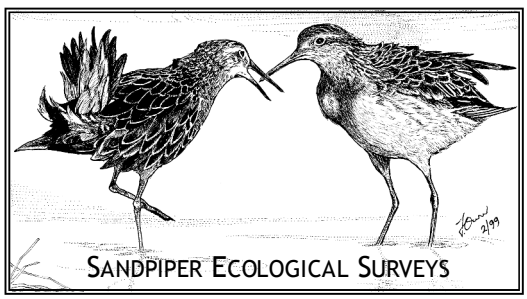
QUEENSLAND GAS COMPANY

LNG PROJECT CURTIS ISLAND

GLADSTONE

~ SUPPLEMENTARY SURVEYS FOR POWERFUL OWL AND MIGRATORY SHOREBIRDS ~

16 NOVEMBER 2009



WILDSEARCH
ENVIRONMENTAL
SERVICES

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1. INTRODUCTION

Sandpiper Ecological Surveys and Wildsearch Environmental Services were contracted by ERM Australia to conduct targeted surveys for the Powerful Owl (*Ninox strenua*) and migratory shorebirds for the proposed QC Liquefied Natural Gas (LNG) facility at Curtis Island, Queensland. These surveys compliment the comprehensive and supplementary bird surveys conducted in spring 2008 and summer 2009 (Sandpiper Ecological Surveys and Wildsearch Environmental Services 2008; Sandpiper Ecological Surveys and Wildsearch Environmental Services 2009, herein referred to as Sandpiper and Wildsearch 2008, 2009). The scope of work for the targeted surveys included:

1. Gather additional information on the existence of Powerful Owls at the LNG facility site prior to the commencement of construction work. The required information included:

    a. Surveys of the LNG facility site to determine the number of Powerful Owl that may be present;

    b. Identification and mapping of Powerful Owl roosting and nesting sites within the LNG facility site;

    c. Mark Powerful Owl roost and nest sites;

    d. Develop site specific mitigation and management measures to avoid disturbance to roosting/nesting sites; and

    e. Consider the cumulative impacts associated with other developments near the QC LNG Facility on Curtis Island.

2. Undertake surveys for Eastern Curlew (*Numenius madagascariensis*), Bar-tailed Godwit, Whimbrel (*Numenius phaeopus*), Common Greenshank (*Tringa nebularia)* and Red-necked Stint (*Calidris ruficollis*) prior to the commencement of construction activities at the LNG facility.

3. Determine if subject species require monitoring during the construction phase of the LNG project.

Some data gathered during the previous comprehensive and supplementary bird surveys have been included in this report to provide contextual information.

1.1 Subject Site and Study Area

The subject site included the terrestrial and adjoining intertidal habitat within the proposed QC LNG facility on Curtis Island (Figure 1). The study area was expanded to include land within 4km of the proposed QC LNG facility on Curtis Island and an area of the adjoining mainland (Figure 1). A more expansive study area was required to gather the necessary data to assess the cumulative impact of other developments, to place the subject site in a local context and to identify potential reference sites should monitoring be required. Whilst most survey effort was concentrated in the subject site, sampling within the broader study area was essential to place the site in a local context.

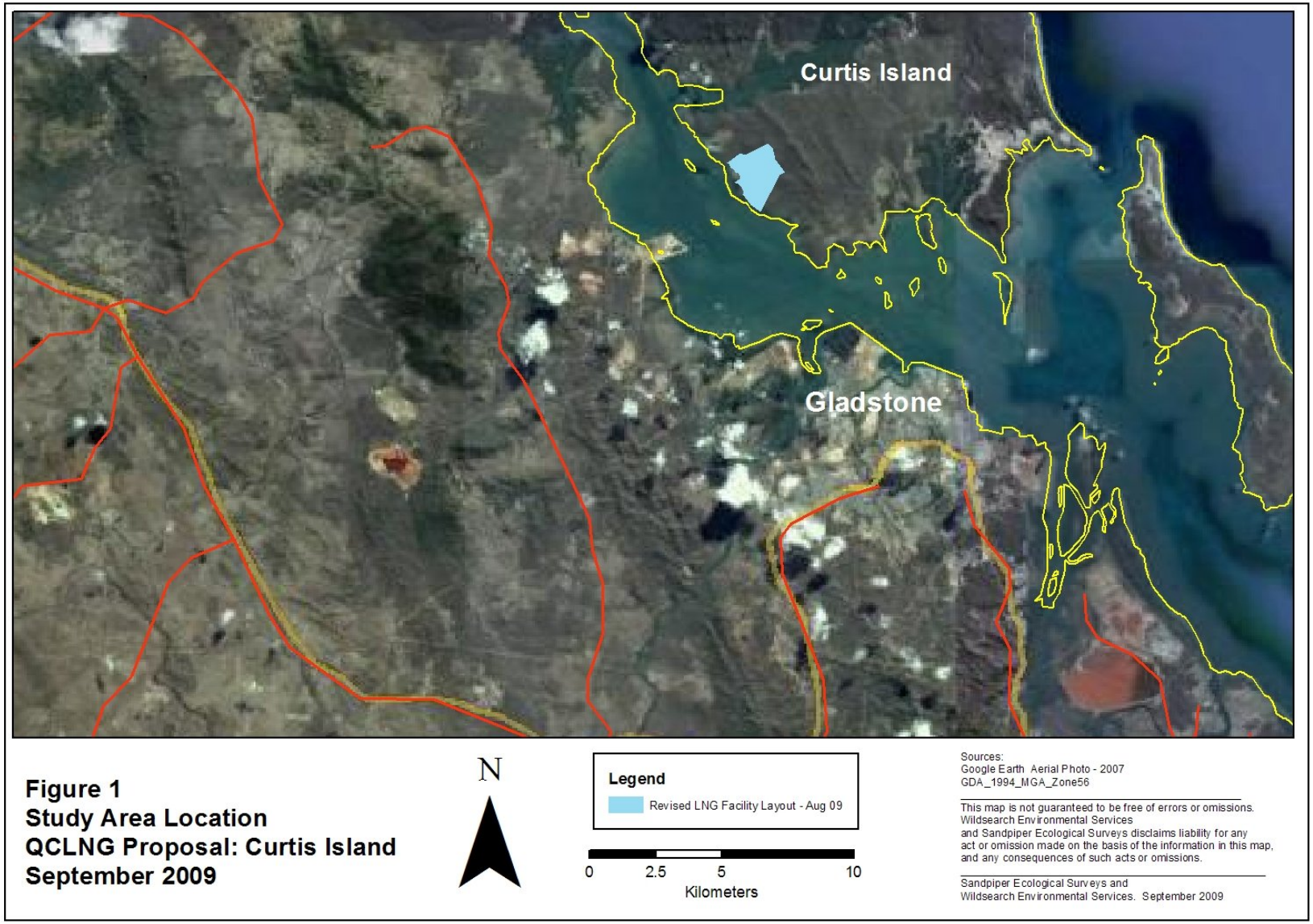

Figure 1
Study Area Location
QCLNG Proposal: Curtis Island
September 2009

2. METHODS

2.1 Powerful Owl

2.1.1 Background

The Powerful Owl is a large forest owl found in a wide range of habitats including open sclerophyll forests, woodland and remnant native vegetation within metropolitan areas (Higgins 1999, Debus and Chafer 1994). Its range extends from about Rockhampton in central eastern Queensland south to the forests of eastern and central western Victoria (Barrett *et al.* 2003, Higgins 1999).

Powerful Owl nest trees are typically large, old living eucalypts and rarely dead stags. Emergent trees are sometimes used however trees within, and therefore sheltered by the canopy, are prefered (Higgins 1999, Hollands 1991, Debus and Chafer 1994). Nests are usually in large tree-hollows where the hollow is at least 50 – 200cm deep and 45 – 75cm in diameter (Schodde & Mason 1980). Hollow entrances range in size from 17cm x 13cm – 76cm x 36cm (Higgins 1999) and are usually in broken-off trunks or in vertical spouts (Higgins 1999). Published reports suggest that breeding pairs remain in their home range for most of their life and exhibit strong nest site fidelity (Higgins 1999). However, other studies suggest that pairs may move nest hollows frequently where tree hollows are more abundant, habitat is marginal or the nest site is disturbed. They will also aggressively defend the nest from other Powerful Owls and even humans (Hollands 1991). Pairs have been reported as having attacked researchers who were in the vicinity of a nest or were conducting call playback within a home range (Hollands 1991).

The Powerful Owl hunts in open forest or woodland where its prey species are primarily medium-sized arboreal mammals such as Sugar Gliders (*Petaurus breviceps*), Squirrel Gliders (*Petaurus norfolcensis*), Common Ringtail Possum (Pseudocheirus peregrinus), large birds and flying-foxes (Higgins 1999).

Observations suggest that Powerful Owls maintain and defend a home range which, in highly productive habitat, may be as small as 300ha but in less productive habitat may be as large as 1500ha (Higgins 1999). Some reports suggest that centres of neighbouring pairs can be as close as 2-5km (Higgins 1999).

Powerful Owls are considered to be sensitive to disturbance of the nest tree. Pairs will abandon the nest if disturbed whilst breeding and may not reuse that particular nest for a number of years. Vegetation removal or disturbance to the surrounding forest will also cause the birds to abandon the nest tree or roost (Higgins 1999).

2.1.2 Previous Owl Surveys

Sandpiper and Wildsearch (2008, 2009) conducted surveys for nocturnal birds during October 2008 and again in January - February 2009. These surveys found that nocturnal birds were at very high densities within the study area. Seven species of nocturnal bird were recorded, including Barking Owl (*Ninox connivens),* Powerful Owl, Eastern Barn Owl (*Tyto alba*), Southern Boobook (*Ninox novaeseelandiae*), White-throated Nightjar (*Caprimulgus mysticalis*), Australian Owlet-nightjar (*Aegotheles cristatus*) and Bush Stone-curlew (*Burhinus grallarius*).

The results of the previous surveys suggest that there were at least seven pairs of Barking Owl, at least one resident Powerful Owl and a number of Southern Boobook pairs within the study area. The Barking Owl was recorded at five locations in February 2009 including pairs at three roost sites (Figure 2). These were in addition to the five locations, including a nest site and three roosts, located during the 2008 survey (Figure 2). The Barking Owl and Southern Boobook were recorded in a majority of the major Regional Ecosystems of the subject site. Both species were often recorded as unsolicited calls or located during foot traverses of the site.

In February 2009 a single Powerful Owl responded to call broadcast. An adult male was observed at close quarters after it responded to calls broadcast from a location at the eastern edge of the study site (Figure 2). It was observed within three minutes of the calls being broadcast and appeared to have come from a location close to the broadcast site. This observation was consistent with the results obtained during the 2008 survey when a response to call broadcast was recorded from the same area.

During the October 2008 and February 2009 surveys three Sugar Glider tails were found during fauna feature traverses of the proposed LNG Facility site. The tails of this prey species are typically removed by Powerful Owls following capture and their occurrence suggests that the Powerful Owl forages widely across the subject site. However, Barking Owls are also known to take Sugar Gliders and these prey remains may have been the result of predation by Barking Owl rather than Powerful Owl.

Surveys conducted as part of the Gladstone Pacific Nickel Refinery Project Environmental Impact Assessment recorded the Powerful Owl in the proposed refinery site near Yarwun (URS 2007). The site is approximately 8km west of Gladstone. URS (2007) suggested that the Powerful Owl utilised the proposed refinery site and the adjacent forested slopes of Mount Stowe. Powerful Owl was also recorded by URS during surveys of the pipeline easement for the adjoining GLNG project.

Figure 2:
QCLNG Proposal: Curtis Island
Owl Records Oct 2008 and Feb 2009

Legend

- All_Owls_09
- Revised LNG Facility Layout - Aug 09

Sources:
DNR & W. Aerial Photo - 18.07.2007
GDA_1994_MGA_Zone56

This map is not guaranteed to be free of errors or omissions. Wildsearch Environmental Services and Sandpiper Ecological Surveys disclaims liability for any act or omission made on the basis of the information in this map, and any consequences of such acts or omissions.

Sandpiper Ecological Surveys and
Wildsearch Environmental Services. September 2009

2.1.3 Field Survey Methods for Current Study

Call Broadcast

Nocturnal call broadcast was conducted by two personnel for nine nights between 1900 and 2230hrs at sites on Curtis Island and on the mainland (Figure 3). Sites were at least 1.5kms apart and were generally located within or adjacent to areas of forest or woodland. Each site was surveyed on three occasions unless Powerful Owls were detected at a site. If owls were detected no further surveys were conducted at that site or at any other site within 3kms of the observation. This protocol was adopted to reduce disturbance to the Powerful Owls. The early evening period was selected to maximise the opportunity to detect owls that were roosting on or in close proximity to the broadcast site.

Calls of the Powerful Owl were broadcast at all sites for five minutes. Ten minutes was spent listening for calls prior to broadcast and another 20 minutes was spent listening for calls following the broadcast. A brief spotlight survey of the playback site was conducted at the completion of the final 20 minute listening period. At each site the number of individuals of each nocturnal species heard or observed was recorded. The direction from which the calls of Powerful Owls were first heard, or the direction from which the owls flew into the broadcast site was also recorded.

Dusk Census

Dusk censuses were conducted at two mainland sites and six sites on Curtis Island (Figure 3). These censuses were conducted by two observers for between 40 and 60 minutes with all surveys undertaken between 1800 and 1930hrs. Where possible, dusk censuses were conducted in the vicinity of potential Powerful Owl nest / roost trees. During the census all species and, if possible, the number of individuals calling or sighted were recorded. In addition, where the calls of Powerful Owls were recorded the direction from which the calls were first heard was also recorded.

Contextual Surveys

Previous targeted bird surveys, and in particular those targeting nocturnal birds, provided an indication of species diversity within the LNG Facility site and an indication of habitat value for these species. These surveys could not provide a contextual assessment of the importance of the owl habitats and populations of the LNG Facility site.

It was important that a more comprehensive Powerful Owl survey of the southern half of Curtis Island and adjacent mainland forested areas be undertaken to assist in determining the number of Powerful Owls resident in the local area and, secondly, to provide data that might assist in assessing the direct and cumulative impacts development on Curtis Island might have on the local Powerful Owl population.

Nocturnal call broadcast surveys, as described above, were undertaken in areas of forest or woodland surrounding the Curtis Island LNG Facility site and in similar habitat on the adjacent mainland.

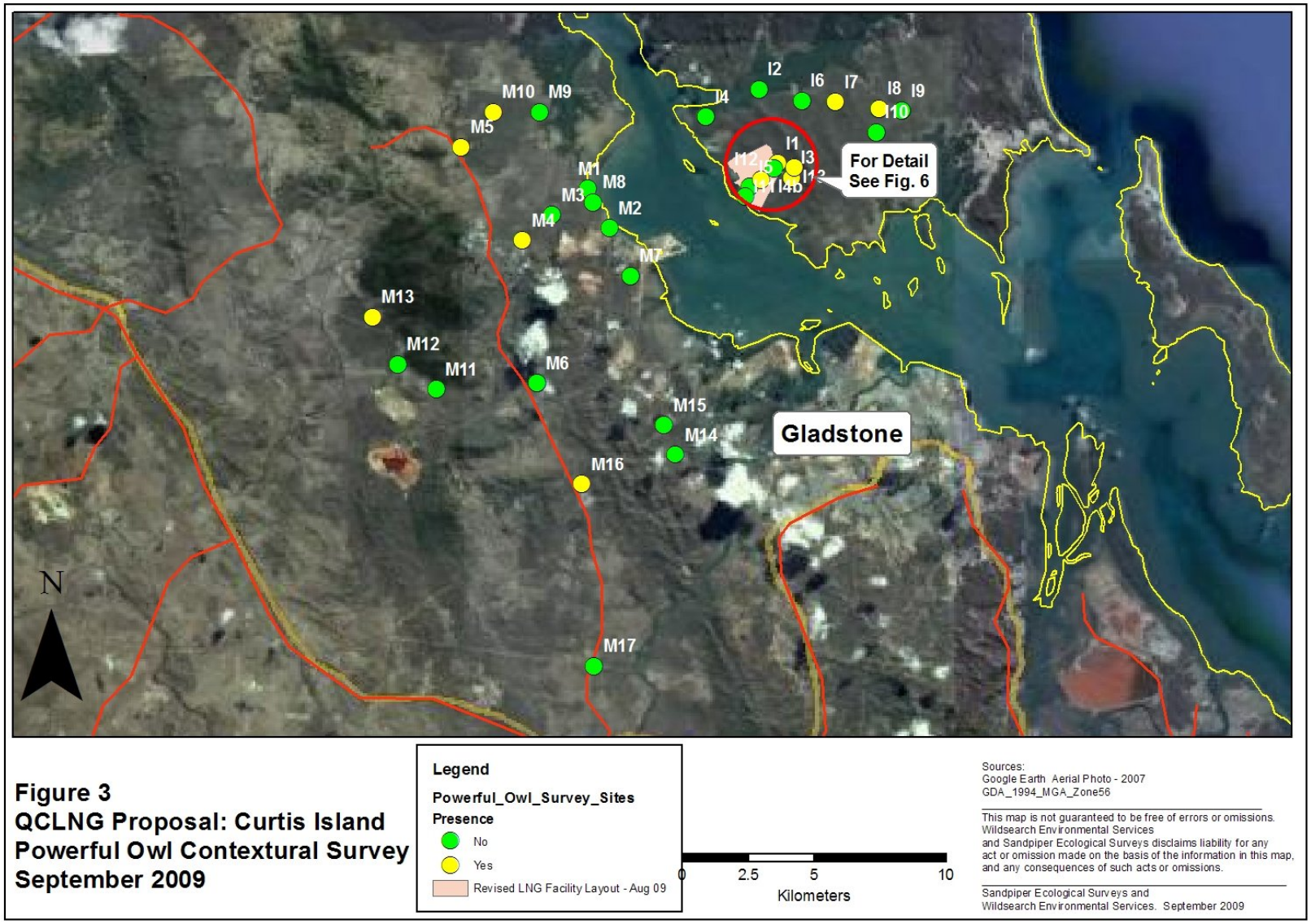

Figure 3
QCLNG Proposal: Curtis Island
Powerful Owl Contextural Survey
September 2009

Roost and Nest Site Surveys

The entire LNG Facility site and an area adjacent to the eastern boundary were surveyed for potential Powerful Owl roost and nest trees. Systematic foot surveys were conducted by two personnel over four half-day periods. All potential nest trees within this area were inspected. Initially the surveys focused on the forests near the eastern boundary of the site and in the valley immediately to the east where Powerful Owls had been observed during the 2008 and February 2009 surveys. Once this area had been searched the survey was extended to include the remaining parts of the site. Particular emphasis was placed on inspecting trees adjacent to creeklines; in steep gullies and large or old Queensland Blue Gum (*Eucalyptus tereticornis*) (species most often observed on site to be hollow-bearing).

The following three categories were used to categorise potential nest trees:

1. **Good:** Large old growth trees where the Diameter at Breast Height (DBH) was greater than 100cm; visible entry hollows were greater than 50cm in diameter and situated within a spout or trunk; the diameter of the hollow limb or trunk was of sufficient size to contain a hollow at least 50cm - 200cm deep; and, a known roost site was within 200m of the potential roost / nest tree.

2. **Moderate:** Large tree where the DBH was greater than 70cm; visible entry hollows were greater than 40cm in diameter and situated within a spout or trunk; the diameter of the hollow limb or trunk with a visible hollow entry was of sufficient size to contain a hollow at least 50cm - 200cm deep.

3. **Poor:** Any tree where the DBH was greater than 50cm; visible entry hollows were greater than 30cm in diameter and situated within a spout or trunk; the diameter of the hollow limb or trunk with a visible hollow entry was of sufficient size to contain a hollow at least 50cm - 200cm deep.

Other signs of activity were also recorded including: the presence of a Powerful Owl at the tree or nearby; presence of “white wash”, feathers, prey remains or pellets below the tree; absence of spider’s webs or other material across the hollow entrance; and, the presence of other fauna such as gliders or other owl species in the hollow.

2.2 Migratory Shorebirds

2.2.1 Background Information

Potential shorebird roost and foraging habitat within the LNG Facility site was sampled in October 2008 and February 2009, whilst potential habitat near the proposed mainland access road and bridge was sampled in February 2009. Small numbers of four species, Whimbrel, Eastern Curlew, Masked Lapwing (*Vanellus miles*) and Pied Oystercatcher (*Haematopus longirostris*), were recorded foraging and roosting within the proposed LNG facility (Sandpiper and Wildsearch 2008). A Beach Stone-Curlew (*Esacus magnirostris*) was recorded flying past the site on one occasion. The maximum number of shorebirds recorded within the subject site was 13 individuals at low tide on 7 October 2008. High tide counts ranged from three to five individuals. Based on these findings it

was concluded that the proposed LNG Facility would have a negligible impact on migratory shorebirds, including the Eastern Curlew, which is listed as rare on the Queensland *Nature Conservation 1992* (NC Act) (Sandpiper and Wildsearch 2008).

A substantially greater number of individuals and species were recorded in the vicinity of the proposed access road and bridge than in the LNG Facility site (Sandpiper and Wildsearch 2009). Three shorebird roosts were identified; Laird Point, Friend Point and Claypan (Figure 4). These roosts were used by shorebirds to varying degrees during surveys in January/February 2009. Friend Point was used regularly during neap high tides, whilst the adjoining Claypan was used during spring high tides and rain events. In contrast, Laird Point appeared to be used as a staging area during spring high tides and by small numbers of birds at other times. Counts of over 150 individuals were recorded at each of the three roosts. Notable counts included 304 Red-necked Stints at the Mainland Claypan, 299 Whimbrel at Friend Point and 173 Whimbrel at Laird Point (Table 1). A substantial area of foraging habitat (intertidal mudflat) occurred along the mainland between Fisherman's Landing and Friend Point.

Shorebird surveys in February 2009 also included a single high tide survey of the Passage Islands, which are situated in the channel between the proposed LNG facility and mainland. A small number of Grey-tailed Tattler (*Tringa brevipes*) (19) and Terek Sandpiper (*Tringa terek*) (105) were recorded roosting at the southern end of South Passage Island.

Table 1: Maximum counts of shorebirds recorded within the subject site and near the proposed mainland access road in October 2008 and January/February 2009.

Common Name	Subject Site	Mainland Claypan	Friend Point Roost	Laird Point Roost
Beach Stone-Curlew	1		3	2
Pied Oystercatcher	1	6	2	
Red-capped Plover		42	5	4
Pacific Golden Plover		12		
Lesser Sand Plover		25		
Masked Lapwing	3			4
Bar-tailed Godwit		41	74	
Whimbrel	9	34	299	173
Eastern Curlew	3	27	56	6
Common Greenshank		1		
Grey-tailed Tattler		7	1	
Great Knot		15	15	
Red-necked Stint		304		
Sharp-tailed Sandpiper		5		

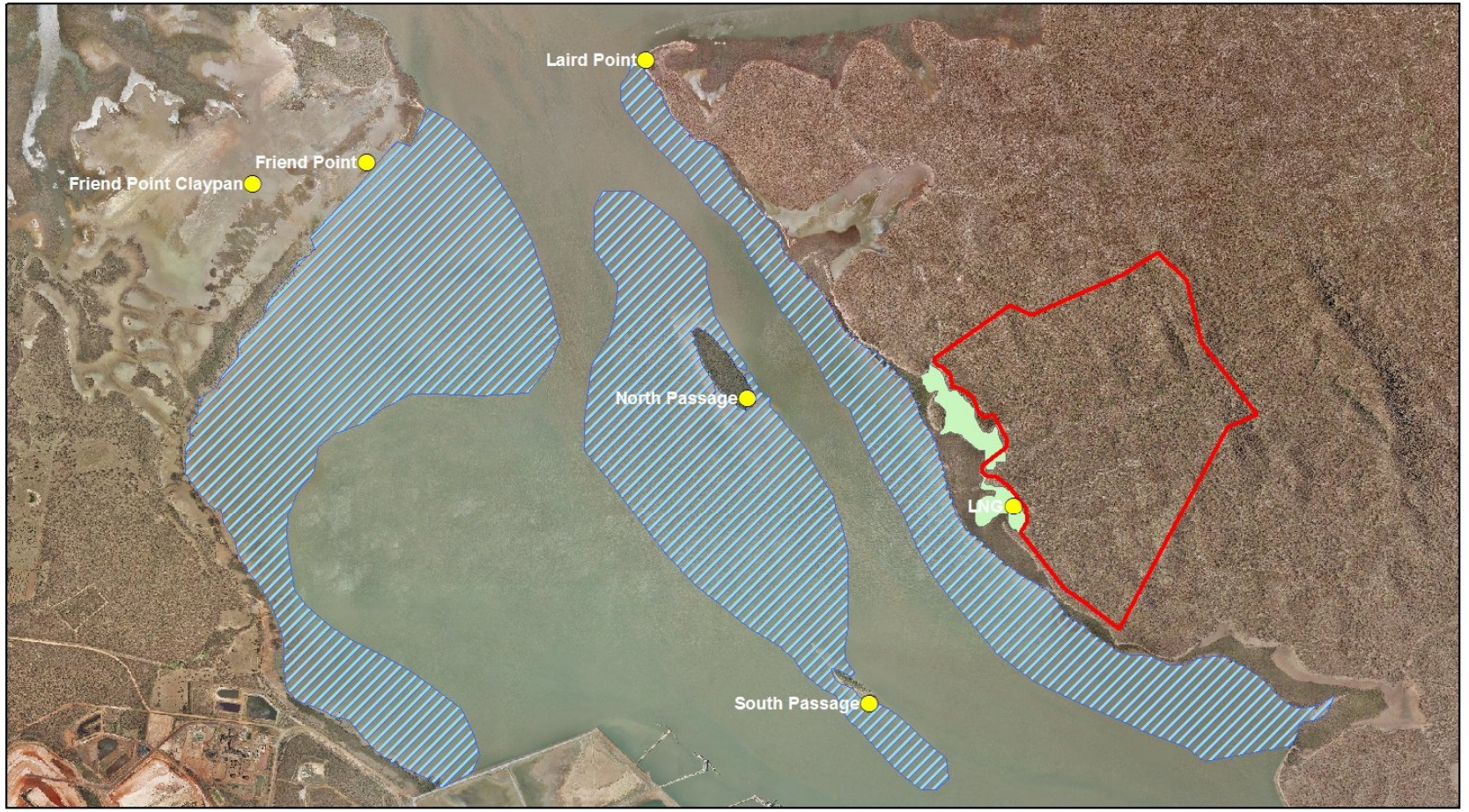

Figure 4:
QCLNG Development Site
Shorebird Foraging Areas / Roosts
September 2009

Legend

- Shorebird_Roosts_Sept_2009
- Revised LNG Facility Layout - Aug 09
- High Tide Claypan Roosts
- Low Tide Foraging Areas

N

0 0.25 0.5 1
Kilometers

Sources:
DNR & W. Aerial Photo - 18.07.2007
GDA_1994_MGA_Zone56

Sandpiper Ecological Surveys and
Wildsearch Environmental Services. September 2009

2.2.2 Field Survey

Shorebird surveys in September 2009 included the subject site, habitat in the vicinity of the former access road and bridge and nearby roosts. Nearby roosts were sampled to provide contextual information on the importance of shorebird habitat in the study area and to assist in identifying an appropriate reference site should long-term monitoring be required. Surveys did not include known shorebird roosts near South End, which were sampled during surveys in October 2008.

Shorebird Roost Surveys

Shorebird surveys included sampling during a spring and neap tide cycle. It was initially intended to sample the LNG site, Laird Point and Friend Point during spring and neap high tides; however, this approach was altered once it became obvious that the mainland access road and bridge were no longer part of the proposal. Consequently Friend Point was sampled during a spring tide cycle only. Laird Point was sampled at both times as that roost was situated near the access point to the Island and was readily observed whilst moving to and from the subject site.

Several roosts in the vicinity of the proposed LNG Facility were sampled on 19 September 2009. The location of roosts was determined from previous surveys, Environment Protection Agency (EPA) maps of shorebird roosts and Shorebird 2020 roost mapping.

All roost surveys were conducted by two personnel using 10x42mm binoculars and 20-60x80mm spotting scopes. Sites were accessed on foot or by boat. At each site the number of individuals of each species was counted by both observers and counts compared to obtain an agreed number. Care was taken to avoid disturbing roosting flocks and minimise the likelihood of double-counting which can occur if birds move between roosts during a survey. Roost surveys were conducted within two hours either side of mean high water.

Foraging Surveys

Intertidal mudflats immediately adjacent to the proposed LNG Facility and on the mainland south of Friend Point were sampled at low tide (Figure 4). Mudflats adjacent to the subject site were sampled on two occasions whilst mudflats near Friend Point were sampled once only. Island surveys were conducted by a single observer whilst sampling on the mainland was conducted by two observers. Spotting scopes and binoculars were used to count the number of individuals of each species within the designated areas. Claypan habitat within the LNG Facility was also observed at low tide. Care was taken to avoid disturbing foraging birds and minimise the likelihood of double-counting.

2.3 Opportunistic Records

Non-target species that had not been recorded during previous surveys but were identified whilst conducting this survey or observed whilst travelling to and from the site were recorded.

3. RESULTS

3.1 Weather Conditions

Weather conditions were ideal for sampling shorebirds and owls. Apart from one day of light rain the weather was fine and warm with nil or light wind, moderate humidity and low or no cloud cover (Table A1, Appendix A). Nocturnal visibility was moderate. Moonlight ranged from nil to a quarter-moon with bright starlight conditions recorded during each evening survey.

3.2 Survey Effort

Shorebird and owl surveys were often conducted during the same day. In such cases shorebird surveys were conducted during the appropriate tidal stages and were either preceded by owl roost and nest searches and/or followed by stag watch, dusk census and call broadcast surveys. Shorebird surveys were conducted over five days, three on the island, one on the mainland and one boat survey of the upper port. Owl surveys were conducted over nine days, three on the mainland and six on the island. Island surveys included both the subject site (4 days) and study area (4 nights). In some cases surveys within the subject site and study area were conducted on the same day. A summary of the sample effort is included in Table A2, Appendix A.

3.3 Limitations

In general, the targeted survey was adequate to satisfy the scope of work. Weather conditions were ideal for owl and shorebird surveys and timing compliments surveys undertaken in October 2008 and January and February 2009. A greater spatial coverage of owl sample sites on Curtis Island would have improved our assessment of cumulative impacts, although the data are sufficient for this purpose. Additional shorebird surveys of intertidal habitat adjoining the subject site during the peak population period (December – February) would have provided more conclusive information on the value of this habitat for foraging. Nonetheless, the data gathered are regarded as satisfactory.

3.4 Powerful Owl

3.4.1 Roost and Nest Site Surveys

A total of 38 trees or stags were identified as potential nest trees within the LNG Facility (Figure 5 and Table A3). Of these, 18 were stags, 12 were Lemon-scented Gum (*Corymbia citriodora*) and eight (8) were Queensland Blue Gum. Only 11 of these potential nest trees were categorised as having “good” suitability as a potential nest tree. Six of these were stags. Large or old-growth Queensland Blue Gum was rare on the site as were large or old growth Lemon-scented Gum.

The majority of potential nest trees were on the lower slopes or flats. A high number of trees were found in the valley immediately to the east of the site. Large entry hollows were uncommon. Hollows in Lemon-scented Gums were also uncommon. Old growth Queensland Blue Gums were rare within the development site; however, large hollows were a notable feature in those trees that were identified.

Seven roost sites used by owls were located (Table A3) however, only three of these were identified as Powerful Owl roosts (Figure 5, Table A3). Roosts of the Barking Owl and Southern Boobook Owl were also found (Table A3).

In addition to these roosts a dead stag (T5) appeared to be an active nest. Whilst conducting a dusk census at the stag (22.09.2009) a male Powerful Owl called from a roost several 100m's to the north east; followed by a few muffled calls from the female which originated from the direction of tree T5; the male then flew to the north where it called several times before flying low over the potential nest tree. Shortly after the male then left the location and could be heard calling from the valley further to the north. No other activity was observed at this site.

The Powerful Owl roosts located during this survey were all in close proximity to this potential nest tree (Figure 5). One roost site was situated within 10-15m from T5. This roost appeared to be used during the survey as fresh breast-feathers were collected from the site on 18 and 22 September. Call playback surveys conducted as part of the October 2008, February 2009 and during this survey all recorded Powerful Owls in this area (Figures 6). A single male was recorded here in October 2008 and a pair was recorded near the site in February 2009 (Figure 6).

3.4.2 Nocturnal Call Broadcast / Contextual Surveys

A total of 26 sites were surveyed (Figures 3 and 6). Sixteen mainland sites and ten on Curtis Island (three within the LNG Facility site) were surveyed using call broadcast. Powerful Owls were recorded at five mainland sites (Figure 7) and at four sites on Curtis Island (Figure 6). The distribution of sites where Powerful Owls were recorded suggests that at least three (3) pairs occur in the mainland section of the study area. Definitely one, and possibly two, pairs occur within the study area on Curtis Island. Mainland sites M13 and M16 at which Powerful Owls were observed were located west of the Mount Larkom Range and were approximately 10km apart (Figure 3). Sites M4, M5 and M10 were all located to the east of the Mount Larkom range and represented another pair separate from those located west of the range. Previous surveys conducted as part of the Gladstone Nickel Refinery project (URS 2007) recorded Powerful Owls to the south of these sites, which may represent a second pair east of the range. However, it is possible that the 2007 record may be the same birds as those recorded at site M16 (west of the range) during this survey.

On Curtis Island, one pair was observed using the eastern part of the LNG Facility site (Figure 6, Sites I1, I13, and I3) and a male Powerful Owl was heard calling east of the low range that is immediately to the east of the development site (Figure 3, Sites I7 and I8). The bird heard from sites I7 and I8 was first detected calling some kilometres to the south west of these survey sites.

Confirmed pairs were observed at sites I1, I13 and at sites M4 and M5. Individual birds were observed or were heard calling at mainland sites M13, M16, M10 and at island sites I1, I3, I7 and I8 (Figures 3, 6 and 7).

The distribution of these observations suggests that pairs are using relatively large home ranges that may be larger than 1000ha.

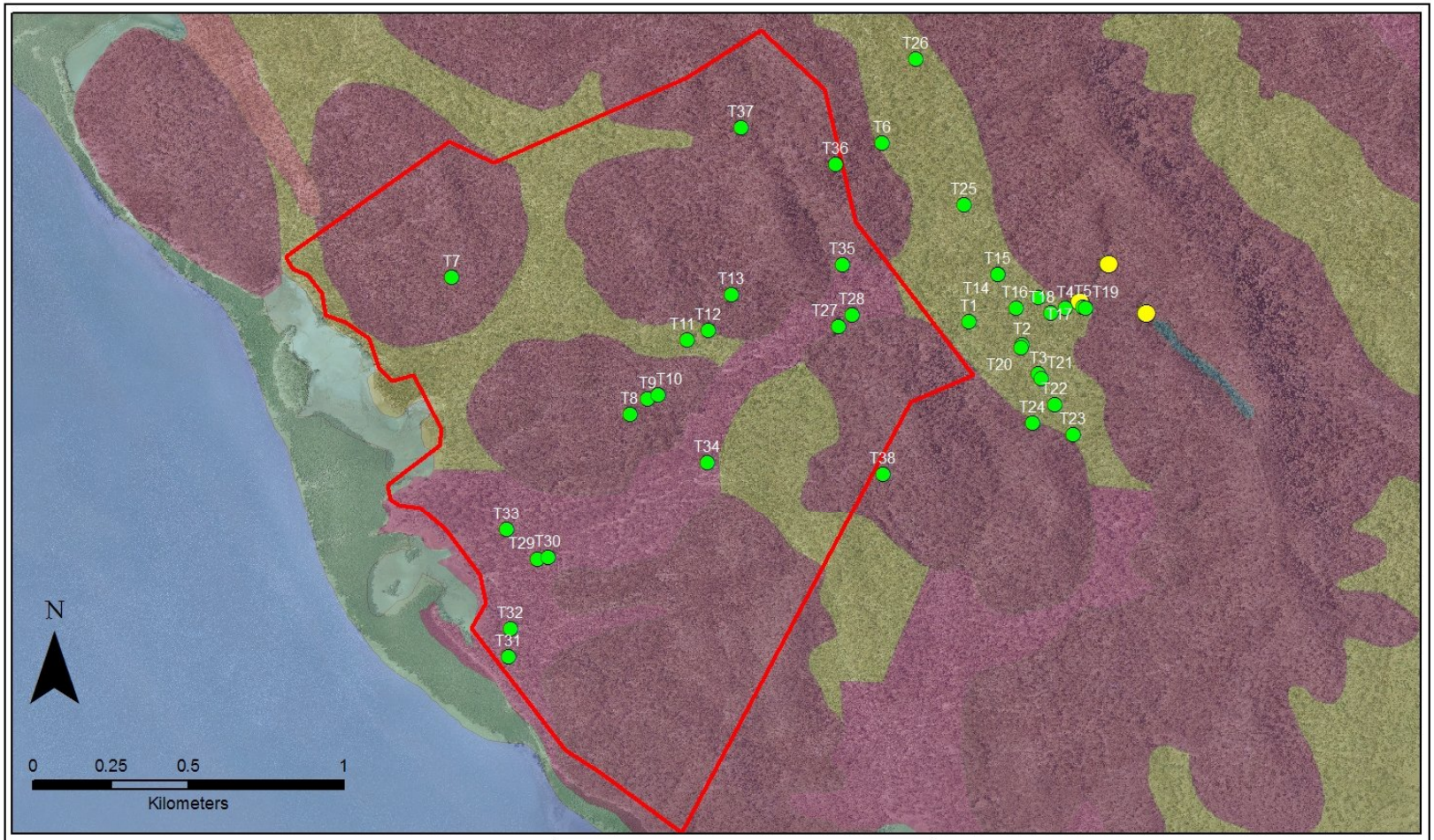

Figure 5:
QCLNG Proposal: Curtis Island
Potential Powerful Owl Nest Trees
September 2009

Legend

- Potential_Nest_Trees
- Powerful_Owl_Roosts_Sept_09
- Revised LNG Facility Layout - Aug 09

Sources:
DNR & W. Aerial Photo - 18.07.2007
GDA_1994_MGA_Zone56

This map is not guaranteed to be free of errors or omissions. Wildsearch Environmental Services and Sandpiper Ecological Surveys disclaims liability for any act or omission made on the basis of the information in this map, and any consequences of such acts or omissions.

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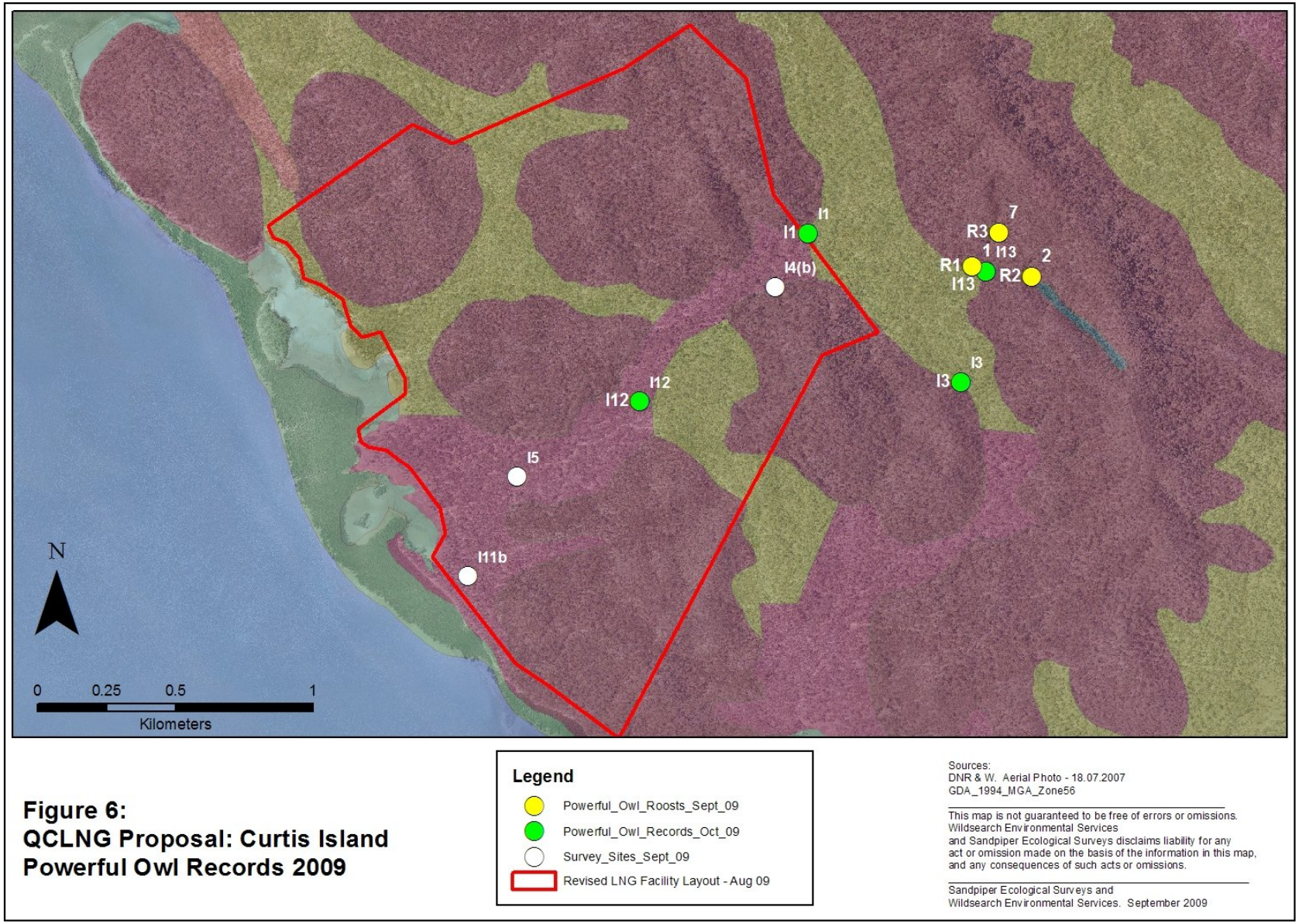

Figure 6:
QCLNG Proposal: Curtis Island
Powerful Owl Records 2009

Figure 7:
QCLNG Proposal
All Owl Records
September 2009

3.5 Migratory Shorebirds

3.5.1 Species Richness

Twelve species of shorebird were recorded during the survey, including four resident and eight migratory species (Table A3, Appendix A). Two threatened species (Beach Stone-Curlew and Eastern Curlew) listed on the NC Act and eight migratory species listed on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded. One species that had not been recorded in the study area during previous surveys, Curlew Sandpiper, was recorded in September 2009. Curlew Sandpiper is listed as a migratory species on the EPBC Act.

3.5.2 Roosts

Twelve high tide roosts were sampled in September 2009 (Figure 8, Table A4, Appendix A). The highest number of individuals (119) and species richness (eight) was recorded at Friend Point, followed by Calliope 2 (85 individuals, two species), Flying-fox Creek (29 individuals, two species) and South Passage Island (20 individuals, four species). The maximum count at Laird Point was nine individuals, with five species recorded over the sample period. Three individuals and three species (Pied Oystercatcher, Eastern Curlew and Whimbrel) were recorded within the subject site during the targeted survey. Three Masked Lapwings were recorded opportunistically in the subject site at high tide. During the survey period the maximum number of shorebirds roosting on-site was probably six. No birds were recorded within the subject site during the high tide survey on 24 September 2009.

3.5.3 Foraging Areas

Seven species were recorded at low tide (Table A4, Appendix A). Eastern Curlew and Whimbrel were the most widespread species, with individuals recorded at most mainland sample sites and on intertidal habitat adjoining the proposed LNG Facility. The highest number of individuals and species were recorded at Site 4 on the Mainland, although this count occurred at mid-tide and includes birds that were coalescing from a much broader area of foraging habitat. Thirteen individuals were recorded at the subject site and immediately adjacent mudflat during both low tide surveys. Whimbrel and Eastern Curlew were the most abundant species on mudflats adjoining the subject site and Mainland sites 1 and 2. Similar counts of shorebirds were obtained at Mainland sites 1 (13 individuals) and 2 (12) and the island (13). Small numbers of shorebirds were recorded foraging in North China Bay.

3.6 Opportunistic Records

Two additional species of bird were recorded during the targeted surveys. One Square-tailed Kite (*Lophoictinia isura*) was recorded flying west from Laird Point towards the mainland and the Large-tailed Nightjar (*Caprimulgus macrourus*) was recorded calling from the northern side of Grahams Creek on two occasions. The Yellow-bellied Glider (*Petaurus australis*) (3 sites) and Greater Glider (*Petaurus volans*) (1 site) were recorded during owl surveys on the mainland. Squirrel Gliders and Sugar Gliders were recorded at three sites on the mainland and eight sites on the island. Both species were abundant at sites with flowering Queensland Blue Gum. Squirrel Gliders were recorded calling and

observed at most sites. Black and Little-red Flying-foxes were widespread on the Island and Mainland. One Bandy Bandy (*Vermicella annulata*) was recorded near Laird Point.

Nine species of nocturnal bird, excluding Powerful Owl, were recorded during the survey (Figure 7). Southern Boobook and Bush Stone-Curlew were widespread on the Island and Mainland; however, Boobooks were more abundant on the Island. Barking Owls were recorded at two sites on the Mainland and four sites on the Island. Records of Barking Owls on Curtis Island include numerous pairs with at least seven pairs occurring within and immediately adjacent to the proposed LNG Facility. Owlet Nightjars were widespread on Curtis Island with individuals recorded at eight of the 14 sites sampled. Eastern Barn Owl, White-throated Nightjar, Large-tailed Nightjar and Tawny Frogmouth (*Podargus strigoides*) were uncommon. Eastern Barn Owls were recorded on the mainland only, although the species has been recorded previously on Curtis Island. Large-tailed Nightjars were recorded only near Grahams Creek and White-throated Nightjars were recorded at two sites on the Mainland and Island.

Figure 8: QCLNG Proposal: Shorebird Roosts Sept 2009

4. DISCUSSION

4.1 Powerful Owl

The subject site is situated at the northern distributional limit for this species (Higgins 1999) and impacts on roost and/or nest sites have a high likelihood of causing detrimental effects on a breeding pair.

This study found that the Powerful Owl was relatively common in the Gladstone region with a total of four or five pairs recorded; three on the mainland and one, possibly two, pairs in the south western parts of Curtis Island. Powerful Owls were not recorded from the fragmented forest habitats within the areas already developed for industry north-west of Gladstone. We suggest that these owls may avoid these fragmented habitats and it is therefore unlikely that they would utilise fragmented forests immediately adjacent to the proposed LNG facility areas on Curtis Island.

This study also confirmed that the subject site represented part of a home range used by one pair of Powerful Owl. Active roosts were located in patches of Semi-evergreen Vine Thicket and other dense riparian vegetation immediately to the east of the proposed LNG Facility. These roosts were outside of the proposed LNG Facility area and therefore should remain unaffected by the proposal.

The results also suggest that only one pair utilises the forest habitats west of the low north – south range situated east of the subject site. This broadly equates to the northern 2/3rds of the Curtis Island Industrial Precinct. Although inconclusive, this survey also suggests that this pair may forage east of the range in the environmental precinct. Approximately 1500ha of suitable habitat occurs west of the north – south range. If fully utilised by the identified pair this represents a very large home range at the upper end of published territory sizes (Schodde & Mason 1980, Higgins 1999).

4.1.1 Impact of the Proposed LNG Facility on Powerful Owl

Changes to the LNG proposal such as shifting the LNG plant to the east and removing the road and bridge has some benefit to Powerful Owls. Removal of the road will avoid impacts on potential Powerful Owl foraging habitat on the mainland. In contrast the change in site boundary on the island will have no benefit to Powerful Owl. The cumulative effect of this and other adjoining proposals would remove a substantial area of foraging habitat used by a pair of Powerful Owls and several potential nest trees. Although most of the nest trees to be affected were classified as poor to moderate value. The ability of owls to alter home range size and distribution requires some understanding of their abundance and distribution in the locality. If suitable habitat occurs elsewhere on the island our study suggests that it is likely that this habitat is already occupied. The territorial nature of owls makes it difficult for pairs (or individuals) to overcome habitat loss by foraging elsewhere. Therefore, based on available evidence it is likely that the cumulative impacts of the proposed LNG developments on Curtis Island would have a detrimental effect on one pair of owls.

4.2 Migratory Shorebirds

4.2.1 Shorebirds in Port Curtis

The Curtis Coast region is known to support a substantial shorebird population. Driscoll (1997) estimated the population at 10 188 and suggested that this was an underestimate as some potentially important sites had not been adequately sampled. Driscoll (1997) lists 33 species as occurring in the region (Table 2). The Curtis Coast region delineated by Driscoll (1997) includes a substantially greater area than Port Curtis, extending from Rockhampton to Seventeen Seventy. Count data summarised by Birds Australia as part of the Shorebirds 2020 project provides a more accurate indication of the shorebird population in Port Curtis. The 2020 data includes a maximum count of 5168 individuals and 25 species in Port Curtis (Table 2). The majority of sample areas mapped by Shorebirds 2020 are situated around Gladstone and it is likely that survey coverage of the Narrows (i.e. upstream of the subject site) is incomplete. Once again the count may underestimate the shorebird population in Port Curtis.

Migratory species that occur in significant numbers in the survey region (i.e. Curtis Coast) are Bar-tailed Godwit, Eastern Curlew, Whimbrel and Common Greenshank (Driscoll 1997). According to Driscoll (1997) the Curtis Coast region supports 6%, 8%, 4% and 8% of the respective statewide populations of these species. According to Bamford *et al.* (2008) the Curtis Coast Region does not support an internationally significant proportion of the population of any shorebird species. However, maximum counts of Eastern Curlew (1532 individuals) and Grey-tailed Tattler (880 individuals) for the Curtis Coast Region, reported by Driscoll (1997), exceed the 1% threshold values of 380 (Eastern Curlew) and 500 (Grey-tailed Tattler) individuals specified by Bamford *et al.* (2008). The reason the Curtis Coast is not listed as a site of International Importance for these species is assumed to be because the counts were derived outside the December to February non-breeding period used by Bamford *et al.* (2008) to define population size. Nonetheless, the counts emphasise the importance of the region for these species and it is likely that region-wide surveys during the non-breeding period may confirm the presence of an internationally significant population of Eastern Curlew.

Shorebird surveys undertaken by the authors as part of the Environmental Impact Assessment for the proposed QC LNG facility and access road have focused on small parts of Port Curtis. These counts provide information on specific sites and whilst they provide baseline information to compare sites (roosts) they are of insufficient spatial and temporal coverage to enable population estimates to be derived. Apart from surveys of the proposed LNG facility on Curtis Island the counts are insufficient to thoroughly determine the relative value of all sites sampled. Longer term sampling of roosts is required to make definitive statements on their importance within Port Curtis. Nonetheless, such surveys are not considered necessary for this project nor are they the responsibility of QGC.

Surveys by the authors at two high tide roosts near South End in October 2008 recorded between 800 and 1200 individuals and 16 species (Table 2). These counts were regarded as underestimates at the time of sampling. During one high tide survey in February 2009 approximately 299 Whimbrel were recorded using the neap tide roost near Friend Point (Table A6). This represents approximately 49% of the Whimbrel population in the Curtis Coast Region (Driscoll 1997). The count of 304 Red-necked

Stints recorded foraging near Friend Point in late January 2009 equates to 25% of the estimated population for that species in the Curtis Coast Region (Driscoll 1997).

To the authors knowledge there have been no detailed studies on shorebird habitat use in Port Curtis. Many high tide roosts have been mapped and intertidal foraging habitat delineated. It is likely that shorebirds in Port Curtis behave in a similar manner to other sites where they roost in close proximity to preferred foraging areas and move regularly between the two habitats in accordance with the tidal cycle. Changes in movement patterns may occur during the migration cycle, between day and night and when environmental conditions create favourable habitat, such as inundation of claypan habitats during rainfall events.

Major habitat features in the vicinity of the proposed LNG Facility include expansive foraging habitat around the Passage Islands, between Friend and Landing Points and in Grahams Creek. Smaller areas of intertidal habitat occur along the western fringe of Curtis Island, particularly in the vicinity of North China Bay. Major high tide roosts occur at Friend Point, Lairds Point, South Passage Island and near the mouth of the Calliope River. Whilst this matrix of foraging and roosting habitat is not used by an isolated population of shorebirds it is predicted, based on limited observation that a subset of the Port Curtis shorebird population relies predominantly on these habitats during the non-breeding period (i.e. December to February).

4.2.2 Impact of the Proposed LNG Facility on Shorebirds

Sandpiper and Wildsearch (2008) indicated that the proposed LNG Facility and immediately adjacent intertidal habitat were of limited value to shorebirds. The supplementary shorebird surveys support this assertion. Data collected during the field surveys show that the subject site and immediately adjacent intertidal habitat support a very small proportion of the migratory shorebird population in the Curtis Coast Region (0.001%), Port Curtis (0.003%) and the nearby section of Port Curtis (0.01%).

Although the section of intertidal foraging habitat immediately adjacent to the subject site has not been sampled during the early summer period when shorebird numbers may peak, the available counts are representative. Even if it were assumed that during peak times the number of shorebirds foraging adjacent to the site was double that recorded in October 2008 and September 2009 the relative proportions are still insignificant. The counts derived for the subject site in October 2008, February and September 2009 are considered reliable.

Whilst the proposed LNG Facility may render the claypan habitat unsuitable for shorebirds this would affect a very small number (i.e. between 3 and 6) of individuals. Despite the presence of a construction dock and loading wharves, substantial areas of the adjoining intertidal habitat will continue to be available to shorebirds at low tide. Shorebirds are likely to continue to use this habitat, albeit in lower numbers. Lights from the wharfs may also benefit some individuals that forage near the site at night. This conclusion assumes that the adjoining foraging habitat will not be affected by dredging.

Recent changes to the proposal, such as shifting the LNG plant away from the shoreline and removing the road and bridge mean that impacts on shorebirds will be less than that discussed in the Environmental Impact Statement. The cumulative effect of several adjoining LNG plants would include increased disturbance of a substantial area of low

value shorebird foraging and roosting habitat. The retention of a buffer between the LNG plants and intertidal habitat, as proposed at the QGC site, will reduce disturbance impacts on foraging shorebirds. However, several individuals that presently roost and forage in claypan habitat at high tide will be displaced. The small number of birds displaced at high tide and low tide are likely to find alternate sites to roost and forage.

Table 2: Counts of shorebirds in the Gladstone area. 1 = Maximum counts for the Curtis Coast Region (Rockhampton to Seventeen Seventy), 2 = Maximum counts for Port Curtis, 3 = Maximum counts for two roosts near South End, 4 = Maximum counts at Friend Point, Friend Point claypan, Laird Point, Passage Islands and Grahams Creek, 5 = Maximum counts at roosts in central Port Curtis, 6 = Maximum counts of roosting and foraging birds at the QGC LNG Facility and immediately adjacent intertidal habitat.

Common Name	Driscoll (1997)[1]	Shorebirds 2020[2]	South End (Oct 2008)[3]	Friend to Laird Pt (Feb 09)[4]	QGC LNG Locality (Sept 09)[5]	QGC LNG Facility (Oct 08, Feb 09, Sept 09)[6]
Snipe sp.	6					
Black-tailed Godwit	41	4				
Bar-tailed Godwit	2726	1509	373	74	82	1
Whimbrel	610	450	126	299	60	6
Eastern Curlew	1532	515	249	62	46	4
Marsh Sandpiper	59	63				
Common Greenshank	370	198	38	1		
Wood Sandpiper	4					
Terek Sandpiper	383	184	1	105	14	
Common Sandpiper		7				
Grey-tailed Tattler	880	496	317	19	30	
Ruddy Turnstone	8	37				
Great Knot	260	265	132	18		
Red Knot		65	5			
Red-necked Stint	1195	1581	24	304	43	
Sharp-tailed Sandpiper	111	90	1	5		
Curlew Sandpiper	446	293	2		1	
Painted Snipe	1					
Bush Stone-Curlew	4					
Beach Stone-Curlew	22		2	7	3	
Pied Oystercatcher	245	165	35	6	4	
Sooty Oystercatcher	23	76				
Black-winged Stilt	108	147				
Banded Stilt	2					
Red-necked Avocet	2	4				
Pacific Golden Plover	10	31	12	20		
Grey Plover	36	5				
Ringed Plover	1					
Red-capped Plover	210	107	22	42	42	
Double-banded Plover	1					
Lesser Sand Plover	434	450	54	25	9	
Greater Sand Plover	304	130				
Black-fronted Plover	40					
Red-kneed Dotterel	6					
Masked Lapwing	6	15		4	5	3

4.2.3 Need for Long-term Monitoring of Shorebirds

- The proposed QGC LNG Facility on Curtis Island and associated wharves will not have a detrimental effect on the migratory shorebird population in Port Curtis. Long-term population monitoring is therefore unnecessary. Impacts on shorebirds may be greater and monitoring may be required if the mainland access road and bridge are constructed or if the proposed pipeline affects the Friend Point roost. Assessing the effect of dredging on shorebird foraging habitat is beyond the scope of this assessment.

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APPENDIX A

Table A1: Weather conditions experienced during the field survey. Temperature and Relative Humidity were recorded using a Kestrel 3000 pocket weather meter. RL = rustles leaves, MSB = moves small branches, MLB = moves large branches, nr = not recorded.

Date	Time	Temperature	Relative Humidity	Wind	Rain	Cloud Cover
14.9.09	dusk	22.3	74	RL	nil	nil
15.9.09	dusk	21.7	72	nil	nil	nil
16.9.09	dusk	22.2	70	MSB	nil	5%
17.9.09	dusk	22.3	82	RL	prev 24hrs	10%
18.9.09	dusk	23.0	72	RL	nil	nil
20.9.09	dusk	22.7	83	nil	nil	nil
21.9.09	dusk	22.5	86	RL	nil	nil
22.9.09	dusk	22.4	81	MSB	nil	nil
23.9.09	dusk	25.4	76	MSB	nil	nil

Table A2: Summary of survey effort. Includes both spring 2008, 2009 and summer 2009 surveys. * does not include numerous casual observations whilst traversing the site conducting other surveys.

Method	Number of Surveys/Sites			
	LNG Facility	Nearby Habitat – Curtis Island	Mainland – near Friend Point	Port Curtis
High Tide Surveys	4*	7	6	2
Low Tide Surveys	4*	4	1	0
Nocturnal Call Playback	3	18	18	
Stag and Tree Watches	3	2	1	
Dusk Census	4	2	2	

Table A3: Potential Nest Trees, Curtis Island development Site, September 2009

Tree No.	Easting	Northing	Tree Species	Hollow Type	Hollow Size	Suitability
T1	317602	7370679	Lemon-scented Gum	Spout	40cm	moderate
T2	317758	7370605	Lemon-scented Gum	Trunk	30cm	poor
T3	317809	7370514	Queensland Blue Gum	Trunk	30cm	poor
T4	317886	7370726	Queensland Blue Gum	Spout	40cm	moderate
T5	317938	7370728	Stag	Trunk	45cm	moderate
T6	317336	7371249	Stag	Spout	40cm	moderate
T7	316070	7370803	Stag	Trunk	30cm	poor
T8	316603	7370369	Stag	Trunk	40cm	poor
T9	316654	7370418	Stag	Trunk	45cm	poor
T10	316687	7370430	Stag	Spout	45cm	moderate
T11	316770	7370610	Stag	Trunk	45cm	moderate
T12	316832	7370640	Stag	Spout	30cm	poor
T13	316898	7370757	Stag	Trunk	45cm	moderate
T14	317684	7370831	Queensland Blue Gum	Spout	30cm	moderate
T15	317684	7370831	Queensland Blue Gum	Spout	30cm	poor
T16	317739	7370724	Stag	Trunk	35cm	moderate
T17	317806	7370757	Lemon-scented Gum	Spout	35cm	poor
T18	317843	7370710	Lemon-scented Gum	Spout	50cm	good
T19	317945	7370727	Stag	Spout	30cm	moderate
T20	317756	7370597	Lemon-scented Gum	Spout	35cm	moderate
T21	317816	7370497	Queensland Blue Gum	Trunk	35cm	poor
T22	317857	7370414	Lemon-scented Gum	Spout	35cm	moderate
T23	317914	7370320	Stag	Spout	30cm	poor
T24	317793	7370355	Lemon-scented Gum	Trunk	35cm	good
T25	317581	7371054	Queensland Blue Gum	Spout	40cm	moderate
T26	317433	7371520	Lemon-scented Gum	Spout	30cm	poor
T27	317217	7370659	Lemon-scented Gum	Trunk	45	good
T28	317256	7370697	Lemon-scented Gum	Spout	30	moderate
T29	316336	7369898	Queensland Blue Gum	Trunk	45	good
T30	316368	7369903	Stag	Spout	50	good
T31	316254	7369584	Stag	Trunk	50	good
T32	316260	7369673	Stag	Trunk	40	good
T33	316242	7369991	Queensland Blue Gum	Spout	30	moderate
T34	316835	7370217	Lemon-scented Gum	Spout	35	moderate
T35	317225	7370857	Stag	Trunk	35	good
T36	317200	7371180	Stag	Spout	35	good
T37	316919	7371293	Lemon-scented Gum	Trunk	40	good
T38	317352	7370186	Stag	Trunk	40	good

Table A4: Owl Roost Sites, Curtis Island Development Site, September 2009

Site No.	Easting	Northing	Vegetation Type	Evidence	Used By	Species Present
1	317927	7370749	Thicket of rainforest shrubs on creek line	P.O. whitewash, pellets and breast feathers; additional P.O. breast feathers recorded between 17.9 and 22.9 indicating recent use.	Powerful Owl / Southern Boobook	Southern Boobook
2	318125	7370714	Thicket of rainforest shrubs on creek line; extends for 120m up gully; shown on RE mapping	P.O. whitewash; large pellets	Powerful Owl / Barking Owl	Barking Owl on 22.9.09
3	317220	7370685	Small clump of rainforest shrubs 10m diameter	whitewash; pellets; possible barking owl roost		
4	316764	7370358	Small clump of Kamala on creekline	whitewash	Southern Boobook	Southern Boobook
5	316439	7370151	Exposed roots on creek bank	whitewash	Southern Boobook	Southern Boobook
6	316943	7370596	Overhanging Dead Branch	whitewash / Pellets	Southern Boobook	Southern Boobook
7	318013	7370871	Trees in gully	Male called at dusk from gully	Powerful Owl	Powerful Owl

Table A5: High tide surveys, September 2009

Common Name	Sth Passage Island	Nth Passage Island	Laird Point			Narrows	Friend Point (roost)		Friend Point (claypan)	Flying-fox Creek	Calliope 1	Calliope 2	QAL 1	QAL 2	LNG	
	19.9.09	19.9.09	16.9.09	19.9.09	24.9.09	19.9.09	15.9.09	19.9.09	15.9.09	19.9.09	19.9.09	19.9.09	19.9.09	19.9.09	16.9.09	24.9.09
Beach Stone-Curlew				2										1		
Pied Oystercatcher	2				1		2							2	1	
Red-capped Plover			4	3	6		30	7	12				2			
Lesser Sand Plover							6	9								
Masked Lapwing				2	2											
Bar-tailed Godwit							19	42				40				
Whimbrel	3	4		1		7	4	8			12	19	1	5	1	
Far Eastern Curlew						3	46	4				26	13		1	
Terek Sandpiper	10									4						
Grey-tailed Tattler	5									25						
Red-necked Stint							12	43								
Curlew Sandpiper								1								
Total Number	**20**	**4**	**4**	**8**	**9**	**10**	**119**	**114**	**12**	**29**	**12**	**85**	**16**	**8**	**3**	**0**

Table A6: Low tide surveys, September 2009.

Common Name	14.9.09				20.9.09					21.9.09				
	Mainland 1	Mainland 2	Mainland 3	Mainland 4 (mid-tide)	Nth Claypan	Nth Flats	Sth Claypan	Sth Flats	Nth China Bay	Nth Claypan	Nth Flats	Sth Claypan	Sth Flats	Nth China Bay
Red-capped Plover			35	2										
Lesser Sand Plover				7										
Masked Lapwing					3						3			
Bar-tailed Godwit				3				1	2					
Whimbrel	8	3		2		4	1	1	2		3	3		
Far Eastern Curlew	5	9		51		2		1	1		3	1		1
Red-necked Stint				4										
Total	**13**	**12**	**35**	**69**	**3**	**6**	**1**	**3**	**5**	**0**	**9**	**4**	**0**	**1**

Table A7: Shorebird Counts, January & February 2009

Tide	Low	High	Neap	Neap	Neap							High
Date	27.1.09	26.1.09	27.1.09	27.1.09**	19.2.09	18.2.09	19.2.09	20.2.09	20.2.09	20.2.09	20.2.09	22.2.09
Location	Mainland - claypan	Mainland claypan	Friend Point roost	Rear of claypan	Friend Point roost	Laird Point	Laird Point	Sth Passage Is	Friend Point roost	Laird Point	Grahams Creek Generally	Laird Point
Easting	311000	311280	311989	310480	311673	313744	313744	315301	311673	313744		313744
Northing	7371800	7372000	7372236	7371280	7372009	7372882	7372882	7368514	7372009	7372882		7372882
Common Name												
Beach Stone-Curlew					3		1 (tracks)					2
Pied Oystercatcher		1		6	2					2		
Red-capped Plover	42	12			5	4			2	2	1	
Pacific Golden Plover	12			8								
Lesser Sand Plover		25										
Masked Lapwing												4
Bar-tailed Godwit	1	41	74	16	8	1			57			
Whimbrel	3	34	7	12	299	8	69		3		10	173
Eastern Curlew	1	27	15	3	56	2	6		7		1	3
Terek Sandpiper								105***				
Grey-tailed Tattler	2	7	2		1			19***				
Common Greenshank	1	1										
Great Knot		15	12	6					10			
Red-necked Stint	304	142										
Sharp-tailed Sandpiper	5											
Total numbers	**371**	**305**	**110**	**51**	**374**	**15**	**75**	**124**	**79**	**4**	**12**	**182**

Table A7: Shorebird Counts, January & February 2009

Tide	Low	High	Neap	Neap	Neap							High
Date	27.1.09	26.1.09	27.1.09	27.1.09**	19.2.09	18.2.09	19.2.09	20.2.09	20.2.09	20.2.09	20.2.09	22.2.09
Location	Mainland - claypan	Mainland claypan	Friend Point roost	Rear of claypan	Friend Point roost	Laird Point	Laird Point	Sth Passage Is	Friend Point roost	Laird Point	Grahams Creek Generally	Laird Point
Easting	311000	311280	311989	310480	311673	313744	313744	315301	311673	313744		313744
Northing	7371800	7372000	7372236	7371280	7372009	7372882	7372882	7368514	7372009	7372882		7372882
Common Name												
Beach Stone-Curlew					3		1 (tracks)					2
Pied Oystercatcher		1		6	2					2		
Red-capped Plover	42	12			5	4			2	2	1	
Pacific Golden Plover	12			8								
Lesser Sand Plover		25										
Masked Lapwing												4
Bar-tailed Godwit	1	41	74	16	8	1			57			
Whimbrel	3	34	7	12	299	8	69		3		10	173
Eastern Curlew	1	27	15	3	56	2	6		7		1	3
Terek Sandpiper								105***				
Grey-tailed Tattler	2	7	2		1			19***				
Common Greenshank	1	1										
Great Knot		15	12	6					10			
Red-necked Stint	304	142										
Sharp-tailed Sandpiper	5											
Total numbers	**371**	**305**	**110**	**51**	**374**	**15**	**75**	**124**	**79**	**4**	**12**	**182**