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GLNG Operations Pty Ltd
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GLNG LNG Facility Curtis Island Shorebird Surveys

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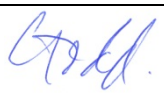
0	16-Feb-2017	FINAL	Chris Todd Principal Ecologist	

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Executive Summary

This migratory shorebirds survey report details the results of 13 migratory shorebird surveys undertaken at China Bay, Curtis Island.

Condition 19 of the Commonwealth EPBC Approval No. 2008/4058 (GLNG LNG Marine Facilities) granted under the EPBC Act requires the preparation of a Migratory Shorebirds Environmental Management Plan (MSEMP).

In accordance with the condition 19(b), migratory shorebird surveys were conducted in:

- January, May-June and November 2011;
- April and December 2012;
- June and December 2013;
- April and December 2014;
- March-April and December 2015; and
- March and November-December 2016.

This report details the survey methodology used in and results of the surveys. A discussion of the results is presented.

1.0 Introduction

1.1 Project Background

GLNG Operations Pty Ltd (GLNG OPL) on behalf of the joint venture partners Santos GLNG Pty Ltd (Santos), PETRONAS Australia Pty Limited (PETRONAS), Total E&P Australia (Total) and KOGAS are proposing to develop coal seam gas (CSG) resources in the Bowen and Surat Basins in the area between Roma and Emerald, Queensland. These CSG resources are proposed to be used as feed gas for a liquefied natural gas (LNG) liquefaction and export facility on Curtis Island, near Gladstone, Queensland.

The GLNG Project comprises the following major components:

- Coal seam gas fields;
- Gas transmission pipeline (GTP); and
- LNG liquefaction and export facility (LNG facility).

The CSG fields will be developed over a period of approximately 25 years to provide CSG to the LNG facility. The gas transmission pipeline will transport the gas from the CSG fields to the LNG facility.

The construction of the marine facilities, which include the Materials Offloading Facility (MOF) and the Product Loading Facility (PLF), will involve disturbance to marine and intertidal habitat. In order to construct the MOF, a temporary Pioneer Barge Ramp Facility (PBRF), will be required to unload bulk aggregate material and equipment onto Curtis Island. Within this report the term ‘marine facilities’ will include the MOF, the PLF and the PBR.

The GLNG LNG facility site and proposed marine facilities are depicted on Figure 1.

1.2 Purpose of this Report

This report presents the results of migratory shorebird surveys undertaken in conjunction with the preparation of a Migratory Shorebirds Environment Management Plan (MSEMP). The preparation of an MSEMP is a requirement of condition (19) of EPBC Approval No. 2008/4058 for the marine facilities at the GLNG LNG facility at China Bay on Curtis Island.

Condition 19 requires the MSEMP to include measures for:

a. Managing the impacts of the action on listed migratory shorebirds including but not limited to the whimbrel (*Numenius phaeopus*) and the Terek Sandpiper (*Xenus cinereus*);

b. Determining baseline population densities and habitat utilisation for migratory shorebirds on or contiguous to the proponent's LNG facility site including, at a minimum, undertaking annual/twice annual surveys during northwards and southwards migrations;

c. Minimising impacts from noise and light on the feeding and roosting sites of listed migratory seabirds; and

d. Monitoring the effect of the construction of the marine facilities on the shorebirds, including but not limited to the extent relevant pile driving, construction dredging, noise impulse levels, light spill, water quality reduction, decreased access to intertidal foreshore habitat, increased sedimentation and displacement.

The MSEMP was approved by the Department on 21 March 2011. This report has been prepared to describe the findings of migratory shorebird surveys as stipulated in Condition 19(b) and 19 (d) above and in accordance with the MSEMP.

1.3 Study Area

The study area is the intertidal wetlands of China Bay, Curtis Island. China Bay is depicted on Figure 1.

1.3.1 Regional Context

1.3.1.1 Curtis Island

Curtis Island is located off the coast of central Queensland near Gladstone forming part of the eastern rim of Port Curtis. It is approximately 40 km long and 20 km across at its widest point. Typical landforms on the island include moderate to steep wooded slopes, wooded alluvial plains, intermittent and semi-permanent watercourses, estuarine systems and fresh and saltwater wetlands.

1.3.1.2 Port Curtis

Port Curtis is a major industrial centre that supports aluminium refineries and smelters, cement production works, chemical plants and Queensland's largest power station. The area of state-owned industrial land measures over 10,000 hectares (Duke *et al*., 2003). The port is a major international and multi-commodity facility. Issues in the region include harbour dredging, port development, industrial development, discharge of effluent and extensive reclamation of intertidal wetlands, including mudflats, mangroves, saltflats and marshes. Although intertidal wetlands are still prevalent along the Port Curtis coastline, they have been extensively cleared, filled or modified around Gladstone City and Auckland Inlet (Duke *et al*., 2003). Intertidal areas along the south-west coastline of Curtis Island in the vicinity of the proposed LNG site are largely undisturbed.

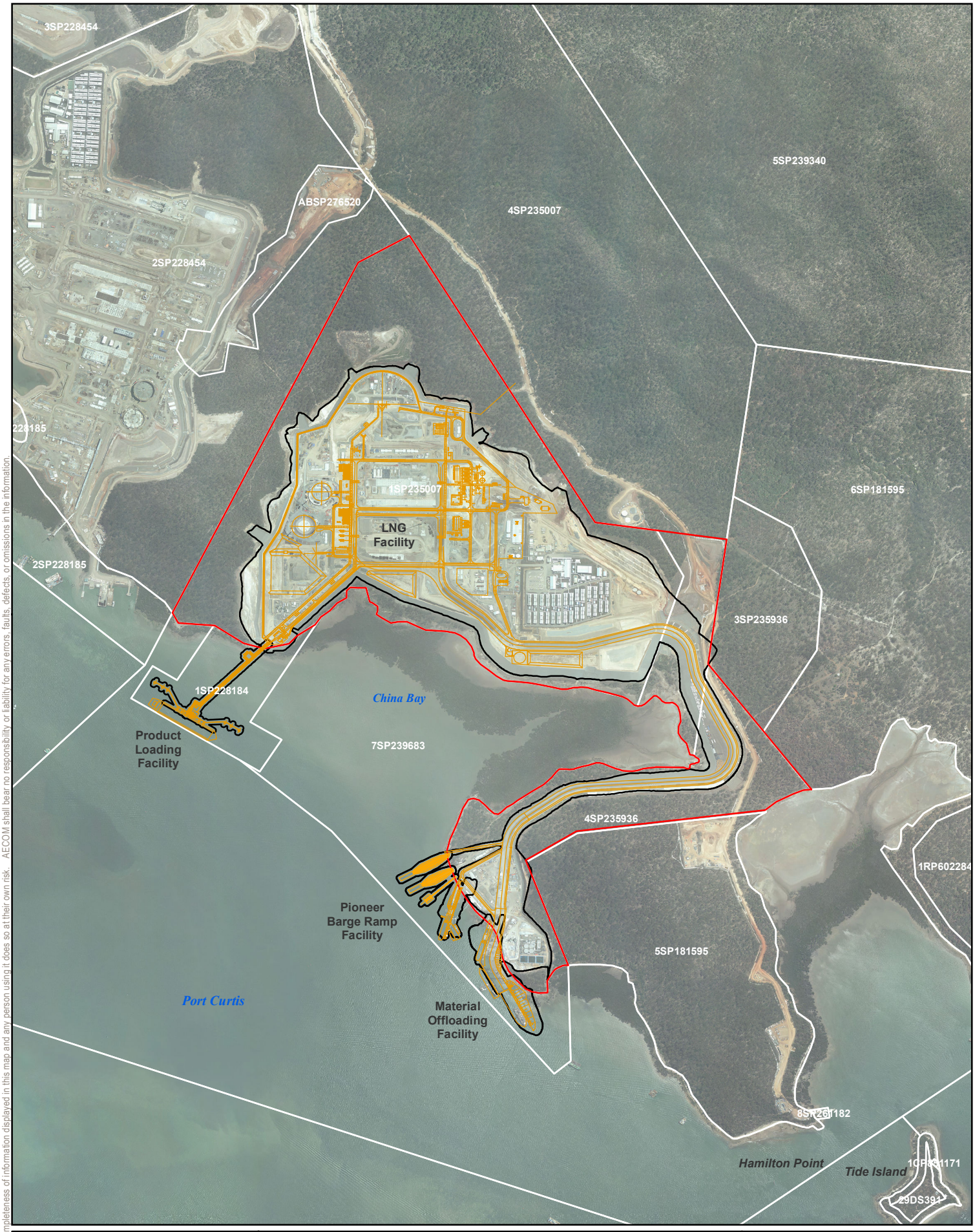
Habitats potentially affected by the proposed LNG infrastructure are represented within Port Curtis (and broader regional areas) and it is considered unlikely that any particular intertidal habitat or individual species would be solely restricted to areas that would be directly cleared or modified by the project given the broad extent of habitat available in the locality and broader region. In the context of significant historical impacts to intertidal habitats in the Port Curtis area from land reclamation projects, the potential direct habitat loss from the LNG project is likely to be small. In Port Curtis, there was a regional loss of mangrove (1,470 ha or 38%) and saltmarsh (1,340 ha or 34.8%) habitats between 1941 and 1999 (Duke *et al*., 2003).

Construction of the GLNG LNG facility, the MOF, PLF and pioneer barge facility will involve the removal of 0.18 ha of Regional Ecosystem (RE) 12.1.2 (Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland on Quaternary estuarine deposits) and 0.92 ha of RE 12.1.3 (Mangrove shrubland to low closed forest on Quaternary estuarine deposits). This equates to < 0.01% and 0.006 % of RE 12.1.2 and RE 12.1.3 respectively within the Burnett-Curtis Hills and Ranges subregion of the Southeast Queensland Bioregion (URS, 2011).

1.3.2 GLNG LNG Facility Site

The GLNG LNG facility site is located on the south-western coast of Curtis Island on the landward flank of China Bay. The site is dominated by *Eucalyptus* and *Corymbia* woodlands on moderate to low slopes and alluvial plains. Mangrove and saltmarsh communities are present within intertidal areas. The study site displays impacts consistent with a long history of use that includes grazing, clearing, cropping, and selected timber felling. The presence of agricultural and environmental weeds and a sub-optimal history of fire have also impacted upon the ecological values of the site. It appears that much of the woodland is regrowth, however some mature trees are scattered throughout. A number of ephemeral streams that only flow following sustained rain, drain into China Bay.

The proposed marine facilities will be constructed at the northern and southern extents of China Bay. The MOF will be constructed at Hamilton Point to the south of China Bay. The PLF is located on the northern side of China Bay. The location of the GLNG LNG facility on Curtis Island and in the region is depicted on Figure 1.



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LEGEND

- LNG Facility Infrastructure
- LNG Facility Site Boundary
- LNG Facility Disturbed Area Footprint (Nov 2010)

Data sources:

Base Imagery sourced from DNRM Queensland 2012

GLNG CURTIS ISLAND MARINE FACILITIES

LOCATION OF GLNG LNG FACILITY AND SITE INFRASTRUCTURE LAYOUT

Shorebird Surveys Report

PROJECT ID	60480058
CREATED BY	RG
LAST MODIFIED	RG - 06 Apr 2016
VERSION:	1

Map

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Filename:

A4 size

2.0 Methods

2.1 Rationale

Migratory shorebird surveys were undertaken to fulfil the requirements of Condition 19(b) of EPBC Approval No. 2008/4058 for development of the GLNG LNG marine facilities.

This condition requires surveys to determine baseline population densities and habitat utilisation for migratory birds on or contiguous to the GLNG LNG facility site. This was to include as a minimum undertaking annual/twice annual surveys during northwards and southwards migrations.

2.2 Survey Timing

Surveys were conducted at the following times:

- January, May-June and November 2011;
- April and December 2012;
- June and December 2013;
- April and December 2014;
- March-April and December 2015; and
- March and November-December 2016.

The January 2011, November 2011, December 2012, December 2013, December 2014, December 2015, and November-December 2016 surveys coincide with shorebird arrival or peak presence periods and allow for a comparison over four years of shorebird usage at this site. The April 2012, April 2014,March-April 2015 and March 2016 surveys coincide with the departure period for shorebirds returning to the northern hemisphere. The other surveys (May-June 2011 and June 2013) were conducted in line with Shorebirds 2020 recommendations for winter surveys to detect overwintering immature migratory shorebirds.

2.3 Target Species

Condition 19(a) of EPBC Approval No. 2008/4058 requires migratory shorebirds to target (but not be limited to) the whimbrel (*Numenius phaeopus*) and the Terek Sandpiper (*Xenus cinereus*).

The literature review for the MSEMP determined that at least 26 species of international migrants utilise Port Curtis (Table 1). These species, along with resident shorebirds and Australian migratory species were targeted during the shorebird surveys.

Table 1 The 26 shorebird species known to utilise Port Curtis

- Latham's snipe
- Pin-tailed snipe
- Swinhoe's snipe
- Black-tailed godwit
- Bar-tailed godwit
- Little curlew
- Whimbrel
- Eastern curlew
- Marsh sandpiper
- Common greenshank
- Terek sandpiper
- Common sandpiper
- Grey-tailed tattler
- Wandering tattler
- Ruddy turnstone
- Great knot
- Red knot
- Red-necked stint
- Sharp-tailed sandpiper
- Curlew sandpiper
- Broad-billed sandpiper
- Pacific golden-plover
- Lesser sand plover
- Greater sand plover

2.4 Survey Methods

Observation sites were established adjacent to potential migratory shorebird foraging and roost habitat areas to conduct surveys for shorebirds at low and high tide respectively. The observation point for the foraging surveys was established at Hamilton Point on the north-west facing beach ridge. This site allowed for a virtually uninterrupted view to the northern extent of China Bay of the soft mudflats that

form foraging habitat seaward of the mangrove zone. Establishment of a survey point on the northern side of China Bay was impractical due to mangroves blocking views from that side.

For the roost surveys, an observation site was set up on the southern fringe of the major expanse of mudflats within China Bay. The sinuous nature of the China Bay coastline landward of the mangroves made it impossible to observe all high tide roost habitat from the one point. However, it was reasoned that this larger area was more attractive to roosting shorebirds due to the size, security and visibility at this site. The majority of the remaining potential roost habitat along the northern coastline of China Bay was initially assessed for usage by shorebirds during vehicle or foot traverses of the area. This task was discontinued in later surveys due to the obvious absence of usage of these sites and access issues associated with the construction of the LNG facility.

Boat-based surveys were not undertaken due to safety concerns and lack of navigable water at high and low tides.

The observation sites are depicted on Figure 2. Coordinates of each observation point are given in Table 2, below.

Table 2 Location of the low and high tide survey observation points

Observation Point	Eastings	Northings	Latitude	Longitude
Foraging (low tide)	317,810.92	7,368,087.00	-23.788095	151.211872
Roosting (high tide)	318,657.18	7,368,350.17	-23.785815	151.220207

A high tide survey of the rocky shore habitat between southern Hamilton Point and the headland at the northern extent of China Bay was conducted by boat during the January 2011 survey to assess the roosting values for shorebirds in these locations.

During each survey period, the foraging and roost areas were continually scanned for shorebirds from the observation points using the naked eye and binoculars. Where the distance was too great for identification using binoculars, a spotting scope was employed. Where shorebirds departed the observation zone, the direction of travel was noted in an attempt to reduce the opportunity for repeat counting. Identifications were confirmed using Morecombe (2004), Geering *et al.* (2007) and Birdlife Australia Australian Shorebirds Identification Sheets. Data was recorded on the standard Shorebirds 2020 data sheet. Data recorded included:

- Observer details;
- Time and date;
- Survey location;
- Wind speed;
- Disturbance from human activity;
- Shorebird species utilising the area;
- Other bird species observed; and
- An estimation of numbers of each species present.

The Shorebirds 2020 data sheet used during the survey is included in Appendix A.

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LEGEND

- LNG Facility Infrastructure
- LNG Facility Site Boundary
- LNG Facility Disturbed Area Footprint (Nov 2010)
- Shorebird Survey Location

Data sources:

Base Imagery sourced from DNRM Queensland 2012

GLNG CURTIS ISLAND MARINE FACILITIES

GLNG LNG FACILITY
SHOREBIRD SURVEY BASES

Shorebird Surveys Report

PROJECT ID	60480058
CREATED BY	RG
LAST MODIFIED	RG - 06 Apr 2016
VERSION:	1

Map
F2

Filename:

A4 size

3.0 Results

3.1 January 2011 Survey

3.1.1 Project Site Conditions

The project site at the time of the survey was generally undeveloped with only a small compound prepared adjacent to the site of the proposed pioneer barge facility. No clearing had been undertaken and vehicular traffic was limited to occasional light vehicle movement on existing tracks.

3.1.2 Findings

Two species of international migrants were observed using foraging and roost habitat at China Bay; eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*).

Very low numbers of each species were observed using available habitat during the surveys as detailed in Table 3, below. Also included in this table are observations and counts of resident shorebirds and other birds observed using intertidal habitat.

Table 3 Shorebird counts at China Bay roost and foraging habitat sites; January 2011 survey

Survey Period	International migrants observed (count)	Other species observed (count)
18/1/11 Roost (high tide)	eastern curlew (2) whimbrel (10)	Australian pied oystercatcher (2) masked lapwing (2) Australian magpie (1) whistling kite (1)
18/1/11 Forage (low tide)	eastern curlew (7) whimbrel (3)	Australian pied oystercatcher (2) striated heron (1) rainbow bee-eater (5) little egret (1)
19/1/11 Roost	eastern curlew (3) whimbrel (8)	masked lapwing (2) little egret (1) striated heron (1)
19/1/11 Forage	eastern curlew (2) whimbrel (5)	nil
20/1/11 Roost*	eastern curlew (4)	masked lapwing (4) brahminy kite (1)
20/1/11 Forage	whimbrel (4)	masked lapwing (1) little egret (4) striated heron (2) brahminy kite (1) crested tern (5)

* Includes results of vehicular and foot traverse of the northern China Bay coastline and boat survey of high tide roost habitat.

3.1.3 Discussion

As shown in Table 3, two species of international migratory shorebirds were observed utilising intertidal habitat within China Bay; eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*). This is a very low diversity when compared to the overall diversity of international migrants (26 species) known from Port Curtis.

The low diversity and abundance of international migrants recorded during the survey can probably be attributed to poor quality foraging resources on the exposed mudflats at low tide and inferior roost habitat landward of the mangroves within China Bay. Sandpiper Ecological Surveys (2008) noted during surveys for the QCLNG project (located on the northern side of China Bay) conducted between 29 September 2008 and 9 October 2008 species diversities and counts that were almost identical to that of the current survey. In addition, they noted at that time that “By way of comparison, high tide counts conducted at a roost site immediately to the west of South End recorded a minimum of 1600 individuals of 16 species, including large flocks of Eastern Curlew, Whimbrel and Grey-tailed Tattler”. It

is evident therefore that superior roosting habitat is present elsewhere in Port Curtis and that China Bay and environs do not support a large diversity and abundance of migratory shorebirds. Surveys of the rocky coast of Curtis Island by boat to the south and north of China Bay did not detect roosting birds at this habitat type at all, thereby indicating that rocky shores in this area do not significantly contribute to roost habitat in Port Curtis.

As the results of this survey are not dissimilar to earlier surveys (e.g. Sandpiper Ecological Surveys, 2008) conducted prior to elevated levels of disturbance, it is unlikely that current disturbance levels are deterring usage of habitat in the area. Sources of disturbance noted during the survey in the vicinity of China Bay were few and of low impact. Vehicular movement along the intertidal/terrestrial ecotone generally did not disturb roosting eastern curlews enough to make them take flight. Pile-driving at the nearby QCLNG site did not disturb shorebirds at high or low tide at all.

3.2 May – June 2011 Survey

3.2.1 Timing

The second migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 31 May and 2 June 2011 inclusive at south China Bay adjacent to the proposed MOF, PLF and LNG facility construction sites. The survey coincided with the neap tide event at a time in the year when a larger proportion of international migrants have left Australian shores to breed.

3.2.2 Project Site Conditions

At the time of the second survey, bulk earthworks were underway following the clearing of large tracts of vegetation. A visual appraisal determined that the majority of clearing had been completed to the south of China Bay, with further removal of vegetation progressing to the north around the western verge of China Bay. Earthworks were focussed on the southern and south-eastern sides of China Bay.

A number of light and heavy vehicles were operating in close proximity to the observation points with elevated noise levels present as a result.

3.2.3 Findings

One individual international migrant was observed on June 1 2011 using foraging habitat at China Bay; eastern curlew (*Numenius madagascariensis*). No international migrants were observed using roost habitat within China Bay during this period.

Along with the eastern curlew, a number of other bird species were observed utilising roost and foraging habitat within China Bay. These are presented in Table 4, below.

Table 4 Shorebird counts at China Bay roost and foraging habitat sites; May-June 2011 survey

Survey Period	International migrants observed (count)	Other species observed (count)
31/5/11 Roost (high tide)	Nil	masked lapwing (2) intermediate egret (1) white-faced heron (2) forest kingfisher (2)
31/5/11 Forage (low tide)	Nil	masked lapwing (1) Pacific black duck (10) pied cormorant (1) white-faced heron (2) striated heron (1) little egret (7) forest kingfisher (1) beach stone-curlew (1) common tern (2) Caspian tern (2) silver gull (1)
1/6/11 Roost	Nil	white-faced heron (1)

Survey Period	International migrants observed (count)	Other species observed (count)
		little egret (1) forest kingfisher (3)
1/6/11 Forage	eastern curlew (1)	Australian pied oystercatcher (2) Pacific black duck (5) little egret (6) Caspian tern (1) crested tern (1) silver gull (3) striated heron (2) sacred kingfisher (2) forest kingfisher (2)
2/6/11 Roost	Nil	white-faced heron (1) little egret (1) sacred kingfisher (2) forest kingfisher (2) welcome swallow (10+)
2/6/11 Forage	Nil	little egret (6) striated heron (2) crested tern (2) silver gull (3) pied cormorant (1) Pacific black duck (4)

3.2.4 Discussion

3.2.4.1 Impacts to Bird Activity from Clearing and Earthmoving Works

The May-June 2011 shorebird survey was conducted whilst clearing and earthmoving activities were being undertaken as part of the development of the LNG facility terrestrial and marine facilities. The clearing and earthmoving works, utilising a large number of heavy and light vehicles and machinery, were being undertaken approximately 20 m from the roost observation point and approximately 70 m from the forage observation point. Operations continued for the entirety of the survey apart from scheduled breaks. Significant levels of noise were present, as well as lesser levels of dust (dust suppression was being undertaken). Visually, the high tide roost area was subjected to a greater degree of impact than the forage area as the vegetated buffer between the terrestrial and intertidal habitats was greatly reduced in this area.

Observations were made of birds using the intertidal areas and the intertidal/terrestrial ecotone whilst the construction activities were progressing. The roost survey observation point, being very close to the construction zone, was ideally placed to determine if shorebirds or other feeding groups were influenced by noise, dust and movement.

The survey results showed that there was little apparent impact on the usage of the surveyed areas by wading and terrestrial bird species. Wading birds such as egrets and herons favoured portions of the mudflats landward of the mangroves (roost habitat) that were located some distance from the main areas of disturbance. However, this usage pattern was mainly determined by the location of drainage lines and associated food resources; closer areas did not support the range of resources required for these species. This was also noted during the January 2011 survey. Terrestrial birds such as butcherbirds, kingfishers and willy wagtails were actively using the verge of the disturbance zone to forage for insects stirred up by the construction activity. There were no observations of construction activity causing birds using intertidal areas to take flight. Conversely, it was difficult to determine if birds were deterred from using the site. Given that a range of species were observed using the area in proximity to the construction zones, it is unlikely that the levels of disturbance experienced were a significant deterrent.

Observations of the forage habitat determined that there was no apparent impact on the use of this habitat by birds from construction noise or the arrival and departure of ferry vessels. The larger area of

vegetated buffer separating low tide forage habitat from the construction zone meant that visual impacts from construction traffic were greatly reduced in this area.

3.2.4.2 Feeding Usage of Intertidal Habitat

The low tide forage surveys determined that a low diversity and abundance of species were utilising the mud flats seaward of the mangrove zone, as was also determined during the January 2011 survey event. However, the species composition and primary feeding locations was noted to have varied between surveys. The majority of observations in January were of international migrants feeding on the exposed mudflats. The second survey event showed that the primary users of the habitat were little egrets (*Egretta garzetta*) and white-faced herons (*E. novaehollandiae*) who actively fished in the shallows of the receding tide for prawns and small fish. Sacred kingfishers (*Todiramphus sanctus*) and forest kingfishers (*T. mcleayii*) were prominent feeders on the intertidal verges and around open mangrove shrublands. Kingfishers were not observed during the January survey and their presence may be due to successful breeding following the elevated summer rainfall experienced in the region. In addition, their presence in intertidal areas may be the result of a prey shift to marine crustaceans from terrestrial sources (small reptiles and insects) which are typically available in reduced numbers in the cooler months. Caspian terns (*Sternia caspia*), common terns (*S. hirundo*) and crested terns (*Thalasseus bergii*) were also more prominent during the May-June survey event.

3.3 November 2011 Survey

The third migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 9 and 11 November 2011 inclusive at south China Bay adjacent to the proposed MOF, PLF and LNG facility construction sites as with the previous surveys. The survey coincided with the spring tide at a time when international migrants have arrived on Australian shores to feed.

3.3.1 Project Site Conditions

At the time of the third survey, the site had been cleared of vegetation and earthworks were still ongoing, with the majority of the works being undertaken north of China Bay including construction of the accommodation facilities. To the south of China Bay, the marine loading facilities were being constructed. These activities meant that a large number of light and heavy vehicles were operating throughout the site. As a result, noise levels at the observation points were high.

3.3.2 Findings

Two species of international migrants were observed using foraging and roost habitat at China Bay; eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*).

The results are consistent with the January 2011 survey in which low numbers were observed using both habitats during the survey as detailed in Table 5, below. Other bird species were observed utilising roost and foraging habitat within China Bay. These are presented in Table 5, below.

Table 5 Shorebird counts at China Bay roost and foraging habitat sites, November 2011 survey

Survey Period	International migrants observed (count)	Other species observed (count)
9/11/11 Roost (high tide)	eastern curlew (2) whimbrel (1)	masked lapwing (1) little egret (1) white ibis (1) brahminy kite (1) whistling kite (1) laughing kookaburra (1) gull-billed tern (18) forest kingfisher (1) dollarbird (2) Australian magpie (3) Galah (2)
9/11/11 Forage (low tide)	eastern curlew (4) whimbrel (6)	white-faced heron (1) little egret (1)

Survey Period	International migrants observed (count)	Other species observed (count)
		Australian pied oystercatcher (2) Caspian tern (3) silver gull (2) brahminy kite (1) white-bellied sea-eagle (1) striated heron (1) welcome swallow (10+) tree martin (10+) Australian magpie (1)
10/11/11 Roost	eastern curlew (3) whimbrel(2)	little egret (1) welcome swallow (10+) osprey (1) gull billed tern (9) brahminy kite (1) whistling kite (1) laughing kookaburra (2) Torresian crow (1) black-faced cuckoo-shrike (1)
10/11/11 Forage	eastern curlew (3) whimbrel (3)	Pacific black duck (1) little egret (1) white-faced heron (1) Australasian darter (1) gull-billed tern (3) striated heron (1)
11/11/11 Roost	eastern curlew (2) whimbrel (1)	masked lapwing (1) white-faced heron (1) gull-billed tern (5) Australian magpie (1) dollarbird (2) osprey (1) whistling kite (1) brahminy kite (1)
11/11/11 Forage	eastern curlew (3) whimbrel (2)	Australian pied oystercatcher (2) beach stone-curlew (1) little egret (1) white-faced heron (1) silver gull (1) gull-billed tern (2) welcome swallow (10+) tree martin (10+)

3.3.3 Discussion

3.3.3.1 Impacts to Bird Activity from Construction Activities

The November 2011 shorebird survey was conducted whilst earthmoving and construction activities were continuing as part of the development of the LNG terrestrial and marine facilities. No earthmoving or construction activities were being carried out in the immediate vicinity of the roost and foraging observation points. However, as the haul road is situated along the border of the roosting observation site, light and heavy vehicle traffic was constant and in close proximity during the roosting habitat surveys. Noise levels at each of the observation sites were less than previously experienced (during the May – June 2011 survey). However, noise levels remained high with excavators and haul road traffic present at the roosting observation site and construction of the marine facilities causing

noise at the foraging observation site. Pile-driving activities produced the greatest source of noise with periods of sustained piling activities taking place sporadically during the survey.

The survey results were consistent with the second survey in that there was little apparent impact from construction activities on the usage of the surveyed areas by wading and terrestrial bird species. Non-migratory shorebirds such as egrets, herons and terns utilising the roost habitat were also unaffected by the proximate activity and noise. However, it was observed on one occasion that noise from nearby machinery apparently caused two eastern curlews to take flight. The two shorebirds proceeded to circle the habitat before returning to their previous location within the site. This was not observed again during the survey.

The regular arrival of boats and ferries appeared to have no impact on bird activity.

Visually, impacts at the foraging observation site were unchanged from previous surveys. Impacts at the roosting observation site were significant with a large proportion of the vegetated buffer having been cleared.

3.3.3.2 Feeding Usage of Intertidal Habitat

The previous shorebird surveys determined that a low diversity and abundance of species were utilising the mud flats seaward (foraging habitat) and landward (roost habitat) of the mangrove zone. The November survey results were consistent with these findings. The species composition during the November survey closely resembled the January survey with the majority of observations consisting of international migrants feeding on the exposed mudflats. Other shorebird species such as the little egret (*Egretta garzetta*) and white-face heron (*E. novaehollandiae*) were still present in low numbers. Gull-billed terns (*Sterna nilotica*) were prominent during the November survey event and were frequently observed in large groups at both observation points.

The observations compiled over the three survey events determined that the mudflats landward of the mangrove zone in China Bay did not act as significant roosting habitat and were used primarily as feeding habitat whilst the seaward mudflats were submerged. Only at the peak of very high tides were shorebirds observed waiting for opportunities to feed. As the tide dropped, they followed the receding tide.

Shorebirds were observed on a couple of occasions to leave the mangroves to alight on the landward mudflat as the incoming tide became visible. It was assumed from this behaviour that roosting had taken place within the security of the mangroves and that feeding was optimal in this area at this time.

3.4 April 2012 Survey

The fourth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 11 and 13 April 2012 at China Bay. The survey followed the full moon event which occurred on 7 April 2012.

3.4.1 Project Site Conditions

At the time of the survey, earthworks were being undertaken to the north of China bay. Soil from these works was being used to raise the haul road, which borders the southern and eastern side of the high tide survey location. The first permanent works had begun on the first LNG Train and the tank farm. The accommodation facility was operational with approximately one third complete. To the south of China Bay, the marine offloading facilities were still being constructed. However, the barge ramp and ferry pontoons were complete and operational. Also, to the south of China Bay, the cement batching plant was complete and construction of the water desalination plant had begun. These activities meant that a large number of light and heavy vehicles were operating throughout the site and piling activities were continuing. These works resulted in high noise levels at both survey locations, with the high tide observation point experiencing the greatest levels of impacts. Strong winds and gusts experienced at the high tide survey location resulted in dust mobilisation across the mud flats.

3.4.2 Findings

The whimbrel (*Numenius phaeopus*) was the only international migratory shorebird species observed during the survey. This species was only recorded within foraging habitat from the low tide survey observation point.

These results are consistent with previous surveys in which low numbers were observed. Table 6 below details the findings of the survey.

Table 6 Shorebird counts at China Bay roost and foraging habitat sites: April 2012 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
11/04/12 Forage (low tide)	whimbrel (7)	masked lapwing (2) Pacific black duck (3) white-faced heron (2) little egret (1) Caspian tern (1) silver gull (1) brahminy kite (1) whistling kite (1) osprey (1) welcome swallow (10+)
11/04/12 Roost (high tide)	nil	masked lapwing (11 fly over) white-faced heron (1) white ibis (1)
12/04/12 Forage	whimbrel (3)	pied cormorant (2) white-faced heron (1) little egret (1) welcome swallow (10+) striated heron (1) brahminy kite (1) whistling kite (1) Australian magpie (4) Torresian crow (3) bar-shouldered dove (2)
12/04/12 Roost	nil	Australian magpie (2) Torresian crow (4)
13/04/12 Forage	whimbrel (1)	pied cormorant (3) white-faced heron (1) whistling kite (1) striated heron (1)
13/04/12 Roost	nil	Australian magpie (2) Torresian crow (3)

3.4.3 Discussion

3.4.3.1 Conditions at the Time of the Survey

The survey was conducted in the week following the full moon. This timing coincided with very little tidal variation, which caused relatively low high tides and relatively high low tides. As a result, only a relatively small area of mudflat was exposed at low tide seaward of the mangrove zone, and the tidal flood did not extend landward of the mangrove zone. As surveys during these conditions had not been undertaken previously, it provided an interesting opportunity to observe shorebird utilisation during a period of low tidal variation.

During the survey significant windy conditions were experienced. Wind was primarily from the east and south-east during the survey, with gusts up to 63 km/hour experienced on Friday 13 April.

3.4.3.2 Shorebird Activity

As determined from previous surveys, migratory shorebird activity was low during the April survey period. Migratory shorebirds arrive in Australia during their non-breeding period as early as August and leave for the return trip around April/May each year. Some juvenile birds do not take part in the return journey and may stay in Australia until they reach maturity (DEWHA 2009). Those shorebirds observed at China Bay during the April 2012 survey are therefore due to commence the return

migration event or are juvenile birds not undertaking the migration flight this year. It was not possible to determine the age of the birds during the survey. Notwithstanding this, as the shorebird counts were similar to previous surveys, the timing of the survey did not appear to affect the results.

It was observed during the survey that the flood tide did not extend landward of the mangroves in China Bay. This coincided with a lack of shorebird observations at the high tide roost site. Previous observations noted feeding activity (by both migratory and resident shorebirds) during the ebbing tide in this area. Although previous observations have determined that shorebirds are generally not affected by the construction activities (only one disturbance event noted in November 2011), this is additional confirmation that it is the tide fluctuations that determine shorebird usage of the high tide area, and not construction of the LNG facility.

Given the lack of shorebird activity within the high-tide mudflat, it was not possible to gauge the impact of the strong winds experienced on potential shorebird usage. However, it is felt that tidal movements influence shorebird usage in a greater manner than other environmental factors such as wind or rain episodes.

3.4.3.3 Impacts to Bird Activity from Construction Activities

No shorebirds were observed using the high tide area and therefore no conclusions can be made regarding potential impacts on shorebirds from construction activity. However, previous surveys with similar levels of disturbance (especially the May-June 2011 survey) have shown that shorebirds are generally highly tolerant of activities within the neighbouring terrestrial areas. There was no evidence of disturbance to shorebirds at the low tide foraging site, probably partly due to the vegetated buffer between this area and sources of disturbance to the south. The overall area of the LNG facility footprint disturbed by construction and earthworks activities is largely unchanged from that existing during the November 2011 survey.

3.5 December 2012 Survey

The fifth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 12 and 14 December 2012 at China Bay. The survey was timed to coincide with the spring tide event on 14 December.

3.5.1 Project Site Conditions

At the time of the survey, the majority of bulk earthworks were completed. This included the raising of the haul road which was a source of noise impact during the previous survey. Along the haul road a high activity of light and heavy vehicle traffic travelling between the MOF and PLF was observed with resultant elevated noise levels. Ongoing works to the north of China Bay included the construction of the product load-out facility, the first and second LNG Train and the tank farm. Stage one of the accommodation facility was completed and operational. To the south of China Bay, the marine offloading facilities were largely complete and operational (some works still ongoing). Operational facilities include the cement batching plant, water treatment plant and sewage treatment plant.

Whilst pile driving activities were not carried out at the time of the survey, site personnel advised that piling works are still ongoing at the site.

3.5.2 Findings

The eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*) were the only international migratory shorebird species observed during the survey. The eastern curlew was observed during all three high tide surveys and only one low tide survey. The whimbrel was only observed on the one occasion within the low tide foraging habitat.

These results are consistent with previous surveys in which low numbers were observed. Table 7 below, details the findings of the survey.

Table 7 Shorebird counts at China Bay roost and foraging habitat sites: December 2012 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
12/12/12 Roost (high tide)	Eastern curlew (3)	masked lapwing (1) white-faced heron (1) Australian white ibis (1) eastern osprey (1) rainbow lorikeet (2) Torresian crow (1) laughing kookaburra (1) noisy friarbird (1) gull-billed tern (5) welcome swallow (5+)
12/12/12 Forage (low tide)	whimbrel (1) eastern curlew (1)	Australian pied oystercatcher (1) little pied cormorant (2) Australian pelican (3) little egret (1) Caspian tern (1) silver gull (1) welcome swallow (5+) tree martin (5+)
13/12/12 Roost (high tide)	eastern curlew (1)	masked lapwing (1) little egret (1) Caspian tern (1) brahminy kite (2) whistling kite (1) pied butcherbird (1) laughing kookaburra (1) Torresian crow (2) Australian magpie (1) rainbow lorikeet (1)
13/12/12 Forage (low tide)	nil	Australian pied oystercatcher (2) white-faced heron (1) Caspian tern (1) gull-billed tern (1) welcome swallow (10+) tree martin (2) bar-shouldered dove (2) common koel (1)
14/12/12 Roost (high tide)	eastern curlew (1)	white-faced heron (1) little egret (2) straw-necked ibis (1) Caspian tern (1) laughing kookaburra (1) Australian magpie (2) Torresian crow (3) welcome swallow (5+) noisy friarbird (2) pied butcherbird (2) whistling kite (2)
14/12/12 Forage (low tide)	nil	Australian pied oystercatcher (2) white-faced heron (2) little egret (1)

Survey Period	International migrants observed (count)	Other species observed (count)
		Caspian tern (1) welcome swallow (5+) tree martin (5+) white-throated honeyeater (1) Australian magpie (3) Pacific black duck (3) white-bellied sea-eagle (1)

3.5.3 Discussion

3.5.3.1 Conditions at the Time of the Survey

The survey was conducted during a spring tide event in which the highest summer tide for the year occurred. As a result, the entire roosting survey site was inundated during high tide and a larger area of the mud flats was exposed during the low tide.

Strong easterly to south easterly winds were experienced during the survey period, with a maximum wind speed of 65 km/hr recorded on Wednesday 12 December. Wind speed decreased throughout the duration of the survey period down to 44 km/hr by the final day.

3.5.3.2 Shorebird Activity

Observed migratory shorebird activity within China Bay was low across the survey period, particularly within the low tide foraging site in which only one migratory shorebird was recorded during the first observation day. This differs to previous surveys where recorded numbers at both the foraging and roosting site were relatively equal or were greater during the low tide (April 2012 survey period).

Similarly to previous observations within the high tide roosting site, migratory shorebirds resident shorebirds were observed foraging on the incoming and outgoing tide. This confirms previous observations that the mudflat landward of the mangroves is being used more as a high tide feeding ground, rather than for roosting.

3.5.3.3 Impacts to Bird Activity from Construction Activities

Unlike previous survey periods (especially the May-June 2011 survey), construction activities were concentrated in areas not immediately adjacent to the observation points. Noise impacts associated with construction activities came predominantly from light and heavy vehicles travelling along the haul road which borders the high tide roosting site. Migratory and resident shorebirds within this site were not observed to be affected by this activity.

No pile driving activities was being undertaken during the survey period. Strong easterly to south easterly winds meant that any dust generated from construction works was directed away from the observation areas back toward Curtis Island.

Only one migratory shorebird species was recorded within the low tide foraging site. Given the low activity within this area, no conclusions regarding potential impact can be made from the survey event. However, it was noted that disturbance from construction activities within the low tide foraging site was minimal, and largely confined to impacts from noise generation associated with the arrival/departure of the barge and ferry. This confirmed previous observations within the site which concluded that that the vegetated buffer between this area and sources of disturbance to the south minimised potential noise impacts.

3.6 June 2013 Survey

The sixth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 25 and 27 June 2013 at China Bay. The survey followed the full moon event which occurred on 23 June 2013.

3.6.1 Project Site Conditions

At the time of the survey, the haul road was completed, and much of the site activity was concentrated on the northern side of China Bay away from the survey areas. Haul road usage was generally light,

and noise levels were typically low during the survey periods. To the south of China Bay, the materials offloading facilities were largely complete and operational (some works still ongoing).

Pile driving activities were carried out occasionally on 25 June at the product loading facility construction area.

3.6.2 Findings

No migratory shorebirds were recorded during the survey. All other species recorded are detailed in Table 8.

Table 8 Shorebird counts at China Bay roost and foraging habitat sites: June 2013 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
25/6/13 Roost (high tide)	nil	masked lapwing (1) intermediate egret (1) little egret (1) Australian white ibis (1) straw-necked ibis (1) gull-billed tern (25) welcome swallow (2) whistling kite (2) Australian magpie (1) nankeen kestrel (1) brahminy kite (1) white-breasted woodswallow (3)
25/6/13 Forage (low tide)	nil	little pied cormorant (2) little egret (1) Caspian tern (3) white-necked heron (1) white-faced heron (1) brahminy kite (1) gull-billed tern (10)
26/6/13 Roost (high tide)	nil	Australian pied oystercatcher (2) Masked lapwing (1) little egret (1) intermediate egret (1) white-faced heron (1) straw-necked ibis (1) gull-billed tern (6)
26/6/13 Forage (low tide)	nil	Australian pied oystercatcher (2) little pied cormorant (2) Australian pelican (3) white-faced heron (1) little egret (2) gull-billed tern (6) brahminy kite (2)
27/6/13 Roost (high tide)	nil	masked lapwing (2) Australian wood duck (4) white-faced heron (1) white-faced heron (1) little egret (1) straw-necked ibis (1) gull-billed tern (8) whistling kite (1)
27/6/13 Forage (low tide)	nil	little pied cormorant (2) Australian pelican (7) white-faced heron (1)

Survey Period	International migrants observed (count)	Other species observed (count)
		little egret (1) intermediate egret (1) gull-billed tern (6)

3.6.3 Discussion

3.6.3.1 Conditions at the Time of the Survey

The survey was conducted immediately after a spring tide event in which the highest tide for the year occurred. As a result, the roosting mudflat area was completely inundated prior to the survey.

Wind conditions were generally mild throughout the survey and no rain was experienced.

3.6.3.2 Shorebird Activity

As mentioned in Section 3.6.2, no migratory shorebirds were observed during the survey. However, a range of resident wading birds were observed. Little egrets (*Egretta garzetta*),white-faced herons (*E. novaehollandiae*) and white-necked herons (*E. pacifica*) were commonly observed but not abundant. Little pied cormorants (*Microcarbo melanoleucos*) and Australian pelicans (*Pelecanus conspicillatus*) were noted feeding on small baitfish in the shallows at the low tide forage site.

The lack of migratory shorebird sightings is not unexpected as during the winter most shorebirds have returned to their breeding grounds in the northern hemisphere. However, it is common for juvenile birds to stay in Australia in their first year. The May-June 2011 survey noted only one eastern curlew during the entire survey period. The results of the current survey are therefore largely consistent with previous results. It has become apparent as a result of the literature review and previous surveys at China Bay that there are superior feeding and roosting resources elsewhere in Port Curtis, and it is likely that it is in these areas that overwintering juvenile birds show habitat preference.

3.6.3.3 Impacts to Bird Activity from Construction Activities

Noise impacts associated with construction activities came predominantly from light and heavy vehicles travelling along the haul road which borders the high tide roosting site. Resident shorebirds within this site were observed to be unaffected by this activity.

Occasional pile driving activity was being undertaken at the PLF during the survey period. There was no evidence of this causing disturbance to any of the species observed.

The only observed disturbance to birds utilising China Bay was caused by a hunting whistling kite (*Haliastur sphenurus*) overflying the high-tide roost area.

3.7 December 2013 Survey

The seventh migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 3 and 5 December 2013 at China Bay. The survey was scheduled around the new moon event which occurred on 3 December.

3.7.1 Project Site Conditions

At the time of the survey the majority of the site activity was concentrated on the northern side of China Bay away from the survey areas. Haul road usage was generally light, and noise levels were typically low during the survey periods.

No pile driving activities were carried out during the survey period.

3.7.2 Findings

Low numbers of the eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*) were observed during the survey.

These results are consistent with results of previous surveys. Table 9 below, details the findings of the survey.

Table 9 Shorebird counts at China Bay roost and foraging habitat sites: December 2013 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
3/12/13 Roost (high tide)	Whimbrel (1) Eastern curlew (2)	masked lapwing (2) little egret (1) whistling kite (1) Australian pied oystercatcher (2) Eastern great egret (1) white-faced heron (1) Caspian tern (1) Laughing kookaburra (1) Torresian crow (2) Channel-bill cuckoo (2) Brown honeyeater (1)
3/12/13 Forage (low tide)	Whimbrel (2)	Australian pied oystercatcher (2) Eastern great egret (1) white-faced heron (1) little egret (1) Caspian tern (3) Welcome swallow (3) Tree martin (2) Beach stone-curlew (1) gull-billed tern (2)
4/12/13 Roost (high tide)	Eastern curlew (2)	Masked lapwing (3) white-faced heron (1) gull-billed tern (2) black-faced cuckoo-shrike (1) Australian magpie (4)
26/6/13 Forage (low tide)	Eastern curlew (2) Whimbrel (2)	Australian pied oystercatcher (2) Masked lapwing (1) white-faced heron (1) intermediate egret (1) little egret (1) gull-billed tern (2)
27/6/13 Roost (high tide)	Eastern curlew (2)	masked lapwing (4) Australian pied oystercatcher (2) Pacific black duck (1) white-faced heron (1) little egret (1) gull-billed tern (1)
27/6/13 Forage (low tide)	Whimbrel (1)	Australian pelican (1) intermediate egret (1) eastern great egret (1) Australasian darter (1) Caspian tern (1) gull-billed tern (2)

3.7.3 Discussion

3.7.3.1 Conditions at the Time of the Survey

The survey was conducted around the new moon event which resulted in very high and low tides being experienced.

Wind conditions were generally mild throughout the survey and typically from the south-east. Gusty winds from the north and north-east were experienced on the 6th. No rain was experienced during the survey.

3.7.3.2 Shorebird Activity

In line with previous surveys, the only migratory shorebirds observed were whimbrels and eastern curlews.

A range of common resident wading birds were observed, also in line with prior survey events. These include little egrets (*Egretta garzetta*), white-faced herons (*E. novaehollandiae*) and eastern great egrets (*Ardea alba*). Tern species recorded typically observed at the site included Caspian terns (*Sterna caspia*) and gull-billed terns (*Sterna nilotica*).

The results of the December 2013 survey reinforce the belief that China Bay acts as secondary or less-preferred habitat within Port Curtis.

3.7.3.3 Impacts to Bird Activity from Construction Activities

Noise impacts emanating from construction were low overall. Light and heavy vehicles travelling along the haul road and general construction noise were the major sources. Pile driving was not occurring during the survey. No impacts on shorebirds were noted from construction activity or noise.

3.8 April 2014 Survey

The eighth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 14 and 16 April 2014 at China Bay. The survey was scheduled around the full moon event which occurred on 15 April.

3.8.1 Project Site Conditions

At the time of the survey the majority of the site activity was concentrated on the northern side of China Bay away from the survey areas. Haul road usage was generally light, and noise levels were typically low during the survey periods.

Pile driving activities had ceased prior to the April 2014 survey.

3.8.2 Findings

Low numbers of the eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*) were observed during the survey.

These results are consistent with results of previous surveys. Table 10 below, details the findings of the survey.

Table 10 Shorebird counts at China Bay roost and foraging habitat sites: April 2014 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
14/04/14 Roost (high tide)	whimbrel (4) eastern curlew (1)	masked lapwing (2) little egret (12) whistling kite (1) white-faced heron (2) Torresian crow (2) Australian white ibis (3) gull-billed tern (15) Australian wood duck (8) rainbow lorikeet (6) rainbow bee-eater (1) white-bellied sea-eagle (1) welcome swallow (15+) magpie-lark (2) sacred kingfisher (2) striated pardalote (1)
14/04/14 Forage (low tide)	whimbrel (3)	Australian pied oystercatcher (2) white-faced heron (1) little egret (1) Australasian darter (1)

Survey Period	International migrants observed (count)	Other species observed (count)
		Australian pelican (10) brahminy kite (1) white-bellied sea-eagle (1) sacred kingfisher (1) rainbow lorikeet (2) Torresian crow (2)
15/04/14 Roost (high tide)	whimbrel (7)	masked lapwing (4) Australian wood duck (3) intermediate egret (1) little egret (1) gull-billed tern (2) sacred kingfisher (1) eastern osprey (1) whistling kite (1)
15/04/14 Forage (low tide)	whimbrel (1)	Australian pied oystercatcher (2) Pacific black duck (1) Australian pelican (1) eastern great egret (1) intermediate egret (2) white-faced heron (1) little egret (1) Caspian tern (1) gull-billed tern (5) whistling kite (1) leaden flycatcher (1) bar-shouldered dove (1)
16/04/14 Roost (high tide)	whimbrel (4)	beach stone-curlew (1) masked lapwing (2) Australian wood duck (2) white-necked heron (1) straw-necked ibis (1) striated heron (1)
16/04/14 Forage (low tide)	Nil	Australian pied oystercatcher (2) Australian pelican (1) eastern great egret (1) white-faced heron (1) little egret (1) gull-billed tern (5) striated heron (1) eastern reef egret (1) spangled drongo (1) bar-shouldered dove (1)

3.8.3 Discussion

3.8.3.1 Conditions at the Time of the Survey

The survey was conducted around the full moon event which resulted in moderately high and low tides being experienced.

Weather conditions were varied throughout the survey. Strong winds were experienced on the morning of 14 April with scattered showers. The conditions eased late on 14 April and for the remainder of the survey mild conditions were encountered. Winds were typically from the south-east.

3.8.3.2 Shorebird Activity

In line with previous surveys, the only migratory shorebirds observed were whimbrels and eastern curlews. These were present in low numbers with between 1-7 international shorebirds observed per session.

Common resident wading birds observed included little egrets (*Egretta garzetta*), white-faced herons (*E. novaehollandiae*) and eastern great egrets (*Ardea alba*). The four marine raptors known from the area were recorded; brahminy kite (*Haliastur indus*), eastern osprey (*Pandion cristatus*), whistling kite (*Haliastur sphenurus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*). While not uncommon, it is unusual to see them together at one site over a short period. This is an indication that prey fish populations are healthy.

Again, the results are consistent with previous survey finding and indicate that China Bay acts as less-preferred habitat within Port Curtis.

3.8.3.3 Impacts to Bird Activity from Construction Activities

Noise impacts emanating from construction were low overall. Pile driving had ceased prior to the survey. Whilst no impacts on shorebirds from construction activity or noise were noted, during the roost survey on 15 April a helicopter's arrival and departure at the helipad located to the north of the high tide survey location caused whimbrels to take flight toward the mangroves. All seven birds returned to normal foraging after approximately 30 minutes.

3.9 December 2014 Survey

The ninth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 3 and 5 December 2014 at China Bay. The survey was scheduled to immediately precede the full moon event on 6 December.

3.9.1 Project Site Conditions

At the time of the survey the majority of the site activity was concentrated on the northern side of China Bay away from the survey areas. Haul road usage was generally light, and noise levels were typically low during the survey periods. Air blows were being undertaken within the Plant on the afternoon of 3 December. This was the only noise experienced considered loud enough to have had an effect on shorebirds.

3.9.2 Findings

Low numbers of the eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*) were observed during the survey.

These results are consistent with results of previous surveys. Table 11 below, details the findings of the survey.

Table 11 Shorebird counts at China Bay roost and foraging habitat sites: December 2014 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
3/12/14 Roost (high tide)	whimbrel (1) eastern curlew (1)	masked lapwing (5) little egret (2) Torresian crow (6) gull-billed tern (12) Caspian tern (1) Australian pied oystercatcher (1) striated heron (1) pheasant coucal (1) laughing kookaburra (2)
3/12/14 Forage (low tide)	whimbrel (2) eastern curlew (2)	white-faced heron (1) little egret (1) Australasian darter (1) Australian pelican (11) brahminy kite (1)

Survey Period	International migrants observed (count)	Other species observed (count)
		gull-billed tern (11) striated heron (1) common koel (1) noisy friarbird (1)
4/12/14 Roost (high tide)	whimbrel (1) eastern curlew (2)	Australian pied oystercatcher (1) masked lapwing (4) little egret (1) gull-billed tern (6) laughing kookaburra (1) Torresian crow (1)
4/12/14 Forage (low tide)	eastern curlew (2)	Australian pelican (1) intermediate egret (1) white-faced heron (2) little egret (1) Caspian tern (1) gull-billed tern (4) whistling kite (1) whiskered tern (1) striated heron (1) forest kingfisher (2) silvereye (1) common koel (1) brahminy kite (1)
5/12/14 Roost (high tide)	eastern curlew (2)	masked lapwing (4) Australian white ibis (1) little egret (1) gull-billed tern (1)
5/12/14 Forage (low tide)	whimbrel (2)	Australian pelican (1) white-faced heron (1) little egret (1) gull-billed tern (1) brahminy kite (1) forest kingfisher (1) laughing kookaburra (1)

3.9.3 Discussion

3.9.3.1 Conditions at the Time of the Survey

The survey was conducted immediately prior to the full moon event of 6 December which resulted in moderately high and low tides being experienced.

Weather conditions were generally hot and humid during the survey. Winds were typically from the south-east and north east. Light rain fell on the morning of 4 December.

3.9.3.2 Shorebird Activity

In line with previous surveys, the only migratory shorebirds observed were whimbrels and eastern curlews. These were present in low numbers with 2-4 international shorebirds observed per session.

Common resident wading birds observed included little egrets (*Egretta garzetta*), white-faced herons (*E. novaehollandiae*) and striated herons (*Butorides striata*). A number of tern species were recorded, including gull-billed terns (*Gelochelidon nilotica*), Caspian terns (*Hydroprogne caspia*) and crested terns (*Thalasseus bergii*). All tern species had previously been recorded for the site. All other wading and terrestrial birds observed are common; their presence indicated that the terrestrial-marine ecotone is functioning well.

Again, the results are consistent with previous survey finding and indicate that China Bay acts as less-preferred habitat within Port Curtis.

3.9.3.3 Impacts to Bird Activity from Construction Activities

Noise impacts emanating from construction were low overall and generally consistent with previous noise levels. Overall noise levels were low with no observed impact on shorebirds. Noise as a result of air blows being undertaken within the Plant were experienced on 3 December. Although these were very audible at the low tide (forage site) there were no observed shorebird flights as a result.

3.9.3.4 Other Disturbance

A wild dog (*Canis lupus familiaris/dingo*) was observed crossing the mudflat near the high tide (roost) site on the morning of 4 December. The dog caused several masked lapwings to take flight. No migratory shorebirds were affected.

3.10 March-April 2015 Survey

The tenth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 31 March and 2 April 2015 at China Bay. The survey was scheduled to immediately precede the full moon event on 4 April.

3.10.1 Project Site Conditions

At the time of the survey, the majority of the site activity was concentrated on the northern side of China Bay away from the survey areas. Haul road usage was generally light, and noise levels were typically low during the survey periods.

3.10.2 Findings

Low numbers of the whimbrel (*Numenius phaeopus*) were observed during the survey.

These results are consistent with results of previous surveys. Table 12 below, details the findings of the survey.

Table 12 Shorebird counts at China Bay roost and foraging habitat sites: March-April 2015 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
31/3/15 Roost (high tide)	whimbrel (4)	masked lapwing (4) little egret (1) Torresian crow (3) Pacific black duck (6) white-faced heron (1) rainbow lorikeet (5) welcome swallow (10) noisy friarbird (1) striated pardalote (1) magpie lark (1) eastern osprey (1) brahminy kite (1) sacred kingfisher (2)
31/3/15 Forage (low tide)	whimbrel (2)	white-faced heron (1) little egret (1) Australian pied oystercatcher (3) masked lapwing (2) Australian pelican (1) eastern great egret (1) Australian white ibis (1) whiskered tern (1) crested tern (1) striated heron (1) welcome swallow (1)

Survey Period	International migrants observed (count)	Other species observed (count)
1/4/15 Roost (high tide)	whimbrel (6)	masked lapwing (4) little egret (1) Torresian crow (3) welcome swallow (>10) sacred kingfisher (2) Australian magpie (1) red-tailed black cockatoo (8) striated pardalote (2)
1/4/15 Forage (low tide)	whimbrel (3)	Australian pied oystercatcher (1) masked lapwing (2) Australian pelican (4) white-necked heron (1) eastern great egret (1) white-faced heron (2) little egret (1) welcome swallow (11) sacred kingfisher (1)
2/4/15 Roost (high tide)	whimbrel (2)	masked lapwing (4) Australian white ibis (1) little egret (2) sacred kingfisher (1) Torresian crow (1) striated pardalote (2) welcome swallow (>10) forest kingfisher (1) laughing kookaburra (2) magpie lark (3)
2/4/15 Forage (low tide)	whimbrel (1)	Australian pelican (4) white-faced heron (1) little egret (1) little pied cormorant (1) eastern great egret (1) eastern osprey (1) welcome swallow (3) gull-billed tern (1) brahminy kite (1) forest kingfisher (1) laughing kookaburra (1)

3.10.3 Discussion

3.10.3.1 Conditions at the Time of the Survey

Weather conditions were generally warm to hot and humid during the survey with cooler mornings. Winds were typically from the south-east. Light rain fell on the morning of 31 March.

3.10.3.2 Shorebird Activity

In line with previous surveys, the only migratory shorebirds observed were whimbrels. These were present in low numbers with 1-6 whimbrels observed per session. No eastern curlews were observed.

Common resident wading birds observed included little egrets (*Egretta garzetta*), white-faced herons (*E. novaehollandiae*) and Australian pied oystercatcher (*Haematopus longirostris*). A number of tern species were recorded, including gull-billed terns (*Gelochelidon nilotica*), Caspian terns (*Hydroprogne caspia*), whiskered terns (*Chlidonias hybrid*) and crested terns (*Thalasseus bergii*). The abundance of terns was lower than previous surveys. All other wading and terrestrial birds observed are common; their presence indicated that the terrestrial-marine ecotone is functioning well. A range of terrestrial

bird species were again encountered, mostly using the narrow strip of narrow-leaved ironbarks (*Eucalyptus crebra*) surrounding China Bay.

The results are consistent with previous survey findings and indicate that China Bay acts as less-preferred habitat within Port Curtis.

3.10.3.3 Impacts to Bird Activity from Construction Activities

Noise impacts emanating from construction were low overall and generally consistent with previous noise levels. No birds were impacted by noise during the survey.

3.10.3.4 Other Disturbance

A wild dog (*Canis lupus familiaris / dingo*) was observed chasing birds on the mudflat at the high tide (roost) site on the morning of 1 April. The dog caused masked lapwings, whimbrels and a little egret to take flight. Of the six whimbrels observed prior to the disturbance, only one returned to the site.

3.11 December 2015 Survey

The eleventh migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 9 and 11 December 2015 at China Bay. The survey was scheduled around the new moon event which occurred on 11 December.

3.11.1 Project Site Conditions

At the time of the survey, the majority of site activity was concentrated toward northern areas associated with commissioning works on both Train one and two. On 10 December, one LNG vessel moored at the PLF, requiring a number of tug boats to position the vessel. This activity coincided with the low tide survey event. The marine flare was in operation whilst the LNG vessel received product. Additionally, a number of air blows were heard throughout the survey. Air blows result in a short, loud noise heard throughout the site and at both survey locations.

3.11.2 Findings

Low numbers of migratory shorebird and waterbird were observed during the survey. Low migratory shorebird numbers is consistent with previous surveys. The findings of the survey are detailed in Table 13 below.

Table 13 Shorebird counts at China Bay roost and foraging habitat sites: December 2015 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
09/12/15 Roost (high tide)	eastern curlew (1) whimbrel (3)	little egret (2) Torresian crow (12) channel billed cuckoo (1) forest kingfisher (2) blue-faced honeyeater (1) gull-billed tern (12) masked lapwing (2) welcome swallow (5)
09/12/15 Forage (low tide)	whimbrel (1)	striated heron (1) beach stone-curlew (1) gull-billed tern (5) little pied cormorant (1) caspian tern (1) welcome swallow (5) white-bellied sea-eagle (2) brahminy kite (1) pheasant coucal (1) Torresian crow (1)

Survey Period	International migrants observed (count)	Other species observed (count)
10/12/15 Roost (high tide)	eastern curlew (1) whimbrel (1)	intermediate egret (1) Australian wood duck (2) white-bellied sea-eagle (1) blue-faced honeyeater (1) masked lapwing (2) brahminy kite (1) forest kingfisher (1) Torresian crow (3)
10/12/15 Forage (low tide)	eastern curlew (1) whimbrel (1)	masked lapwing (1) intermediate egret (1) Australian pelican (1) little egret (2) gull-billed tern (1) black-faced cuckoo shrike (1) Torresian crow (1) striated heron (1) white-faced heron (1)
11/12/15 Roost (high tide)	eastern curlew (1) whimbrel (2)	little pied cormorant (1) Australian pied cormorant (2) little egret (1) masked lapwing (2) forest king fisher (2) brown goshawk (1) bar-shouldered dove (2)
11/12/15 Forage (low tide)	whimbrel (2)	eastern great egret (1) white-faced heron (1) pheasant coucal (1) striated heron (1) white-bellied sea-eagle (1)

3.11.3 Discussion

3.11.3.1 Conditions at the Time of the Survey

Weather conditions were generally warm to hot and humid during the survey with winds typically from the east or north-east. Light rain fell on the morning of 9 December; however it did not impede visibility or appear to disturb shorebird foraging/roosting activity.

3.11.3.2 Shorebird Activity

The only migratory shorebirds observed during the survey period were whimbrels and eastern curlews. This is in line with previous survey data. Migratory shorebirds were present in low numbers with a maximum of three whimbrels observed in one survey period.

Wading birds were also observed in low numbers during the survey event, and included little egret (*Egretta garzetta*), striated heron (*Butorides striata*) and white-faced heron (*Egretta novaehollandiae*). Tern species were also low, with only two being recorded including Caspian tern (*Hydroprogne caspia*) and gull-billed terns (*Gelochelidon nilotica*).

The resident shorebird species, beach stone-curlew (*Esacus magnirostris*) was recorded during the survey program. This species is listed as Vulnerable in Queensland (*Nature Conservation Act 1992*). The eastern great egret (*Ardea modesta*) was also recorded, listed as Migratory under the EPBC Act.

Three raptors were recorded during the survey including white-bellied sea-eagle (*Haliaeetus leucogaster*), brahminy kite (*Haliastur indus*) and brown goshawk (*Accipiter fasciatus*). The white-bellied sea-eagle and brahminy kite were observed within the survey area, typically within and above mangrove vegetation. The brown goshawk was recorded with a number of terrestrial birds within the adjacent terrestrial woodland habitat.

Whilst abundance counts were generally down during this survey period, they are considered consistent with baseline data, being that whilst China Bay supports suitable shorebird habitat, species richness and abundances are typically low with shorebirds favouring alternate habitat within Port Curtis.

3.11.3.3 Impacts to Bird Activity from Construction Activities

A number of construction related noises and activities that had potential to impact on shorebirds was recorded, including air blows, LNG vessel and tugboat activity, marine flaring, safety intercom messaging and works along the haul road. In all cases, no migratory shorebirds or waterbirds were observed to be disturbed by the above construction activity.

3.11.3.4 Other Disturbance

Brumbies were observed within fringing habitat adjacent to the high tide roosting area. No disturbances to migratory shorebirds or waterbirds were noted.

3.12 March 2016 Survey

The twelfth migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 21 and 23 March 2016 at China Bay. The survey was scheduled around the full moon event which occurred on 23 March.

3.12.1 Project Site Conditions

At the time of the survey, the majority of activity was concentrated toward northern areas of the site, including operation of Train one and commissioning works on Train two. On 21 December, one LNG vessel departed the PLF, requiring a number of tug boats to escort the vessel. This activity coincided with the low tide survey event. The marine flare was in operation whilst the LNG vessel received product.

3.12.2 Findings

Two species of international migrants were observed using foraging and roost habitat at China Bay; eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*). Very low numbers of each species were observed using available habitat during the surveys. Low numbers of these species is consistent with previous surveys. The findings of the survey are detailed in Table 14 below.

Table 14 Shorebird counts at China Bay roost and foraging habitat sites: March 2016 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
21/03/16 Roost (high tide)	whimbrel (3)	Australian pied oystercatcher (2) masked lapwing (2) white-faced heron (1) little egret (1) Torresian crow (5) channel billed cuckoo (1) white-bellied sea-eagle (1) Pacific black duck (1 + 3 ducklings)) noisy friarbird (2) laughing kookaburra (3) Australian magpie (1) dollarbird (1) rainbow lorikeet (2)
21/03/16 Forage (low tide)	whimbrel (3)	beach stone-curlew (2) Australian pied oystercatcher (2) Australian pelican (2) sacred kingfisher (2) brahminy kite (1) whistling kite (1) Torresian crow (4)

Survey Period	International migrants observed (count)	Other species observed (count)
		bar-shouldered dove (1)
22/03/16 Roost (high tide)	eastern curlew (1) whimbrel (2)	Australian pied oystercatcher (2) Eastern great egret (1) little egret (1) (breeding) white-faced heron (1) brahminy kite (1) magpie-lark (1) rainbow lorikeet (2) Australian magpie (1) welcome swallow (5) masked lapwing (1) nankeen kestrel (1) Torresian crow (3) galah (10) osprey (1) striated heron (1) striated pardalote (1) little pied cormorant (1)
22/03/16 Forage (low tide)	whimbrel (2)	beach stone-curlew (1) Australian pied oystercatcher (2) masked lapwing (1) white-bellied sea-eagle (1) sacred kingfisher (2) mistletoe bird (1) white-faced heron (1) little egret (1) crested tern (2) common tern (5)
23/03/16 Roost (high tide)	eastern curlew (1) whimbrel (4)	sacred kingfisher (2) Torresian crow (2) galah (1) osprey (1) brahminy kite (1) Pacific black duck (1) white-faced heron (2) little egret (1)
23/03/16 Forage (low tide)	eastern curlew (1) whimbrel (3)	beach stone-curlew (2) Australian pied oystercatcher (2) Australian pelican (2) Eastern great egret (1) little egret (2) white-faced heron (1) sacred kingfisher (1) mistletoe bird (1) striated heron (1)

3.12.3 Discussion

3.12.3.1 Conditions at the Time of the Survey

Weather conditions were generally warm to hot and humid during the survey with winds typically from the south-east in the morning and north-east in the afternoon. Light rain fell on the afternoon of 21 March; however it did not impede visibility or appear to disturb shorebird foraging/roosting activity.

3.12.3.2 Shorebird Activity

The only migratory shorebirds observed during the survey period were whimbrels and eastern curlews. This is in line with previous survey data. Migratory shorebirds were present in low numbers with a maximum of four whimbrels observed in one survey period.

The resident shorebird species, beach stone-curlew (*Esacus magnirostris*) was recorded during the survey program. This species is listed as Vulnerable in Queensland (*Nature Conservation Act 1992*). The eastern great egret (*Ardea modesta*) was also recorded, listed as Migratory under the EPBC Act.

Common resident wading birds observed included little egrets (*Egretta garzetta*), white-faced herons (*E. novaehollandiae*), striated herons (*Butorides striata*) and Australian pied oystercatcher (*Haematopus longirostris*). A number of tern species were recorded, including common terns (*Sterna hirundo*), Caspian tern (*Hydroprogne caspia*) and crested terns (*Thalasseus bergii*). All tern species had previously been recorded for the site.

The four marine raptors known from the area were recorded; brahminy kite (*Haliastur indus*), eastern osprey (*Pandion cristatus*), whistling kite (*Haliastur sphenurus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*). With the white-bellied sea-eagle (*Haliaeetus leucogaster*) and eastern osprey (*Pandion cristatus*) observed foraging within the survey area suggesting that prey fish populations are healthy.

The results are consistent with previous survey findings and indicate that, whilst China Bay supports suitable shorebird habitat, species richness and abundances are typically low with shorebirds favouring alternate habitat within Port Curtis.

3.12.3.3 Impacts to Bird Activity from Construction / Operational Activities

A number of construction and operational related noises and activities that had potential to impact on shorebirds were recorded, including LNG vessel and tugboat activity, marine flaring, safety intercom messaging and works along the haul road. In all cases, no migratory shorebirds or waterbirds were observed to be disturbed by the above construction activity.

3.12.3.4 Other Disturbance

Brumbies were observed within fringing habitat adjacent to the high tide roosting area. No disturbances to migratory shorebirds or waterbirds were noted.

Two LNG vessels unrelated to the GLNG LNG Marine Facilities were observed: one departing the QCLNG site on the morning of 22 March and one arriving at the Australia Pacific LNG site on the afternoon of 23 March. No disturbances to migratory shorebirds or waterbirds were noted relating to these vessels or associated tugboat activity.

A rescue helicopter was observed circling the LNG facility. Whilst no bird flights were observed, this activity has been noted to disturb shorebirds at the high tide site which is situated adjacent to the helipad.

3.13 November-December 2016 Survey

This migratory shorebird survey conducted to fulfil Condition 19(b) of EPBC Approval No. 2008/4058 was undertaken between 29 November and 1 December 2016 at China Bay. The survey was scheduled around the new moon event which occurred on 29 November.

3.13.1 Project Site Conditions

At the time of the survey, the site was fully operational with commissioning works on Trains one and two complete. One LNG vessel arrived at the PLF on the 29 November, departing on the 1 December once loaded. Noise produced by the site was minimal given construction activities had completed.

3.13.2 Findings

Two international migrant species were observed using foraging and roost habitat at China Bay; eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*). Individual bird numbers were low, consistent with previous surveys. The findings of the survey are detailed in Table 16 below.

Table 15 Shorebird counts at China Bay roost and foraging habitat sites: November-December 2016 Survey

Survey Period	International migrants observed (count)	Other species observed (count)
29/11/16 Roost (high tide)	eastern curlew (1) whimbrel (3)	masked lapwing (5) little egret (2) (breeding) Australian white ibis (1) channel billed cuckoo (3) brahminy kite (1) noisy friarbird (2) laughing kookaburra (1) galah (2) blue-faced honeyeater (1) rainbow lorikeet (2)
29/11/16 Forage (low tide)	whimbrel (1)	beach stone-curlew (1) Australian pied oystercatcher (1) little egret (2) caspian tern (1) eastern reef egret (1) noisy friarbird (1) striated heron (1)
30/11/16 Roost (high tide)	eastern curlew (1) whimbrel (2)	little egret (1) (breeding) noisy miner (5) masked lapwing (4) blue-faced honeyeater (1) laughing kookaburra (1)
30/11/16 Forage (low tide)	whimbrel (1)	striated heron (1) little egret (1) caspian tern (1) welcome swallow (5) eastern koel (1)
1/12/16 Roost (high tide)	whimbrel (2)	little egret (1) (breeding) masked lapwing (5) blue-faced honeyeater (1) noisy friarbird (2) brown goshawk (1) forest kingfisher (1) laughing kookaburra (2)
1/12/16 Forage (low tide)	eastern curlew (1) whimbrel (2)	Caspian tern (1) Australian pelican (1) striated heron (1) eastern koel (2) welcome swallow (2)

3.13.3 Discussion

3.13.3.1 Conditions at the Time of the Survey

Weather conditions were generally warm to hot and humid during the survey with winds typically from the north-east. No rain occurred during the field survey. However, a thunder storm occurred within the immediate region of Mount Larcom on 30 November, which resulted in high humidity during the low tide survey event.

3.13.3.2 Shorebird Activity

Two migratory shorebird species were observed during the survey period including whimbrel and eastern curlew. Migratory shorebirds were present in low numbers with a maximum of three whimbrels observed during one survey event, whilst only a maximum of one eastern curlew recorded during any survey event. This result is consistent with previous survey events.

Consistent with the March survey, the beach stone-curlew (*Esacus magnirostris*) was recorded during the survey program. This species is listed as Vulnerable in Queensland (*Nature Conservation Act 1992*).

Common resident wading birds observed included little egrets (*Egretta garzetta*), striated herons (*Butorides striata*) and Australian pied oystercatcher (*Haematopus longirostris*). Although, these species were recorded in lower numbers than during previous survey events. One tern species, Caspian tern (*Hydroprogne caspia*) was recorded at both survey locations. No other tern species were recorded.

Raptors were also recorded in low numbers during the survey with the brahminy kite (*Haliastur indus*) the only species observed to forage within the survey sites. One brown goshawk (*Accipiter fasciatus*) was recorded dispersing through the high tide survey location.

The results are consistent with previous survey findings and indicate that, whilst China Bay supports suitable shorebird habitat, species richness and abundances are typically low with shorebirds favouring alternate habitat within Port Curtis.

3.13.3.3 Impacts to Bird Activity from Operational Activities

This survey event was the first to occur with the site in operational mode. As such, activities with potential to impact on shorebirds were minimal and confined to LNG vessel loading, marine flaring, and maintenance work. One LNG vessel was loaded during the survey event, with no impact on migratory shorebirds or waterbirds observed.

4.0 Conclusions

4.1 Compliance With Project EPBC Conditions

As outlined in Section 1.2, this report presents the results of migratory shorebird surveys undertaken in conjunction with the preparation of the Project's MSEMP. The preparation of an MSEMP was the requirement of condition (19) of EPBC Approval No. 2008/4058 for the marine facilities at the GLNG LNG facility at China Bay on Curtis Island.

Monitoring surveys undertaken as part of this study were in accordance with monitoring requirements outlined in the Project's MSEMP, including that surveys be undertaken twice a year (minimum) for five years. This report documents the results of biannual migratory shorebirds surveys undertaken over a six year period between 2011 and 2016, thus satisfying the requirements of the Project's MSEMP.

Further to the above, the MSEMP also satisfied condition 22 of EPBC Approval No. 2008/4057, which stipulated that a management plan must be prepared where migratory species are identified during verification surveys.

4.2 Survey Conclusions

Overall, 13 shorebird surveys have been undertaken within China Bay, situated adjacent to the GLNG LNG facility site. These surveys have recorded two migratory and three resident shorebird species. Table 17 below lists these species and provides the number of records for each. It is likely that tallies of resident shorebirds, in particular, includes territorial pairs or families recounted each day.

As per Condition 19 (b) of EPBC Approval No. 2008/4058, this migratory shorebirds study is to determine baseline population densities and habitat utilisation for migratory shorebirds on or contiguous to the proponent's LNG facility site including, at a minimum, undertaking annual/twice annual surveys during northwards and southwards migrations.

Depending upon the species of shorebirds being surveyed, the arrival (southwards migration) and departure (northwards migration) periods can be variable in timing and duration. There are two shorebirds of particular focus to this study; whimbrel (*Numenius phaeopus*) and Terek sandpiper (*Xenus cinereus*).

The Whimbrel begins to leave the breeding grounds in July (Hayman *et al*. 1986 in DotE, 2014a). They move south along the east coast. Influxes (which are mostly temporary) occur at sites along the east coast during migration in September-October south of 20° S (Alcorn 1988; Lane 1987 in DotE, 2014a). Whimbrels begin migrating northward from February onwards (Higgins & Davies 1996 in DotE, 2014a). Some birds (mainly juveniles) remain in non-breeding areas all year (Hayman *et al*. 1986 in DotE, 2014a).

Female Terek Sandpipers leave their breeding grounds to migrate in early July, before the males and juveniles, which leave later, mainly in August (Birds in Backyards, 2014). The Terek Sandpiper passes through Torres Strait (Draffan *et al*., 1983 in DotE, 2014b) and arrives in Cairns, Queensland and Darwin, Northern Territory in August and in northern and north-western Australia in the first week of September (Lane, 1987 in DotE, 2014b). Arrival in the south is later than in the north in (DotE, 2014). In Australia, temporary influxes during northward migration are observed during March-April at sites on the east coast (DotE, 2014b). Small numbers of Terek sandpipers, probably first-year birds, remain in Australia during the breeding season (Fry, 1990 in DotE, 2014b).

The Shorebirds 2020 organisation recommends winter surveys to detect overwintering immature migratory shorebirds.

Table 16 details the timing of the shorebird surveys with respect to the respective migration periods.

Table 16 Shorebird survey timing and relationship to shorebird migration periods

Year	Southward Migration	Northward Migration	Peak Presence	Over-wintering
2011	November		January	May-June
2012	December	April		
2013	December			June
2014	December	April		
2015	December	March-April		
2016	November-December	March		

Table 17 details shorebird observations at the China Bay survey sites. It is probable that counts include the same individual birds at both survey locations and on different days. Therefore it is likely that there are fewer birds using the area than the numbers presented in Table 17 indicate.

As shown in Table 17, overall shorebird counts were highest during the January 2011 survey. This was expected as the survey coincided with the time in which the majority of shorebirds have arrived in Australia from their migration. The June 2013 survey yielded the lowest counts. These results were also expected, with migratory shorebirds having mostly departed on their northern migration with only some juveniles choosing to remain in Australia, as shown in the results from May-June 2011. The November 2011 count yielded slightly less numbers than the January 2011 survey. This may be a result of the November 2011 survey being conducted prior to the arrival of all shorebirds. It may also be due to variation in feeding and roosting preferences within Port Curtis. The April 2012 results are relatively consistent with the previous surveys, although the small tidal fluctuation appeared to diminish shorebird usage at the high tide area. The December 2012 count yielded low numbers compared to the previous summer month surveys. This result could be due to a range of factors including natural fluctuation in population numbers, resource availability and site utilisation. Although there is a slight increase in observations in December 2013 from December 2012, there are fewer observations in these periods compared to the January and November 2011 surveys. Construction was yet to commence in January 2011 and this coincides with the greatest number of observations. Observations have been reduced since then but fairly steady through November 2011, December 2012, December 2013, April 2014, December 2014, March-April 2015, December 2015 and March 2016. During the November-December 2016 survey the plant was operational following the commissioning of the plant earlier in the year. Observations during this survey were consistent with records from the previous years. Potential impacts during operational periods were noted to be lower than the construction phase of the Project.

A migratory shorebird monitoring program is being carried out by the Gladstone Ports Corporation within Port Curtis and the broader area with surveys having been undertaken between January 2011 and February 2015. Within Port Curtis, the 2015 count of the shorebird population is 1757 with 12 species across 57 survey sites (Wildlife Unlimited, 2015). Whimbrel and eastern curlew population counts were 147 and 221 respectively. This equates to approximately 3-4 individuals per survey site. Based on this, the number of eastern curlew and whimbrel individuals recorded at each individual site is generally consistent with the results obtained from China Bay. However, the absence of other shorebird species within China Bay suggests that other areas within Port Curtis contain superior foraging or roosting habitat for the other species.

The field surveys conducted during this study recorded a number of migratory and resident waterbirds using both the roosting and foraging habitats within China Bay. Whilst no birds were observed in large flocks, the presence of these species and their apparent indifference to the adjacent works suggest that impacts from sources such as noise and movement are minimal. Additionally, the presence of these species indicates that the foraging and roosting habitat within China Bay is suitable (if not preferred) shorebird habitat.

Within Port Curtis and the greater Gladstone coastal region, there exist many areas that are used by shorebirds. Site fidelity amongst shorebird species is not uncommon (Rehfisch *et al*., 2003). Fidelity to other sites within Port Curtis may explain the lack of additional shorebird species recorded within China Bay and usage of the site by a small number of individuals when other habitat options are present nearby.

Based on the field survey results of this study and the known number of shorebird species within the region, it is considered that China Bay does not currently act as significant shorebird habitat. Observations of shorebird activity have shown that there is negligible impact on behaviour from site activities, and, on the basis of monitoring conducted to date, it appears that China Bay has not acted as preferred shorebird habitat since studies in Port Curtis were initiated.

Table 17 Shorebird species recorded within China Bay

		Survey Period / # of records												
Common Name	**Scientific Name**	**January 2011**	**May-June 2011**	**November 2011**	**April 2012**	**December 2012**	**June 2013**	**December 2013**	**April 2014**	**December 2014**	**March-April 2015**	**December 2015**	**March 2016**	**Nov-Dec 2016**
eastern curlew [M]	*Numenius madagascariensis*	18	1	14	-	6	-	8	1	9	-	4	3	3
whimbrel [M]	*Numenius phaeopus*	30	--	13	11	1	-	6	16	6	18	10	17	11
Australian pied oystercatcher [R]	*Haematopus longirostris*	4	2	2	-	5	-	8	6	2	2	2	10	1
masked lapwing [R]	*Vanellus miles*	9	3	2	13	2	-	10	8	13^	16	7	4	14
beach stone-curlew [R]	*Esacus neglectus*	-	1	1	-	-	-	1	1	-	-	1	5	1

M = International migrant R = Resident species ^ = records consisted of a breeding pair and 3 fledged young

5.0 References

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure

Appendix A

Shorebirds 2020 Data Sheet

SHOREBIRD COUNT FORM

Birds Australia
CONSERVATION THROUGH KNOWLEDGE

AWSG
Australasian Wader Studies Group

CARING FOR OUR COUNTRY

OFFICE USE
VISIT ID:

OBSERVER DETAILS

For detailed instructions on how to fill out this form refer to "Count Form Instructions"

FULL NAME:

PHONE NUMBER:

If more than one observer, only name the count leader or main contact

EMAIL:

TOTAL NO. OBSERVERS

YEARS OF COUNTING EXPERIENCE OF MOST EXP. COUNTER

TIME & DATE

SURVEY DATE: DAY MONTH YEAR

TIME STARTED: *(24 hour clock)* HOUR MINS

TIME FINISHED: *(24 hour clock)* HOUR MINS

SURVEY DETAILS

IF COUNT ***WAS*** CONDUCTED IN A SHOREBIRDS 2020 COUNT AREA
(count area names and maps available at www.shorebirds.org.au)

SHOREBIRD AREA

COUNT AREA

COMPLETE COVERAGE OF MAPPED COUNT AREA? YES or NO

OR

IF COUNT WAS ***NOT*** CONDUCTED IN A SHOREBIRDS 2020 COUNT AREA:

SITE NAME

LAT/ LONG

STATE

SURVEY TYPE *(land, boat, air)* L,B,A

TIDE HEIGHT *Height in metres or rising, high, falling or low*

AREA UNDER WATER *(wetlands only)* %

WIND DIRECTION *E.g. N, NE, NNE*

WIND SPEED

- ◯ **0 - 5 kph** *(flat to ripples / wind not felt on face)*
- ◯ **6 - 11 kph** *(small wavelets, crests not breaking / wind felt on face)*
- ◯ **12 - 19 kph** *(large wavelets, crests begin to break / leaves in motion)*
- ◯ **20 - 28 kph** *(small waves / dust, small*
- ◯ **29 - 38 kph** *(moderate waves, some foam & spray / small trees sway)*
- ◯ **39 - 49 kph** *(large waves with foam,crests and spray / large branches in motion)*
- ◯ **>50 kph** *(sea heaps up, foam beings to streak / strong resistance while walking)*

HUMAN ACTIVITY

Write down the number of times the following were observed during the count within the count area:

PEOPLE MOVING	BOATS - AT ANCHOR	JET SKI
PEOPLE FISHING	BOATS - MOVING	ATV/MOTORCYCLE
DOGS - OFF LEAD	BOATS - WATERSKIING	CARS/TRUCKS
DOGS - ON LEAD	BOATS - VERY LOUD/FAST	OTHER *(specify)*

NUMBER OF FLIGHTS CAUSED BY DISTURBANCE:

THREATS

Add timing, scale and severity scores to obtain a total threat score for each threat type

	TIMING		SEVERITY		SCALE		TOTAL THREAT SCORES
	3 = Occurring now		3 = Will persist for >10 years		3 = >90% population decline		0-5 = Low threat
	2 = Likely to occur within 1-3 years		2 = Will persist for 3-10 years		2 = 50-90% population decline		6-7 = Medium threat
	1 = Likely to occur in >3 years		1 = Will persist for 0-3 years		1 = 10-49% population decline		8-9 = High threat
	0 = Not occuring, not likely to in future		0 = Will not persist		0 = 0-9 % population decline		
HABITAT LOSS		+		+		=	
HUMAN DISTURBANCE		+		+		=	
INVASIVE SPECIES		+		+		=	
POLLUTION		+		+		=	
WATER LEVEL		+		+		=	

HABITAT CHANGE

HAS HABITAT CHANGED SINCE LAST COUNT?: YES or NO

AREA AFFECTED BY HABITAT CHANGE: *(area used by shorebirds only)* %

TYPE OF HABITAT CHANGE: *(mark all that apply)*

- ◯ URBAN DEVELOPMENT (within 200m)
- ◯ RECLAMATION
- ◯ HARVESTING/FISHING
- ◯ FISH FARMING/AQUACULTURE
- ◯ CHANGE IN WATER LEVELS
- ◯ EROSION
- ◯ POLLUTION
- ◯ ENCROACHMENT FROM NATIVE VEGETATION
- ◯ INVASIVE SPECIES/INTRODUCED PESTS
- ◯ ALGAL BLOOMS

Count forms, count area maps, instructions at www.shorebirds.org.au. Return form to Shorebirds 2020, Birds Australia, 60 Leicester Street, Carlton, Victoria, 3053. Ph (03) 9347 0757. Email: shorebirds@birdsaustralia.com.au.

Online data entry form at http://data.shorebirds.org.au/

SHOREBIRDS

(B) = breeding; please enter comments below
Enter 'P' for present in box where a species was present but not counted

STONE-CURLEWS

(B) Bush Stone-curlew	
(B) Beach Stone-curlew	

OYSTERCATCHERS, STILTS

(B) Aust. Pied Oystercatcher	
(B) Sooty Oystercatcher	
(B) Black-winged Stilt	
(B) Red-necked Avocet	
(B) Banded Stilt	

PLOVERS, DOTTERELS, LAPWINGS

Pacific Golden Plover	
Grey Plover	
Little Ringed Plover	
(B) Red-capped Plover	
Double-banded Plover	
Lesser Sand Plover	
Greater Sand Plover	
Oriental Plover	
(B) Black-fronted Dotterel	
(B) Hooded Plover	
(B) Red-kneed Dotterel	
(B) Banded Lapwing	
(B) Masked Lapwing	

JACANA, PAINTED SNIPE, SNIPE

(B) Comb-crested Jacana	
(B) Australian Painted Snipe	
Latham's Snipe	
Other *Gallinago* sp.	

GODWITS, CURLEWS, SANDPIPERS, ALLIES

Black-tailed Godwit	
Bar-tailed Godwit	
Little Curlew	
Whimbrel	
Eastern Curlew	
Terek Sandpiper	
Common Sandpiper	
Grey-tailed Tattler	
Wandering Tattler	
Common Greenshank	
Marsh Sandpiper	
Common Redshank	
Wood Sandpiper	
Ruddy Turnstone	
Asian Dowitcher	
Great Knot	
Red Knot	
Sanderling	
Red-necked Stint	
Long-toed Stint	
Pectoral Sandpiper	
Sharp-tailed Sandpiper	
Curlew Sandpiper	
Broad-billed Sandpiper	
Ruff	
Red-necked Phalarope	

PRATINCOLES

Oriental Pratincole	
(B) Australian Pratincole	

UNIDENTIFIED

Unident. small wader	
Unident. med. wader	
Unident. large wader	

GEESE, DUCKS, SWANS, GREBES

(B) Magpie Goose	
(B) Plumed Whistling-duck	
(B) Musk Duck	
(B) Cape Barren Goose	
(B) Black Swan	
(B) Australian Shelduck	
(B) Australian Wood Duck	
(B) Pink-eared Duck	
(B) Australasian Shoveler	
(B) Grey Teal	
(B) Chestnut Teal	
(B) Northern Mallard	
(B) Pacific Black Duck	
(B) Hardhead	
(B) Blue-billed Duck	
(B) Australasian Grebe	
(B) Hoary-headed Grebe	
(B) Great Crested Grebe	

GANNETS, CORMORANTS

(B) Australasian Gannet	
(B) Australasian Darter	
(B) LIttle Pied Cormorant	
(B) Great Cormorant	
(B) Little Black Cormorant	
(B) Pied Cormorant	
(B) Black-faced Cormorant	

PELICAN, HERONS, ALLIES

(B) Australian Pelican	
(B) White-necked Heron	
(B) Eastern Great Egret	
(B) Intermediate Egret	
(B) Cattle Egret	
(B) White-faced Heron	
(B) Little Egret	
(B) Nankeen Night Heron	
(B) Glossy Ibis	
(B) Australian White Ibis	
(B) Straw-necked Ibis	
(B) Royal Spoonbill	
(B) Yellow-billed Spoonbill	
(B) Purple Swamphen	
(B) Dusky Moorhen	
(B) Eurasian Coot	

GULLS, TERNS

(B) Little Tern	
(B) Fairy Tern	
(B) Caspian Tern	
(B) Whiskered Tern	
(B) White-fronted Tern	
(B) Common Tern	
(B) Crested Tern	
(B) Pacific Gull	
(B) Kelp Gull	
(B) Silver Gull	

EXTRA BIRDS NOT LISTED ABOVE

(B) _____	
(B) _____	
(B) _____	
(B) _____	

TOTAL BIRDS

Total shorebirds	
Total other birds	

COMMENTS

Enter comments, extra species counts, presence of dead birds, details of habitat change, disturbances and threats here. Attach additional pages if neccessary.

YES or NO

WERE ALL VISIBLE SHOREBIRDS COUNTED?

YES or NO

WERE ALL WATER-BIRDS COUNTED?