Dampier Port Authority
Project Margins Vegetation and Flora Survey
August 2009

Prepared for
Dampier Port Authority

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Report Reference: 1176-09SRV1Rev0_091223

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Revision Status

Rev	Date	Description	Author	Reviewer	Approval
A	26/08/2009	Draft Issued For Review	V. Long	J. Brown	
B	23/12/09	Revised Draft Issued For Review	V. Long	W. Wishart	
0	23/12/09	Final Issued for Information	V. Long	W. Wishart	D. Pedersen

Report Reference: 1176-09SRV1Rev0_091223

Report Parameters	
Format	Word 2007
Network Location	P:\Reimbursible\DPA 1100\1176 DMSF Project Margin Flora & Veg Survey\Reports\Clearing permit\1176-09SRV1Rev0_091223 DPA Project Margins Vegetation and Flora Survey.docx
Figures	IR
Referencing	Harvard

Checking Status	
Text	IR
Figures	IR
Tabulations	IR
Calculations	NR
Statistics	NR

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Executive Summary

The Dampier Marine Services Facility (DMSF) project will involve the dredging of berth pockets and swing basins, the construction of a 300 m wharf and the development of a laydown area. The footprint of the berth pockets and swings basins is expected to be 45 hectares. The laydown area will be constructed largely via reclamation and will be 22 hectares in size. The footprint of this laydown area includes a narrow stretch of land along the foreshore, approximately 2 hectares in size, which contains the flora and vegetation to which this document refers (the Survey Area).

The flora and vegetation within the proposed Dampier Port Authority's (DPA) DMSF site (the Survey Area), which is located on the western side of the Burrup Peninsula, was surveyed by Astron Environmental Services (Astron) Principal Botanist on 5 August, 2009. The Survey Area comprises a total area of 4.69 ha. Of this, approximately 3.16 hectares is bare land (contained within the marine wash zone) while the remainder consists of sparse to good vegetation cover.

The Survey Area is situated within a location which has been identified for future development by the Burrup Peninsula Land Use Plan and Management Strategy (BPMAB, 1996), and is a use which is consistent with this Study.

The aim of the flora and vegetation survey was to update information supplied in the previous survey of the area (Astron, 2004) in compliance with procedures outlined in the Environmental Protection Authority (EPA) Position Statement No 3 and EPA Guidance Statement 51 relating to Flora and Vegetation Surveys at a level 1 assessment.

The Survey Area is located on the western side of the Burrup Peninsula, approximately 12 km from Karratha, along the coastal portion of DPA Lot 565 extending from the Dampier Cargo Wharf (DCW) northwards for approximately 500 m. The seaward edge of the Survey Area has large Rhyodacite blocks of rock dipping down into the sea interspersed by areas of rocky platform. At one area the rocky coastline is interrupted by a small narrow remnant drainage line, which, before construction of the current DPA facility, was fed by a rocky gully. The coastal strip immediately behind the rocky coastline features a flat coastal plain with brownish colluvial soils. A full description of the location and site is given in Astron 2004.

A total of 51 vascular species and one fern species from 29 families were recorded within the Survey Area. The dominant families represented were Poaceae (grasses), Papillionaceae (peas) and Mimosaceae (wattles).

A total of four weed species were recorded within the Survey Area: **Aerva javanica*, * *Cenchrus ciliairs*, **Passiflora foetida* var. *hispida* and **Phsalis angulata* (Wild Gooseberry).

No Declared Rare Flora species as listed under State and Federal legislation were recorded within the Survey Area. Further, no vegetation communities listed under State or Federal legislation were recorded. No marine associated flora, such as mangroves and salt marsh species, were recorded in the Survey Area.

Two Priority 3 species were recorded: *Terminalia supranitifolia* and *Rhynchosia bungarensis*. Additional five species identified as having conservation significance were also recorded within the Project Area: *Paspalidium tabulatum* (Burrup form), *Triodia angusta* (Burrup form), *Triodia epactia* (Burrup form), *Corchorus walcottii* (Burrup form) and *Triumfetta appendiculata* (Burrup form).

Five vegetation types were broadly described within the Survey Area and vegetation condition was described as Excellent. The Survey Area contains one vegetation association that was considered by Trudgen (2002) as having high conservation value. It is described as:

> *Dwarf shrubland of Pluchea tetranthera (and annual Streptoglossa decurrens) over hummock grassland of Triodia epactia (Burrup form) with tall annual herbland of Trichodesma zeylanicum with scattered Acacia colei.*

This is the single known occurrence of this Trudgen (2002) vegetation association on the Burrup Peninsula.

No Threatened Ecological Communities were recorded within the Survey Area. One Priority Ecological Community was recorded: Burrup Rock Pile Communities, listed as a poorly known ecological community. A small proportion (0.63 ha) of this community will be impacted by the DMSF project.

Following is a summary of the environmental survey findings, addressing the context of the Ten Clearing Principles.

a) Native vegetation shall not be cleared if it comprises a high level of biological diversity.

There are no Declared Rare Flora (*Wildlife Conservation Act 1950*) or Threatened flora (*Environment Protection and Biodiversity Conservation Act 1999*) recorded within the Survey Area. There are six Priority listed species recorded on the Declared Rare and Priority Flora list for the Burrup Peninsula (DEC, 2009), two of which were recorded within the Survey Area. Both species, *Terminalia supranitifolia* (Priority 3) and *Rhynchosia bungarensis* (Priority 3), are well represented on a local scale on the Burrup Peninsula, however, are less well represented elsewhere in the Pilbara region (Western Australian Herbarium, 2009). In addition, five Priority species are listed on the WA Herbarium Specimen Database as having been collected within a 50km radius of the Project Area (DEC, 2009).

Astron (2004) has previously indicated that a greater density of *T. supranitifolia* appears to be supported in the area between King Bay Supply Base and the Karratha Gas Plant, than found elsewhere on the Burrup Peninsula. The majority of this area has now been cleared for Woodside's Pluto Project. Astron based this knowledge on numerous flora and vegetation surveys conducted on the Burrup Peninsula (Astron 1999, 2001c, 2001d, 2002, 2004, participation in the Trudgen Burrup Survey 2002 and general observations (V. Long and J. Kruger)). At least 289 individual GPS locations for *Terminalia supranitifolia* have been recorded on the Burrup Peninsula (Pluto, 2006). The proposed DMSF will reduce the number of *T. supranitifolia* by 22 individuals. It is noted that Rock

Pile Vegetation Communities, of which *T. supranitifolia* is a component, have PEC status according to the Department of Environment and Conservation (2008).

The occurrence of *Rhynchosia bungarensis* on the Burrup is still been evaluated but is generally a component of the PEC Rock Pile communities.

There are 37 species on the Burrup Peninsula identified by Trudgen (2002) as having conservation significance, of which five were recorded within the Survey Area. *Paspalidium tabulatum* (Burrup form), *Triodia angusta* (Burrup form), *Triodia epactia* (Burrup form), *Corchorus walcottii* (Burrup form) and *Triumfetta appendiculata* (Burrup form) are all locally common to abundant, but are considered to be moderately restricted.

However, it is difficult to place this number of species into perspective given that no dedicated survey work has been done to determine the number of individuals of *T. supranitifolia* on the Burrup Peninsula; and large areas of the Burrup Peninsula are now in a Conservation Reserve.

Of the five vegetation associations described within the Survey Area, one was identified by Trudgen (2002) as having high conservation value. It was mapped as PtTe by Trudgen (2002) but referred to as Cp2 in Astron (2004). The vegetation association is described as: Dwarf shrubland of *Pluchea tetranthera* (and annual *Streptoglossa decurrens*) over hummock grassland of *Triodia epactia* (Burrup form) with tall annual herbland of *Trichodesma zeylanicum* with scattered *Acacia colei*. The extent of this vegetation association crosses the boundary outside the current disturbance footprint, with approximately 0.16 hectares impacted. While the individual species is common, this vegetation association is the only occurrence of its kind on the Burrup Peninsula.

No known TEC's were recorded within or adjacent to the Survey Area. There are two Priority 1 PEC's listed for the Burrup Peninsula, Burrup Peninsula Rock Pool Communities and Burrup Rock Pile Communities. The Burrup Peninsula Rock Pile Community, recognised as a Priority 1 Poorly Known Ecological Community, was identified within the Survey Area. No occurrences of the Rock Pool Community were recorded in or immediately adjacent to the Survey Area. The union of the PEC Rock Pile Community species with more typical coastal low tree and shrubs species distinguishes this from the majority of Burrup rock pile vegetation and thus increases the conservation significance of this Rock Pile Community. PEC's do not have the same official status as TEC's and are not listed as Special Environmental Areas for vegetation clearing controls, however it is expected that efforts are made to protect PEC's where possible as part of good environmental management practice.

The loss of 22 individuals of *Terminalia supranitifolia* (Priority 3) and the part clearing of the Rock Pile Community identified by Trudgen (2002) means the clearing of vegetation within the Survey Area may be at variance to Principle a).

b) Native vegetation shall not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Terrestrial fauna habitats on the Burrup Peninsula are well represented throughout the Pilbara regions (Pluto, 2006). A variety of habitat types are known to occur on the Burrup Peninsula

including rocky outcrops, rocky scree slopes, drainage gullies and valleys and coastal habitats such as mangals, beaches, saline flats and rocky coastlines. The Survey Area contains examples of these habitat types.

The fauna of the Burrup peninsula has been extensively surveyed and is well documented and most vertebrate are widespread throughout the Pilbara region. Of the 300 vertebrate species recorded in the area there are approximately 36 mammal species, 186 bird species, 78 terrestrial reptile species and four amphibian species. None of these are known to be restricted to the Burrup Peninsula (Worley Astron 2005).

The Survey Area is considered potentially suitable habitat for four declared threatened terrestrial fauna species, the Northern Quoll (*Dasyurus hallucatus*), Pilbara leaf-nosed bat (*Rhinonicteris aurantius*, Pilbara Form), Pilbara olive python (*liasis olivaceus*) and the peregrine falcon (*Falco peregrines*).

Most of the conservation significant species possibly occurring within the region that includes this project are mobile species (Woma Python, Star Finch, Peregrine Falcon, Grey Falcon, Australian Bustard and Bush Stone-curlew) and given the small area proposed for disturbance and adjacent areas of similar habitat, impacts to these species will be minimal. The Survey Area is considered potentially suitable habitat for two conservation significant mammal species, the Northern Quoll and the Pilbara leaf-nosed bat, although no evidence of these species were found during the current site inspection. If present, the impact to these species is also considered to be low as the habitat within the Survey Area would not be considered necessary for the maintenance of these species. The area proposed for disturbance is small and similar habitat is widespread in the area. However, it is recommended that a thorough search of the disturbance area is conducted for these species and any individuals are relocated, further reducing the potential impacts to these species if present.

Given the low likelihood of impact on mobile species and a recommended management approach the clearing of vegetation within the Survey Area is unlikely to be at variance to Principle b).

c) Native vegetation shall not be cleared if it includes, or is necessary for the continued existence of, rare flora.

There are no records of Declared Rare Flora or EPBC listed flora within a 50km radius of the Survey Area or the Burrup Peninsula. A field survey was undertaken for the Project Area in accordance with EPA Guidance Statement 51. No DRF was identified. The clearing of vegetation within the Survey Area is therefore not likely to contain DRF or to be at variance to Principle c).

d) Native vegetation shall not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a threatened ecological community.

There are no known occurrences of Threatened Ecological Communities (TEC) within the Survey Area or the Burrup Peninsula. Therefore the clearing of vegetation within the Survey Area is considered not to be at variance with Principle d).

e) Native vegetation shall not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

The Survey Area is located in the Abydos Plain vegetation association which was categorised by Kendrick and Stanley (2001) as having a medium reservation priority. An estimated 13,760 ha of this association is protected within conservation reserves. The Survey Area does not comprise an isolated remnant of intact vegetation, thus the clearing of vegetation within the Survey Area is not likely to be at variance to Principle e).

f) Native vegetation shall not be cleared if it is growing in, or in association with an environment associated with a watercourse or wetland.

The Survey Area does not include and is not in close proximity to any watercourse or any wetlands listed as Ramsar sites (DEWHA, 2009). The clearing of vegetation within the Survey Area is therefore not likely to be at variance to Principle f).

g) Native vegetation shall not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

The soils within the Survey Area are predominantly alluvial sand and loams. These soils are not susceptible to accelerated erosion (Payne *et al.*, 1987). As with any land clearing, the proposed clearing at the DMSF site has the potential to affect soil surfaces, resulting in a degree of land degradation. However, in an environment that is already well adapted to erosive processes the small area proposed to be impacted is unlikely to lead to land degradation.

Four common invasive weeds were recorded during the survey, Buffel Grass, Kapok Bush, Wild Passionfruit and Wild Gooseberry. Buffel Grass (**Cenchrus ciliaris*) is now widespread in the Pilbara region and on disturbed areas of the Burrup peninsula, however was not abundant within the Project Area. Kapok Bush (**Aerva javanica*) has long been known to occur on the Burrup Peninsula and is subject to weed control. All occurrences of Wild Passionfruit located during the field survey were cut and sprayed by the DPA Environment Team on August 17th, 2009. Wild Gooseberry has not previously been recorded on the Burrup Peninsula, and the individual identified within the Survey Area was destroyed at the time of the field survey.

Given the relatively small amount of vegetation clearing required for the project (1.5 hectares), the current presence of invasive weed species within the Survey Area, it is considered that the clearing of vegetation within the Survey Area should not be at variance to principle f).

h) Native vegetation shall not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

The Survey Area is not located within or adjacent to any conservation areas and the clearing of vegetation within the Survey Area is therefore not likely to be at variance to Principle h). The boundary of the nearest conservation area is greater than 2 km from the Survey Area.

i) Native vegetation shall not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

The Survey Area is not located within a Public Drinking Water Source Area (PDWSA) (DoW, 2009), and the site is only two to three metres above the highest astronomical tide. Groundwater in the vicinity of the project area is limited (Pluto, 2006). The clearing of vegetation in the Survey Area is unlikely to impact on the quality of ground water resources within the area.

With respect to potential contamination from the port expansion, this facility will be constructed and managed in accordance with a licenses and works approvals to be obtained from the Department of Environment and Conservation in accordance with Part V of the *Environmental Protection Act 1986.*

Therefore, given appropriate design and management the construction and operational phase of the the clearing of vegetation within the Survey Area should not be at variance to Principle (i).

j) Native vegetation shall not be cleared if the clearing of the vegetation is likely to cause, or exacerbate the incidence or intensity of flooding.

The closest weather station**,** Karratha and the Survey Area experience both seasonal rainfall during winter as well as summer rainfall associated with cyclone activity. Given the nature of the proposed project (immediately adjacent to and only through to three metres above the sea) and the relatively small area of vegetation to be cleared (1.5 hectares), it is highly unlikely that it would cause or exacerbate the incidence or intensity of flooding and thus it is anticipated that the clearing of vegetation within the Survey Area will not be at variance to j).

Other matters for consideration

During the planning phase of the DMSF project, the DPA undertook extensive research to ensure the potential impacts to the environment, and in particular the native vegetation, was minimised. In 2007, the DPA commissioned a study (Worley Parsons, 2007) which comprehensively reviewed the options available for locations of the DMSF facility within the Dampier region. The study initially assessed and ranked potential sites on the basis of dredging and infrastructure development requirements and heritage and environmental constraints. Four sites were able to be discounted from further investigation due to the requirement to disturb significant areas of mangroves and significant dredging requirements. The remaining options were then subject to a rigorous assessment, which included more detailed investigation of environment and heritage constraints. The final location for the proposed DMSF was considered to achieve the best balance between environmental, heritage and a multitude of development considerations.

During the construction phase of the DMSF project, DPA proposes several measures to minimise the impact on vegetation, including the following:

- Minimise the disturbance footprint and therefore the area of vegetation to be disturbed;
- Avoiding disturbance to the PEC Burrup Rock Pile Community; and

- Avoiding, as far as practicable, disturbance to the Priority species *Terminalia supranitifolia*.

In addition, DPA has proposed a strategy to mitigate the loss of vegetation from the DMSF area, which includes the following:

- Develop cultivation techniques for a sub-set of local native species – working closely with Astron Environmental Services and a native plant nursery situated at Mingullatharndo (Five Mile Aboriginal Community) to develop new techniques to germinate and grow local native plants in a nursery environment. Species would be prioritised toward those from the DMSF development footprint, and the Burrup Peninsula.
- Establish a nursery program in conjunction with Roebourne Regional Prison – basic cultivation techniques developed at the nursery will be incorporated into a horticultural module of the existing Department of Environment and Conservation Course offered by Roebourne Regional Prison. This may also include the collection of native seed.

The aim of this work is to establish cultivation techniques for the native species and to provide this information to local nurseries and encourage the use of endemic species (and therefore highly suited to the local environment) in landscaping and rehabilitation projects. Further details of the mitigation strategy are outline in correspondence in Appendix A.

It should also be noted that some 60 ha of the Burrup Peninsula is within a Conservation Reserve, providing permanent protection to the flora (and fauna) within this area. The DMSF project footprint does not encroach on any of these areas.

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1 Introduction

1.1 Background

The Dampier Port Authority (DPA) is proposing to commence the construction of the Dampier Marine Service Facility (DMSF) as part of their Port Expansion Project. The facility is located on the western side of the Burrup Peninsula, approximately 12 km from Karratha in the Pilbara Region and 100 metres east of the existing Dampier Cargo Wharf (DCW) (Figure 1). The DMSF project will include the development of ~20 hectare laydown area via reclamation of submerged lands, dredging of berth pockets and swing basins and the construction of a 300 metre wharf (Figure 2). The footprint of this laydown area includes a narrow stretch of land along the foreshore of 4.69 hectares in size, which is herein referred to as the Survey Area.

The area of terrestrial disturbance has previously been surveyed for vegetation and flora (Astron 2004), however DPA has requested that the Survey Area be re-surveyed to capture the occurrence of any potential Priority Flora (DEC 2009) and any changes to vegetation that may have occurred.

1.2 Scope

Astron Environmental Services (Astron) was commissioned by DPA to undertake the terrestrial flora and vegetation survey within the Survey Area. The aim of the survey was to update information supplied in the previous survey (Astron 2004) in compliance with procedures outlined in *Environmental Protection Authority (EPA) Position Statement No 3* and *EPA Guidance Statement No 51* relating to Flora and Vegetation Surveys at a Level 1 assessment.

1.3 Objectives

The flora and vegetation survey was designed to:

- Check the accuracy of previous vegetation mapping within the Survey Area;
- Record any Priority or Significant Flora locations with GPS;
- Record the location of weed species;
- Make changes to previous vegetation mapping as necessary;
- Address any limitations to the survey; and
- Prepare a report which will update the previous report prepared for this area (Astron 2004) to satisfy all relevant State regulatory requirements.

1.4 Project Location and Site Description

The Survey Area is located on the western side of the Burrup Peninsula, along the coastal portion of DPA Lot 565 extending from the Dampier Cargo Wharf (DCW) northwards for approximately 500 m (Figure 2). The seaward edge of the Survey Area has large Rhyodacite blocks of rock dropping down into the sea, interspersed by areas of rocky platform. At one area the rocky coastline is traversed by a narrow remnant drainage line which, before construction of the current DPA facility, was fed by a rocky gully. The coastal strip immediately behind the rocky coastline features a flat coastal plain with brownish colluvial soils. A full description of the location and site is given in Astron (2004). Photographs of the Survey Area are provided in Figure 3.

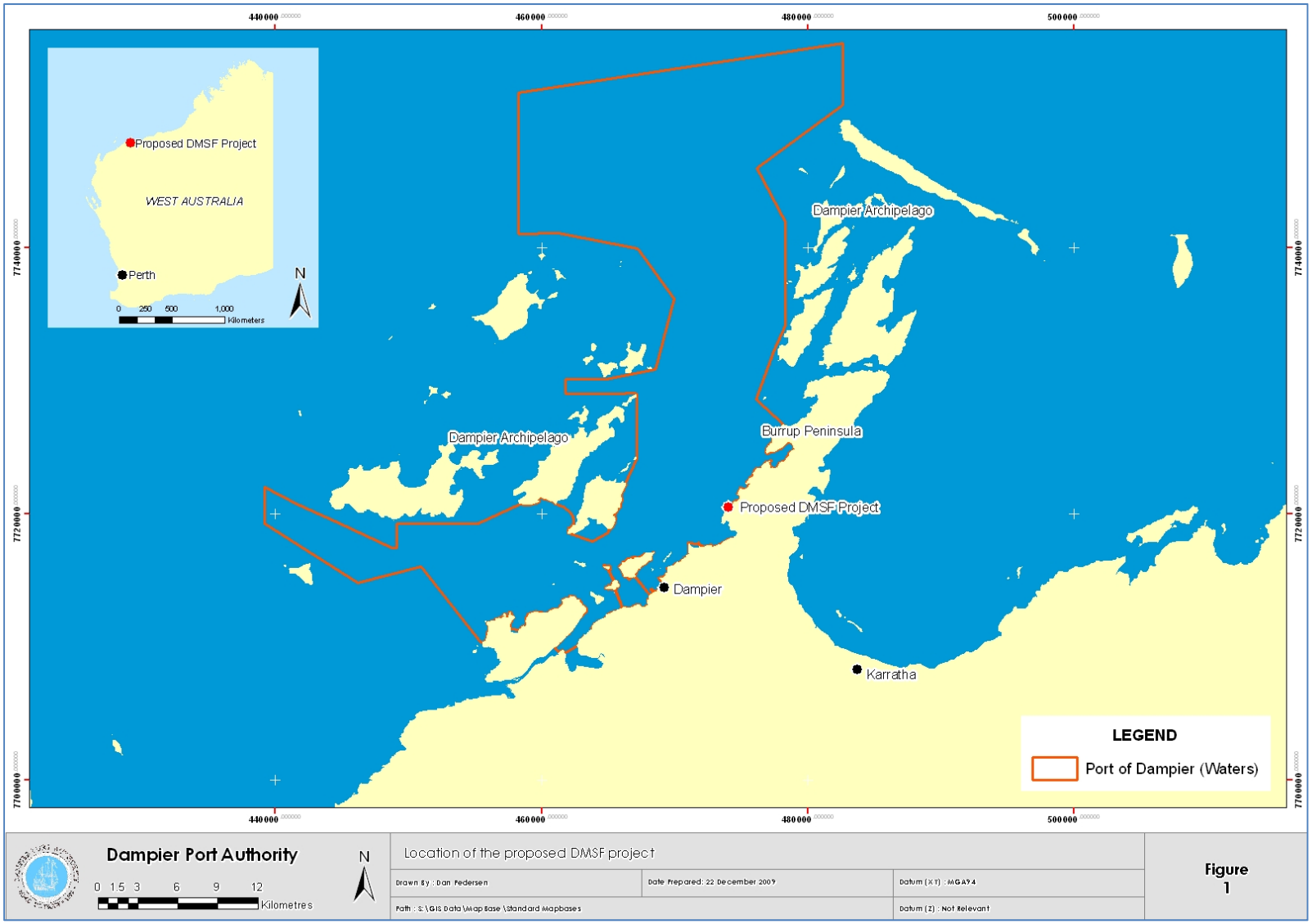

Figure 1: Regional Location of the DMSF Project (Dampier Port Authority, 2009).

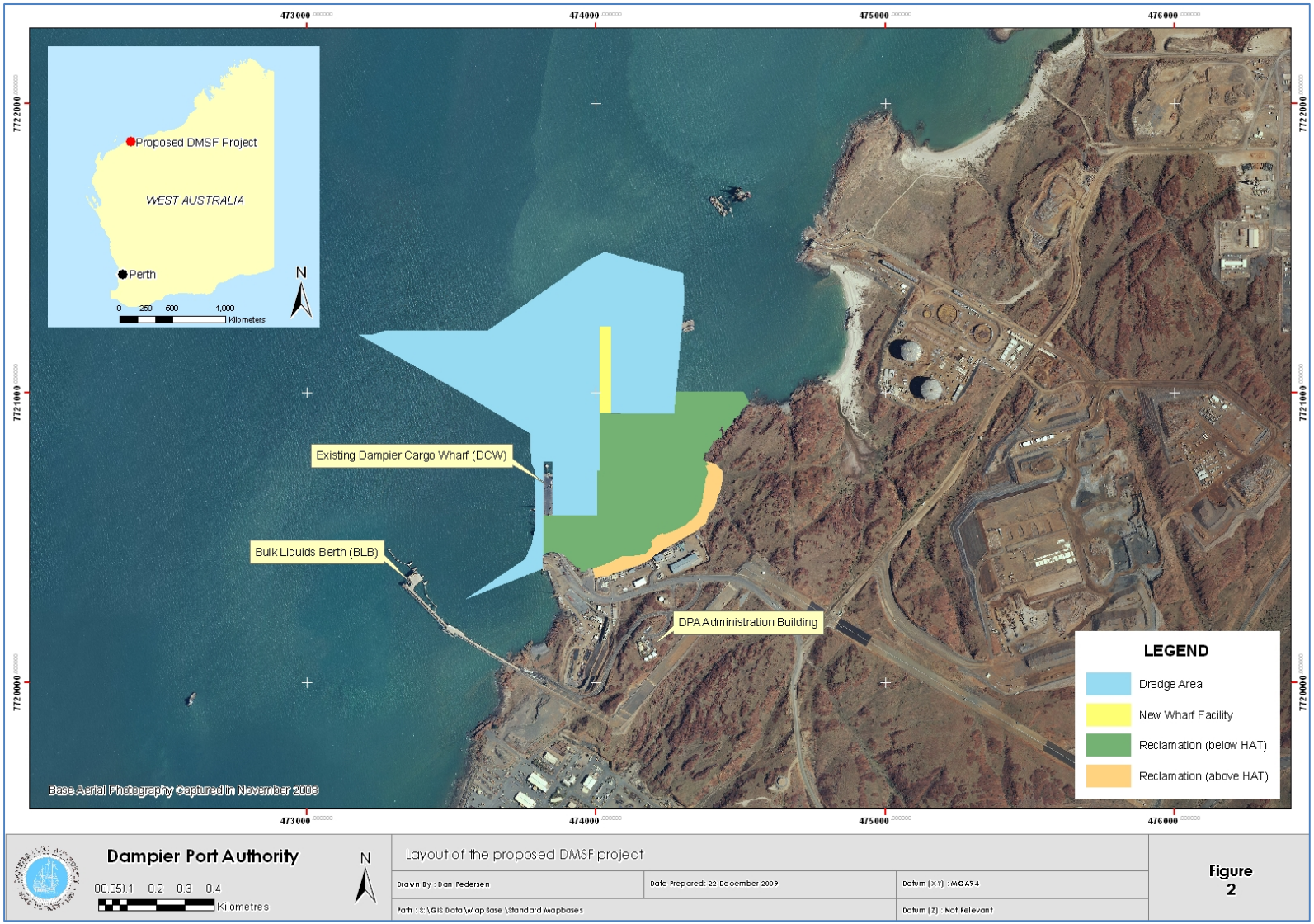

Figure 2: Layout of the DMSF Project (Dampier Port Authority, 2009).

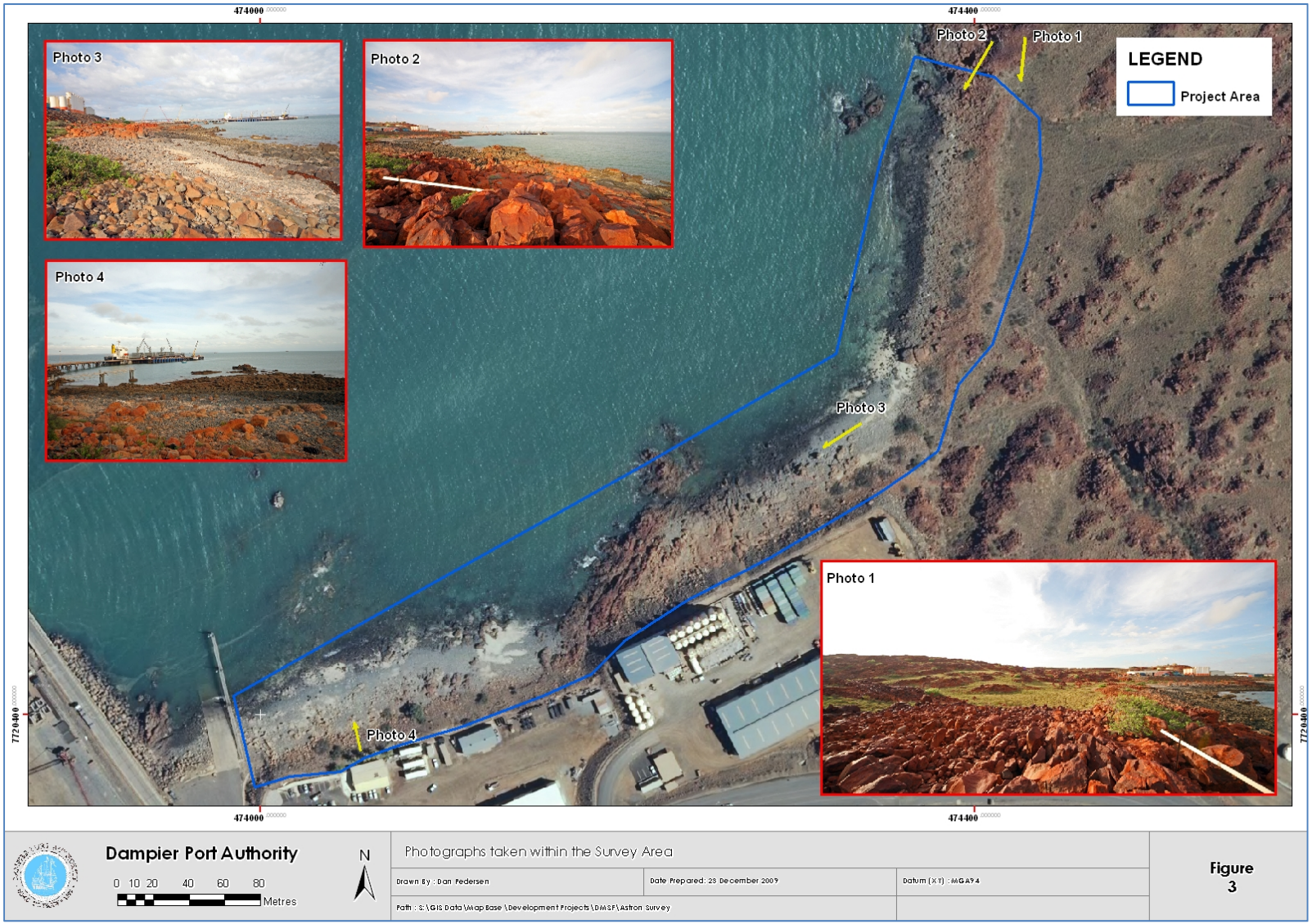

Figure 3: Photos of the proposed DMSF Project Area (Dampier Port Authority, 2009).

1.5 Proposed Land Use

The proposed land use for the Survey Area is consistent with the Burrup Peninsula Land Use Plan and Management Strategy (September 1996). This document indicates the Survey Area forms a component of Policy Area C, which defines the future use as Industrial and Port uses, as shown below in Figure 4. This document was endorsed by the West Australian State Government and represents the current Land Use Plan for the region.

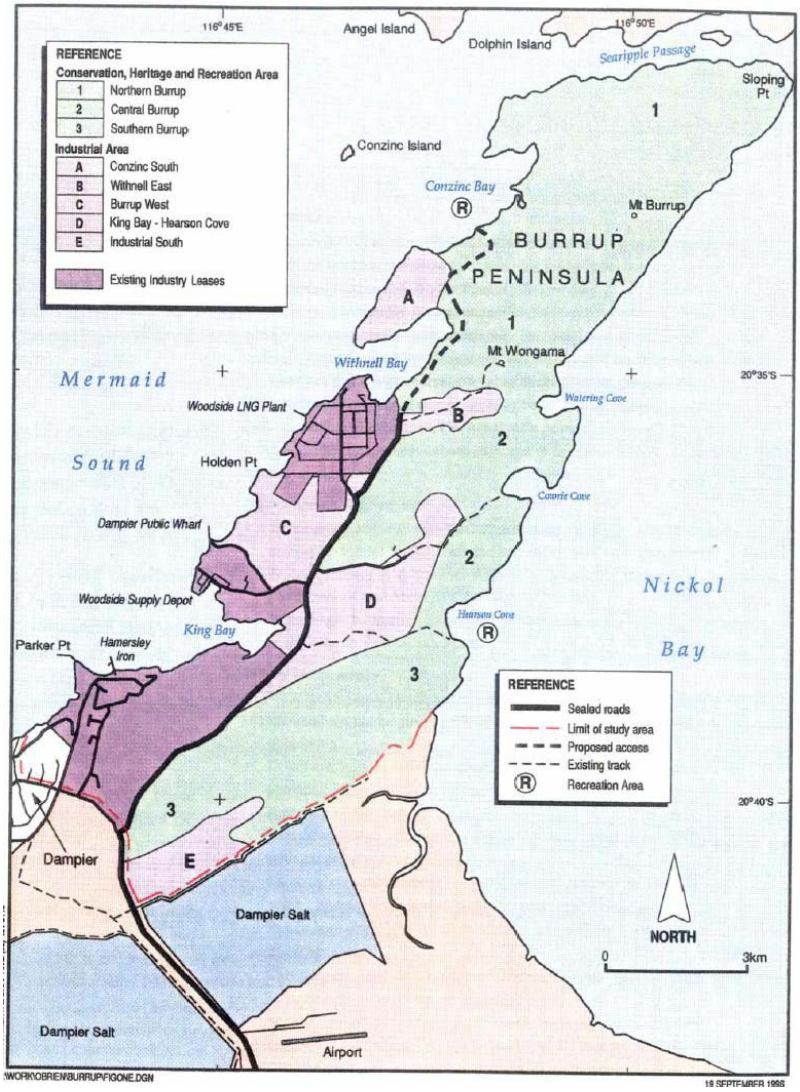

Figure 4: Proposed Burrup Peninsula Land Uses (BPMAB, 1996).

In addition, the Dampier Port Authority identified the need to expand the Dampier Port facilities to meet continued strong growth in the region. This need was outlined in the Port Development Plan, 2004, which was endorsed by the West Australia State Government. The Survey Area falls within the area discussed within this report.

2 Existing Knowledge of the Vegetation and Flora on the Burrup Peninsula

A summary of previous vegetation and flora surveys of the Burrup Peninsula, including Blackwell and Cala (1979), Trudgen and Griffin (2001) and Trudgen (2002), is detailed in Astron (2004). Trudgen (2002) did not map coastal or rock pile vegetation associations, but mapped two associations (Table 1) on the coastal plain immediately behind the coastal rocks.

Table 1. Vegetation Associations Identified by Trudgen (2002) within the current Survey Area.

Vegetation Code	Vegetation Description
PtTe	*Pluchea tetranthera* low open shrubland over *Triodia epactia* (Burrup form) hummock grassland.
CpTe	*Cullen pustulatum* scattered tall shrubs over *Triodia epactia* (Burrup form) hummock grassland.

The Astron (2004) survey identified four vegetation associations, including the coastal rockpile vegetation association (Table 2).

Table 2. Vegetation Associations Identified by Astron (2004) within the current Survey Area

Vegetation Code	Vegetation Description
R3 BaTsAc	Open low woodland of *Brachychiton acuminatus* and *Terminalia supranitifolia* over shrubland of *Acacia coriacea*, *Ipomoea costata*, *Stylobasium spathulatum* over very open mixed grassland of *Triodia epactia* (Burrup form) and *Cymbopogon ambiguus*.
R10 AcIcFvRp	Open very low mixed woodland and shrubland of *Acacia coriacea*, *Ipomoea costata* with *Ficus virens* var. *virens*, *Rhagodia preissii obovata*, *Stylobasium spathulatum*, *Brachychiton acuminatus*, *Terminalia supranitifolia* with occasional liane *Rhynchosia minima* (82-1C).
Cp1 AcIcTe	Low shrubland of *Acacia coriacea* and *Ipomoea costata* over open hummock grassland of *Triodia epactia* (Burrup form).
Cp2 PtTe	Dwarf shrubland of *Pluchea tetranthera* (and annual *Streptoglossa decurrens*) over hummock grassland of *Triodia epactia* (Burrup form) with tall annual herbland of *Trichodesma zeylanicum*. Scattered *Acacia colei*.

3 Methods

3.1 Desktop Research

Prior to undertaking the vegetation and flora survey, a brief desktop assessment was undertaken following procedures outlined in the EPA Guidance Statement 51. This involved a review of all available flora and vegetation information relevant to the Burrup Peninsula.

The databases listed in Table 3 were searched either on-line or by request to the relevant agency to obtain environmental information about the Survey Area and its surrounds.

Table 3. Description of Databases Searched.

Database	Area Searched	Information	Administrating Agency
Australian Government Protected Matters Search Tool	Burrup Peninsula	Matters of national significance and matters protected by *Environmental Protection and Biodiversity Conservation* (EPBC) *Act 1999*, e.g. heritage areas, Register of National Estate, Ramsar and Important wetlands	Department of Environment, Water, Heritage and the Arts
Directory of Important Wetlands in Australia (includes Ramsar)	Roebourne Biogeographic sub-region	Details of specific Ramsar and Directory Wetlands (Internationally and Nationally important wetlands, respectively)	
Threatened (Declared Rare) Flora database	Entire Burrup Peninsula	Validated populations of declared rare flora and some priority flora	Dept. of Environment and Conservation (WA) (DEC)
Western Australian Herbarium Specimen database		All records of declared Rare and Priority species from the WA Herbarium collection of specimens, includes un-validated historical specimens	
Declared Rare and Priority Flora list		Declared Rare Flora and Priority Flora –provides a list of species and general distribution in an area of interest	
Threatened Ecological Communities database	Roebourne Biogeographic sub-region	Threatened Ecological Communities	
Priority Ecological Communities list		Priority Ecological Communities	
Native Vegetation Map Viewer		Environmentally Sensitive Areas, Local Government Areas, roads, wetlands and rivers, conservation estate	

3.2 Field Survey

3.2.1 Data Collected

The field survey was conducted on the 5th of August 2009 by Astron's Principal Botanist, Vicki Long. Mr Wayne Young and Mr Dan Pedersen from the DPA accompanied Ms Long. As far as practicable, the survey was conducted in accordance with the EPA Guidance Statement 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* and the EPA Position Statement 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection*.

Vegetation descriptions were recorded from releve sites (unbounded quadrats) which were considered to be representative of the surrounding vegetation. These were then checked against those given in Astron (2004). A total of four releves were described within the Survey Area with the following information being collected at each site:

- Species: Species within each releve were recorded. Species unable to be identified in the field were collected for identification against the Pilbara Regional Herbarium.
- Vegetation Description: Vegetation was described according to Specht (1970) as modified by Aplin (1979) and Trudgen (2002) based on height and foliar cover of each strata (Table 4).
- Vegetation Condition: The condition of vegetation present was assessed according to Keighery (1994) and Kaesehagan (1995) (Table 5).
- Habitat and Soil: A brief description of the surrounding landscape based on landform, topography and soil was given.

Table 4. Vegetation Classification System, Aplin (1970) as Modified by Specht(1979) and Trudgen (2002).

Stratum	70-100 cover	30-70 cover	10-30 cover	2-10 cover	<2 cover
Trees > 30 m	Tall closed forest	Tall open Forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees < 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs > 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs < 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, sedges, herbs	Closed tussock grassland/ sedgeland/ herbland	Tussock grassland/ sedgeland/ herbland	Open tussock grassland/ sedgeland/ herbland	Very open tussock grassland/ sedgeland/ herbland	Scattered tussock grasses / sedges / herbs

Table 5. Vegetation Condition Assessment Scale as Adapted from Keighery (1994) and Kaesehagen (1995).

VEGETATION CONDITION SCALE		
Rating	**Condition**	**Descriptive Features**
1	Excellent	• >80% Native Flora Composition • Vegetation structure intact or nearly so • Minor signs of disturbance • Weeds are non-aggressive species (cover <5%)
2	Good	• 60 - 80% Native Flora Composition • Vegetation structure altered in places • Obvious signs of disturbance • Weed cover/abundance 5 - 20%
3	Fair ,	• 40 - 60% Native Flora Composition • Vegetation structure significantly altered yet retains basic • vegetation structure or ability to regenerate to it • Very obvious signs of multiple disturbance • Weed cover/abundance 20 - 50%
4	Poor / Partially Degraded	• 20 - 40% Native Flora Composition • Vegetation structure severely impacted by disturbance. • Scope for regeneration but not to state approaching good • Condition without intensive management. • Weed cover/abundance 50 - 80%
5	Completely Degraded	• <20% Native Flora Composition • Vegetation structure no longer intact • Extensive disturbance / modification present • Weeds are highly invasive (cover/abundance >80%)

3.2.2 Vegetation

Vegetation was described at association level incorporating structure and dominance of species. This made results comparable with Trudgen (2002) and Astron (2004). Colour aerial photography (November 2008, provided by the DPA) was used to assist in vegetation mapping.

3.2.3 Flora

Dominant species from each vegetation type were recorded with releve descriptions. Other species of less frequency but common to that particular vegetation were also recorded. Most species were identified by the botanist in the field while those species not able to be positively identified were collected and taken to the Karratha Regional Herbarium for verification.

3.2.4 Conservation Significance

A Threatened Ecological Community (TEC) is an ecological community that has been identified as being subject to processes that threaten to destroy or significantly modify it across much of its range. A TEC is on which is found to fit into one of the following categories: “presumed totally destroyed”, “critically endangered”, “endangered”, or “vulnerable” (DEC, 2007) (Table 6).

Table 6: Threatened Ecological Community categories and definitions (DEC, 2007).

TEC Category	Definition
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located.
Critically Endangered (CE)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range

Priority Ecological Communities (PECs) are those that do not meet survey criteria for or are not adequately defined to be TEC's at this stage. PECs can be placed in one of the five categories as listed in Table 7.

Table 7: Categories of priority ecological communities (DEC, 2007).

Priority 1 Poorly known from a few, small occurrences, all or most not actively managed for conservation and for which current threats exist.
Priority 2 Poorly known from few small occurrences, all or most of which are actively managed for conservation and not under imminent threat of destruction or degradation.
Priority 3 Poorly known ecological communities: Known from several to many occurrences, a significant number or area of which are not under threat or: Known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; Made up of large, and/or widespread occurrences that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.
Priority 4 Adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list.
Priority 5 Not threatened but are dependent on a specific conservation program.

Habitat types and vegetation communities within the Survey Area were assessed against criteria described for listed PECs on the Burrup Peninsula.

3.2.5 Limitations

There were no factors considered to limit the success or accuracy of this survey. Additionally the initial survey of the area by Astron (2004) was conducted after adequate rainfall.

4 Results

The results presented under each heading below are those required to update the information in Astron (2004) to meet current government requirements and to address the most recent Priority Flora List (DEC 2009).

4.1 Habitats

Five habitat types exist within the Project Area, however each is represented within very narrow corridors that occur parallel to the rocky coastline:

- Exposed coastal rock and platform;
- Toe of lower hill slope with rocks and rockpiles;
- Coastal plain with rocks and boulders;
- Alluvial coastal plain;
- Narrow incised remnant drainage line; and
- Revetment Wall.

4.2 Vegetation

The vegetation within the Survey Area was found to be similar to that mapped by Astron in the 2004 survey. Due to the detail possible for this small scale survey, an additional small vegetation association was described, this being present in a remnant drainage line that was not mapped during the 2004 survey. Vegetation present is described with its habitat and condition in Table 8. Table 8 also details the area of each vegetation association that will be disturbed by the proposed project footprint. Vegetation mapping is provided in Appendix B.

Table 8: Vegetation, Habitat, Condition and Area of Disturbance in Survey Area.

Vegetation and Code as per Astron (2004)	Habitat	Condition[1]	Area in disturbance footprint (ha)
R10 & **RW1**[2] Scattered low mixed woodland and shrubland of *Acacia coriacea*, *Ipomoea costata* with *Ficus virens* var. *virens*, *Stylobasium spathulatum*, *Brachychiton acuminatus*, *Terminalia supranitifolia* with occasional liane *Rhynchosia bungarensis.*	Exposed coastal rocks and rockpiles (R10). Trees are stunted. Scattered along revetment wall (RW1)	1	0.63
R3 Low woodland of *Brachychiton acuminatus* with *Terminalia supranitifolia* over shrubland of *Acacia coriacea*, *Ipomoea costata*, *Stylobasium spathulatum, Pittosporum phylliraeoides* over very open mixed grassland of *Triodia epactia* (Burrup form) and *Cymbopogon ambiguus*.	Narrow corridor along toe of lower hill slope with rock knolls, rocks and boulders.	1	0.33
CP1 Low shrubland of *Acacia coriacea* and *Ipomoea costata* over open hummock grassland of *Triodia epactia* (Burrup form).	Coastal plain with rocks and boulders	1	0.048
CP2 Dwarf shrubland of *Pluchea tetranthera* over hummock grassland of *Triodia epactia* (Burrup form). There is a tall annual herbland of *Trichodesma zeylanicum*. Scattered *Acacia colei*.	Coastal plain with grey-brown alluvial loamy silts.	1	0.16
CD1[3] Open dwarf shrubland of *Stemodia grossa* over sedgeland of *Cyperus vaginatus* over open tussock grassland of *Paspalidium tabulatum*	Narrow remnant drainage line incised and draining through coastal rocks.	1	0.045
Bare Ground	n/a	n/a	3.16
TOTAL DISTURBANCE FOOTPRINT			**4.69**

[1] Condition Assessment scale as adapted from Keighery (1994) and Kaesehagan (1995) See Table 5.

[2] RW1 (Revetment Wall) is a new code for this report – not coded in Astron 2004 survey.

[3] CD1 (Coastal Drain) is a new code for this report – not coded in Astron 2004 survey.

4.3 Vegetation with High Conservation Value

According to Trudgen (2002), the Survey Area contains one vegetation association that has high conservation value. It was mapped as PtTe by Trudgen (2002) but referred to as Cp2 in Astron (2004). This is the only reported occurrence of this vegetation association on the Burrup Peninsula. It is described as:

- Dwarf shrubland of *Pluchea tetranthera* (and annual *Streptoglossa decurrens*) over hummock grassland of *Triodia epactia* (Burrup form) with tall annual herbland of *Trichodesma zeylanicum*. Scattered *Acacia colei*.

Plate 1: Conservation Significant Vegetation Association, as described by Trudgen, 2002 (Astron, 2009).

It should be noted that the species comprising this vegetation association are common and secure across their wide distribution and so it is the limited occurrence of these species growing together that is of significance.

4.4 Declared Rare, Priority and Significant Flora

There are no known occurrences of Declared Rare Flora (*Wildlife Conservation Act 1950*) or Threatened Flora Species (*EPBC Act 1999*) in the Survey Area or on the Burrup Peninsula.

There are six Priority listed species recorded on the Declared Rare and Priority Flora list for the Burrup Peninsula (DEC 2009). These are:

- *Gymnanthera cunninghamii* Priority 3
- *Rhynchosia bungarensis* Priority 3
- *Schoenus punctatus* Priority 3
- *Stackhousia clementii* Priority 3
- *Tephrosia bidwillii* Priority 3
- *Terminalia supranitifolia* Priority 3

In addition, the following five Priority species are listed on the WA Herbarium Specimen Database as having been collected within a 50 km radius of the Survey Area (DEC, 2009):

- *Acacia glaucocaesia* Priority 3
- *Eragrostis lanicaulis* Priority 3
- *Eriochloa decumbens* Priority 3
- *Goodenia pallida* Priority 1
- *Heliochrysum oligochaetum* Priority 1

Two *Priority 3* species were recorded within the Survey Area. These species, their habitats and the number of occurrences recorded within the Survey Area are detailed in Appendix C.

Trudgen (2002) identified 37 species as having conservation significance on the Burrup Peninsula, five of which were recorded within the Survey Area (Table 9). These species were identified as having high conservation value as a result of a combination of varying rarities and restrictions. The WA Herbarium and Department of Environment and Conservation (DEC) are currently reviewing the species nominated by Trudgen (2002) in order to verify their status.

Table 9. Species with Conservation Significance according to Trudgen (2002) identified within the Survey Area

Species	Status according to Trudgen (2002)
Paspalidium tabulatum (Burrup form)	Locally common, moderately restricted, newly recognised.
Triodia angusta (Burrup form)	Locally very common to abundant, moderately restricted, newly recognised.
Triodia epactia (Burrup form)	Locally very common to abundant, moderately restricted, newly recognised
Corchorus walcottii (Burrup form)	Locally very common to abundant, moderately restricted, newly recognised
Triumfetta appendiculata (Burrup form)	Locally very common to abundant, moderately restricted, newly recognised

4.5 Other Flora

A total of 392 native species of flowering plants and one native fern have been recorded from the Burrup Peninsula (Trudgen 2002). Fifty-one vascular species from 29 families and 45 genus were recorded within the Survey Area. A complete species list is presented in Appendix D.

The exposed, salt laden nature of the habitat within the Survey Area is likely to have resulted in the low number and diversity of flora present. It was notable that the low tree species associated with rock piles on the Burrup Peninsula were also present on the more exposed coastal rocks. In addition to this they were also recorded on the revetment wall.

No marine associated flora, such as mangroves and salt marsh species were recorded in the Survey Area.

4.6 Weeds

Environmental weeds have been defined as plants that establish themselves in natural ecosystems and proceed to modify the natural environment (CALM 1999). The DEC has allocated a rating to weeds according to their perceived potential to impact on the natural ecosystem in which they are found. Four weed species were recorded during the survey and they are presented in Table 10, together with their DEC rating.

Table 10: Weeds Found Within the Survey Area, their DEC Rating and Comment with Regard to Occurrence on the Burrup Peninsula.

Weed Species	CALM Rating	Comment
**Aerva javanica* (Kapok Bush)	High	Has spread along roads, access tracks, disturbed areas, and hind dunes and is now spreading onto undisturbed rockpiles where it lodges in rock crevices on the Burrup Peninsula. Should be controlled.
**Cenchrus ciliaris* (Buffel Grass)	High	Is not abundant along roads, access tracks, hind dunes and all disturbed areas on the Burrup Peninsula.
**Passiflora foetida* var. *hispida* (Wild Passionfruit)	High	Was recorded in 2004 survey as occurring on Lot 565. Not common on the Burrup. Should be controlled.
**Physalis angulata* (Wild Gooseberry)	Moderate	Not previously recorded for the Burrup. Was removed at the time of survey.

4.7 Threatened and Priority Ecological Communities

There are no known occurrences of Threatened Ecological Communities (TECs) within the Survey Area or on the Burrup Peninsula.

There are two Priority Ecological Communities (PECs) listed for the Burrup Peninsula[1]:

- **Burrup Peninsula Rock Pool Communities**: calcareous (tufa) deposits, interesting aquatic snails.
    - Threats: recreational impacts and potential development; NO_X and SO_X emissions.

- **Burrup Rock Pile Communities**: Compromise a mixture of Pilbara and Kimberly species, communities are different from those of the Hamersley and Chichester Ranges.

Both are listed as Priority 1: Poorly known ecological communities and are defined as:

Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (eg. Within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range (DEC, 2007).

These two communities have more recently been updated to a Provisional list of Threatened Ecosystems (Australia Natural Resources Atlas, 2009).

[1] www.naturebase.net/component/option.com 2008

The Burrup Peninsula PEC vegetation Rock Pile communities vary and are currently described as:

Pockets of vegetation in the rockpiles and outcrops. The rock pocket communities vary from open Cymbopogon ambiguus assemblages with Ptilotus obovatus and few small forbs and grasses on otherwise bare calcrete, through to Triodia sub shrub communities, to dense shrub/tree communities with Flueggea virosa subsp. melanthesoides, Phyllanthus ciccoides, small spreading trees of Ficus brachypoda, Brachychiton acuminatus, Pittosporum phylliraeoides and Terminalia supranitifolia often as large trees and sometimes in numbers (DEC, 2009).

Vegetation association R10 found within the Survey Area includes scattered (<2% total area cover) rock pile community low trees over open grasses (*Brachychiton acuminatus, Terminalia supranitifolia, Ficus brachypoda, Triodia epactia, Cymbopogon ambiguus)* on the coastal rocks in addition to more specific coastal habitat low tree and shrub species (*Ficus virens* subsp. *virens, Ipomoea costata, Acacia coriacea*).

Vegetation association R3 found within the Survey Area includes PEC listed community species (*Brachychiton acuminatus, Terminalia supranitifolia, Ficus brachypoda, Pittosporum phylliraeoides, Flueggea virosa* subsp. *melanthesoides, Triodia epactia,* and *Cymbopogon ambiguus*.) The low woodland represented both in very small pockets and as scattered individuals over scattered to open grasses in pockets.

While there were no Rock Pool Communities located within the Survey Area, the above vegetation associations are analogous to the PEC Rock Pile Community.

5 Discussion

The proposed DMSF will result in the loss of 1.92 ha of vegetation, extending approximately 700 metres along the Burrup Peninsula coastline. There are no Declared Rare Flora or significant flora species as listed under State or Federal legislation within the Project Area. Two Priority species as listed on the Declared Rare and Priority Flora list (DEC 2009) occur on the site. Five species listed by Trudgen (2002) as having conservation significance were also recorded. The Burrup Peninsula Rock Pile PEC is represented within the Survey Area. According to Trudgen (2002), one vegetation association, on the northern end of the Survey Area has high conservation significance because this is its only representation on the Burrup Peninsula.

Two Priority 3 species were found within the Survey Area, including: *Terminalia supranitifolia* and *Rhynchosia bungarensis*. *Terminalia supranitifolia* is typically found as a low spreading tree on rockpiles on the Burrup Peninsula. Astron has previously indicated that there appears to be a predominance of *Terminalia supranitifolia* in the area between the Woodside (King Bay) Supply Base and the Woodside LNG Plant. The majority of this area has now been cleared for the Pluto Project. Astron based this knowledge on numerous flora and vegetation surveys conducted on the Burrup Peninsula (Astron 1999, 2001c, 2001d, 2002, 2004, participation in the Trudgen Burrup Survey (Trudgen 2002) and general observations (V. Long and J. Kruger). It is noted that Rock Pile Vegetation Communities, of which *Terminalia supranitifolia* is a component have PEC status (DEC, 2007). This species is also known from scattered populations in the Chichester Ranges. *Terminalia supranitifolia* is a recalcitrant species; young plants are very rarely recorded and casual attempts to propagate the plant in a nursery situation have not been successful (Astron, 1997).

Rhynchosia bungarensis (P3) is a relatively new addition (2009) to the Priority Flora List. It is reasonably widespread on the Burrup Peninsula although less commonly occurring than *Rhynchosia minima* (Trudgen 2002). It is frequently found along the more sheltered bases of rockpiles, along gully walls or in more dense vegetation where it is protected. Outside the Burrup Peninsula, this species occurs as scattered populations within the Pilbara region.

The five species of high conservation significance identified by Trudgen (2002) are all widespread on the Burrup Peninsula.

The Burrup Peninsula Rock Pile community PEC, as defined by the DEC (2009), is represented within the Project Area although generally vegetation pockets are small in size and low trees also occur as individuals. The union of the PEC rock pile community species with more typical coastal low tree and shrub species (*Ficus virens* var. *virens, Ipomoea costata, Stylobasium spathulatum*) distinguishes this from the majority of Burrup Rock Pile vegetation and probably increases the conservation significance of this Rock Pile community. Given that rocky outcrops, rockpiles and coastal rock communities have not been mapped for the Burrup Peninsula as a whole, it is difficult to determine how well they are represented in the area. Much of the rocky coastline on the western side of the Burrup Peninsula has been developed (Dampier town site, Rio wharf facilities, King Bay Industrial Estate, DPA facility, Pluto and NWSV LNG plant site) and is now significantly fragmented. The west coast on the northern section of the Burrup does not have the same rock platform as on the

southern portion and tends to taper into sandy bays or to mangroves. It is possible though that the coastal rockpile habitats do harbour the same vegetation communities as on the Project Area.

Communities that are identified as potential TECs are first listed by DEC so that additional information can be gathered in order to make further assessment. The Priority status refers to their priority for further survey work. PECs do not have the same official status as TECs and are not listed as Special Environmental Areas for vegetation clearing controls.

Five vegetation associations were identified within the Survey Area. One of these vegetation associations (CP2) was identified by Trudgen (2002) as having high conservation value, due to its limited occurrence on the Burrup Peninsula. At the time of the Trudgen (2002) survey, it was known that there was between two and four occurrences of this vegetation association on the Burrup Peninsula. Currently, however, the Survey Area contains the last remaining area of the association in the Burrup Peninsula, due to the loss of other areas to development since 2002. Although this vegetation association was recorded at only a few other locations on the Burrup Peninsula, its occurrence outside this region is largely unknown. Therefore, it is difficult to put the impact of the proposed DMSF into context at a regional scale.

In general the Survey Area was in excellent condition, with few weed species present. However, four weed species were recorded within the area: Buffel Grass, Kapok Bush, Wild Passionfruit and Wild Gooseberry. Buffel Grass (**Cenchrus ciliaris*) is now widespread in the Pilbara region and on disturbed areas of the Burrup Peninsula. Old Woodside borrow pits (20 years old) are testament to the fact that Buffel Grass will dominate disturbed areas on the Burrup in preference to native hummock grass. Buffel Grass was not abundant within the Survey Area.

Kapok Bush (**Aerva javanica*) occurred as scattered populations in disturbed areas on the Burrup Peninsula 20 years ago (V. Long *pers obs*). It now dominates many disturbed areas and industrial sites in dense populations. It has spread along road verges into pristine vegetation, in particular on rock piles where crevices provide favourable habitat for seeds to establish. Kapok Bush was recorded in association with the disturbed DPA facility and it is subject to weed control.

Wild Passionfruit (*Passiflora foetida*) was recorded growing on *Acacia coriacea* at three locations within the Survey Area. Wild Passionfruit is a serious weed in the Kimberley where it forms dense vine thickets along creek banks and coastal dunes. Its spread through the Pilbara is occurring rapidly as witnessed by the increased numbers and locations of this weed being recorded. It has only been recorded once previously on the Burrup Peninsula (on Lot 565, Astron 2004). Wild Passionfruit is also subject to weed control by the DPA. All three occurrences of this weed within the Survey Area were cut and sprayed by the DPA Environment Team on 17 August 2009.

Wild Gooseberry (*Physalis angulata*) is a Kimberley weed species that has not previously been recorded on the Burrup Peninsula. It was found growing down in a crevice in the coastal rocks, which indicates the plant is somewhat saline tolerant, and may have been washed up there. This individual was removed and destroyed at the time of the survey.

6 Conclusions

The vegetation and flora survey undertaken within the Survey Area has determined the following:

- The area of vegetation to be removed by the proposed DMSF comprising approximately 1.59 hectares.

- Two Priority 3 flora occur on the site, *Terminalia supranitifolia* and *Rhynchosia bungarensis*. They are both well represented on a local scale, on the Burrup Peninsula. They are less well represented elsewhere in the Pilbara region.

- A small area (0.63 ha) of the Burrup Peninsula Rock Pile Community PEC is represented in the Survey Area. This is as defined by DEC (2008) and email communication with the DEC Species and Communities Branch (5 October 2009). In addition, the PEC vegetation community combined with low trees and shrubs associated with the coastal rock platform and piles is probably less well represented, being confined to coastal rock platform habitat. PEC's on the Burrup Peninsula are not yet well defined or mapped (Jill Pryde DEC *pers comm*).

- A vegetation association with high conservation value was recognised in the Survey Area by both Trudgen (2002) and Astron (2004). The construction of the proposed DMSF will impact this association and therefore may be to the detriment of the diversity of vegetation associations on the Burrup Peninsula. Since 2001 Malcolm Trudgen has continued to compile data for the Pilbara. To date the results continue to support the conclusion made 2001 (Trudgen, 2001), that vegetation on the Burrup is distinct from any found on the mainland and is of national significance (see correspondence in Appendix E).

- The proposed DMSF will reduce the number of *Terminalia supranitifolia* on the Burrup Peninsula by 22 individuals. It is recognised that the abundance of this species is being reduced by resource and industrial development on the Burrup Peninsula. However, the impact of the proposed DMSF on the occurrence of *T. supranitifolia* on the Burrup Peninsula and on a wider regional scale is difficult to quantify. This is symptomatic of the lack of dedicated research into the abundance, distribution and propagation of this species in Western Australia. It should be noted that the DPA has minimised the original footprint of the disturbance area in an effort to preserve several *T. Supranitifolia* individuals. The occurr*ence of Rhynchosia bungarensis* on the Burrup is still being evaluated. It is generally a component of PEC Rock Pile communities.

- Management of weeds along the perimeters of the Survey Area after disturbance and the prevention of their spread into pristine areas should be addressed the Environmental Management Plan for the project.

During the planning phase of the DMSF project, the DPA undertook extensive research to ensure the potential impacts to the environment, and in particular the native vegetation, was minimised. In

2007, the DPA commissioned a study (Worley Parsons, 2007) which comprehensively reviewed the options available for locations of the DMSF facility within the Dampier region. These options included: King Bay Industrial Estate (Sites 1 through to 5); East Intercourse Island (Site 6) and; the proposed Maitland Industrial Estate on West Intercourse Island (Site 7). The study initially assessed and ranked these sites on the basis of dredging and infrastructure development requirements and heritage and environmental constraints. Four sites were able to be discounted from further investigation due to the requirement to disturb significant areas of mangroves and significant dredging requirements. The remaining options were then subject to a rigorous assessment, which included more detailed investigation of environment and heritage constraints. The final location for the proposed DMSF was considered to achieve the best balance between environmental, heritage and a multitude of development considerations.

In accordance with advice from DEC (2009b), the DPA has undertaken several measures to avoid disturbance to the Burrup Rock Pile PEC. Firstly, by undertaking a reclamation project and developing facilities offshore, the DPA have eliminated the need to disturb a significant area of terrestrial flora and vegetation (up to 20 ha). Further, on advice from Astron, detailed design work has been undertaken to:

a) Minimise the onshore disturbance footprint;
b) Retain the Priority species *Terminalia supranitifolia*; and
c) Avoid the Burrup Rock Pile PEC.

In addition, DPA has proposed a strategy to mitigate the loss of vegetation from the DMSF area, which includes the following:

- Develop cultivation techniques for a sub-set of local native species – working closely with Astron Environmental Services and a native plant nursery situated at Mingullatharndo (Five Mile Aboriginal Community) to develop new techniques to germinate and grow local native plants in a nursery environment. Species selection be prioritised toward species in the DMSF development footprint, and the Burrup Peninsula.
- Establish a nursery program in conjunction with Roebourne Regional Prison – basic cultivation techniques developed at the nursery will be incorporated into a horticultural module of the existing Department of Environment and Conservation Course offered by Roebourne Regional Prison. This may also include the collection of native seed.

The aim of this work is to establish cultivation techniques for the native species and to provide this information to local nurseries and encourage the use of endemic species (and therefore highly suited to the local environment) in landscaping and rehabilitation projects. Further details on the proposed mitigation strategy are provided in correspondence in Appendix A.

It should also be noted that some 60 ha of the Burrup Peninsula is within a Conservation Reserve, providing permanent protection to the flora (and fauna) within this area. The DMSF project footprint does not encroach on any of these areas (see http://www.ont.dotag.wa.gov.au/_Files/burrup_draft.pdf).

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Appendix A:
DPA Correspondence Detailing Mitigation Strategy

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Your Ref: None
Our Ref: ENV-0103
Enquiries: Dan Pedersen

Friday 18th December 2009

Vicki Long
Astron Environmental Services
PO Box 713
Karratha WA 6714

Dear Vicki

LANDSCAPING FOR NATIVE BIODIVERSITY AND WATERWISE GARDENS (DMSF PROJECT)

The proposed Dampier Marine Services Facility development will require the removal of native vegetation from approximately two hectares of land fringing the foreshore to the east of the existing Dampier Cargo Wharf (DCW). We (DPA) have developed a concept for an environmental program to mitigate the loss of vegetation from this area. The proposed concept addresses the lack of local native plant species that are commercially available in the western Pilbara and engages local indigenous people and business. It is believed that this package will have both beneficial and tangible outcomes from an environment and community perspective.

The concept developed from the observation that a very small group of water hungry exotic plants dominate current landscaping projects and private gardens in Karratha. We (DPA) recently set out to use plants native to the local / Pilbara region to landscape several new houses that are under construction at present. However, we had limited success with this given the two nurseries supplying the local area were able to supply only one or two local native species.

The recent botanical surveys along the foreshore of the proposed DMSF development highlighted a large number of native groundcovers and shrubs that would be highly suited to cultivation from seed and/or cuttings. Further, many of these would present extremely well in a landscaped environment. Importantly, these plants are highly adapted to the climate of the western Pilbara and as such require very limited water and nutrients to grow and persist.

There are two key components of this environmental off-set package for the proposed DMSF development:

1. **Develop cultivation techniques for a sub-set of local native species**: The DPA will work closely with subject matter experts (e.g. Astron Environmental) and a new native nursery situated at Mingullatharndo (Five Mile Community) to develop techniques to germinate and grow local native plants in a nursery environment. A number of local native groundcovers and shrubs will be targeted for these trials. Some species would be selected from within the DMSF development footprint while

others would come from a broader area (i.e. Burrup Peninsula). Initial stages of this component will focus on seed collection for each of the target species.

2. **Establish a nursery program in conjunction with Roebourne Regional Prison:** It is envisaged that more basic cultivation techniques developed at the Mingullatharndo Nursery will be incorporated into a horticultural module of the existing Conservation and Land Management (CALM) Course offered by Roebourne Regional Prison. Roebourne Regional Prison has regular classes outside the prison at DECCA Station, which contains existing (unused) infrastructure including a nursery and reticulated greenhouse. The concept for this program has received a great deal of support from the Campus Manager at the Prison (Delphine McFarlane). The program would be further supported by an Indigenous TAFE lecturer who currently delivers the CALM's course at the Prison. There is also scope for Roebourne Regional Prison to be involved in the collection of seeds

The key stakeholders for this concept would include the following organisations:

- Dampier Port Authority
- Astron Environmental
- Mingullatharndo Nursery
- Roebourne Regional Prison

I look forward to receiving your comment on the above approach.

Kind Regards,

DAN PEDERSEN
SENIOR ENVIRONMENT OFFICER

Appendix B:
Vegetation Map

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474000
474400
7720800
7720400
LEGEND
Vegetation to be Retained
Project Area
Vegetation Association
Bare
CD1
CP1
CP2
R10
R10+RW1
R3
Dampier Port Authority
0 10 20 40 60 80 100
Metres
N
Vegetation Associations within Survey Area
Drawn By : Dan Pedersen
Date Prepared: 23 December 2009
Datum (X Y) : MGA94
Path : S:\GIS Data\Map Base\Development Projects\DMSF\Astron Survey
Figure B1


474000
474400
7720800
7720400
R10
CP2
CP1
R3
Bare
CD1
R10+RW1
R10+RW1
LEGEND
Vegetation Associations
Vegetation to be Retained
Dampier Port Authority
0 10 20 40 60 80 100
Metres
N
Vegetation Associations within Survey Area
Drawn By : Dan Pedersen
Date Prepared: 23 December 2009
Datum (X Y) : MGA94
Path : S:\GIS Data\Map Base\Development Projects\DMSF\Astron Survey
Figure
B2

Appendix C:
Priority Flora Recorded within the Project Area

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Species	Habitat	Number of Occurrences
Terminalia supranitifolia (P3)	Recorded on coastal rocks, coastal plain rock knolls and in rocks on manmade revetment wall.	22 (4 off in revetment wall)
Rhynchosia bungarensis (P3)	Coastal rocks, at foot of rock knolls on coastal plain and along foot of revetment wall.	Between 75 and 100 individuals, particularly common amongst the toe of rockpiles and revetment wall in the upper supratidal area.

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Appendix D:
Species List 2009

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Family	Genus/Species	Habitat
31 Poaceae	**Cenchrus ciliaris*	RW1
	Cymbopogon ambiguus	R3, RW1
	Paspalidium tabulatum (Burrup form) [1]	CD1, R10, RW1
	Triodia angusta (Burrup form) [1]	CD1
	Triodia epactia (Burrup form) [1]	R3, CP1, CP2
32 Cyperaceae	*Cyperus vaginatus*	CD1
87 Moraceae	*Ficus aculeata* var *indecora*	R10, RW1
	Ficus brachypoda	R10, R3, RW1
	FIcus viren var *virens*	R10
90 Protaceae	*Grevillea pyramidalis* subsp *pyramidalis*	CP2
	Hakea lorea subsp *lorea*	R3
105 Chenopodiaceae	*Enchylaena tomentosa*	CP1
	Rhagodia eremea	R3
106 Amaranthaceae	*Achyranthes aspera*	CP2
	**Aerva javanica*	RW1
	Ptilotus exaltatus	Dist area
107 Nyctaginaceae	*Boerhavia coccinea*	R3, RW1
110 Aizoaceae	*Trianthema triquetra*	RW1
122 Menispermaceae	*Tinospora smilacina*	R3
137A Capparaceae	*Capparis spinosa* var *nummularia*	R10, R3, RW1
	Cleome viscosa	CD1
152 Pittosporaceae	*Pittosporum phylliraeoides* var *phylliraeoides*	R3
160 Surianaceae	*Stylobasium spathulatum*	R3
163 Mimosaceae	*Acacia bivenosa*	R3, RW1
	Acacia coriacea subsp *coriacea*	R10, R3, CP1, RW1
	Acacia colei	CP1, CP2
164 Caesalpinaceae	*Senna venusta*	R3
165 Papillionaceae	*Cullen pustulatum*	CP2
	Indigofera monophylla	R3
	Rhynchosia bungarensis (P3)	R10, R3
	Sesbania cannabina	CP1
	Swainsona formosa	CP1
	Tephrosia rosea var *clementii*	CD1, RW1

Family	Genus/Species	Habitat
173 Zygophyllaceae	*Tribulus occidentalis*	RW1
185 Euphorbiaceae	*Euphorbia australis*	RW1
	Euphorbia coghlani	R10
	Flueggea virosa subsp *melanthesoides*	R3, CP1
207 Sapindaceae	*Alectryon oleifolius* subsp *oleifolius*	R3
220 Tiliaceae	*Corchorus walcottii* (Burrup form) [1]	R3
	Triumfetta appendiculata (Burrup form) [1]	R10, R3, RW1
223 Sterculiaceae	*Brachychiton acuminatus*	R10, R3, RW1
248 Passifloraceae	**Passiflora foetida* var *hispida*	R3
272 Combretaceae	*Terminalia supranitifolia* (P3)	R10, R3, CP1
310 Boraginaceae	*Trichodesma zeylanicum*	CD1, R3, CP1, CP2, RW1
307 Convolvulaceae	*Ipomoea costata*	R10, R3, CP1, RW1
311 Verbenaceae	*Clerodendrum tomentosum*	R3, RW1
315 Solanaceae	**Physalis angulata* (removed)	R10
316 Scrophulariaceae	*Stemodia grossa*	CD1
337 Cucurbitaceae	*Cucumis maderaspatanus*	CD1, R10
345 Asteraceae	*Pluchea tetranthera*	CP2
	Pterocaulon sphaeranthoides	CP2

[1] Trudgen (2002) Significant species currently under review by WA Herbarium

Appendix E:
Trudgen Correspondence

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Ms Vicky Long
Astron Environmental Services
Karratha, Westen Australia
Dear Vicky,

Essentially your question with regard to vegetation on the Burrup Peninsula with a significant cover of *Pluchea tetranthera* is a vegetation issue, not a flora issue; that is the commoness or otherwise of the vegetation type is the issue, not the commoness of *Pluchea tetranthera.*

The PATTN anlysis for the Burrup Penisula report that you helped with showed that the vegetation of the Burrup Peninsula is floristically distinct from that of the mainland. This difference was found to be at least partly due to the maritime effect with floristic groups distributed on the Peninsula in a manner that was best explained by that effect. The geological types on the Burrup Peninsula would be the other main factor causing the vegetation there to differ from areas on the mainland.

The difference of the vegetation on the Burrup from the mainland has been confirmed by a larger PATTN analysis that Ted Griffin and I have run recently. This analysis was based on a much larger data set with a much larger geographic coverage than the analysis carried out for the Burrup report (two thousand eight hundred and eighty-five sites against ca. 700). It included data from coastal and near coastal areas near Port Hedland as well as the data from the Karatha Hills. As with the earlier analysis there was extremely little overlap between the vegetation of the Burrup Peninsula and the vegetation on the mainland.

In fact most of the sites from the Burrup Peninsula occurred in one large block near the end of the dendrogram. There was a smaller block of Burruup Peninsula sites that formed a group (without any mainland sites) earlier in the dendrogram, these were flowline sites with vegetation quite unlike that you have asked about. Otherwise, there were six Burrup Peninsula that either occurred singly or in pairs, either as one of two sites in a group or the only site in a group, this again emphasises the difference of the vegetation of the Burrup Peninsula to that of the mainland.

The implication for conservation value is extremely clear. Vegetation types found on the Burrup Peninsula are extremely unlikely to be found off of it. I emphasise that the data set in the recent analysis included mainland sites with *Pluchea tetranthera* in them so the particular vegetation type you are asking about is almost certainly restricted to the Burrup Peninsula.

For what it is worth, I will re-iterate a main conclusion of the Burrup Report. The Burrup Peninsula has vegetation of at least national significance. In view of this (and especially when other values of the Peninsula are taken into account) it is an area where further development is simply environmentally unacceptable by any reasonable meaning of those words.

To be blunt, the environmental impact assessment process in Western Australia has simply failed to cope with a conflict that has pitted one of the most environmentally important areas of the Pilbara against development.

Regards,

Malcolm Trudgen
Consultant Botanist
8 October 2009