km) Dambara Yambara (approx. 10km) Kulkakutjarra pool. (approx. 2km) Turner river (Tjirrlil) (approx. 4km) Mingkanya pool (approx. 1km) Coonarrie creek (approx. 1km) Tjilling creek (approx.11km) Route 5 passes through the Black Range Dyke Section (4 km) and Abydos-Woodstock Art Sites (43 km) listed on the Register of the National Estate
Aboriginal Communities	The Route is 2.7 km from the Mumbultjari Group and approximately 3.5 km from the Abydos Woodstock Group
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5 km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 6.2 km from the route
Important Wetlands	The closest important wetland to the route is Fortescue

Within and adjacent to Route	Description
	Marshes which is 6.2 km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (22 km) No Threaten Ecological Community (TEC) within 1 km of the route
Land Tenure	Intersects the following State Agreement: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (27 km)
Land Use	• Freehold Land (47 km) • Leasehold Land (211.6 km) • Reserve (44.2 km) • Road Reserve (0.3 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Garden Creek • Christmas Creek • Cutinduna Creek • Gillam Creek • Yule River • Western Shaw River
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD It also intersects with exploration licences, miscellaneous licences and general purpose leases
Road	The route intersects with the Great Northern Highway at one point
Rail	The route intersects with the FGM and BHP rail lines

Within and adjacent to Route	Description
Pipeline	The route intersects with the one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified 6 threatened species and 11 migratory species that may occur within the Route 5 area. The threatened, migratory and listed species identified in the Route 5 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 5 is the longest of the routes with a footprint of 303 km and has a large disturbance footprint. Impacts would be reduced by generally limiting the footprint to previously disturbed areas.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and thirty six threatened fauna (including 11 vulnerable mammal species) are within 2 km of the route. Three bird species and one vulnerable mammal species listed as DEC priorities are within 1 km of the route. However, the majority of the route has been previously disturbed; therefore additional disturbance to threatened species habitat is likely to be limited.

The route intersects 4 km of the Black Range Dyke Section and 43 km Abydos-Woodstock Art Sites. These sites are listed on the Register of the National Estate for its heritage significance.

The entire length of Route 1 is subject to Native Title claims by one Aboriginal group (*Palyku* People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through seven registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.6 Route 6 – PFS_RH_PH_WA_002 (Figure 21)

Figure 21 Oblique view of Route 6 – PFS_RH_PH_WA_002

The total length of the route is 299 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (208 km). The remainder of the route traverses reserve land (89.4 km), freehold land (1.6 km) and road reserve (0.4 km) and vacant crown land (2 km). The route deviates from the easement to avoid the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 6.

Route 6 passes through six Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 6 passes through the following:

- A Schedule 1 area (19 km);
- The Black Range Dyke Section (4 km). This site is listed on the Register of the National Estate for its heritage significance;
- Six DIA Aboriginal sites and Native Title claim areas of the *Kariyarra* People, *Palyku and Nyiyaparli*; and

- Six Priority 4 threatened fauna species including birds and mammals species, listed in the DEC database are within 2 km from the route, and two Priority 4 threatened fauna species including birds, listed in the DEC database are within 1 km from the route.

Table 21: General Description of Route 6 – PFS_RH_PH_WA_002

Within and adjacent to Route	Description
Total Route length	299 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 6 Aboriginal sites Dambara Yambara (approx. 10km) Kulkakutjarra pool. (approx. 6km) Turner river (Tjirrlil) (approx. 1km) Yule river (Kakurka) (approx. 1km) Redmont access 1 (approx. 1km) Tjilling creek (approx. 2km) Route 6 passes through the Black Range Dyke Section (4 km) listed on the Register of the National Estate
Aboriginal Communities	The route is approximately 3.5 km from the nearest Aboriginal community (Abydos Woodstock Group)
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5 km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5 km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 6.2 km from the route
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is 6.2 km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (19 km) No Threaten Ecological Community (TEC) within 1 km of the

Within and adjacent to Route	Description
	route
Land Tenure	Intersects the following State Agreement: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (26 km)
Land Use	• Freehold Land (1.6 km) • Leasehold Land (208 km) • Reserve (89.4 km) • Road Reserve (0.4 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Garden Creek • Christmas Creek • Cutinduna Creek • Gillam Creek • Yule River • Western Shaw River
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD It also intersects with exploration licences, miscellaneous licences and general purpose leases
Road	The route intersects with the Great Northern Highway at three points
Rail	The route intersects with the FGM and BHP rail lines
Pipeline	The route intersects with the one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified 6 threatened species and 11 migratory species that may occur within the Route 6 area. The threatened, migratory and listed species identified in the Route 6 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 6 is the third longest of the routes with a footprint of 299 km and has a larger disturbance footprint than all the routes except Route 3 and 5. Impacts would be reduced by generally limiting the footprint to previously disturbed areas.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and six threatened fauna are within 2 km of the route. Two bird species listed as DEC priorities are within 1 km of the route. However, the majority of the route has been previously disturbed; therefore additional disturbance to threatened species habitat is likely to be limited.

The route intersects 4 km of the Black Range Dyke Section. This site is listed on the Register of the National Estate for its heritage significance.

The entire length of Route 1 is subject to Native Title claims by two Aboriginal groups (*Palyku* and Nyiyaparli People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through six registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.7 Route 7 – PRE_DFS_RH_PH_002_T_06 (Figure 22)

Figure 22 Oblique view of Route 7 – PRE_DFS_RH_PH_002_T_06

The total length of the route is 271 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (214 km). The remainder of the route traverses reserve land (25.5 km), freehold land (21.7 km), road reserve (0.8 km) and vacant crown land (9.2 km). The route intersects the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 7.

Route 7 passes through six Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 7 passes through the following:

- A Schedule 1 area (26 km);
- The Black Range Dyke Section (6 km) and Abydos-Woodstock Art Sites (20 km). These sites are listed on the Register of the National Estate for its heritage significance;
- Six DIA Aboriginal sites and Native Title claim areas of the *Kariyarra* People, *Palyku, Nyiyaparli and Njamal*; and

- Sixteen Priority 4 threatened fauna species including birds and mammals species, listed in the DEC database are within 2 km from the route, and six Priority 4 threatened fauna species including birds species, listed in the DEC database are within 1 km from the route.

Table 22: General Description of Route 7 – PRE_DFS_RH_PH_002_T_06

Within and adjacent to Route	Description
Total Route length	271 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 6 Aboriginal sites Wilgie Talu (approx 1km) Route 7 passes through the Black Range Dyke Section (6 km) and Abydos-Woodstock Art Sites (20 km) listed on the Register of the National Estate
Aboriginal Communities	They is no Aboriginal community within 10 km of this route
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli • Njamal
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5 km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 7.3 km from the route
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is over 5 km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (26 km) No Threaten Ecological Community (TEC) within 1 km of the route
Land Tenure	Intersects the following State Agreements: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (24 km)

Within and adjacent to Route	Description
	• IRON ORE (MOUNT GOLDSWORTHY) AGREEMENT ACT 1964 (8 km)
Land Use	• Freehold Land (21.7 km) • Leasehold Land (214 km) • Reserve (25.5 km) • Road Reserve (0.8 km) • Vacant crown Land (9.2 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Haunted Hole Creek • Big Creek • Garden Creek • Christmas Creek • Cutinduna Creek • Chinnamon Creek • Gillam Creek • Houston Creek • Tambourah Creek • Turner River • Western Shaw River
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • ELAZAC MINING PTY LTD • VAN UDEN, JOHANNES THEODORUS • BGC CONTRACTING PTY LTD • BHP BILLITON MINERALS PTY LTD (MINERAL LEASE S.A) It also intersects with exploration licences, miscellaneous

Within and adjacent to Route	Description
	licences, and prospecting licences
Road	The route intersects with the Great Northern Highway at one point
Rail	The route intersects with the FGM and BHP rail lines
Pipeline	The route intersects with the one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified 6 threatened species and 11 migratory species that may occur within the Route 7 area. The threatened, migratory and listed species identified in the Route 7 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 7 is the shortest of the routes and has the smallest disturbance footprint. However, impacts can further be reduced by generally limiting the footprint to previously disturbed areas.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and sixteen threatened fauna are within 2 km of the route. Six bird species listed as DEC priorities are within 1 km of the route. However, the majority of the route has been previously disturbed; additional disturbance to threatened species habitat is likely to be limited.

The route intersects 6 km of the Black Range Dyke Section and 20 km Abydos-Woodstock Art Sites. These sites are listed on the Register of the National Estate for its heritage significance.

The entire length of Route 7 is subject to Native Title claims by one Aboriginal group (Nyiyaparli People). Negotiations with the Native Title claimants will be required prior to detailed design and construction activities. The route also passes through six registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route. Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.2.8 Route 8 – PRE_DFS_RH_PH_004_U_06 (Figure 23)

Figure 23 Oblique view of Route 8 – PRE_DFS_RH_PH_004_U_06

The total length of the route is 280 km and it passes through the Shire of East Pilbara and the Town of Port Hedland. The route mainly traverses crown leasehold land (239.1 km). The remainder of the route traverses reserve land (3.7 km), freehold land (0.5 km), road reserve (0.1 km) and vacant crown land (36.6 km). The route intersects the Abydos-Woodstock Art Site listed on the Register of the National Estate and therefore under Commonwealth Protection. There was no risk of ASS identified in areas intersected by Route 8.

Route 8 passes through six Department of Indigenous Affairs (DIA) listed Aboriginal sites including mythological, ceremonial, art and engraving sites.

Route 8 passes through the following:

- A Schedule 1 area (57 km);
- The Black Range Dyke Section (7 km). These sites are listed on the Register of the National Estate for its heritage significance;
- Six DIA Aboriginal sites and Native Title claim areas of the *Kariyarra* People, *Palyku, Nyiyaparli and Njamal*; and

- Five Priority 4 threatened fauna species including birds species, listed in the DEC database are within 2 km from the route. No threatened fauna species listed in the DEC database are within 1 km from the route.

Table 23: General Description of Route 8 – PRE_DFS_RH_PH_004_U_06

Within and adjacent to Route	Description
Total Route length	280 km
Indigenous and Cultural Heritage *Includes European heritage*	Passes through 6 Aboriginal sites Turner river (Tjirrlil) (approx. 2km) Hillside 9 (approx. 1km) Soanville (approx. 1km) Abydos Station (approx. 1km) Tjilling creek (approx. 8km) Route 8 passes through the Black Range Dyke Section (7 km) listed on the Register of the National Estate
Aboriginal Communities	The route is approximately 3.5km from the nearest Aboriginal community (Abydos Woodstock Group)
Native Title *Native Title claims along Route length.*	• Kariyarra People • Palyku • Nyiyaparli • Njamal
Local Government Areas	• Shire of East Pilbara • Town of Port Hedland
Environmentally Sensitive Area	No ESA within 5km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of a homestead
Important Bird Areas	The Fortescue Marshes is approximately 6.2km from the route
Important Wetlands	The closest important wetland to the route is Fortescue Marshes which is 6.2km from the route
Direct disturbance to other areas of conservation significance.	Intersects a Schedule 1 area (57 km) No Threaten Ecological Community (TEC) within 1 km of the

Within and adjacent to Route	Description
	route
Land Tenure	Intersects the following State Agreements: • IRON ORE (*FMG CHICHESTER PTY LTD) AGREEMENT ACT 2006* (26 km) • IRON ORE (*MOUNT GOLDSWORTHY) AGREEMENT ACT 1964* (5 km)
Land Use	• Freehold Land (0.1 km) • Leasehold Land (239.1 km) • Reserve (3.7 km) • Road Reserve (0.5 km) • Vacant crown Land (36.6 km)
Rivers and Creeks	The following rivers and creeks are within 500 m of the route: • Pilgangoora Creek • Paddy Market Creek • Big Creek • Garden Creek • Christmas Creek • Tambina Creek • Cutinduna Creek • Tambourah Creek
Mining Activities	Intersects the following mining lease: • FMG CHICHESTER PTY LTD • ROY HILL IRON ORE PTY LTD • DOMAIN MINING PTY LTD • ELAZAC MINING PTY LTD • VAN UDEN, JOHANNES THEODORUS • CYCLONE RESOURCES PTY LTD • MONEY, JOHN ROBERT VENN

Within and adjacent to Route	Description
	• BHP BILLITON MINERALS PTY LTD (MINERAL LEASE S.A) It also intersects with exploration licences, miscellaneous licences, and prospecting licences
Road	The route intersects with the Great Northern Highway at one point
Rail	The route intersects with the FGM and BHP rail lines
Pipeline	The route intersects with the one pipeline. • Epic Energy (Pilbara Pipeline) Pty Ltd

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

A search of the *EPBC Act* database identified 6 threatened species and 11 migratory species that may occur within the Route 8 area. The threatened, migratory and listed species identified in the Route 8 area are the same as those in the Route 1 area (Section 4.2.1).

POTENTIAL IMPACTS

Route 8 is the second shortest of the routes and has the smallest disturbance footprint than all the routes except Route 7. Impacts can further be reduced by generally limiting the footprint to previously disturbed areas.

The rail route passes through a Schedule 1 area. Several Commonwealth listed threatened species are likely to occur in the area and five threatened fauna are within 2 km of the route. However, the majority of the route has been previously disturbed; therefore additional disturbance to threatened species habitat is likely to be limited.

The route intersects 7 km of the Black Range Dyke Section. These sites are listed on the Register of the National Estate for its heritage significance.

The entire length of Route 8 is subject to Native Title claims by one Aboriginal group (Nyiyaparli People). Negotiations with the Native Title claimants would be required prior to detailed design and construction activities. The route also passes through six registered Aboriginal sites therefore they require assessment against the terms of Section 39(2) of the *Aboriginal Heritage Act 1972* in regard to their importance and significance. An on-ground Indigenous archaeology and ethnography survey, including consultation with local Indigenous groups would be required for these sites along this route.

Dependent on the outcomes of such a survey, an application to use the land under Section 18 of the *Aboriginal Heritage Act 1972* for some or all of the sites will be required.

4.3 Round 2 – Discussion

Round 2 has provided an overview of identified and known values including environmental, social and engineering constraints for each route. The routes generally follow the same corridor, however the exact length of the routes differ.

It is not feasible to qualify the 'best route' from this process. The purpose of Round Two is to provide RHIO with identified environmental and social values of each route, to assist in the overall assessment process. Stakeholder input is recommended, as is traditionally associated with an MCA approach, together with the collation and application of more refined data in subsequent phases of this route selection process. A more detailed assessment is required to confirm the technical and financial viability of each of the routes.

Key constraints identified for each route are detailed below:

Route 1 – OPTION-A-WA-002-Full

- Six Department of Indigenous Affairs listed Aboriginal sites;
- Three Native Title Claim;
- Nineteen kilometres of a Schedule One area;
- Four kilometres of the Black Range Dyke Section;
- Six threatened species identified in the EBPC search;
- Five species of threatened fauna species are within 2 km of the route;
- Two bird species listed as DEC priorities are within 1 km of the route; and
- The route crosses eight rivers and creeks, three roads and one pipeline.

Route 2 – OPTION_B_WA_002_FULL

- Seven Department of Indigenous Affairs listed Aboriginal sites;
- Three Native Title Claim;
- Eighteen kilometres of a Schedule One area;
- Six threatened species identified in the EBPC search;
- Five species of threatened fauna species are within 2 km of the route;
- Two bird species listed as DEC priorities are within 1 km of the route; and

- The route crosses three roads and one pipeline.

Route 3 – OPTION_C_WA_002_FULL

- Six Department of Indigenous Affairs listed Aboriginal sites;
- Three Native Title Claims;
- Twenty two kilometres of a Schedule One area;
- Four kilometres of the Black Range Dyke Section;
- Six threatened species identified in the EBPC search;
- Five species of threatened fauna species are within 2 km of the route;
- Two bird species listed as DEC priorities are within 1 km of the route; and
- The route crosses seven rivers and creeks, three roads and two pipelines.

Route 4 – OPTION_D_WA_002_FULL

- Seven Department of Indigenous Affairs listed Aboriginal sites;
- Three Native Title Claim;
- Nineteen kilometres of a Schedule One area;
- Four kilometres of the Black Range Dyke Section and Abydos-Woodstock Art Sites (21 km);
- Six threatened species within 2 km identified in the EBPC search;
- Eleven species of threatened fauna species are within 2 km and four bird species listed as DEC priorities are within 1 km of the route; and
- The route crosses eight rivers and creeks, one roads and one pipeline.

Route 5 – OPTION_E_WA_002_FULL

- Seven Department of Indigenous Affairs listed Aboriginal sites;
- Three Native Title Claim;
- Twenty two kilometres of a Schedule One area;
- Four kilometres of the Black Range Dyke Section and Abydos-Woodstock Art Sites (43 km);
- Six threatened species within 2 km identified in the EBPC search;
- Thirty-six species of threatened fauna species are within 2 km and one mammal species and three bird species listed as DEC priorities are within 1 km of the route; and
- The route crosses eight rivers and creeks, one roads and one pipeline.

Route 6 – PFS_RH_PH_WA_002

- Six Department of Indigenous Affairs listed Aboriginal sites;
- Three Native Title Claims;
- Nineteen kilometres of a Schedule One area;
- Four kilometres of the Black Range Dyke Section;
- Six threatened species within 2 km identified in the EBPC search;
- Six species of threatened fauna species are within 2 km and two bird species listed as DEC priorities are within 1 km of the route; and
- The route crosses eight rivers and creeks, three roads and one pipeline.

Route 7 – PRE_DFS_RH_PH_002_T_06

- Six Department of Indigenous Affairs listed Aboriginal sites;
- Four Native Title Claim;
- Twenty six kilometres of a Schedule One area;
- Six kilometres of the Black Range Dyke Section and Abydos-Woodstock Art Sites (20 km);
- Six threatened species within 2 km identified in the EBPC search;
- Sixteen species of threatened fauna species are within 2 km and six bird species listed as DEC priorities are within 1 km of the route; and
- The route crosses eleven rivers and creeks, one roads and one pipeline.

Route 8 – PRE_DFS_RH_PH_004_U_06

- Six Department of Indigenous Affairs listed Aboriginal sites
- Four Native Title Claim;
- Fifty seven kilometres of a Schedule One area;
- Seven kilometres of the Black Range Dyke Section;
- Six threatened species within 2 km identified in the EBPC search;
- Five species of threatened fauna species listed as DEC priorities are within 2 km of the route; and
- The route crosses eight rivers and creeks, one roads and one pipeline

5. ROUND 3 – SUITABILITY INDEX

Round 3 assesses the financial feasibility against the route constraints identified in Round 1 and Round 2.

For this Round a Concordance Analysis was used. Concordance Analysis is a pair-wise comparison technique. It can be applied to mixed qualitative and quantitative data as it does not work directly with scores but with weights, allowing mathematical operations (Buchanan; Vanderpooten 2007; Isac; Durac 2007).

Concordance Analysis is a three stage process in which criteria/alternatives are first presented in the Effects Matrix. The second stage (Concordance Matrix) involves comparing scores (the pair-wise analysis) between two alternatives across the full range of criteria, for all combinations of pairs. The third stage is preparation of a Dominance Matrix which identifies which alternatives dominate for which criteria. The dominant alternatives are summed to produce a final ranking and compared to CAPEX for an overall suitability index.

5.1 Effects Matrix

In order to permit meaningful comparison and ranking of routes, it is necessary to use assessment criteria which will not only allow consideration of an appropriate range of issues, but it will also allow differentiation between routes.

The Effects Matrix is a common element of all assessment methods. It sets out the routes and criteria against which they will be judged.

Once assessment criteria have been determined, scores are assigned. This could be quantitative data (mangroves along an alignment, calculated by GIS), or qualitative data (acid sulphate soil risk, rated on a scale of 0 to 5). When completed, the Effects Matrix forms the basis for ranking assessment.

Table 24 identifies delineated values from the available data. These values are the fundamental values used to rank the routes.

Table 24 RHIO Route Selection – Effects matrix

	Fill	Cut	Borrow	Dump	Paving	Mass Haul	Wall	Culvert	Bridge	Tunnel	Footprint Area	Length	Indigenous sites	Indigenous communities	Native Title Claimants	ESA	Homestead within 5km	Schedule 1 area	State agreement	River Crossings	Mining lease intersects	Great Northern Hwy Intersects	FMG/BHP intersects	Pipeline intersects
	(m3)	(m3)	(m3)	(m3)	(m3)	(m3 km)	(m2)	(m)	(m)	(m)	(m2)	km	#	km	#	#	#	km	#	#	#	#	#	#
Route 1.	5657092	5246204	1749969	1685957	621725	23330722	0	13607	1565	0	5828032	297	6	3.5	3	0	1	19	1	8	3	3	2	1
Route 2.	8478161	6647807	3373006	2044468	618636	41451341	0	13413	1414	0	6298181	295	7	3.3	3	0	2	18	1	6	3	3	2	1
Route 3.	6107685	5352332	2045053	1696303	628475	26442755	0	13282	1214	0	5985805	300	6	3.4	3	0	1	22	1	7	3	3	2	2
Route 4.	6060851	4919475	2498816	1711560	624122	20609272	0	14363	1627	0	5874629	298	7	3.3	3	0	1	22	1	8	3	1	2	1
Route 5.	6348980	5633512	2233671	1906368	633848	27093715	0	12787	1264	0	6104188	303	7	2.7	3	0	1	22	1	8	3	1	2	1
Route 6.	5762388	5343910	1875908	1825960	625480	24274241	0	14015	1564	0	5891971	299	6	3.5	3	0	1	19	1	8	3	3	2	1
Route 7.	7034184	5827623	2256726	1500141	568375	29148583	872	15764	457	0	5761517	271	6	10	4	0	1	26	2	11	6	1	2	1
Route 8.	11210515	9197633	3299899	1982541	585035	129819574	22234	14896	1486	2304	6515837	280	6	3.5	4	0	1	57	3	8	8	1	1	1

5.2 Concordance Matrix

The concordance matrix compares all routes with each other ({n(n - 1)/2 }). Two possible outcomes of each pairwise comparison are possible. Comparing route *x* and route *y* on attribute *j*, then one of the following may exist:

Route *x* is preferred to *y* (*x* > *y*)

Route *x* inferior to *y* (*x* < *y*)

Each pairwise comparison will have a concordance index which can be summarised in a concordance matrix (Table 25). The concordance index is derived by summing the weights associated with the various attributes of the effects matrix[6].

Table 25 Concordance Matrix

	Route 1.	Route 2.	Route 3.	Route 4.	Route 5.	Route 6.	Route 7.	Route 8.
Route 1.	X	0.29	0.17	0.17	0.17	0.04	0.25	0.21
Route 2.	0.71	X	0.42	0.33	0.46	0.33	0.50	0.33
Route 3.	0.83	0.58	X	0.42	0.21	0.38	0.33	0.25
Route 4.	0.83	0.67	0.58	X	0.17	0.25	0.29	0.21
Route 5.	0.83	0.54	0.79	0.83	X	0.42	0.25	0.17
Route 6.	0.96	0.67	0.63	0.75	0.58	X	0.29	0.25
Route 7.	0.75	0.50	0.67	0.71	0.75	0.71	X	0.17
Route 8.	0.79	0.67	0.75	0.79	0.83	0.75	0.83	X

5.3 Dominance Matrix

Once the Concordance Matrix is populated, the third matrix is produced – the Dominance Matrix.

Patterns of dominance are identified from the concordance matrix, in the Dominance Matrix, the dominant alternative is given a 1 ranking, the subservient a 0 when compared to a predefined 'threshold'. The threshold is an arbitrary value which can be used to determine the extent of dominance (by counting as dominant only those Concordance Matrix values which exceed the threshold). For this assessment, an alternative is only considered dominant if it dominates an

[6] For this analysis all attributes were considered equal. Weighting have already been undertaken during Round 1 and this Round's intention was to identify a superior route in comparison to its counterparts.

alternative by greater than 80%. Using this threshold, the following pattern of dominance can be identified (detailed in Table 26):

- Route 1 dominates all other routes
- Routes 4, 5 and 7 dominate Routes 2, 3 and 6

Table 26 Dominance Matrix

	Route 1.	Route 2.	Route 3.	Route 4.	Route 5.	Route 6.	Route 7.	Route 8.
Route 1.	X	0	0	0	0	0	0	0
Route 2.	0	X	0	0	0	0	0	0
Route 3.	1	0	X	0	0	0	0	0
Route 4.	1	0	0	X	0	0	0	0
Route 5.	1	0	0	1	X	0	0	0
Route 6.	1	0	0	0	0	X	0	0
Route 7.	0	0	0	0	0	0	X	0
Route 8.	0	0	0	0	1	0	1	X
Sum	**4**	**0**	**0**	**1**	**1**	**0**	**1**	**0**

5.4 Cost Estimates

Cost estimates for each proposed route were based on benchmarking costs built into the pre DFS study. A full breakdown of the costings is detailed in the *Estimate Basis Report* (RH_00-ES-REP-0001REV0).

Full details for the cost estimates for all routes were prepared and are detailed in Appendix D. As with all costs, for this phase of the project, the estimates are accurate to +/- 30%. For ease of reference these values will be referred to as Comparative Cost Estimate (CAPEX).

5.5 Results

The suitability results have been presented for each of the cases as a composite score for all categories. This was based on engineering, environmental, social (Table 26) and financial criteria (Figure 24). CAPEX costs reflect the values in Appendix D.

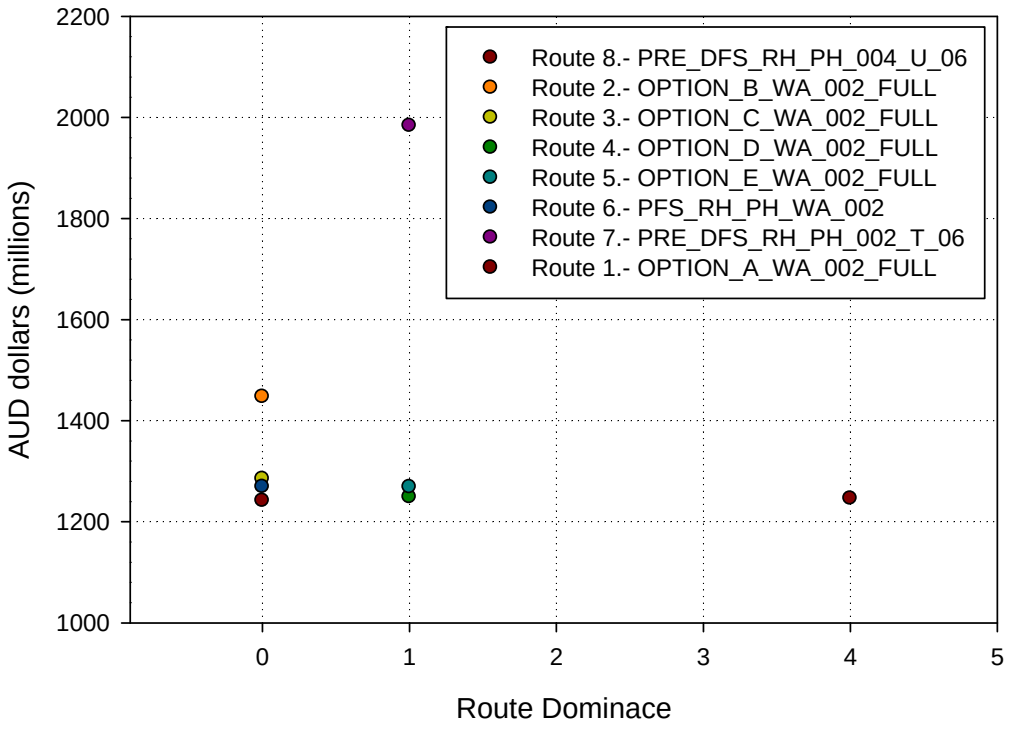

Figure 24 Suitability Index (CAPEX verse route dominance)

A visual depiction identifies the variation between the routes. Numerically, less than 1 billion dollars and 0-4 on the dominance matrix separates the routes. Route 7 was the only route requiring tunnels ($230 million) and required substantial walls in comparison to the other routes and is the reason for the ~1.6 times cost difference to the other routes.

The dominance matrix indicated Route 1 was clearly more dominant than all other routes and is a clear candidate for further investigation.

At the conclusion of Round 3 a sanity check for the outcomes was undertaken to check they make sense and are not accepted purely because the assessment says so. During this assessment it was discovered that Route 6 had been screened out due to its larger construction footprint when compared to Route 1 (as identified in Table 24). Route 6 differed from Route 1 for only 20km of the alignment to avoid a known lease close to the Roy Hill Mine. Based on this analysis Route 6 was considered a better route than Route 1.

Cost aside, Routes 4, 5 and 7 would be suitable candidates as backup routes.

6. DISCUSSION, RECOMMENDATIONS AND LIMITATIONS

This route selection study has undertaken a Multi Criteria Analysis approach that includes the assessment of environmental, social, engineering and economic constraints for a proposed rail route to support the development to mine iron ore from the Roy Hill 1 Iron ore project. The methodology adopted included several distinct phases in the evaluation process with Round 1 screening the region of interest to broadly identify areas of least constraint. In Round 2, a more detailed assessment was carried out to locate specific routes using Quantm whilst avoiding the fatal flaws identified in Round 1. In Round 3, these routes were analysed in three matrixes, namely, effects matrix, concordance matrix and the dominance matrix. These values were then plotted against the respective CAPEX cost to visually depict the relationship between the routes suitability compared to CAPEX.

At the completion of Round 1 screening, broad localities for the sitting of a rail line were identified as being the least constrained areas. The Round 1 results were used as a guide for routes that would offer the least overall constraint.

The Round 2 review identified eight potential rail routes from the Roy Hill 1 mine in the south of port Hedland in the vicinity of Boodarie. The environmental/social values and engineering setting of each route were investigated to determine overall suitability (no financial criteria). A comparison of all routes (Section 4.3) indicated in general all routes had some level of constraint.

Round 3 compared the overall dominance to the comparative CAPEX costs of each route and these results are summarised in Figure 24.

At the conclusion of Round 3 a sanity check for the outcomes was undertaken to check they make sense and are not accepted purely because the assessment says so. During this assessment it was discovered that Route 6 had been screened out due to its larger construction footprint when compared to Route 1. Route 6 differed from Route 1 for only 20km of the alignment to avoid a known lease close to the Roy Hill Mine. Based on this analysis Route 6 was considered a better route than Route 1 (which was screened the dominant route).

Based on the screening level nature of this study, Route 1 was identified as one of highest route suitability with a low comparative CAPEX cost. Based on Routes 6 similarities it is recommended Route 6 be adopted as the preferred location to be used for the future assessments and referral to the EPA.

The analysis assumes similar development concepts for each route. If RHIO elected to conduct more detailed route selection work in the next study phase, it is likely that a more refined technical study of the short listed routes will result in each route having a (slightly) different development concept, to cater for the differences in topography and foundation conditions along each route. However, for this

phase, the key to the analysis was to reveal relative ranking of preferred routes to underpin high level development concept screening work and potentially form the basis of further verification and investigation. Based on the knowledge to date it is recommended Route 1 form the basis of the EPA referral.

Data for the MCA has been sourced through RHIO and from non copyright material freely available on the internet or through libraries. In a similar vein, the assessment and evaluation of the weighting criteria applied to the screening process has been carried out by WorleyParsons and RHIO's engineering, environmental and social personnel. If the rail development concept was to be taken beyond the screening phase, it is recommended that wider and more all encompassing stakeholder input, as is traditionally associated with an MCA approach, together with the collation and application of more refined data, will need to be carried out in subsequent phases of this route selection process.

This report has assessed each route for environmental, social, engineering and financial feasibility. The methodology adopted for this strategy is sufficiently robust to identify potentially viable routes to support concept screening analysis. However, a significantly more detailed assessment is required in order to conclusively confirm the commercial and technical viability of the short listed routes. Such a task is beyond the scope of this report and is not appropriate for the concept screening phase currently undertaken by RHIO.

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Appendix A – Environmental Literature Review

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EcoNomics™

ROY HILL IRON ORE PTY LTD

Roy Hill 1 Iron Ore Project

Rail Desktop Environmental Study

RH-50-EN-REP-0001

17-Dec-08

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PROJECT RH-50-EN-REP-0001 - ROY HILL 1 IRON ORE PROJECT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Issued for use	M White	A. Jacobs	D Kealley	17-Dec-08	N/A	

CONTENTS

Appendices

EXECUTIVE SUMMARY

WorleyParsons Services Pty Ltd has been commissioned by Roy Hill Iron Ore Pty Ltd to complete a Pre-Feasibility Study (PFS) engineering package for a rail alignment for the transport of iron ore from the Roy Hill to Port Hedland.

A desktop environmental assessment was used to identify the various regional issues which may inhibit or delay the project development at a particular geographic location. Land tenure constraints were not within the scope of this work and thus were not assessed. The environmental and social constraints are listed below, in order of perceived relative difficulty in gaining ministerial approval for development:

- Aboriginal heritage sites
- Native title claim
- Nationally threatened species and migratory species
- Surface water drainage

It is recommended that contact is made with the local Aboriginal Communities and Native Title groups to negotiate access for land use.

1. INTRODUCTION

WorleyParsons Services Pty Ltd has been commissioned by Roy Hill Iron Ore Pty Ltd to review options for a rail alignment between their Roy Hill mine to Port Hedland for the export of iron ore. WorleyParsons Services Pty Ltd has conducted a desktop study to identify the environmental and social constraints in the area. As part of the study this literature review provides environmental information on the general area proposed for development. The environmental and social constraints included:

- Environmentally sensitive areas
- Matters of national environmental significance
- Threatened flora, fauna and ecological communities
- Important bird areas
- Mine infrastructure and stakeholders
- Aboriginal heritage
- Surface water

Collation of publicly available reports and databases was undertaken to define the overall environmental, social and engineering characteristics of the region of interest. Principal sources included:

- Commonwealth Department of the Environment, Water, Heritage and the Arts
- Department of Environment and Conservation
- Department of Industry and Resources
- Department of Indigenous Affairs
- Environmental Assessment reports from stakeholders surrounding the project area

The purpose of the desktop study is to identify environmental, social and marine engineering issues which may constitute critical paths in design, delays in government approvals, or represent other general constraints to the execution of the Roy Hill rail. The potential impacts arising from the construction and operations of the new facilities have been assessed in an effort to maximise environmental outcomes.

1.1 Project Background

Roy Hill Iron Ore Pty Ltd (RHIO) proposes to undertake construction of a rail from their Roy Hill mine to a rail loop at Boodarie, Western Australia (Figure 1). The area of investigation covers the RHIO rail corridor in the Pilbara region of Western Australia, from Boodarie in the North to Roy Hill in the South. This investigation is focused on the terrestrial habitats present within the rail corridor with respects to social, heritage and environmental features. The project will result in a large environmental disturbance footprint which will include vegetation clearing, altering creek / river beds and impacts to Aboriginal heritage sites.

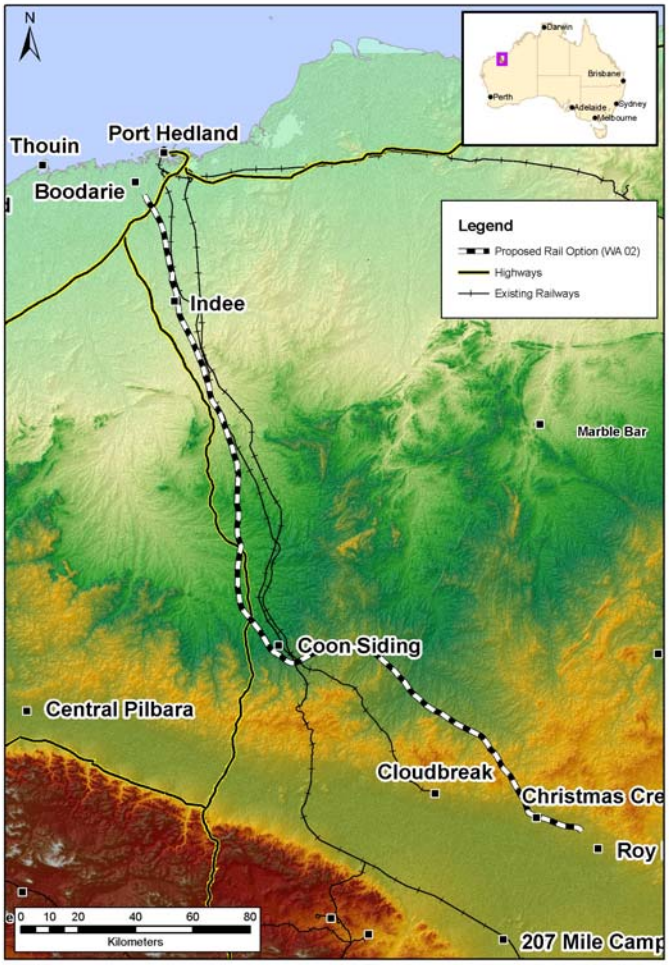

Figure 1 Location of the project area indicating the Roy Hill to Boodarie rail alignment.

2. RELEVANT LEGISLATION AND GOVERNMENT POLICIES

2.1 Commonwealth Legislation and Agreements

A major legislative requirement that may be required for the Project is a referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act requires the approval of the Commonwealth Minister for the Environment, Heritage and the Arts to undertake actions that may have a significant impact on matters of national environmental significance (NES).

The following relevant legislation and agreements may also apply to the proposed works:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Native Title Act 1993*
- *Japan-Australia Migratory Bird Agreement 1974*
- *China-Australia Migratory Bird Agreement 1986*
- *Republic of Korea-Australia Migratory Bird Agreement 2007*

It is important to note that approval under State legislation is also required, in addition to any approvals from the Commonwealth.

2.2 State Legislation

A range of State legislation that relates to the maintenance of ecological integrity and biodiversity conservation in Western Australia's terrestrial environment is applicable to all proposals. Primary among these is the *Environmental Protection Act 1986* (EP Act). The overarching objective of the EP Act is to protect the environment of WA.

The *Wildlife Conservation Act 1950* is another significant piece of legislation, which lists threatened flora and fauna species and threatened ecological communities.

The following relevant legislation and policies may also apply to the proposed works:

- Environmental Protection Regulations 1987
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004
- *Aboriginal Heritage Act 1972* and Regulations 1974

- *Native Title (State Provisions) Act 1999*
- *Dangerous Goods Act 1961* and Regulations 1963
- *Contaminated Sites Act 2003*
- Wildlife Conservation Regulations 1970
- Wildlife Conservation (Rare Flora) Notice 2008
- Wildlife Conservation (Specially Protected Fauna) Notice 2008

2.3 State Policies

The Environment Protection Authority (EPA) has released the following Guidance and Position Statements which offer advice and the overarching principals used to assess proposals:

- EPA Guidance Statement 41: Assessment of Aboriginal heritage.
- EPA Guidance Statement 51: Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia.
- EPA Guidance Statement 54: Consideration of subterranean fauna in groundwater and caves during environmental impact assessment in Western Australia.
- EPA Guidance Statement 55: Implementing best practice in proposals submitted to the environmental impact assessment process.
- EPA Guidance Statement 56: Terrestrial fauna surveys for environmental impact assessment in Western Australia.
- EPA Position Statement 2: Environmental protection of native vegetation in Western Australia.
- EPA Position Statement 3: Terrestrial biological surveys as an element of biodiversity protection.
- EPA Position Statement 8: Environmental protection in natural resource management.
- EPA Position Statement 9: Environmental offsets.

The Department of Environment and Conservation (DEC) have released the following Policy Statements which indicate the overarching principals that are used in order to assess proposals. The following Policy Statements have relevance for the proposed RHIO development:

- DEC Policy Statement 9: Conservation of threatened flora in the wild.
- DEC Policy Statement 33: Conservation of threatened fauna in the wild.

- DEC Policy Statement 50: Setting priorities for the conservation of Western Australia's threatened flora and fauna.

3. ASSESSMENT OF PROJECT BY REGULATORY AUTHORITIES

The EPA can assess proposals which are likely, if implemented, to have a significant effect on the environment. Proposals are defined by EP Act to include a project, plan, programme, policy, operation, undertaking or development or change in land use, or an amendment of any of these things. A critical element of the EP Act provides that the form, content, timing and procedure of any environmental impact assessment is to be determined by the EPA. The EPA's administrative procedures outline a number of different types of formal assessment. There are currently four types of formal assessment [1]:

- Assessment on Referral Information (ARI)
- Environmental Protection Statement (EPS)
- Public Environmental Review (PER)
- Environmental Review and Management Programme (ERMP)

Based on previous experience and a review of similar projects in close proximity to the RHIO rail, WorleyParsons believes the EPA is likely set a level of assessment under Section 40 of the EP Act as Public Environmental Review (PER).

The EPA sets a PER level of assessment for proposals that are of local or regional interest that raise a number of significant environmental factors, some of which are considered complex and require substantial assessment including a formal public review and legally binding conditions of approval.

[1] The Western Australian EPA is currently reviewing this process and is likely to reduce the number of different levels of assessment with the amalgamation of the PER/ERMP levels of assessment.

4. INFORMATION SOURCES

Collation of publicly available reports and databases was undertaken to define the overall environmental, social and engineering characteristics of the region of interest. A review of the approvals process and relevant legislation was also undertaken to determine the constraints.

Information used in the course of the site assessment included spatial data in digital form as well as hardcopy maps and a variety of reports. The sources for the geographical information system (GIS) datasets have been included as Appendix A. Each of the datasets was projected in a GIS format. The principal references included:

- Commonwealth Department of the Environment, Water, Heritage and the Arts
- Department of Environment and Conservation
- Department of Industry and Resources
- Department of Water
- Department of Indigenous Affairs
- CSIRO
- National Native Title Tribunal

4.1 Identification of Evaluation Criteria

Criteria for assessment were identified in the categories of: environmental, social and engineering. A search of government databases for sites that are protected under State and Commonwealth legislation was conducted for the region. A summary of each criterion is provided in Section 5. The evaluation criteria for each category are as follows:

Environmental:

- Climate
- Geology
- Surface water
- Wetlands
- Groundwater
- Environmentally sensitive areas

- Important bird areas
- Flora, fauna and threatened ecological communities as matters of national environmental significance
- Migratory birds of international significance
- DEC listed threatened flora, fauna and threatened ecological communities
- Short range endemic fauna
- Subterranean fauna

Social:

- Local shire
- Surrounding mine infrastructure
- Register of the National Estate (natural and cultural sites – Indigenous and European)
- Listed Aboriginal heritage sites
- Native title
- Aboriginal communities

5. EXISTING ENVIRONMENT AND POTENTIAL CONSTRAINTS

5.1 Climate

The closest weather station to the project area can be found at Port Hedland, located on the Pilbara coast of Western Australia. This data indicates the average conditions to be expected within the region.

5.1.1 Temperature

Port Hedland experiences warm winters and hot summers, with mean maximum temperatures of 36°C in January and 27°C in July and mean minimum temperatures of 26°C in January and 13.1°C in July (BOM 2008). Maximum temperatures in summer are usually moderated by warm, humid sea breezes.

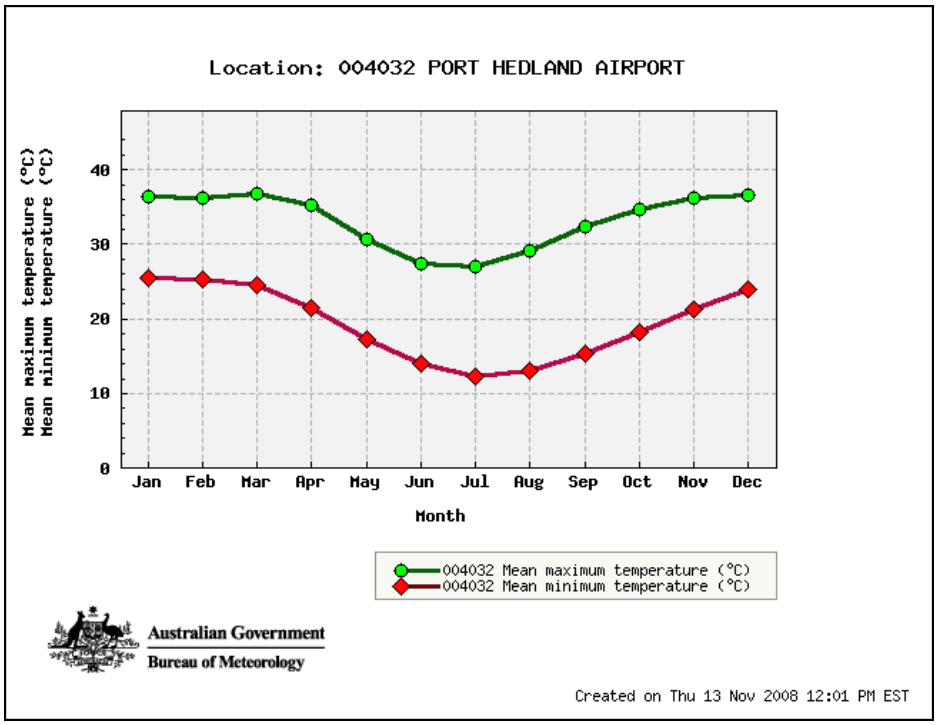

Figure 2 Mean Annual Maximum and Minimum Temperature at Port Hedland

5.1.2 Rainfall

Rainfall is low and variable. The average annual rainfall recorded at Port Hedland Airport from 1942 - 2008 is 312.3 mm; and the mean number of rain days (equal to or more than 1 mm) is 20.5. Most rain is received between January and March. Thunderstorms and tropical cyclones are responsible for most of the summer rainfall and tropical cloud bands cause a secondary peak in monthly rainfall during May. There are 20-30 thunderstorms per annum over most of the area, but closer to the coast there are between 15-20 thunderstorms per annum (BOM 2008). Average rainfall pattern are summarised in Figure 3.

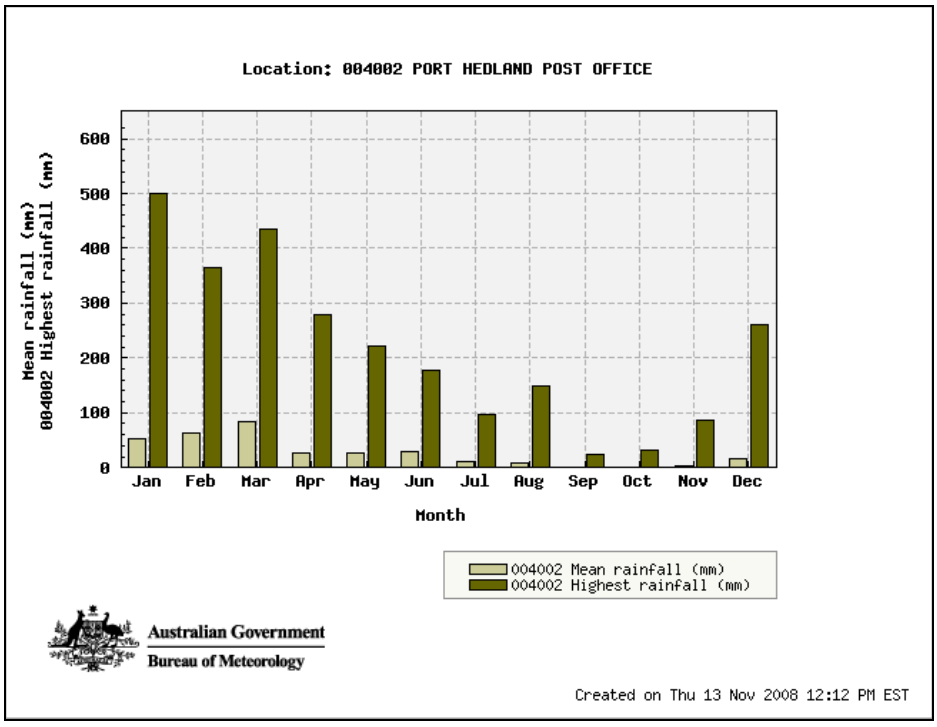

Figure 3 Mean Annual Rainfall Data for Port Hedland

5.1.3 Cyclones/Wind Speed

The stretch of coast between Port Hedland to Exmouth Gulf is the most cyclone-prone area in Australia. The maximum wind speed recorded, at Port Hedland airport between 1954 and 2008, is 208 km/h (reached during a cyclone). The mean annual wind speed over the same period is 17.4 km/h and varies between 14.3 km/h in January to 20.7 km/h in June and July. The average wind speed is 69 km/h and the area falls into building category A (BOM 2008). Therefore construction,

engineering and infrastructure developments in the Port Hedland area need to take into account possible periodic destruction or damage. This may have associated environmental risks. These potential events would need an environmental risk assessment to be conducted and a management plan executed. Cyclones are expected to impact on approximately 10 days per annum of the rail alignment construction and day to day activities.

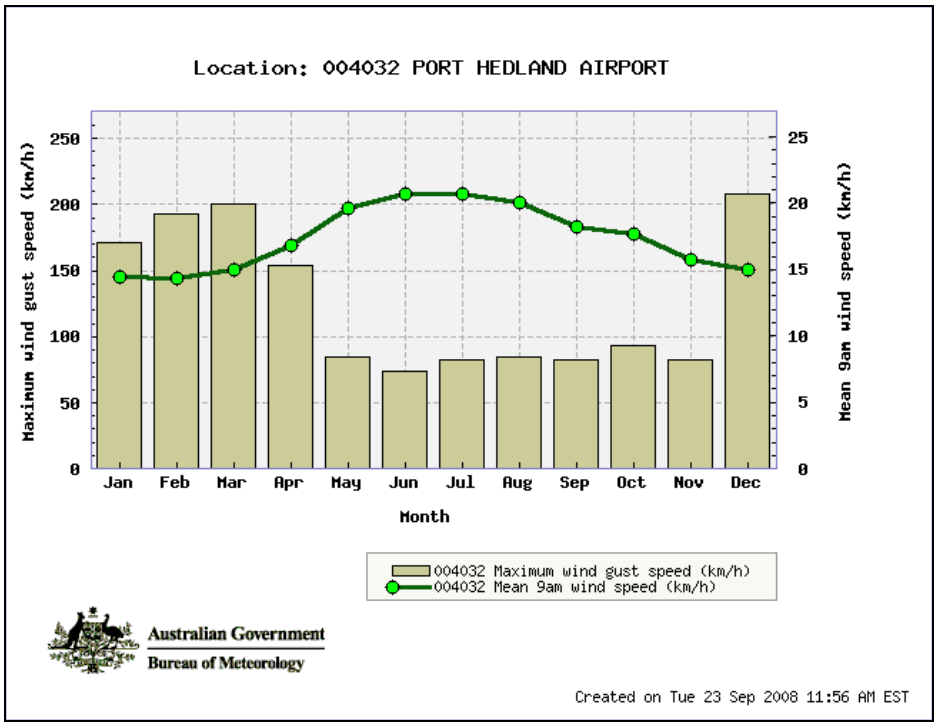

Figure 4 Mean Annual Wind Speed Data for Port Hedland

5.2 Geology

The region may be divided broadly into three physiographic types: low ranges, wide floodplains and a coastal zone. The ranges form part of the Pilbara craton which has been emergent since the Palaeozoic. They comprise the Early Proterozoic - Archaean metasedimentary Hamersley Range in the central Pilbara, reaching around 900 m, with peaks around 1250 m, and the predominantly volcanic Chichester Range to the north, with a more subdued topography of around 600 m (Trendall 1990). These units overlie the Archaean greenstones and granites, which outcrop to the northeast of the region. The regolith comprises a fine red blanket over much of the region, resulting in a very thin vadose zone. The Fortescue and Ashburton Rivers form extensive floodplains, draining either side of the Hamersley Ranges. The Robe, Yule and De Grey Rivers extend as broad deltas from the

highlands toward the Indian Ocean. Several other minor rivers also traverse this path. The coastal zone comprises broad, flat hummock and tussock grasslands, with scattered woodlands, on cracking clays or sandy soils. Minor Tertiary limestone outcrops occur across the plain (Beard 1973, 1998).

5.3 Surface Water

Numerous major drainage lines occur in the area of investigation, with the rail alignment likely to impact directly by crossing the system, or indirectly by disturbances to the surrounding environment. All proclaimed surface water crossings are listed below:

- Turner River
- Four crossings of the Yule River
- Cutinduna Creek
- Three crossings of the Shaw River
- Western Shaw River
- Edgina Creek
- Two crossings of Coonarrie Creek
- Turner River East
- Turner River West
- A waterhole

All drainage channels in the area are ephemeral. Following significant rainfall, the channels carry large discharges for up to a few days then retreat back to isolated pools. In the main channels, smaller discharges may persist for a few weeks. During the large flood events, floodwater can overflow the main river channels into the surrounding floodplains. River pools are sustained by local bank storage or the local water table and springs are fed by local aquifers, particularly in the karstic areas.

The Department of Water will require a Section 17 Permit to modify bed and banks under the *Rights in Water and Irrigation Act 1914* for all proclaimed surface water drainage line crossings made by the rail route.

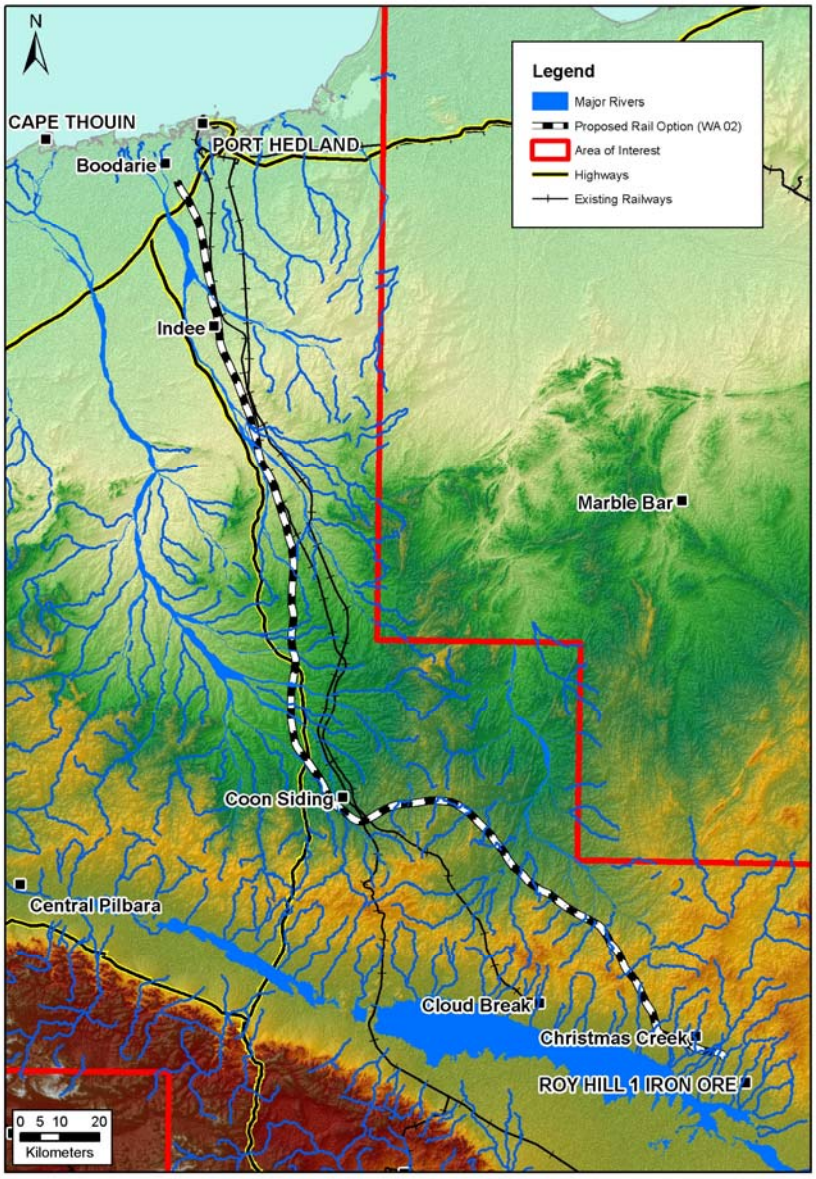

Figure 5 Surface Water Drainage Lines intercepted by the Rail Alignment

5.4 Wetlands

A wetland is defined by the Directory of Important Wetlands of Australia (DIWA) as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent of temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters” (Environment Australia 2001). The rail alignment does not intercept any important wetlands listed by the DIWA.

The Fortescue Marsh is under consideration for listing as a wetland of international importance under the EPBC Act and the Ramsar Convention on Wetlands 1971 (Ramsar). Although this wetland is not officially listed as a wetland of NES, any proposals likely to impact on this wetland will be assessed under the EPBC Act. The rail alignment will not directly impact the Fortescue Marshes; however, the rail alignment may result in secondary impacts to this wetland. All proposals potentially impacting on a wetland of significance should consult Position Statement 4 *Environmental Protection of Wetlands* (EPA 2004). This document outlines the overarching principals and guidelines that the EPA uses when assessing proposals. The locations of all important wetlands in the rail alignment area are displayed in Figure 6.

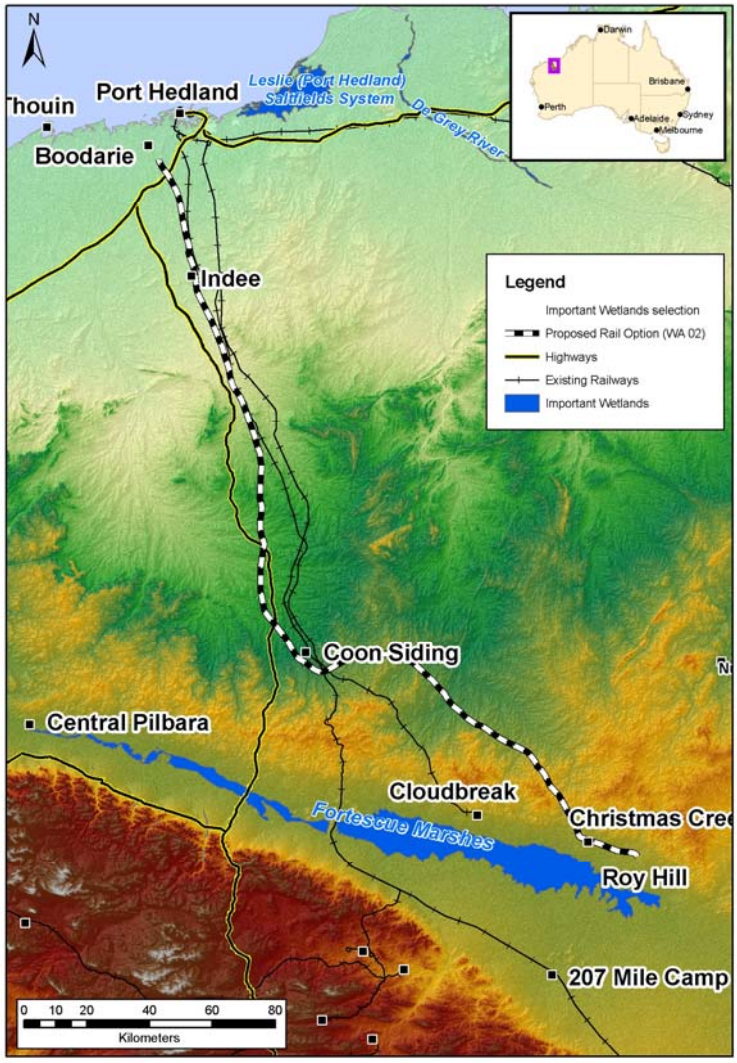

Figure 6 Important Wetlands in the Local Area

5.5 Groundwater and Aquifers

There are three significant aquifer-types in the Pilbara region:

- Unconsolidated sedimentary aquifers, including recent valley-fill alluvium and colluvium and coastal deposits.
- Chemically-deposited calcretes and pisolites within Tertiary drainage channels.
- Fractured-rock dolomite, banded-iron formations and granite, which form local aquifers.

The Wittenoom Dolomite forms an extensive aquifer, skirting the base of the Hamersley Ranges, commonly with cavernous karst development.

There is a relationship between the host rock aquifers and the resultant hydrochemistry. Groundwater in the region is typically fresh to low salinity (200–1500 mg l–1) and bicarbonate-dominated, although sodium-chlorine-rich waters are common in both the coastal and arid eastern margins. Isotopic analysis (d18O, dD) of a selection of groundwater samples taken along a transect from the coast to approximately 300 km inland reveals that the majority of recharge is resultant from cyclonic rains. There is also a component of seepage through the major waterways to the alluvial aquifers during peak flow times.

5.6 Acid Sulphate Soils

The Project does not intersect any areas with a high risk Acid Sulphate Soil (ASS) rating.

5.7 Environmentally Sensitive Areas

Environmentally Sensitive Area (ESA) locations are based on the Environmental Protection (Environmentally Sensitive Areas) Notice 2005. ESAs are generally areas where the vegetation has high conservation value. Under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 ESA's include:

- Defined wetlands and riparian vegetation
- Areas covered by threatened ecological communities (TEC)
- Areas of vegetation within 50 m of Declared Rare Flora (DRF)
- Declared World Heritage property sites

The rail alignment does not intercept any registered ESAs.

5.8 Register of National Estate

The Register of National Estate is a listing of natural and cultural heritage places in Australia. Registered Places can be protected under the EPBC Act if they are also included in another Commonwealth statutory heritage list or are owned or leased by the Commonwealth.

The Register of National Estate was frozen in 2007, meaning the Australian Heritage Council can no longer add or remove sites from the register. The Commonwealth Heritage list and National Heritage list is replacing the register of the National Estate. In the interim State and local governments can transfer sties to the appropriate list. Relevant sites listed on the Register of National Estate will be referred to the Minister for assessment under the EPBC Act.

A listing on the Register requires that a Commonwealth Minister or authority should not take any course of action that will adversely affect the listed subjects unless there is no other alternative, in which case all steps must be taken to minimise impacts to the subject. The Heritage Council must be consulted if a course of action that may have an adverse effect on a listed subject is proposed. The Commonwealth Minister (or other relevant authority) makes all decisions on a proposed course of action with the advice of the Heritage Council.

The rail alignment at Marble Bar intersects a portion of the Black Range Dyke Section (place ID 18769) which is listed as an “Indicative Place” under the Register of National Estate. An “Indicative Place” status refers to a place where the data provided to or obtained by the Heritage Division has been entered into the Register of National Estate database. However, a formal nomination has not been made and the Australian Heritage Council has not received the data necessary for assessment.

The Black Range Dyke Section is a topographic ridge more than 100 km long, up to 200 m wide and approximately 60 m high which trends east-north-east through Hillside Station in the East Pilbara district of Western Australia. It is considered to be an outstanding example of a type of gabbro intrusion because of its great strike, length, weathering pattern and landscape development and is an important research site in the investigations into the geological age dating of the Pilbara region.

The rail alignment also runs outside of the western boundary of the Abydos-Woodstock Reserve, (place ID 10061) which is a registered Indigenous site. According Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) Heritage Library, the area is one of the richest rock art centres of the world and the Woodstock Station was one of the earliest built in the area, originally to service nearby goldfields. The area holds special significance for local Aboriginal communities in the locality.

The locations of the Black Range Dyke Section and the Abydos-Woodstock Reserve are highlighted below in Figure 7.

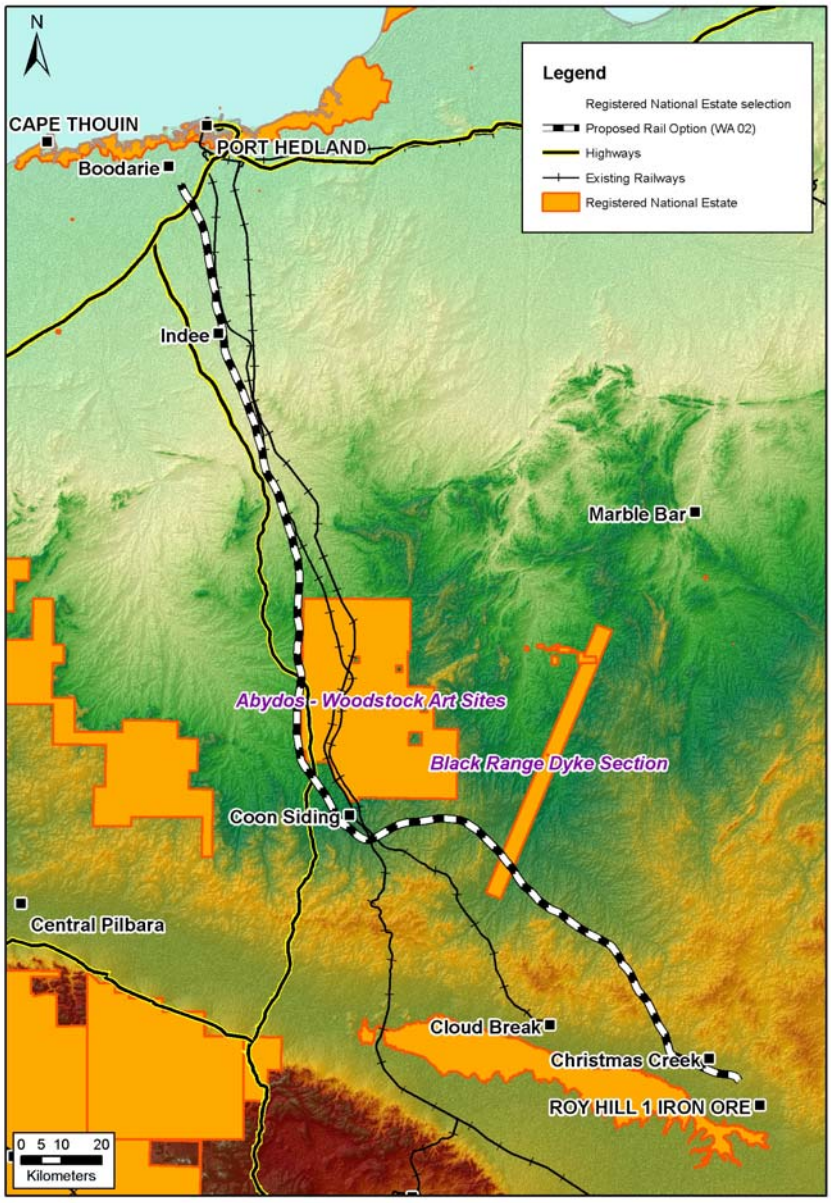

Figure 7 Location of Register of National Estate Places

5.9 Matters of National Environmental Significance

Nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined as matters of NES, are protected and managed under the EPBC Act.

The DEWHA Protected Matters Search Tool (Department of Environment and Conservation 2008) was used to identify any potential matters of NES. The Protected Matters Search Tool did not identify any listed world heritage properties, Commonwealth heritage places, critical habitats, threatened flora species or threatened ecological communities in the area of investigation, however six threatened fauna species and 12 migratory species were identified (Department of Environment and Conservation 2008). These results are summarised below in Section 5.9.1 and displayed in Figure 8.

Field surveys would be required to verify these results. It would be the responsibility of RHIO to refer any proposal to the DEWHA under the EPBC Act if they consider a proposal will have, or is likely to have a significant impact on a matter of NES.

5.9.1 Fauna Species Protected under the EPBC Act

The DEWHA Protected Matters Search Tool (Department of Environment and Conservation 2008) was used to identify fauna of significance in the investigation area. Threatened species categories include endangered, critically endangered, conservation dependant, vulnerable and species that are extinct in the wild. Nominations for species and ecological communities are assessed by the Threatened Species Scientific Committee (Department of Environment, Water, Heritage and the Arts 2008a). Six fauna species (or their habitat) were listed as potentially occurring within the rail alignment. These results are summarised in Table 1.

Table 1 Threatened Species Protected as Matters of NES

Birds	Status	Comments
Pezoporus occidentalis Night Parrot	Endangered	Species or species habitat likely to occur within area
Mammals	**Status**	**Comments**
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Macrotis lagotis Greater Bilby	Vulnerable	Species or species habitat may occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area

5.9.2 Migratory Species Protected under the EPBC Act

Twelve migratory species were recorded from areas surrounding the proposed rail alignment (**Table 2**). These species are listed as matters of NES under the EPBC Act and on a number of international agreements such as the *Japan-Australia Migratory Bird Agreement 1974* (JAMBA), *China-Australia Migratory Bird Agreement 1986* (CAMBA) and the *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA). These agreements list terrestrial, water and shorebird species which migrate between Australia and respective countries.

These agreements require the parties to protect migratory birds by:

- Limiting the circumstances under which migratory birds are taken or traded
- Protecting and conserving Important habitats
- Exchanging information
- Building cooperative relationships

Table 2 Migratory Species

Migratory Terrestrial Species		
Birds	**Status**	**Comments**
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

5.9.3 Other Matters Protected by the EPBC Act

A referral to DEWHA under the EPBC Act may be required for activities that may have a significant environmental impact on a Commonwealth area, a listed threatened species or ecological community, a listed migratory species, or a listed marine species. Nine listed marine species may utilise portions of the rail alignment from time to time. A summary of all listed marine bird species is shown below in Table 3.

Table 3 Other Matters Protected by the EPBC Act

Birds- Listed Marine Species	Status	Comments
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly marine area	Species or species habitat may occur within area

5.10 DEC Listed Threatened Flora, Fauna and Ecological Communities

Rare or threatened native flora and fauna are protected under the *Wildlife Conservation Act 1950* because they are under identifiable threat of extinction. DEC Policy Statements No's 9: *Conservation of threatened flora in the wild*, 33: *Conservation of threatened fauna in the wild* and 50: *Setting Priorities for the conservation of Western Australia's threatened flora and fauna* outline the details related to the protection of threatened flora and fauna in Western Australia.

5.10.1 DEC Listed Threatened Flora

All native flora species are protected under the Western Australian *Wildlife Conservation Act 1950* (WC Act). Threatened flora species as defined by DEC, are protected species considered to be either Declared Rare Flora (DRF) which are presumed extinct or extant taxa, or Priority Flora, which are poorly known and potentially under threat. Priority Flora do not have the same legal status as DRFs but are still considered during the approvals process. These DRF and Priority species have been gazetted by the Minister for Environment and require special management attention. The current list of specially protected flora was published in the *Government Gazette* on the 5th August 2008 under the *Wildlife Conservation (Rare Flora) Notice 2008.*

A search of the DEC threatened flora database showed no DRF species have been recorded within the rail alignment corridor, although a Priority Two species, *Gonocarpus ephemerus,* was recorded 50 m from the rail alignment. Priority Two flora are poorly known taxa that are known from only a few (generally less than five) populations, some of which are not thought to be under immediate threat. They are considered candidates for DRF status but are in need of further surveying efforts.

Field flora surveys would be required to verify these results and to ensure that there are no additional impacts to threatened flora. All future flora surveys are required to consider the principals and guidelines outlined in Position Statement 2 *Environmental Protection of native Vegetation in Western Australia* (EPA 2000), Position Statement 3 *Terrestrial Biological Surveys as an element of Biodiversity Protection* (EPA 2002) and Guidance Statement *51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

5.10.2 DEC Listed Threatened Fauna

All native fauna species in Western Australia are protected under the WC Act. Fauna species that are considered rare, threatened with extinction or have a high conservation value are specially protected under the WC Act. The current list of specially protected fauna was published in the

Government Gazette on the 5th August 2008 under the *Wildlife Conservation (Specially Protected Fauna) Notice 2008(2)*.

A search of the DEC threatened fauna database showed several threatened fauna species are known from the area of interest, although only one Priority Four bird species has been recorded within the proposed rail alignment. The location of this Priority fauna species is shown in Figure 8. Priority Four fauna are taxa in need of monitoring but are not considered to be threatened or in need of special protection.

Field fauna surveys would be required to verify these results and to ensure that there are no additional impacts to threatened fauna. All future fauna surveys are required to consider the principals and guidelines outlined in Position Statement 3 *Terrestrial Biological Surveys as an element of Biodiversity Protection* (EPA 2002) and Guidance Statement 56 *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

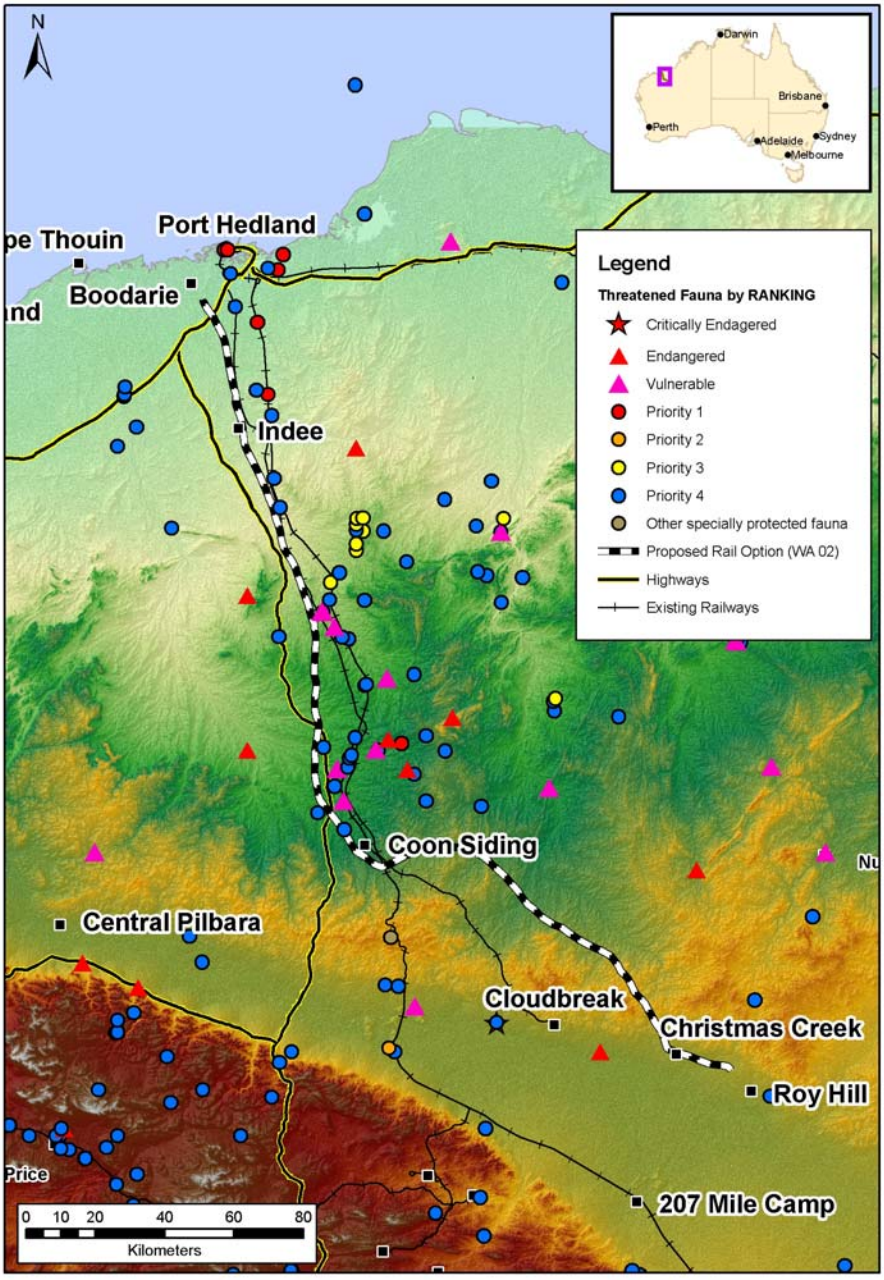

Figure 8 Location of Threatened Fauna along the Rail Corridor

5.10.3 DEC Listed Threatened Ecological Communities

Threatened ecological communities (TECs), as defined by DEC, are communities that are presumed totally destroyed, critically endangered, endangered or vulnerable. Possible threatened ecological communities that do not meet survey criteria are listed as conservation priorities one, two and three. Conservation Priority Four communities are those that are adequately known, rare but not threatened or meet criteria for near threatened, or that have been recently removed from the threatened list.

The Cracking Clay communities of the Chichester and Mungaroona Range (Mulga Downs Site ID) has a conservation status of Priority One. The rail alignment occurs within 36.7 km of this community, but will not intercept it. Construction activities must minimise impacts to this DEC listed TEC.

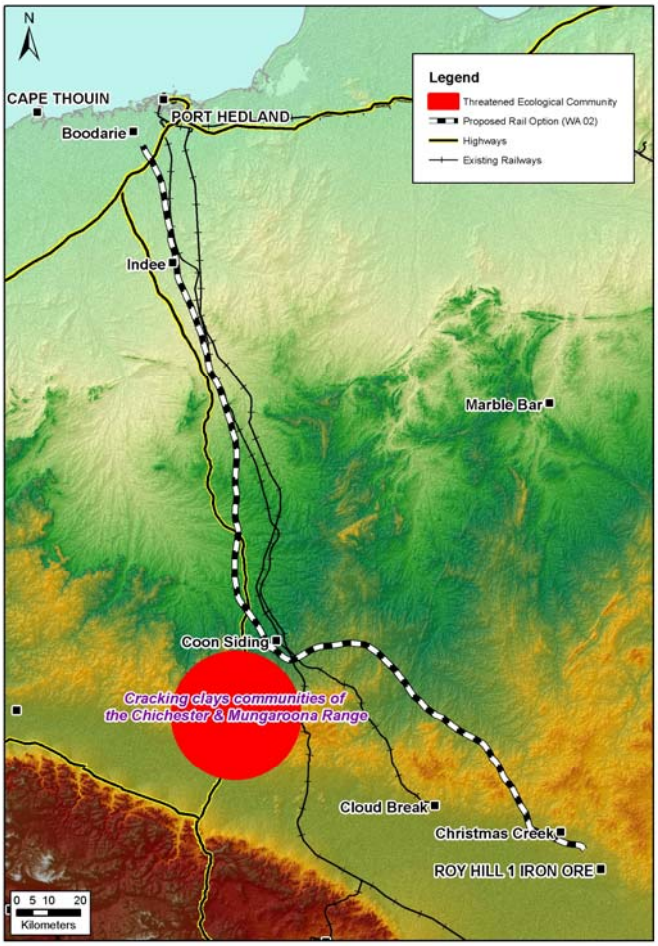

Figure 9 Threatened Ecological Communities in the Local Area

5.11 Important Bird Areas

Birds Australia maintains a database of important bird areas. An important bird area, as defined by Birds Australia must meet one of four global criteria to be included in the database. The criteria are:

- *Globally threatened species*: the site must regularly support a Critical or Endangered species or at least 10 pairs of a vulnerable species, as categorised by the IUCN Red List
- *Restricted-range species*: the site forms one of a set protecting 'restricted-range species' (birds with a global range of <50,000 km2)
- *Biome-restricted species*: the site forms one of a set protecting all species restricted to a given biome. For this purpose, Australia has been divided into seven biomes using the following paper, Hutchinson et al. 2005 (2005 Global Ecol. Biogeogr. 14: 197-212.)
- *Congregations*: the site supports > 1% of the world population of a waterbird (matching Ramsar Convention criteria)

The Fortescue Marshes and Port Hedland Saltworks are wetlands currently listed as important bird areas in the area of investigation. The rail alignment does not directly impact upon these areas; however, potential secondary impacts to these areas must be avoided. Examples of secondary impacts include changes to surface water drainage lines which supply these wetlands and increasing the sediment loads into the wetlands through increased surface soil erosion.

5.12 Short Range Endemic Invertebrate Fauna

Short Range Endemic (SRE) invertebrate fauna are made up of species which typically occupy small geographic areas up to 10,000 km^2 but are often made up of smaller, more isolated populations (Harvey 2002). Additionally Harvey (2002) found these species possess a series of ecological and life-history traits including:

- Poor powers of dispersal
- Confinement to discontinuous habitats
- Usually highly seasonal, only active during the cooler, wetter periods
- Low levels of fecundity

The current distributions of populations are restricted to habitats that are generally moist and shaded (although they can experience a summer dry period). These habitats are characterised by high rainfall and/or fog, or are associated with freshwater courses or microhabitats which are generally shaded and damp (such as southern slopes of ridges or deep litter beds).

SRE invertebrate fauna are protected under the WC Act. These species are protected at differing levels, depending on whether the species is considered rare or endangered. The current list of specially protected fauna was published in the *Government Gazette* on the 5th August 2008. Specific species have also been listed as threatened under the EPBC Act.

Proposals that could potentially have a significant impact on SRE habitat may be subject to formal environmental impact assessment under the EP Act. Any such proposal should incorporate sustainability principles, particularly the following, which are relevant for the protection of SRE fauna and their habitat:

1. *The precautionary principle*

Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

2. *The principle of intergenerational equity*

The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

3. *The principle of the conservation of biological diversity and ecological integrity*

Conservation of biological diversity and ecological integrity must be a fundamental consideration.

Position Statements and Guidance Statements indicate the overarching principles, standards and thinking used by the EPA when giving advice to the Minister and other relevant parties. Proposals potentially impacting on subterranean habitats must consider the following document: Position Statement 3 *Terrestrial Biological Surveys as an element of Biodiversity Protection* (EPA 2002), when planning SRE fauna assessments.

It is likely that SRE species are present along river banks and other cooler / moister habitats (such as along the major river / creeks intercepted by the rail in Figure 5). There is very little data available regarding existing SRE populations within the area, however, SREs listed under the EPBC Act as threatened species have not been recorded within the Pilbara. Therefore it is highly unlikely that SREs will pose a fatal flaw to this proposed route. However, the proponent must adhere to all relevant legislation and demonstrate, to the satisfaction of the EPA and DEC, the absence of any significant threat to SRE invertebrate fauna in order to gain approval for proposals as SRE

assessment has become a significant part of the environmental impact assessment process in Western Australia.

5.13 Subterranean Fauna

Subterranean fauna are generally divided into stygofauna (which are aquatic) and troglofauna (which reside in air cavities above the water table or in caves). Subterranean fauna are a very ancient group that have evolved over time to occupy niche subterranean environments and are highly adapted to their local conditions. The Pilbara is known to be a regional hotspot for stygofauna in particular, with over 350 species recorded by surveys being conducted by DEC in conjunction with the Western Australian Museum and the University of Western Australia. Stygofauna are highly adapted to the underground environment and are sensitive to changes in humidity, nutrient availability, water chemistry and pollutants.

Figure 10 A copepod collected in the Pilbara Bioregion (source http://www.dec.wa.gov.au/science-and-research/biological-surveys/stygofauna-of-the-pilbara.html#methods)

The EP Act and the EPBC Act facilitate the conservation of subterranean fauna, their habitats and the bio-physical processes that support them. Approval from the Commonwealth Minister for the Environment, Heritage and the Arts is required to impact species listed under the EPBC Act or their habitat. At the State level, formal environmental impact assessment under the EP Act is required for proposals which have the potential for significant impacts on subterranean fauna habitat, for example through:

- Changes to water levels or removal of groundwater;
- Changes to water quality and contamination of water;

- Compaction of sediments (e.g. from heavy equipment, thereby reducing groundwater recharge rates and compacting interstitial voids); and
- Destroying or damaging caves (including humidity and temperature).

The WC Act protects individual native species within Western Australia. These species are protected at differing levels, depending on whether the species is considered rare or endangered. The current list of specially protected fauna was published in the *Government Gazette* on the 5th August 2008. There are currently a number of subterranean which are listed as specially protected.

Position Statements and Guidance Statements indicate the overarching principals, standards and thinking used by the EPA when giving advice to the Minister and other relevant parties. Proposals potentially impacting on subterranean habitats must consider the following documents: Position Statement 3 *Terrestrial Biological Surveys as an element of Biodiversity Protection,* Guidance Statement 54 *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* and Draft Guidance Statement 54a *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* when planning subterranean fauna assessments.

The proponent must adhere to all relevant legislation and demonstrate, to the satisfaction of the EPA and DEC, the absence of any significant threat to subterranean fauna in order to gain approval for proposals.

6. SOCIAL CONSTRAINTS

6.1 Local Shire

The proposed rail alignment will enter lands controlled by two local government authorities, the Shire of East Pilbara and the Town of Port Hedland. Potential land tenure constraints have not been considered in this assessment because they were outside of the scope of works. It is strongly advised that the proponent commences negotiations for land access along the rail corridor as soon as possible. Denial of land access could result in a fatal flaw to any given alignment.

6.2 Mine Infrastructure

There are numerous existing, planned and operating mining operations in the area of investigation. It is important to note that the rail alignment will intersect abandoned sites, mines and towns, which may have asbestos issues. A summary of all mining operations present in the area of investigation is presented in Table 4.

Table 4 Mining Infrastructure Surrounding the Roy Hill Rail Alignment

SITE TITLE	NAME	Site Type	Site Sub-type	Site Stage	Project Title	Latitude GDA94	Longitude GDA94
Yule River Sand	Yule River Sand	Mine	Open pit	Care and Maintenance	Yule River Sand	-21.6026	118.8050
Yule River Sand	Yule River Sand	Mine	Open pit	Care and Maintenance	Yule River Sand	-21.6026	118.8050
Newman Line Rail Ballast	Quarry 2 Rail Ballast	Mine	Open pit	Shut	Pilbara Rail Construction / BHPB	-20.9217	118.6851
Coonarrie Sand	Coonarrie Sand	Mine	Open pit	Care and Maintenance	Yule River Sand	-21.7012	118.8230
Coonarrie Sand	Coonarrie Sand	Mine	Open pit	Care and Maintenance	Yule River Sand	-21.7012	118.8230
Sandy Hill / Boral	Sandy Hill/Boral	Mine	Open pit	Shut	Turner River East / Boral	-20.4500	118.4785
Sandy Hill / Cemex	Sand	Mine	Open pit	Operating	Turner River / Cemex	-20.4525	118.4752
Turner River East / Ministerial	Turner River E	Deposit	Unspecified	Undeveloped	Turner River East / Ministerial	-20.4353	118.4707
Turner River East / Boral	Turner River E / Boral	Mine	Open pit	Shut	Turner River East / Boral	-20.4289	118.4663
Boodarie Sand / Young	Boodarie Sand / Young	Mine	Open pit	Care and Maintenance	Port Hedland Sand and Gravel / Young	-20.4104	118.5104
Boodarie Sand / Young	Boodarie Sand / Young	Mine	Open pit	Care and Maintenance	Port Hedland Sand and Gravel / Young	-20.4104	118.5104
Turner River South Sand / Cemex	Sand	Mine	Open pit	Operating	Turner River / Cemex	-20.6211	118.5213
Turner River / Hanson Constructions	Turner River / Hanson	Mine	Open pit	Operating	Turner River / Hanson Constructions	-20.6051	118.5187
Turner River - Boodarrie / Cemex	Aggregate	Mine	Open pit	Operating	Turner River / Cemex	-20.6440	118.5224
Turner River Dune Sane North / Cemex	Sand	Deposit	Unspecified	Undeveloped	Turner River / Cemex	-20.4948	118.4665
Newman Line Rail Ballast	Quarry 4 Rail Ballast	Mine	Open pit	Shut	Pilbara Rail Construction / BHPB	-21.9713	119.0095
Carubumya Well -Indee	Carubumya Well	Mine	Open pit	Operating	Carubumya Well	-20.6864	118.6394
Turner River Dune Sand South / Cemex	Sand	Mine	Open pit	Shut	Turner River / Cemex	-20.5012	118.4687
White Hill Rail Ballast	White Hill Ballast	Mine	Open pit	Shut	Pilbara Rail Construction / BHPB	-20.4552	118.5872
Boodarie / Boral	Boodarie / Boral	Mine	Open pit	Shut	Turner River East / Boral	-20.4050	118.4507
Elazac Quarry	Elazac	Mine	Open pit	Operating	Port Hedland / BGC	-20.7250	118.6666
South Hedland / Boral	South Hedland / Boral	Deposit	Unspecified	Undeveloped	South Hedland / Boral	-20.3931	118.5605
Redmont	Redmont	Mine	Open pit	Care and Maintenance	Redmont	-22.0148	119.0163
Redmont	Redmont	Mine	Open pit	Care and Maintenance	Redmont	-22.0148	119.0163
Port Hedland Sand 2 / BGC	Port Hedland Sand 2	Mine	Open pit	Operating	Port Hedland / BGC	-20.3727	118.4660
Newman Line Rail Ballast	Quarry 1 Rail Ballast	Mine	Open pit	Shut	Pilbara Rail Construction / BHPB	-20.5292	118.6501
Camel Hill Aggregate 2	Camel Hill 2	Mine	Open pit	Proposed	Camel Hill Aggregate	-21.2779	118.8938
Camel Hill Aggregate Plant	Camel Hill Plant	Infrastructure	Processing Plant	Proposed	Camel Hill Aggregate	-21.2650	118.8941
Camel Hill Aggregate 1	Camel Hill 1	Mine	Open pit	Proposed	Camel Hill Aggregate	-21.2529	118.8916
Turner River Limestone / Cemex	Turner River Lst / Cemex	Mine	Open pit	Care and Maintenance	Turner River / Cemex	-20.3533	118.4713
Turner River Limestone / Cemex	Turner River Lst / Cemex	Mine	Open pit	Care and Maintenance	Turner River / Cemex	-20.3533	118.4713
Newman Line Rail Ballast - Quarry 3	Quarry 3 Rail Ballast	Mine	Open pit	Shut	Pilbara Rail Construction / BHPB	-21.3984	118.9050
Boodarie Limestone / BGC	Boodarie / BGC	Mine	Open pit	Operating	Port Hedland / BGC	-20.3501	118.4612

SITE TITLE	NAME	Site Type	Site Sub-type	Site Stage	Project Title	Latitude GDA94	Longitude GDA94
Port Hedland Sand / Young	Port Hedland Sand	Mine	Open pit	Operating	Port Hedland Sand and Gravel / Young	-20.4313	118.6265
DRI Borrow Pit 2	Borrow Pit 2	Mine	Borrow Pit	Shut	Boodarie Iron	-20.3417	118.5227
Port Hedland Sand 1 / BGC	Port Hedland Sand 1	Mine	Open pit	Care and Maintenance	Port Hedland / BGC	-20.3503	118.4488
Port Hedland Sand 1 / BGC	Port Hedland Sand 1	Mine	Open pit	Care and Maintenance	Port Hedland / BGC	-20.3503	118.4488
Trig Hill - Pippingarra Rd	Trig Hill Aggregate	Mine	Open pit	Operating	Trig Hill - Pippingarra Rd / Mansour	-20.5860	118.6888
Kangan	Kangan	Mine	Open pit	Care and Maintenance	Kangan	-21.0638	118.5742
Kangan	Kangan	Mine	Open pit	Care and Maintenance	Kangan	-21.0638	118.5742
Beebingarra Creek / Cemex	Beebingarra Ck/Cemex	Deposit	Unspecified	Undeveloped	Pippingarra / Cemex	-20.5555	118.7112
MT Weld Sand Pit	Sand	Mine	Open pit	Care and Maintenance	Pippingarra / Cemex	-20.4738	118.6895
MT Weld Sand Pit	Sand	Mine	Open pit	Care and Maintenance	Pippingarra / Cemex	-20.4738	118.6895
Newman Line Rail Ballast - Quarry 8	North Shaw Rail Ballast	Mine	Open pit	Operating	Pilbara Rail Construction / BHPB	-22.0958	118.9972
Cloud Break Airstrip Borrow Pit	Airstrip Borrow Pit	Mine	Borrow Pit	Operating	East Pilbara Iron Ore / FMG	-22.3007	119.4414
Cloud Break Airstrip Quarry	Airstrip Quarry	Mine	Open pit	Operating	East Pilbara Iron Ore / FMG	-22.2898	119.4259
Boomerang Aggregate	Boomerang	Mine	Open pit	Operating	Pippingarra / Cemex	-20.5497	118.7544
Cloud Break Access Road Borrow Pit 1	Borrow Pit	Mine	Borrow Pit	Operating	East Pilbara Iron Ore / FMG	-22.2746	119.2807
Cloud Break Access Road Borrow Pit 2	Borrow Pit	Mine	Borrow Pit	Operating	East Pilbara Iron Ore / FMG	-22.2757	119.2021
Cloud Break Access Road Borrow Pit 3	Borrow Pit	Mine	Borrow Pit	Operating	East Pilbara Iron Ore / FMG	-22.2250	118.8774
Cloud Break Access Road Borrow Pit 4	Borrow Pit	Mine	Borrow Pit	Operating	East Pilbara Iron Ore / FMG	-22.2212	118.8307

*Table 4 Continued

6.3 Aboriginal Heritage

The EP Act and the *Aboriginal Heritage Act 1972* provide requirements for the assessment and reporting on issues pertaining to Aboriginal heritage by the proponent. Further guidance on reporting and assessment requirements is outlined in Guidance Statement 41 Assessment of Aboriginal Heritage (EPA 2004).

6.3.1 Aboriginal Communities

Nine Aboriginal communities registered with the Department of Indigenous Affairs (DIA) were identified in close proximity to the rail alignment corridor (Figure 11). The Aboriginal communities and distance to the rail corridor are listed in Table 5. Potential impacts to these Aboriginal communities arising from the construction and development should be avoided.

Table 5 Aboriginal Communities Registered with DIA

Group Name	Incorporation	Distance to Rail Alignment (km)
Abydos Woodstock Group	Mumbultjari Aboriginal Corporation	2.8
Mumbultjari Group	MumbultjariAboriginal Corporation	13.3
Pippingarra Group	Pippingarra Pastoral Company Pty Ltd	15.8
Tjalka Wara Group	Tjalka Wara Community Incorporated	19.3
Tkalka Boorda Group	Tkalka Boorda Community Aboriginal Corporation	19.4
Strelley Group	Ngarla-Coastal Njamal Aboriginal Corporation	31.8
Jinparinya Group	Jinparinya Aboriginal Corporation	33.3
Mugarinya Group	Mugarinya Community Association Incorporated	37.7
Strelley Group	Strelley Housing Society Inc	52.1

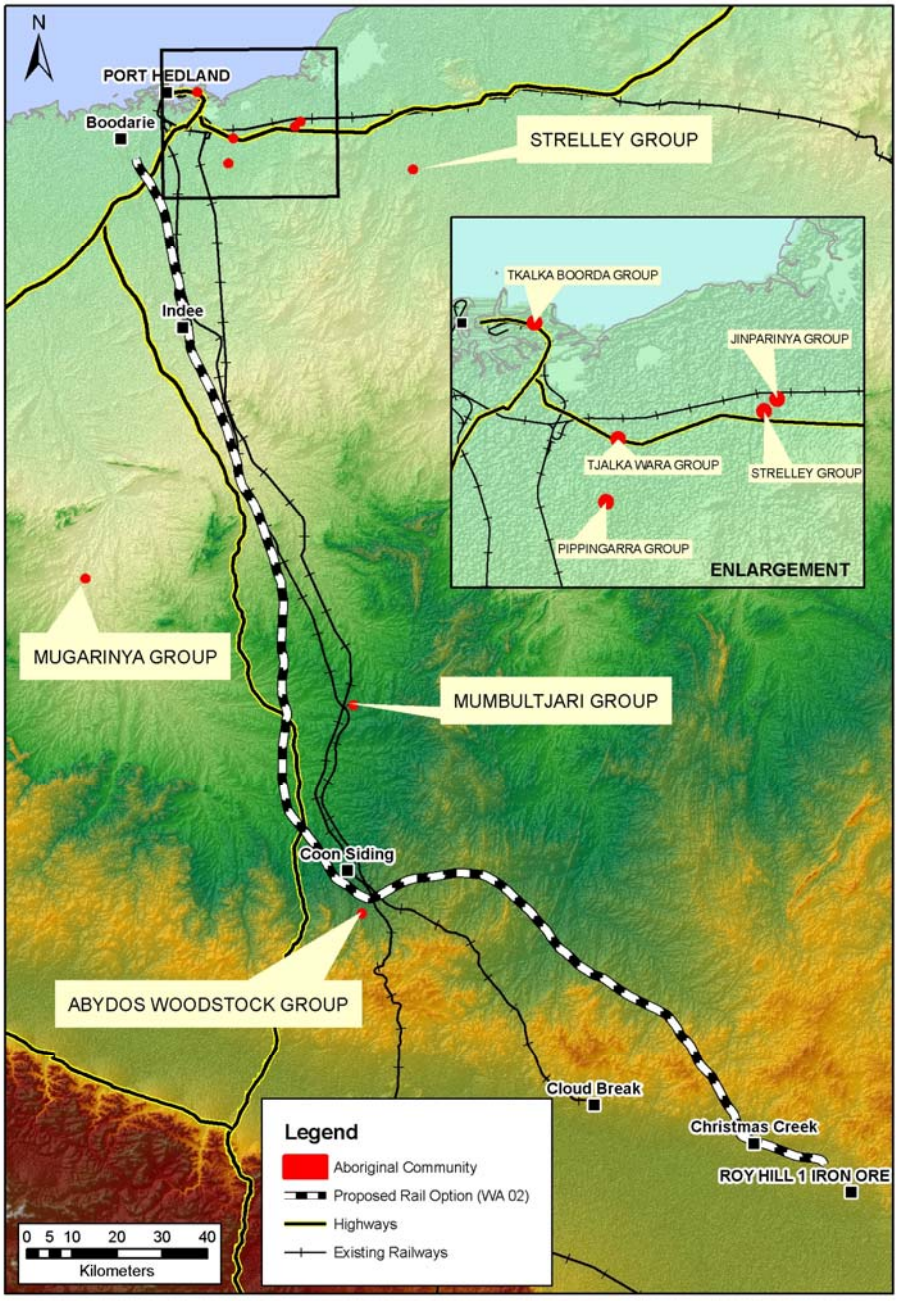

Figure 11 Aboriginal Communities Located within the Local Area

6.3.2 Native Title

The Commonwealth *Native Title Act 1993* (NTA) provides for Aboriginal people to claim native title and a process for negotiation and compensation where the land is leased out by the State. The NTA allows States and Territories to develop their own native title regimes that apply instead of the right to negotiate where the Australian Government Minister determines that the regime complies with criteria set out in the NTA. The *Native Title (State Provisions) Act 1999* represents Western Australia's native title regime. Native title claims ensure that the stated native title rights and interests of the Aboriginal traditional owners of the land are recognised by law. These rights and interests include the continued use and occupation of the land for traditional purposes such as ceremonies, hunting, fishing and procuring ochre and bush foods. The rail alignment will pass through three registered native title claim areas comprising: the Kariyarra People, the Palyku, and the Nyiyaparli (Figure 12). This requires the project to obtain agreement from the groups to use the land for rail purposes.

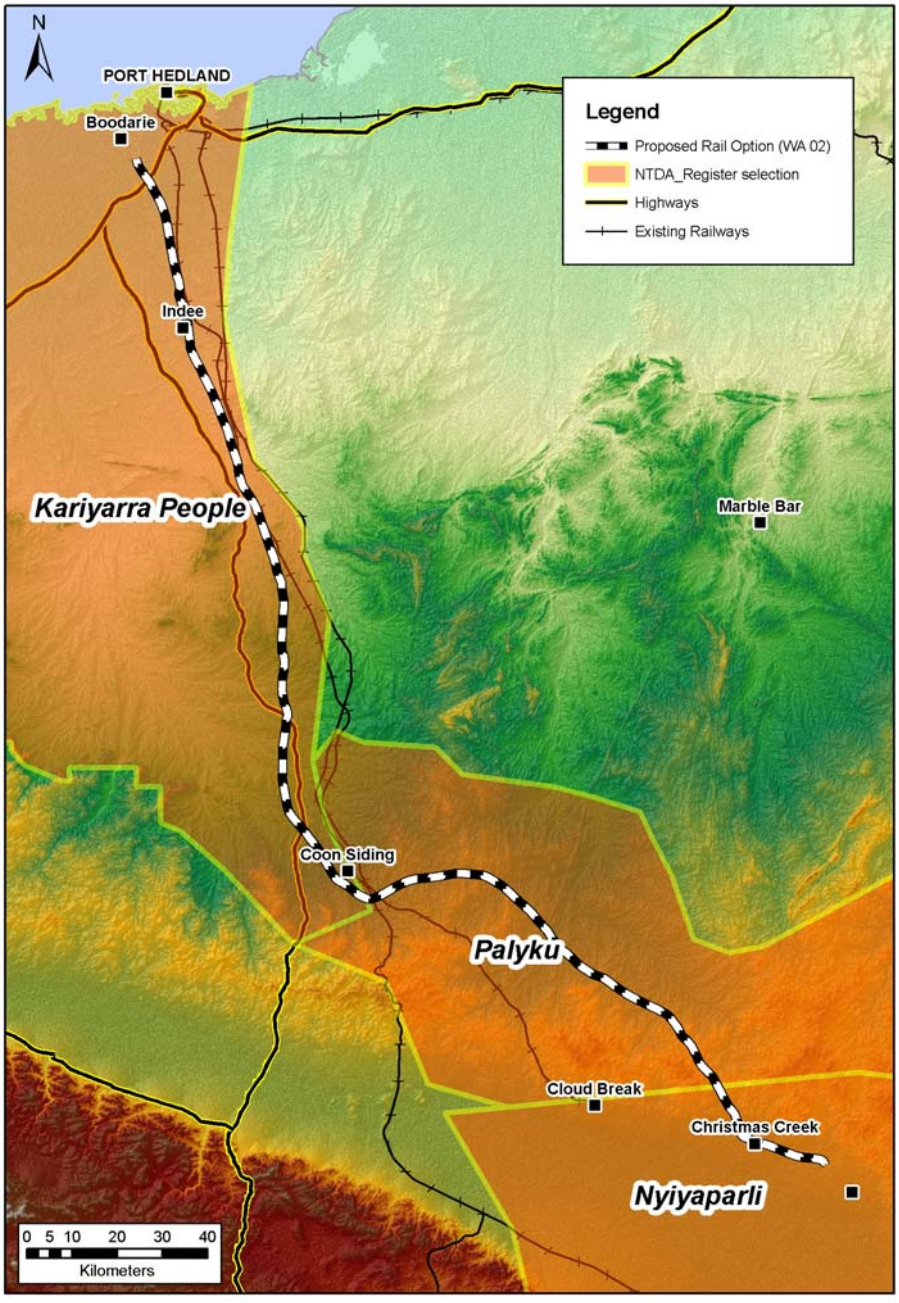

Figure 12 Native Title Claimants along the Rail Alignment

6.3.3 DIA Registered Heritage Sites

DIA maintains a register of Aboriginal sites that are protected under the *Aboriginal Heritage Act 1972*. Under Section 17 of this Act it is an offence to excavate damage, destroy, conceal or in anyway alter an Aboriginal site without the written permission of the Minster for Indigenous Affairs.

The rail alignment is expected to impact 13 Aboriginal heritage sites either directly or indirectly (works occurring within 50 m of the site) which have been registered with the DIA (Figure 13). Sites listed on the DIA register are protected under the *Aboriginal Heritage Act 1972*. One site in particular which is intersected by the rail alignment (total area impacted 72.6 m^2), formally lodged within the Wodgina area, the WodE#2 Law Ground Site Complex is registered as a ceremonial, meeting and burial site and should be avoided by the proposal.

Table 6 DIA Registered Aboriginal Heritage Sites along the Rail Alignment

Site Name	Site Number	Status	Access Type	Site Type
Dambara Yambara	P03491	Permanent Site	Open	Ceremonial, Mythological
Kulkakutjarra Pool	P06290	Insufficient Information Site	Open	No information
Turner River (Tjirril)	P06291	Stored Site	Open	No information
Yule River (Kakurka)	P06293	Stored Site	Open	No information
Redmont Access 1	P05902	Permanent Site	Open	Quarry, Art
Redmont Access 2	P05903	Permanent Site	Open	Quarry, Art
White Springs (MRD) 06	P05299	Lodged Site	Open	Quarry, Art
Wallyanna Well	P00521	Permanent Site	Open	Engraving
Tjilling Creek	P06295	Stored Site	Open	No information

The “Status” of these sites is explained below.

- One Site with Insufficient Information Status

  This site has been lodged with the Registrar, placed on the DIA Register, and assessed as having insufficient information to complete an assessment within the terms of Section 5 of the *Aboriginal Heritage Act 1972*. The provisions of the Act apply to this place until it is assessed as a place to which the Act does not apply.

- One Lodged Site

  Lodged sites have not been assessed against Section 5 of the *Aboriginal Heritage Act 1972*. The provisions of the Act apply to these places until they are assessed as places to which the Act does not apply.

- Four Permanent Sites

  Permanent sites have been assessed as meeting the terms of Section 5 of the *Aboriginal Heritage Act 1972*. These sites are also assessed against the terms of Section 39(2) of the Act in regard to their importance and significance. Sites on the Permanent Register are places to which the Act applies.

- Three Stored Sites

  Stored sites are assessed as not meeting the terms of Section 5 of the *Aboriginal Heritage Act 1972*. Sites assessed as having no Aboriginal association are also listed as stored in the Register. The provisions of the Act do not apply to these places unless further information is lodged with the Registrar requiring a reassessment of the place. Information relating to stored sites is not deleted from the Register, but is retained for a number of reasons including the following.

  - Information provided may be incomplete at the time of assessment and further information will be provided in the future that may change the assessment of the place.
  - To alert people to sites that may not meet the terms of the Act, there may still be some level of Aboriginal heritage value associated with a place.
  - To identify the location of places reported as sites but assessed as not meeting the terms of the Act for planning purposes.

The “Access” categories of Aboriginal heritage sites refer to public access to the site file information. An ‘Open’ access file is available for public viewing. Reasons for a ‘Closed’ access file status could include cultural reasons, gender restrictions, physical danger of site and the condition of the site.

6.3.4 Abydos Plain

The Abydos-Woodstock Reserve is registered as a protected area pursuant to Section 19 of the *Aboriginal Heritage Act 1972* and has been assessed as a fatal flaw for this project. This is due to the length of time required to organise heritage supervision for all field surveys, the small window of time allowed for archaeological surveys and the importance of the area. It is highly unlikely that proposals impacting this area will be approved in a timely manner. The proposed rail alignment currently runs west and outside of the Abydos-Woodstock Reserve (Figure 13).

The engravings located on the Woodstock and Abydos pastoral leases near the upper reaches of the Yule and Turner Rivers are listed on the Register of the National Estate. The protected area includes approximately 154,450 ha, comprising the area surrounding the upper reaches of the Yule and Turner Rivers on former stations Abydos and Woodstock (being WA Museum Reserves 22626 and 22627, excluding Timber Reserves 13629, 13630, 13631, and 13632). All engravings, particularly the human figures as well as geometric designs are of current significance to the Aboriginal Traditional Owners.

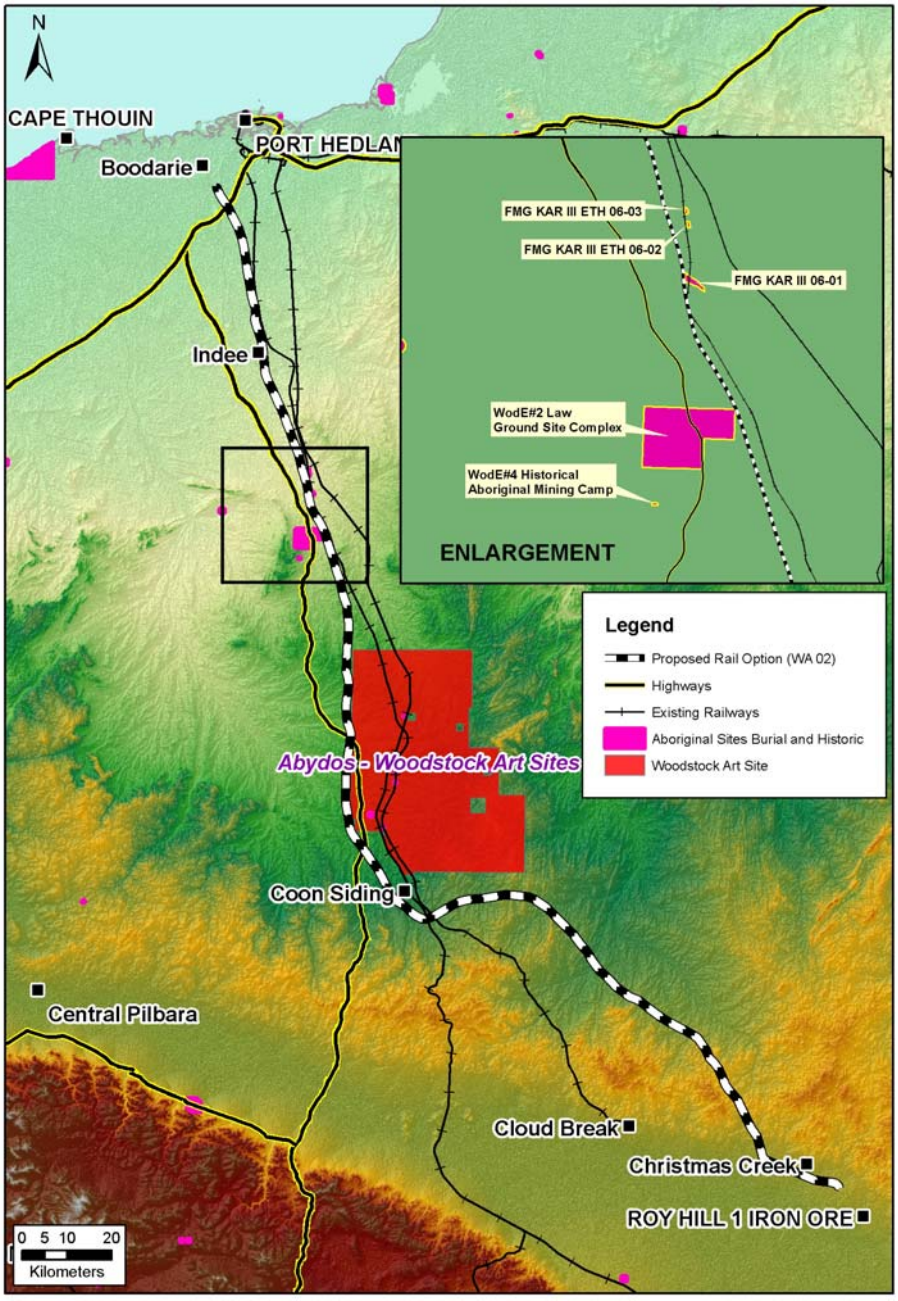

Figure 13 Registered Aboriginal Heritage Sites along the Rail Alignment

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Appendix A Sources of GIS Data

Environmental	Source
Schedule one areas	Former Department of Environment (DoE)
Environmentally Sensitive Areas	Former Department of Environment (DoE)
Threatened Flora	Department of Environment and Conservation (DEC) Threatened Flora database
Threatened Fauna (including migratory species, important habitat)	Department of Environment and Conservation (DEC) Threatened Fauna database
Threatened Ecological Communities	Department of Environment and Conservation (DEC) Threatened Ecological Communities database
Important Bird Areas	Birds Australia
Drainage (watercourses)	Landgate
Wetlands	Australian Government Department of the Environment and Water Resources
Social	
Register of the National Estate (Natural and Cultural sites –Indigenous and European)	Department of the Environment, Water, Heritage and the Arts (DEWHA)
Aboriginal Heritage Sites	Department of Indigenous Affairs (DIA)
Native Title	Geoscience Australia
Aboriginal Communities	Department of Indigenous Affairs (DIA)

Appendix B DEWHA Protected Matters Search Results

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Australian Government
Department of the Environment, Water, Heritage and the Arts

Protected Matters Search Tool

24 November 2008 11:47

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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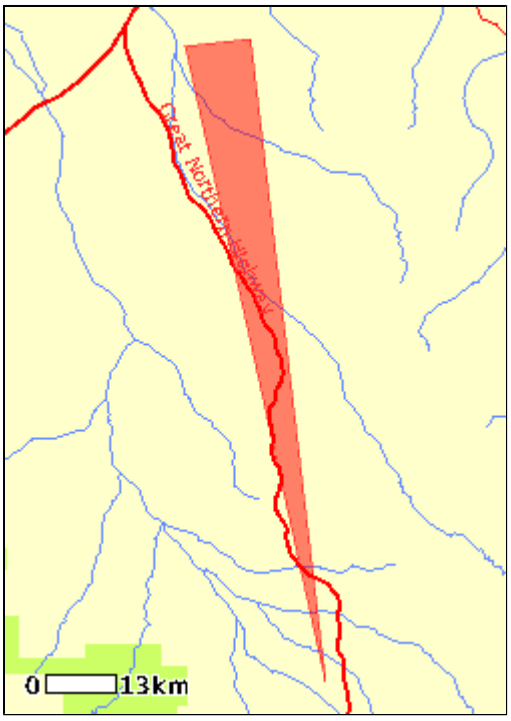

Search Type: Area

Buffer: 0 km

Coordinates: -21.7257,118.7942, -20.5890,118.6617, -20.6018,118.5463

Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	4
Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the

environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Places on the RNE:	None
Listed Marine Species:	9
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Threatened Species [Dataset Information]	Status	Type of Presence
Mammals		
Dasycercus cristicauda	Vulnerable	Species or species habitat likely to

Mulgara		occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly	Species or species habitat may occur within area

	marine area	
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly marine area	Species or species habitat may occur within area

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Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999.* It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a

referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium

- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution.
Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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Appendix B – MCA Data Sheets

ENVIRONMENT

Table 27 Native Vegetation

Objective	**To avoid clearing native vegetation and any impact on environmentally sensitive areas.**
Rationale for including this criteria	**Remnant native vegetation has significant value for conservation of individual species and biodiversity.** *Terrestrial vegetation was regarded as more important than most of the engineering criteria except rivers and creeks because of environmental considerations in clearing vegetation. Conservation priorities set by the Department of Conservation and Environment are protected by state legislation and permits are required for clearing so their weighting is consistent with legislation. Of the environmental and social criteria only national heritage sites and mining activities are considered to be more important than native vegetation.*
Legislative and Policy context	Environmental Protection (Clearing of Native Vegetation) Regulations 2004; *Environmental Protection Act 1986*; and Environmental Protection Authority Position Statement No. 2, Environmental Protection of Native Vegetation in Western Australia: Clearing of native vegetation, with particular reference to the agricultural area, 2000.
How measured	Declared Rare Flora - Extant Taxa Declared Rare Flora - Presumed Extinct Taxa Priority 1 - Poorly known Taxa Priority 2 - Poorly Known Taxa Priority 3 - Poorly Known Taxa Priority 4 - Rare Taxa
Data Source	Threatened Flora (Data received was a subset of the Threatened (Declared Rare) Flora database from the DEC in the search for rare flora in the Pilbara area). Threatened Flora data Conservation Codes 1,2,3,4 , X & R.
Ratings	Comments
Fatal Flaw (999)	Route within 500 m of Declared

Objective	To avoid clearing native vegetation and any impact on environmentally sensitive areas.
	Rare Flora (Extant Taxa) Route within 500 m of Declared Rare Flora (Presumed Extinct Taxa) Route within 500 m of Threaten Ecological Communities
Poor (100)	Route within 500 m of Priority 1 taxa Route within 500 m of Priority 2 taxa
Moderate (50)	Route within 500 m of Priority 3 taxa Route within 500 m of Priority 4 taxa
Good (1)	None of the above

Table 28 Wetlands

Objective	To minimise and avoid an impact on wetlands.
Rationale for including this criteria	Wetland ecosystems provide high levels of biodiversity; habitat; recreation and aesthetic values and also can have a functional value with the removal of pollutants from surface waters and stabilisation of coastal areas. Wetlands were considered to be more important than all engineering criteria. The engineers agreed they would select a less suitable engineering route to avoid the loss of significant wetlands. When assessing the importance of this criterion the impact on internationally significant 'Ramsar' wetlands was considered. Ramsar wetlands are protected by government legislation. The importance of wetlands as a criterion should be relative to a wetlands significance and the environmental values it holds so further examination in round two may be required to determine a particular wetlands importance. Of the environmental and social criteria only mining activities is considered to be more important than wetlands.

Legislative and Policy context	Convention on Wetlands (Ramsar, Iran 1971) *Commonwealth Environment Protection and Biodiversity Conservation Act 1999;* *Environmental Protection Act 1986;* Environmental Protection (Clearing of Native Vegetation) Regulations 2004; and Environmental Protection Authority Position Statement No. 4, Environmental Protection of Wetlands, 2004.
How measured	
Data Source	DEC - List of internationally important wetlands under the Ramsar Convention
Ratings	
Fatal Flaw (999)	Ramsar wetland
Poor (100)	The route is within Fortescue Marshes
Moderate (50)	The route is within a wetland
Good (1)	None of the above

Table 29 Avifauna

Objective	**To minimise the impact on avifauna.**
Rationale for including this criteria	**A significant number of species recorded in the North West Shelf area are protected under Sate and Commonwealth legislation.** *Avifauna was considered to be more important than all of the engineering criteria because of occupational health and safety issues associated with these criteria. Avifauna was also regarded as less important than mining activities because mining is thought to have a substantially larger footprint and cause delays in project schedule due to negotiating with other mining companies.*
Legislative and Policy context	*Wildlife Conservation Act 1950*; Japan and Australia Migratory Bird Agreement (JAMBA) 1974;

	China-Australia Migratory Bird Agreement (CAMBA) 1986; *Environmental Protection Act 1986;* Bonn Convention 1991 (The Convention on the Conservation of Migratory Species of Wild Animals).
How measured	Distance from Important Bird Areas (IBA's) and Seabird Islands
Data Source	Birds Australia -List of coordinates for Important Bird Areas (IBA's) 9 April 2008 Seabird Islands
Ratings	Category
Fatal Flaw (999)	Route within 0-1 km of an Important Bird area
Poor (100)	Route <10 km from an Important Bird area
Moderate (50)	Route 10-25 km from an Important Bird area
Good (1)	Route >25 km from an Important Bird area

Table 30 Threatened Fauna

Objective	Routes near threatened fauna are avoided**.**
Rationale for including this criteria	Listed threatened species are matters of national environmental significance (protected matters) under the EPBC Act's assessment and approval provisions. Threatened fauna includes species which are declared as 'Rare or likely to become extinct (Schedule 1)', 'Birds protected under an international agreement (Schedule 3)', and 'Other specially protected fauna (Schedule 4)'. *Threatened Fauna was considered to be more important than all of the engineering criteria because of occupational health and safety issues associated with these criteria. Threatened Fauna was also regarded as less important than mining activities because of the perceived time delays in project schedule involved with negotiating with other mining companies.*
Legislative and	*Environment Protection and Biodiversity Conservation Act 1999*

Policy context	Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar, Iran) 1971 Bonn Convention 1991 (The Convention on the Conservation of Migratory Species of Wild Animals) China-Australia Migratory Bird Agreement (CAMBA) 1986 Japan and Australia Migratory Bird Agreement (JAMBA) 1974 *Environmental Protection Act 1986* *Fauna Conservation Act 1950-75* *Wildlife Conservation Act 1950*
How measured	Distance from Threatened Fauna Sites
Data Source	Department of Environment and Conservation - Threatened Fauna database
Ratings	Category
Fatal Flaw:	N/A
Poor:	Threatened fauna are <1 km from route
Moderate:	Threatened fauna are 1-2 km from route
Good	None of the above

Table 31 Conservation Estate

Objective	**Impacts on sites with legal conservation are avoided or minimised.**
Rationale for including this criteria	**Typically, conservation estates have high biological diversity, often supporting rare and threatened species or ecosystems and are in pristine or largely undisturbed condition. Additionally, these areas usually have high recreational and aesthetic value to the community.** *Conservation estate was rated as more important than most environmental and engineering criteria but less important than wetlands and avifauna. It was also more important than most social criteria but less important than mining activities. Conservation estates are protected by government legislation and while it is appreciated that there is limited scope for negotiations regarding dual usage in these areas, the impact of*

Objective	**Impacts on sites with legal conservation are avoided or minimised.**	
	a mining activities along the route because of the perceived time delays in project schedule involved with negotiating with other mining companies was considered important.	
Legislative and Policy context	*Conservation and Land Management Act 1984;* Conservation and Land Management Regulations 2002; *Land Administration Act 1997;* *The Parks and Reserves Act 1895;* IUCN Guidelines for Protected Areas Management Categories 1994; Environmental Protection Authority Position Statement No. 1, Environmental Protection of Cape Range Province 1999.	
How measured	Strict nature reserve (1a) Wilderness Area (1b) National park (2) Natural Monument (3) Habitat/species Management Area (4) Protected Landscape/Seascape (5) Managed Resource Protected Areas (6) Conservation Park	
Data Source	Australian Landuse & Mapping Classification	
Ratings	Category	Comments
Fatal Flaw (999)	Nature reserve, National park	
Poor (100)	Proposed Addition to Nature Reserve Proposed addition to National park State forest Conservation park Timber reserve	
Moderate (50)	Miscellaneous Reserve 5(1)(g) Reserve 5(1)(h) Reserve CALM Exec Body	

Objective	**Impacts on sites with legal conservation are avoided or minimised.**
	CALM Exec Body Freehold
Good (1)	None of the above/ infrastructure corridor

SOCIAL

Table 32 National Heritage (natural, historic, and indigenous sites)

Objective	**To conserve significant cultural heritage sites.**
Rationale for including this criteria	**Significant cultural and heritage sites are valued by specific communities and the larger community public.** *Significant cultural or heritage sites including rock art areas were considered to be more important than most social criteria but less important than mining activities. The importance of significant cultural and heritage sites was assessed according to legislation, company policy and the level of public interest involved in their protection.*
Legislative and Policy context	*Heritage of Western Australia Act 1990* *Aboriginal Heritage Act 1972* *Aboriginal Communities Act 1979* *Aboriginal Affairs Planning Authority Act 1972* *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* Aboriginal Lands Trust Land Use and Development Policy (ALT) 2006
How measured	Proximity to Cultural or Heritage site
Data Source	Department of Land and Information – Heritage Places database
Ratings	
Fatal Flaw (999)	Route is within Woodstock art site Route within Protected Areas Route is <50m from a cemetery (indigenous or european), a burial ground, a lighthouse, memorial or historic building

Poor (100)	Route is <50m from a known, significant cultural or heritage site (all of the above listed but not those included as a fatal flaw [cemeteries, burial grounds, lighthouses, memorials or historic buildings]) Route is <50 m from an Aboriginal site listed by the Department of Indigenous Affairs Route is <500 m from an Aboriginal community Route is <500 m from Geoheritage site
Moderate (50)	Site is 50-100 m from a known, significant cultural or heritage site (all listed)
Good (1)	None of the above

Table 33 Aesthetics

Objective	**The distance between residences and the corridor is within a reasonable distance.**
Rationale for including this criteria	The rail line route should complement surrounding land uses. Strategic placement of the rail line will minimise visual impacts. *Aesthetics was considered to be less than most environmental, social and engineering criteria. Aesthetics was only considered more important than road*
Legislative and Policy context	N/A
How measured	Distance from residential buildings
Data Source	Department of Land and Information (Landgate) - Travellers Atlas Google Earth - Aerial Imagery Geoscience Australia 1:250k

Ratings	Category
Fatal Flaw:	N/A
Poor:	Route is within 5 km from homestead
Moderate:	N/A
Good	None of the above

Table 34 Land Tenure

Objective	**Impacts on land tenure are avoided or minimised.**
Rationale for including this criteria	**Impact on existing land tenures would probably entail negotiations between landowners.** *Land tenure was regarded as less important than all environmental and social and engineering criteria because the level of public interest in land tenure is thought to be lower than the other criteria.*
Legislative and Policy context	*Land Administration Act 1997* *Western Australian Pearling Act 1990* *Fisheries Resources Management Act 1994* *Petroleum Act 1967* *Pearling Act 1990* *Mining Act 1978*
How measured	Distance from pearling lease Proximity to existing RHIO lease
Data Source	Roebourne Cadastre Ashburton Cadastre RHIO (digitized map from Geoscience Australia) Department of Infrastructure and Resources
Ratings	
Fatal Flaw (999)	N/A
Poor (100)	Road

Objective	Impacts on land tenure are avoided or minimised.
	Leasehold land, strata plan
	Freehold land
Moderate (50)	Reserved crown land
	Crown land
Good (1)	Vacant crown Land
	All other remaining areas

Table 35 Native Title – past and pending titles masked out

Objective	Reduce or minimised complexity native title issues.
Rationale for including this criteria	**Native title mediation can be complex and time-consuming.** *All of the environmental social and engineering criteria were considered to be more important than native title.*
Legislative and Policy context	*Native Title Act 1993*
How measured	Number of claims in area
Data Source	National Native Title Tribunal State Map http://www.nntt.gov.au/publications/WA_RATSIB.html
Ratings	
Fatal Flaw (999)	N/A
Poor (100)	Kariyarra People
	Njamal People
Moderate (50)	Palyku
	Nyiaparli
	Martu Idja Banyjima People
	Innawonga and Bunjima People
Good (1)	No claim in area

Table 36 Mining Sites

Objective	**Impact on mining and mineral exploration activities are not impacted on, mineral resources are not sterilised.**
Rationale for including this criteria	**Mining activities are likely to physically preclude locations and mining activities and mineral resources cannot be relocated.** *Mining tenure was considered more important than all environmental and social criteria. Mineral resources could be sterilised due to surface or subsurface disturbance with the location of a rail route. It is also perceived that there could be time delays in project schedule involved with negotiating with other mining companies.*
Legislative and Policy context	*Mining Act 1978*
How measured	Distance from mine site
Data Source	DMP
Ratings	
Fatal Flaw (999)	<1 km from a mine site
Poor (100)	Within 5 km of a mine site
Moderate (50)	N/A
Good (1)	> 5 km from a mine site

ENGINEERING AND INFRASTRUCTURE

Table 37 Rivers and Creeks

Objective	**To minimise the number of river and creek crossings within the corridor.**
Rationale for including this criteria	Increased engineering and construction costs would be required to cross creeks and rivers. Construction involving river and creek crossings could impact water quality through sedimentation and disturbance to banks and riparian vegetation. *Rivers and creeks were considered to be more important than most social criteria but less important than national heritage sites and mining activities. It was considered to be more important than all engineering criteria but less important than most of the environmental criteria.*
Legislative and	*Waterways Conservation Act 1976*

Policy context	*Water and Rivers Commission Act 1995* *Conservation and Land Management Act 1984*
How measured	Distance to Major Rivers
Data Source	Department of Land and Information (Landgate) Geoscience Australia
Ratings	Category
Fatal Flaw:	N/A
Poor:	Route is <200 m from a major river
Moderate:	Route is 200-300 m from a major river
Good	None of the above

Table 38 Road

Objective	**To minimise the number of road crossings and maintain a safe distance from road within the corridor.**
Rationale for including this criteria	**While the major inputs and outputs of the plant will be delivered to and from the site via pipeline, chemicals and equipment will need to be delivered to the site in trucks via the road network.** *Road was considered to be more important than only two criteria; land tenure and native title because of the ability to mitigate poor road issues.*
Legislative and Policy context	N/A
How measured	Proximity to major and minor roads. Land use adjacent to these roads was not considered, i.e. a district road is considered equally suitable whether it passes through residential, industrial, agricultural or other land uses.
Data Source	Existing Dataset - Mapinfo Pro
Ratings	

Fatal Flaw (999)	N/A
Poor (100)	0-500 m from major road
Moderate (50)	100-500 m from secondary road
Good (1)	Road is > 500 m

Table 39 Interference with infrastructure

Objective	**To minimise interference with infrastructure.**
Rationale for including this criteria	**Interference with infrastructure is a health and safety issue.** *Interference with infrastructure was considered to be less important than all environmental and social criteria except aesthetics, land tenure and native title because any interference with infrastructure could be mitigated with engineering options.*
Legislative and Policy context	N/A
How measured	Distance from infrastructure
Data Source	Department of Land and Information (Landgate) Geoscience Australia - Mines, state agreements Department of Industry and Resources - Mines, Pipelines
Ratings	Category
Fatal Flaw (999)	Within a water body (e.g. dam)
Poor (100)	Within a BHP mining\ mineral leases or proposed tenement Within a third party state agreement Within 1 km of an asbestos mine (current and abandoned) Within a third party mining\ mineral lease

Moderate (50)	Within a RIO lease or proposed tenement
	Within a third party prospecting or exploration licences
	Within a third party retention licence
	Within a third party general purpose licence
	Within a third party miscellaneous licence
Good (1)	Within the proposed RHIO state agreement

Appendix C – GIS Bibliography

ROY HILL MULTI CRITERIA ANALYSIS DATA BIBLIOGRAPHY

DATA SET	TYPE	DESCRIPTION	CUSTODIAN	Supplementary Info and Links
Aboriginal.gdb				
Aboriginal_Burial_Grounds	AREA	Aboriginal Sites compiled by DIA since 1998. Burial grounds only. Clipped to AOI	Department of Indigenous Affairs	02DataIncoming\Aboriginal\AboriginalSites
Aboriginal_sites	AREA	Aboriginal Sites compiled by DIA since 1998.	Department of Indigenous Affairs	02DataIncoming\Aboriginal\AboriginalSites
DIA_Comminities	POINT	Aboriginal Communities	Department of Indigenous Affairs	02DataIncoming\Communities\
NTDA_Register	AREA	Registered Native Title Determination Applications. AKA Native Title Claims	National Native Title Tribunal	02DataIncoming\Aboriginal\NativeTitle
Administration.gdb				
Cadastre	AREA	Cadastral data for the AOI.	Landgate	02DataIncoming\Landgate\20090421_2544_RH1lOP
MCA_AOI	AREA	MCA Area of Interest shape		
Mineral_Tenemants	AREA	Mineral Tenements for Western Australia	DMP	02DataIncoming\DoIR\080715
Environmental.gdb				
Acid_Sulfate_Soil	AREA	Acid sulfate materials are saline soils or sediments containing the build-up of iron sulfides in the upper soil layers under waterlogged or highly reducing conditions (ie. sulfidic conditions).	WA Planning Comission	02DataIncoming\CSIRO\Acid_Sulfate_Soils
DEC_Tenure	AREA	DEC Managed Lands and Waters within Western Australia. Tenure categories include National Parks, Nature Reserves, Conservation Parks, State Forest and Timber Reserves, ex Pastoral Lease and Freehold areas managed by DEC.and Marine Parks and Marine Nature	DEC	02DataIncoming\DEC
ESA	AREA	Environmentally Sensitive Areas as declared in Regulation 6 in Government Gazette No. 115 Environmental Protection (Clearing of Native Vegetation) Regulations 2004.	Department Of Environment	02DataIncoming\DOE
Herb	POINT	WA Herb data	DEC	02DataIncoming\DEC\Threatened Flora
Important_Bird_Areas	AREA	Draft Important Bird Areas	Birds Australia	02DataIncoming\Important Bird Areas Australia
Important_Wetlands	AREA	This is a polygon coverage representing the wetlands cited in the "A Directory of Important Wetlands in Australia" Third Edition (EA, 2001), plus various additions for wetlands listed after 2001.	Australian Government Department of the Environment and Water Resources	\02DataIncoming\Department of Environment and Heritage\080508\Wetlands
Marine_Turtles	POINT	Potential Areas for Marine turtles	Wildlife Division Environment Australia	02DataIncoming\Wildlife Division Environment Australia
Proposed_DEC_Tenure	AREA	An extension of DEC_Tenure showing future proposed additions.	DEC	02DataIncoming\DEC
Registered_Nat_Estate	AREA	Places on the Register of the National Estate (RNE)	Aus Gov Dept of the Environemt, Water Heritage and the Arts	\02DataIncoming\Australian Government Department of the Environment, Water, Heritage and the Arts

Schedule_1	AREA	Areas requiring a permit for clearing resulting from low impact mineral or petroleum activities as declared in Regulation 6 in Government Gazette No. 115 Environmental Protection (Clearing of Native Vegetation) Regulations 2004 - Schedule 1.	Department Of Environment	02DataIncoming\DOE
Threatened_Ecological_Community	AREA	Threatened Ecological Community	DEC	02DataIncoming\DEC\DEC TEC's- inc Port Hedland and Rail corridor
Threatened_Fauna	POINT	Threatened Fauna database, which includes species which are declared as 'Rare or likely to become extinct (Schedule 1)', 'Birds protected under an international agreement (Schedule 3)', and 'Other specially protected fauna (Schedule 4)'.	Dept of Environment and Conservation	02DataIncoming\DEC
Threatened_Flora	POINT	Threatened Flora	DEC	02DataIncoming\DEC\Threatened Flora
Infrastructure.gdb				
Minedex	POINT	Minedex minesite locations.	DOIR	02DataIncoming\DoIR\18Nov2008
Major_Roads	LINE	Major and minor roads.	Landgate	
Railways_Pilbara	LINE	Railways in the Pilbara region.		
MCA Engineering.gdb				
Airstrips_3k	AREA	Airports and landing strips buffered by 3k		
Water_Bodies	AREA	Waterbodies within the AOI	Geoscience Australia	\02DataIncoming\GA\GlobalMap
Rivers	AREA	Major rivers in the AOI	Landgate	
State_Agreements	AREA		DMP	
MCA Environmental.gdb				
Mangrove_fatal_2	AREA	Mangrove locations in the AOI.	Geoscience Australia	
MCA Social.gdb				
BHP_Rail_Easment_Digitised	AREA	BHP Rail Easement digitised from Landgate WFS cadastre	Landgate/WP	
Homesteads_5km	AREA	Homesteads digitised from 250K Geoscience raster	WorleyParsons	02DataIncoming\Geoscience Australia\2003\localities
Woodstock_Art_Site	AREA	Woodstock Art Site Only. Clipped to AOI	Aus Gov Dept of the Environemt, Water Heritage and the Arts	DataIncoming\Australian Government Department of the Environment, Water, Heritage and the Arts
BHP_Tenements	AREA	BHP Tenements in the AOI	DOIR	02DataIncoming\DoIR\080715
Tenements	AREA	Tenements in the AOI	DOIR	02DataIncoming\DoIR\080715
Rail Extension Proposal.gdb				
Contours_Landgate_2m_Rail_Ext	LINE	2m contours clipped to the Rail AOI.	Landgate	02DataIncoming\Landgate\Landgate1
Contours_Roy_Hill_2m_Clipped	LINE	2m contours clipped to the Rail AOI.	Roy Hill/WorleyParsons	
EthelCreek20m	RASTER		Landgate	
RoyHill20m	RASTER		Landgate	
Social_Cultural.gdb				
Landuse	AREA	National landuse	Australian Land Use and Management	DataIncoming\ALUM\Rec_080508\Landuse
Homesteads	POINT	Homesteads digitised from 250K Geoscience raster	WorleyParsons	02DataIncoming\Geoscience Australia\2003\localities

Appendix D – CAPEX Costs

Roy Hill Rail Estimate Summary

Quantm Rail Alignment CAPEX Assessment

301012-00928 WBS 004

WorleyParsons

15/06/2009

DESCRIPTION	PFS	DFS1	DFS2	Opt A	Opt B	Opt C	Opt D	Opt E
General Mobilisation	$ 4,090,848	$ 4,090,848	$ 4,909,018	$ 4,090,848	$ 4,602,204	$ 4,090,848	$ 4,704,475	$ 4,090,848
Earthworks Mobilisation	$ 7,706,496	$ 9,033,754	$ 12,339,262	$ 7,403,466	$ 9,677,715	$ 8,132,320	$ 7,675,768	$ 8,347,900
Railworks Mobilisation	$ 3,048,854	$ 2,760,607	$ 2,851,909	$ 3,030,655	$ 3,014,150	$ 3,059,809	$ 3,042,911	$ 3,086,377
Port Area Loop	$ 67,968,504	$ 67,968,504	$ 67,968,504	$ 67,968,504	$ 67,968,504	$ 67,968,504	$ 67,968,504	$ 67,968,504
Earthworks	$ 493,273,949	$ 578,228,455	$ 987,257,454	$ 473,877,757	$ 688,274,303	$ 520,529,931	$ 491,307,125	$ 534,328,630
Paving	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Walls	$ -	$ 1,308,581	$ 33,350,924	$ -	$ -	$ -	$ -	$ -
Culverts	$ 37,342,931	$ 41,739,759	$ 37,268,036	$ 36,558,462	$ 34,809,653	$ 36,239,967	$ 34,809,653	$ 33,741,081
Trackwork	$ 440,736,061	$ 399,067,606	$ 412,265,999	$ 438,105,232	$ 435,719,293	$ 442,319,629	$ 439,876,910	$ 446,160,274
Bridges	$ 152,395,799	$ 74,878,105	$ 131,886,940	$ 152,443,371	$ 140,006,726	$ 139,190,793	$ 457,170,105	$ 108,504,130
Tunnels	$ -	$ -	$ 230,814,384	$ -	$ -	$ -	$ -	$ -
Track Maintenance Yard	$ 9,224,718	$ 9,224,718	$ 9,224,718	$ 9,224,718	$ 9,224,718	$ 9,224,718	$ 9,224,718	$ 9,224,718
Mine Area Loop	$ 30,017,576	$ 30,017,576	$ 30,017,576	$ 30,017,576	$ 30,017,576	$ 30,017,576	$ 30,017,576	$ 30,017,576
Marshalling Yard	$ 23,315,862	$ 23,315,862	$ 23,315,862	$ 23,315,862	$ 23,315,862	$ 23,315,862	$ 23,315,862	$ 23,315,862
TOTALS	**$ 1,269,121,599**	**$ 1,241,634,376**	**$ 1,983,470,587**	**$ 1,246,036,452**	**$ 1,446,630,704**	**$ 1,284,089,957**	**$ 1,569,113,607**	**$ 1,268,785,901**
Inserted into PFS CAPEX Estimate	**$ 4,019,559,317**	**$ 3,992,072,094**	**$ 4,733,908,305**	**$ 3,996,474,170**	**$ 4,197,068,423**	**$ 4,034,527,676**	**$ 4,319,551,325**	**$ 4,019,223,619**
Alignment Difference	0.00%	-2.17%	56.29%	-1.82%	13.99%	1.18%	23.64%	-0.03%
Overall CAPEX Difference	0.00%	-0.68%	17.77%	-0.57%	4.42%	0.37%	7.46%	-0.01%