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# EFFECTS ON MARINE BIRDS

# Lyttelton Port Company Channel Deepening Project

Marine Avifauna Assessment
Prepared for Lyttelton Port Company Limited

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## Document Quality Assurance

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*Cover photograph:* View through the heads into Lyttelton Harbour/Whakaraupō.

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# Appendices

# Executive Summary

- Lyttelton Port Company (*LPC*) engaged Boffa Miskell Ltd to prepare this assessment of effects on marine avifauna of the proposed 'Lyttelton Port Company Channel Deepening Project' (*CDP*).
- LPC is proposing to widen and deepen the existing Lyttelton Harbour/Whakaraupō navigation channel and extend it approximately 4km beyond the harbour heads. A depth of between 16.85 to 17.85 metres below chart datum is required for the whole channel. The dredged seabed material is proposed to be deposited at a 1,200 ha offshore spoil ground located, at its nearest points, some 6.2 km from Godley Head and 3.3 km from Baleine Point, at an average depth of approximately 20 m.
- A new maintenance disposal ground is proposed for the deepened channel. The new ground is located between Godley Head and the capital dredging spoil disposal ground. The site is 1.6 km by 1.6 km and is located approximately 2.25 km offshore from Godley Head.
- Both field observational data and previous reports confirm that the Lyttelton Harbour/Whakaraupō and the surrounding coastline provide a diversity of habitat types for marine avifauna for nesting, roosting and foraging activities.
- A subset of 17 marine avifauna species was identified as having been recorded in association with the waters of the Lyttelton Harbour/Whakaraupō or the offshore disposal area, <u>**and**</u> which have a local breeding or wintering population within Lyttelton Harbour/Whakaraupō or the wider Bank Peninsula.
- These 17 species comprise penguins, fairy prion and sooty shearwater, tern, shag, gull and waders, and inhabit two major ecosystems; those being the coastal (including the outer Lyttelton Harbour/Whakaraupō and the offshore area where dredged material will be disposed) and intertidal areas within the Lyttelton Harbour/Whakaraupō.
- It is these 17 species which are likely to have a greater exposure to the dredging operation and the associated potential effects. As such, further information was obtained regarding these species' diet and foraging parameters to inform the assessment of effects.
- The following potential adverse effects associated with the proposal were considered for the 17 marine avifauna species:
    - Direct effects of <u>disturbance</u> associated with dredging operations;
    - Direct effects of <u>bird strike</u> with dredging vessel and equipment;
    - Indirect effects of impacts on benthic and fish communities (and therefore <u>food supply</u>);
    - Indirect effect on <u>foraging ability</u> due to increased water turbidity associated with dredging operations;
    - Both direct and indirect effects associated with <u>pollution</u>.

- The level of the effect on each of these species from the CDP was determined by considering the magnitude of the ecological effect in association with the ecological values.
- For the majority of the marine avifauna species assessed, the level of effect associated with the CDP was determined to be Low or Very Low; this is due to the mobile nature of these species, the relatively large foraging area available and the restricted spatial extent and short term nature of any effects.
- The species for which the level of effect may be greatest is the little penguin, for which a moderate level of effect has been determined. This is due to the combination of *Threatened* classification currently assigned to the white-flippered form, its foraging behaviours, location of breeding populations in the upper harbour above the dredging operation and the nature of the potential effects (i.e. potential to impact foraging success and therefore breeding success). However, this effect will be short term as the CDP operation will be completed within two 9-14 month stages.
- Given the level and short term nature of the potential effects, mitigation is not anticipated. However, given that the conclusions regarding potential impacts on food supply and foraging ability are based on modelling, it is recommended that the sediment plumes be measured and assessed during the CDP dredging process.
- Recommendations are made regarding methods to minimise any effects of deck strike associated with vessel lights and collision with cables.

# 1.0 Introduction

## 1.1 Background

Lyttelton Port (the “Port”) is located on the northern shores of Lyttelton Harbour/Whakaraupō approximately halfway up the harbour (Map 1). The natural water depth between the port and harbour entrance is 5-13 m. This is shallower than the draught of cargo vessels which need to access the Port.

To allow ships to travel up the harbour and dock at the port, a channel with a greater depth than the surrounding natural harbour has been created by dredging. Dredging of the Inner Harbour and the navigation channel commenced with bucket dredgers creating a channel with a depth of 7.8 m. The first suction dredge (Canterbury) arrived in 1912 and worked on the channel, which at 1943 was 10.5 m below chart datum. This was further deepened over the period up to the mid 1970’s when it reached the current depth of approximately 12.2 m below chart datum, ending adjacent to Mechanics Bay. This channel has not been deepened since the mid 1970’s, but undergoes annual maintenance dredging.

In order to keep up with the international trend of increasing ship sizes (particularly container vessels), LPC is proposing to widen and deepen the existing navigation channel and extend it approximately 4km beyond the harbour heads (Map 1). A depth of between 16.85 to 17.85 metres below chart datum is required for the whole channel.

Boffa Miskell Ltd was engaged by LPC to prepare this assessment of effects on marine avifauna associated with these proposed works, known as the CDP.

## 1.2 This Assessment

This report begins with a brief description of the Lyttelton Harbour/Whakaraupō and the current shipping channel (Section 2.0). Details are then provided regarding the methodologies used to obtain information pertaining to the marine avifauna values (habitat and species) present (Section 3.0), and a description of these values (Section 4.0) and their significance (Section 5.0). A description of the proposal is provided (Section 6.0), followed by the potential effects considered and an assessment of those on the marine avifauna species likely to be exposed to the effects (Sections 7.0 and 8.0). The final section (9.0) of this report outlines recommendations to avoid, minimise or mitigate any significant adverse effects.

For the purpose of this report:

- “Marine avifauna” refers to any species which may have an association with the saline environment (i.e. coastal, estuarine or oceanic). Any such association may include roosting, nesting or foraging activities.
- The “project site” refers to the dredging and disposal areas identified on Map 1.
- “Lyttelton Harbour/Whakaraupō” refers to the entire Lyttelton Harbour/Whakaraupō from its mouth to Teddington, having a low-tide area of approximately 43 $km^2$ (refer to Map 1).

- "The wider area" refers to the area beyond the Lyttelton Harbour/Whakaraupō heads, including the wider Banks Peninsula (refer to Map 2).
- "Zone of influence" or "ZOI" refers to the areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities (EIANZ, 2015).

# 2.0 Site Location & Context

Lyttelton Harbour/Whakaraupō is one of two major inlets in Banks Peninsula on the coast of Canterbury (refer to Maps 1 and 2). The physiography is dominated by the harbour and the Port Hills. The harbour is a rock-walled inlet which is approximately 15km in length, inland from its mouth, with an average width of approximately 2km. The upper harbour widens to form the three bays (Governors Bay, Head of the Bay and Charteris Bay) which are separated by peninsulas and Quail Island (Lyttelton Port Company, 2014). The harbour has a low-tide area of approximately 43km$^2$ and a central, long axis oriented in an ENE-direction (Lyttelton Port Company, 2014).

The natural water depth between the port and harbour entrance is 5-13m, while the current navigational channel depth is approximately 12.2m below chart datum. The location of the existing navigational channel, ship-turning basin and berth areas are shown in Map 1. Currently these areas are dredged annually, generally during the period September through November, due to sediment in-fill. This type of dredging is called 'maintenance dredging' as its purpose is to maintain the channel's depth. On average, the navigation channel at Lyttelton shallows by approximately 0.5 m each year. With the exception of 2009, the volume of material dredged per year from the existing channel in the last 10 years has varied from approximately 280,000 m$^3$ to 590,000 m$^3$. While being undertaken, the maintenance dredging generally operates 24 hours a day seven days a week (aside from crew changeover).

The spoil from the maintenance dredging are deposited on the north side of the harbour at Gollans Bay, Livingstons Bay, Breeze Bay, White Patch North, Mechanics Bay and Godley Head (refer to Map 1).

# 3.0 Methodology

In order to conduct an assessment of the potential effects of the proposal on the marine avifauna, information was gathered on the ecological values (habitat and species) present within the wider area through a combined desktop and field approach as described below.

## 3.1 Desktop

Data from the Ornithological Society of New Zealand's atlas (C. J. R. Robertson, Hyvonen, Fraser, & Pickard, 2007) was collated from two 10 km x 10 km grid squares (248, 573; 249, 573) which encompass the entire Lyttelton Harbour/Whakaraupō (inner and outer) and surrounding terrestrial area (refer to Map 2). The primary and secondary habitats[1] for each of the species recorded within these grid squares was obtained from Heather & Robertson (2005), along with each species' New Zealand threat status according to Robertson *et al*. (2013). The species list obtained from the OSNZ atlas data served as a base list of avifauna species recorded in the wider Lyttelton Harbour/Whakaraupō area and therefore potentially present at or near the project site.

Further literature (published and unpublished) and website searches were undertaken to obtain additional information regarding marine bird species known to occur within the surrounding coastal habitats. The information researched included diets, foraging ranges and foraging behaviours for marine avifauna species for which food availability and foraging performance may be impacted by the CDP. Representative foraging range values and diets for species were established from this information. The potential foraging areas of marine avifauna breeding or wintering within the zone of influence was then overlaid with the proposed dredging areas to identify an initial suite of species considered for the assessment.

## 3.2 Field Investigation

On 19 November 2015, a boat-based survey was conducted by the author (a qualified and experienced ornithologist) over a three hour period (08:00-11:00) along the alignment of the proposed dredging channel and the disposal ground in Pegasus Bay, as well as the coastline and headlands to Little Pigeon Bay (refer to Map 1). Weather conditions were scattered cloud, cool (approximate 10°C) with an ENE breeze. The survey was conducted during an incoming tide, with high tide being at approximately 11:05 hours.[2]

The objective of the survey was to identify the marine avifauna habitat and compile a species list and behavioural observations. Any species identified during this trip were recorded, including a note relating to the birds activity and the numbers present.

**NOTE:** It is acknowledged that the information obtained represents a snapshot of the species and habitat utilisation of the area at that time and does not account for temporal and seasonal variability that is likely to occur. However, the survey was conducted during the seabird breeding season, a time when marine birds are making regular trips between foraging and nesting habitats.

As part of the Port Recovery Plan process, additional marine avifauna site investigations had been undertaken by the author in the wider Lyttelton Harbour/Whakaraupō. These included:

- On 30 January 2015, a boat-based survey was conducted over a three hour period (09:00-12:00) along the coastline of the Lyttelton Harbour/Whakaraupō. Weather conditions were overcast, light winds with passing drizzle patches and a temperature of approximately 18°C. The survey was conducted during an incoming tide, with low tide

[1] For the purpose of this report, primary habitat refers to the habitat in which the species spends most of its time. Secondary habitats are other habitat types which the species may also utilise.

[2] http://www.lpc.co.nz/siteapps/LPCWeatherNetApp.jasc?Node=N168P0

being at approximately 08:00 hours.[3] The objective of that survey was to identify the marine avifauna habitat and compile a species list and behavioural observations.

- Also on 30 January 2015, a land-based survey was conducted (14:00-15:00) of the mudflats at Governors Bay, Head of the Bay and Charteris Bay. Despite the tide being high at this time, areas of the mudflats were still exposed. The objective of that survey was to identify the wading bird habitat and compile a species list and behavioural observations.
- On 18 November 2015, a little penguin nesting survey was conducted along the Port reclamation in front of the coal yard and the breakwater. The objective of that survey was to confirm the presence of nesting penguins at that location.

Information obtained from these surveys and the data obtained from the OSNZ atlas have all been used to inform the current assessment.

## 3.3 Supporting documentation

In addition to the information collected through site visits and desktop investigation of relevant literature and databases, this assessment has been based on the information provided in the following supporting documents and plans:

- Lyttelton Port Company Channel Deepening Project AEE – Chapter 2 Project Description.
- MetOcean Solutions Ltd (2016a). '*Lyttelton Port Company Channel Deepening Project – Numerical modelling of sediment dynamics at proposed offshore maintenance disposal ground'*. Report No. P0201-04 (RevC, 08/08/16) prepared by MetOcean Solutions Ltd for Lyttelton Port Company Ltd.
- MetOcean Solutions Ltd (2016b). '*Lyttelton Port Company Channel Deepening Project – Simulations of suspended sediment plumes generated from the deposition of spoil at the offshore capital disposal site'*. Report No. P0201-02 (RevG, 04/08/16), prepared by MetOcean Solutions Ltd for Lyttelton Port Company Ltd.
- MetOcean Solutions Ltd (2016c). '*Lyttelton Port Company Channel Deepening Project – Simulations of Dredge Plumes from Dredging Activities in the Channel'*. Report No. P0201-03 (RevF, 04/08/16), prepared by MetOcean Solutions Ltd for Lyttelton Port Company Ltd.
- MetOcean Solutions Ltd (2016d). '*Lyttelton Port Company Channel Deepening Project – Simulations of suspended sediment plumes generated from the deposition of spoil at proposed maintenance disposal grounds'*. Report No. P0201-06 (RevB, 08/08/16), prepared by MetOcean Solutions Ltd for Lyttelton Port Company Ltd.
- MetOcean Solutions Ltd (2016e). '*Lyttelton Port Company Channel Deepening Project – Numerical modelling of sediment dynamics for a proposed offshore capital disposal ground'*. Report No. P0201-01 (RevF, 19/5/16) prepared by MetOcean Solutions Ltd for Lyttelton Port Company Ltd.

[3] http://www.lpc.co.nz/siteapps/LPCWeatherNetApp.jasc?Node=N168P0

- Sneddon et al. (2016). *Assessment of impacts to benthic ecology and marine ecological resources from the proposed Lyttelton Port Company Channel Deepening Project.* Report No. 2860 prepared by Cawthron Institute for Lyttelton Port Company Ltd, dated May 2016

# 4.0 Existing Environment – Marine Avifauna

## 4.1 Base list of marine avifauna species & habitats

The OSNZ atlas data provided a base list of 42 species (including *Threatened* and *At Risk*), which potentially utilise the marine environment, that have been recorded within the two 10km x 10km grid squares encompassing the entire Lyttelton Harbour/Whakaraupō and some surrounding terrestrial areas (refer to Appendix 2 for species lists and Map 2 for grid square locations).

During the site visit to the off-shore disposal area in Pegasus Bay (November 2015), a total of 12 marine avifauna species were recorded utilising the Lyttelton Harbour/Whakaraupō waters, the open ocean beyond the harbour head, and the coastal margin (e.g. coastal cliffs, rocky reef platforms etc); these species are listed in Appendix 2.

While this represents a diverse avifauna community which may be associated with the Lyttelton Harbour/Whakaraupō marine environment, the relative importance of that area will vary for each of those species according to the activity undertaken (i.e. nesting, roosting, foraging) and the availability of similar habitat elsewhere. Both observational data and reports confirm that the Lyttelton Harbour/Whakaraupō and surrounding coastline provides a diversity of habitat types (refer to photos provided in Appendix 1) for marine avifauna required to undertake nesting, roosting and foraging activities, including:

- The extensive **inter-tidal rocky shoreline** provides key habitat for many coastal species to feed and roost. It is estimated that this habitat type makes up more than 50% of Lyttelton Harbour/Whakaraupō shoreline.
- The **outer harbour wave-cut platforms, exposed reefs and sand beaches** have been identified as a major wintering site for variable oystercatcher (*At Risk*) (Crossland, 2001).
- The **inner harbour inter-tidal mudflats** at Governors Bay, Head of the Bay and Charteris Bay in the upper harbour provide foraging habitat for a number of wading shorebird species (Crossland, 2001).
- The **large conifers** around the harbour and the **coastal cliffs** provide valuable nesting and roosting habitat for several shag species (N. Allen, 2013; Christchurch City Council, 2013).
- **Quail Island** provides nesting habitat for black-backed gull and little (white-flippered) penguin (*Threatened*) (N. Allen, 2013; Challies & Burleigh, 2004). Other species recorded on the island include white-faced heron, NZ pied oystercatcher, red-billed gull (*Threatened*), little shag, white-fronted tern and spotted shag (Genet & Burrows, 1999).
- The **pelagic and demersal waters** of the Lyttelton Harbour/Whakaraupō and beyond the entrance provide foraging habitat for a number of marine avifauna species (N. Allen, 2013).

## 4.2 Species of Concern

The potential vulnerability of the species recorded within Lyttelton Harbour/Whakaraupō and the wider area (refer to Section 4.1 and Appendix 2) to the effects of dredging is based on the species' sensitivity and exposure to different effect (Cook & Burton, 2010).

As such, further information was obtained regarding diet and foraging parameters of the 17 marine avifauna species which have been recorded in association with the waters of the Lyttelton Harbour/Whakaraupō or the offshore disposal area, **and** which have a local breeding or wintering population within Lyttelton Harbour/Whakaraupō or the wider Bank Peninsula. It is these species which are likely to have a greater exposure to the dredging operation and the associated potential effects. These 17 species comprise penguins, fairy prion and sooty shearwater, tern, shag, gull and waders, and inhabit two major ecosystems; those being the coastal (including the outer Lyttelton Harbour/Whakaraupō and the offshore area where dredged material will be disposed) and intertidal areas within the Lyttelton Harbour/Whakaraupō.

The species information summarised in the sections below has been used to assist with informing the assessment of effects of the CDP. We note that the information obtained is not readily available in the literature and had to be collated from a range of sources to provide the level of information necessary for assessing potential effects.

### 4.2.1 Penguins

#### 4.2.1.1 Little penguin

*Threat classification and population status*

Little penguin (*Eudyptula minor*) are native to New Zealand and Australia; the New Zealand population is estimated to be c.50,000-100,000 (C. J. R. Robertson & Bell, 1984). Robertson et al. (2013) have assigned a *Threatened* classification to white-flippered penguin (*Eudyptula minor albosignata),* compared to *At Risk* for the other little penguin subspecies listed. However, Flemming (2013)[4] notes that there are no recognized little (blue) penguin subspecies; rather, that regional morphological differences are minor, clinal and not supported by analyses of genetic diversity. In particular, Banks et al. (2008) report that the Banks Peninsula birds, previously identified as white-flippered penguins, while superficially distinct, are not genetically distinctive. For the purpose of this report, the reference to little penguin on Banks Peninsula encompasses all forms of little penguin found there. Furthermore, a conservative approach has been taken where by the *Threatened* classification has been adopted for the assessment.

Little penguin are found in small numbers around Banks Peninsula, with the highest numbers in the remote eastern bays (Challies & Burleigh, 2004; Newton, 2006; Williamson, 2002). Challies & Burleigh (2004) recorded 68 colonies around Banks Peninsula, with an estimated population of 5,870 birds. Within the Lyttelton Harbour/Whakaraupō, Quail Island provides nesting habitat for little penguin (N. Allen, 2013); birds have also been confirmed nesting along the coastal rip-rap in front of the Port coal yard (*Pers. obs.;* also see photo in Appendix 1). Adults are present at colonies

[4] Flemming, S.A. 2013. Little penguin. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

throughout the year, though numbers are lowest between completion of moult (April) and start of breeding (August) (Marchant, Ambrose, Higgins, Davies, & Sharp, 1990).

Little penguin exhibit highly variable breeding success rates and breeding season timing, generally dictated by local conditions (W. J. Allen, Helps, & Molles, 2011). For most colonies in New Zealand the breeding season begins around August and continues until January when chicks fledge (Davis & Renner, 2010).

### *Foraging range*

During the breeding season, little penguin are central-place (near shore) foragers, restricted to foraging areas close to their nest. This is particularly the case during the chick-rearing phase, when adults need to return to land frequently to feed the chick, meaning they are capable of acquiring only local resources at this time (Chiaradia, Ropert-Coudert, Kato, Mattern, & Yorke, 2007; Collins, Cullen, & Dann, 1999). Numerous studies have found that little penguin generally travel no further than 20km from the colony while feeding chicks (Cannell, 2016; Chiaradia & Kerry, 1999; Collins et al., 1999; Hoskins et al., 2008; Klomp & Wooller, 1988; Preston et al., 2008; Weavers, 1992).

Bräger & Stanley's (1999) recorded at-sea near-shore (within 1 km) observations of little penguin at numerous sites around Banks Peninsula. The majority of near-shore observations were at Flea Bay and Akaroa Harbour, but other areas along the southern shores of Banks Peninsula with high numbers of observations were Le Bons Bay, Shell Bay to Damons Bay, and Squally Bay to Long Bay (refer to Map 3) (Bräger & Stanley, 1999). Individual birds were recorded at up to 12 km out to sea. Due to the restriction on their foraging range, little penguin are vulnerable to small regional changes in prey abundance and distribution (Chiaradia et al., 2007), particularly during the chick-rearing phase (Flemming, Lalas, & van Heezik, 2013).

Hoskins et al.'s (2008) study of little penguin found that the mean maximum foraging range (16.9 to 18.8 km) were similar between three breeding colonies, despite variation in bathymetric environments. However, bathymetry has found to be an important factor influencing fledging success of little penguins; lower diving effort and shallower diving activities have been observed in colonies where a high fledging success was recorded (Chiaradia et al., 2007).

Both McCutcheon et al. (2011) found that the foraging range of little penguins was greater during the winter non-breeding period; individuals conducting single-day trips (72% of individuals) typically foraged 8–14km from the colony, whereas individuals conducting longer trips (28%; 2-49 days) foraged at maximum distances of 62–147 km from the colony (McCutcheon et al., 2011). Weavers (1992) reported the same pattern of short foraging trips during the breeding season (95% within a radius of 15 km from the burrow) and longer trips during the non-breeding season (up to 710 km from the colony, but 74% within 20 km of the coast).

Weavers (1992) showed that little penguin foraging during years of lowered prey availability responded by increasing their foraging ranges, presumably to increase their search areas and prey encounter rates. Several other studies have also reported a level of plasticity in the foraging strategies of little penguins (McCutcheon et al., 2011; Saraux, Robinson-Laverick, Le Maho, Ropert-Coudert, & Chiaradia, 2011; Zimmer, Ropert-Coudert, Poulin, Kato, & Chiaradia, 2011).

### *Foraging behaviour and diet*

Little penguin are visual feeders foraging by pursuit diving; consequently diving is exclusively diurnal, with a midday peak (Cannell & Cullen, 1998; Preston et al., 2008; Ropert-Coudert, Kato, Naito, & Cannell, 2003; Ropert-Coudert, Kato, Wilson, & Cannell, 2006, p.).

Numerous studies investigating dive depth of little penguin have recorded most birds foraging in shallow waters within 15 m of the surface, with maximum dive depths up to 27 m (Bethge, Nicol, Culik, & Wilson, 1997; Gales, Williams, & Ritz, 1990; Preston et al., 2008; Ropert-Coudert et al., 2003, 2006). A primary determinant of maximum dive depth in penguins seems to be the availability of light since these birds rely primarily on vision to hunt (Cannell & Cullen, 1998).

Diet composition typically varies between little penguin colonies as a consequence of their small foraging range and varying abundances of their preferred prey, which are influenced by local conditions such as ocean temperature and bathymetry (Chiaradia et al., 2012, 2007; Cullen, Montague, & Hull, 1992; Gales & Pemberton, 1990). In New Zealand, little penguins are generalist feeders of small inshore species, able to switch between a number of prey species, probably in response to temporal variation in availability (Flemming et al., 2013). At Banks Peninsula (Otanerito Bay), Flemming et al. (2013) reported that arrow squid (*Nototodarus sloanii*) occurred most frequently (87.5%), but two fish species – slender sprat (*Sprattus antipodum*) (33.9%) and ahuru (*Auchenoceros punctatus*) (37.4%) – contributed most to little penguin meal mass. These two fish species are energetically-rich schooling fish (Flemming et al., 2013).

Preston et al. (2008) found evidence of little penguins utilising shipping channels in Port Phillip Bay (southern Australia) and suggested that it was possible that the penguins use both the sea floor and the 3-dimensional structure of the shipping channels to trap their prey. This foraging strategy is similar to that suggested for little penguin at Penguin Island by Ropert-Coudert et al. (2006).

#### 4.2.1.2 Yellow-eyed penguin

Yellow-eyed penguin (*Megadyptes antipodes*) is a New Zealand endemic species which is classified as *Threatened – Nationally Vulnerable* (H. A. Robertson et al., 2013). There are estimated to be around 1,700 breeding pairs, with the majority of these in the subantarctic on the Auckland and Campbell Islands.[5]

Dilks & Grindell (1990) reported small numbers (11 pairs) of yellow-eyed penguin breeding on the east and south-eastern bays of Banks Peninsula (Lucas Bay, Stony Bay, Otanerito, Goughs Bay and Hickory Bay; refer to Map 3). This included four Otago reared adults, suggesting that migration of birds from further south may be important to keep the Banks Peninsula population viable (Dilks & Grindell, 1990). For this species, egg laying takes place between mid-September and mid-October; chicks hatch in early November and leave for sea in mid-late February (Dilks & Grindell, 1990).

Yellow-eyed penguins forage from the inshore to mid-shelf region 2-25 km offshore. Dive depths of 40-120 m indicate that they feed predominantly on the seafloor, obtaining bottom-dwelling fish species such as sprat, red cod, opalfish, ahuru, silversides and blue cod, plus cephalopods and crustaceans (Mattern et al., 2013; Mattern, Ellenberg, Houston, & Davis, 2007; Moore, 1999; Moore & Wakelin, 1997; Seddon & van Heezik, 1990; van Heezik, 1990).

[5] Seddon, P.J. 2013. Yellow-eyed penguin. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

### 4.2.2 Fairy prion & sooty shearwater

Small breeding colonies of both fairy prion (*Pachyptila turtur*) and sooty shearwater (*Puffinus griseus*) have been recorded on islets off Banks Peninsula (Wilson, 2008); both species are classified as *At Risk* (H. A. Robertson et al., 2013). Though only small numbers are breeding on the islets of Banks Peninsula, both fairy prion and sooty shearwater have relatively large New Zealand populations in the order of millions of pairs. Both species are summer breeders and migrate considerable distances from their breeding colonies during the winter non-breeding season. In the case of fairy prion, during winter many birds are in Foveaux Strait, in the Cook Strait and Taranaki Bight area, and east of Northland; but some disperse further north to subtropical waters as far as the Coral Sea and the Kermadecs (Heather & Robertson, 2005). New Zealand sooty shearwater migrate to the north Pacific during winter (Shaffer et al., 2006; Spear & Ainley, 1999).

Both species belong to the Procellariidae genus, which Shealer (2002) classifies as pelagic[6] feeders. Fairy prions mainly eat small pelagic crustaceans, along with small fish and squid; most prey is taken by surface-seizing, dipping or surface plunging (Harper, 1987).

Kitson et al. (2000) recorded the following six major prey categories in the diet of sooty shearwater: decapod, fish, squid, euphausiid, salp and amphipod. Birds frequently plunge or dive for food to depths averaging 16 m, and have been recorded swimming to depths of over 60 m (Shaffer et al., 2009; H. Weimerskirch & Sagar, 1996). Between September and mid-May, breeding and pre-breeding birds disperse widely throughout New Zealand seas, mainly over continental-shelf and deeper waters off southern New Zealand, although some move south to the pack ice. Birds have been shown to travel mean distances of 1970 km and 515 km from the colony on long and short trips respectively during the breeding season (Shaffer et al., 2009).

### 4.2.3 Terns

Both white-fronted (*Sterna striata*) and Caspian tern (*Hydroprogne caspia*) have been observed foraging in the Lyttelton Harbour/Whakaraupō. However, it is only the former which has a local summer breeding population which includes Otamahua/Quail Island (Genet & Burrows, 1999). The white-fronted tern national population is estimated to be 15,000-20,000 pairs and the species classified as *At Risk – Declining* (Heather & Robertson, 2005; H. A. Robertson et al., 2013). In comparison the Caspian tern national population is estimated to be 3,000 birds and has a New Zealand threat classification of *Threatened – Nationally vulnerable*, but has a secure overseas population (Heather & Robertson, 2005; H. A. Robertson et al., 2013).

Shealer (2002) classifies terns as inshore-pelagic foragers. Caspian terns feed mostly on small surface-swimming fish such as yellow-eyed mullet, piper and smelt which are caught by plunge-diving (Heather & Robertson, 2005). White-fronted tern feed on shoaling fish such as smelt and pilchard in coastal waters, often associated with gulls and shearwaters (Heather & Robertson, 2005). Feeding terns dive from 5-10 m above the surface.

[6] Pelagic = Any water in a sea or lake that is neither close to the bottom nor near the shore. The pelagic zone can be contrasted with benthic and demersal zones at the bottom of the sea (Lincoln, Boxshall, & Clark, 1998).

### 4.2.4 Shags

Shealer (2002) classifies the foraging technique of shags as coastal-inshore pursuit divers.

#### 4.2.4.1 Spotted shag

The spotted shag (*Stictocarbo punctatus*) is endemic to New Zealand and classified as *Not Threatened* (H. A. Robertson et al., 2013). The total breeding population is up to 30,000 pairs, with approximately 22,123 breeding pairs nesting around Banks Peninsula from Sumner Head to Birdlings Flat (see Map 3) (Doherty & Bräger, 1997); within Lyttelton Harbour/Whakaraupō the colonies are located on edges of coastal cliffs overhanging the sea below, including along the south-eastern outer harbour around Little Port Cooper (see Map 3).

Timing of breeding varies year-to-year and in different parts of the range, depending on food availability; peak laying period at Banks Peninsula is during September - November.[7] Spotted shag are concentrated around breeding sites when breeding but disperse to other coastal areas in winter (Owen & Sell, 1985).

Spotted shag feed in deep water up to 15 km from the shore, and they sometimes feed in harbours (Heather & Robertson, 2005). Their diet is mainly small fish less than 15 cm long, and marine invertebrates (Heather & Robertson, 2005). The main fish taken are ahuru, red cod, gudgeon, bullies and sprats; arrow squid are also taken frequently (Heather & Robertson, 2005).

#### 4.2.4.2 Pied and little shag

Both pied (*Phalacrocorax varius*) and little shag (*Phalacrocorax melanoleucos*) nest in trees (particularly large conifers) along coastal cliffs within Lyttelton Harbour/Whakaraupō, including along the eastern side of Stoddart Point/Upoko o Kuri and on King Billy Island (N. Allen, 2013).

The national population of pied shag, classified as *Threatened – Nationally Vulnerable*, is widespread and estimated to be approximately 6,400 breeding pairs (Wildlife Management International Ltd, 2013). Pied shag clutches are laid in all months, with peaks during February-April and August-October.[8] They generally forage close to shore in shallow water less than 10 m deep and their diet is mainly 6-15 cm long fish such as flounder, mullet, perch, smelt and eel (Heather & Robertson, 2005; Lalas, 1983).

Little shag are considered to be widespread and common, with a national population of 5,000-10,000 breeding pairs and is classified as *Not Threatened* (Heather & Robertson, 2005; H. A. Robertson et al., 2013). Peak breeding activity for little shag occurs in October to December. Diet varies greatly with habitat but is mainly small fish (<13 cm long); the main marine species taken are bullies, flounder, sole and smelt. Little shag generally feed close to shore in waters less than 3 m deep (Heather & Robertson, 2005; Lalas, 1983).

### 4.2.5 Gulls

Both red-billed (*Larus novaehollandiae*) and black-backed gull (*Larus dominicanus*) have breeding colonies within the Lyttelton Harbour/Whakaraupō (N. Allen, 2013). While both species have been

[7] Szabo, M.J. 2013 [updated 2015]. Spotted shag. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

[8] Powlesland, R.G. 2013. Pied shag. *In* Miskelly, C.M. (ed.) New Zealand Birds Online. www.nzbirdsonline.org.nz

recorded on Quail Island, black-backed gull colonies are also located along the coastline of Stoddart Point/Upoko o Kuri around to Church Bay and at the end of Mansons Peninsula (Christchurch City Council, 2013; Dawson & Cresswell, 1949; Genet & Burrows, 1999). Shealer (2002) classifies gulls as inshore-pelagic foragers.

The red-billed gull is a very abundant species, but has been afforded a classification of *Threatened – Nationally Vulnerable* due to the recent large declines at its three main breeding colonies (Three Kings Islands, Mokohinau Islands and Kaikoura Peninsula) (H. A. Robertson et al., 2013). This species nests in dense colonies and have an extremely long egg-laying period that can extend from mid-September to January[9]. During the breeding season, red-billed gull feed mainly in inshore waters on the planktonic euphausiid *Nyctiphanes australis,* although some other marine invertebrates and small fish are taken (Heather & Robertson, 2005). Birds disperse during the non-breeding season, at which time the diet is much more varied and opportunistic (Higgins & Davies, 1996).

Black-backed gull is a very abundant, widespread and locally common native species which is classified as *Not Threatened* (H. A. Robertson et al., 2013). It also breeds in large dense colonies, but with most eggs laid mid-October to late-November. Black-backed gull are both predators and scavengers, and have been recorded catching and consuming a wide range of marine and terrestrial invertebrates, fish, small mammals, birds and their eggs and chicks[10]. At sea, they feed on algae and plunge dive for small fish and marine invertebrates; along the coast they forage for shellfish (Heather & Robertson, 2005).

### 4.2.6 Wading birds

#### 4.2.6.1 Variable oystercatcher

Lyttelton Harbour/Whakaraupō has been identified as a wintering site for variable oystercatcher (*Haematopus unicolor*), an *At Risk – Recovering* species which is almost exclusively a coastal wader, favouring sandy and rocky shorelines (Crossland, 2001). Their diet includes a wide range of littoral[11] invertebrates, including molluscs, crustaceans, and annelids; foraging patterns are influenced by tidal cycles (Heather & Robertson, 2005).

#### 4.2.6.2 New Zealand pied oystercatcher, godwit & pied stilt

The inner harbour inter-tidal mudflats at Governors Bay, Head of the Bay and Charteris Bay in the upper harbour (see Map 1) provide foraging habitat for *At Risk* wading shorebird species such as godwit (*Limosa lapponica*), pied stilt (*Himantopus himantopus*) and New Zealand pied oystercatcher (*Haematopus finschi*) (Crossland, 2001). This habitat preference is reflected in the diets: godwit mainly eat polychaete worms and molluscs found in soft mud; pied stilt mainly aquatic and terrestrial invertebrates; NZ pied oystercatchers mainly molluscs (especially bivalves) and estuarine worms (Heather & Robertson, 2005).

[9] Mills, J.A. 2013. Red-billed gull. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

[10] Miskelly, C.M. 2013. Southern black-backed gull. In Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

[11] Pertaining to the shore (Lincoln et al., 1998).

### 4.2.6.3 Reef heron

Reef heron (*Egretta sacra*) is a *Threatened* species which has been recorded foraging along the coastline between Stoddart Point/Upoko o Kuri and Church Bay (Christchurch City Council, 2013). Daily feeding routines are influenced by tidal cycles, with birds feeding on the falling or low tide, including at night. Diet comprises mainly small fish, eels, flounder, crabs and molluscs (Heather & Robertson, 2005).

### 4.2.6.4 White-faced heron

White-faced heron (*Egretta novaehollandiae*) is a widespread and common species which is classified as *Not Threatened* (H. A. Robertson et al., 2013). This species is a tree-top dweller, favouring the tops of large pine trees or macrocarpa growing near water[12].Within Lyttelton Harbour/Whakaraupō, white-faced heron have recorded breeding along the coastline of Stoddart Point/Upoko o Kurī around to Church Bay (see Map 1) (Christchurch City Council, 2013). Laying peaks around October.

Both saline and freshwater habitats are used for foraging, as indicated by the wide range of prey they consume: small fish, crabs, worms, insects, spiders, mice, lizards, tadpoles and frogs (Marchant et al., 1990). The white-faced heron is a predator that depends on vision and captures prey with a variety of methods; when foraging, they were essentially searchers, usually wading and walking, but occasionally standing and waiting for prey (Moore, 1984). Thus, they are coastal edge shallow-water foragers.

## 4.2.7 Species summary

The main species parameters relevant to this assessment of effects are summarised in Table 1 below.

The general foraging range for coastal inshore species (e.g. penguin, tern, gulls and shag) is within 20 km of the breeding colonies; this zone has been delineated on Map 3. As indicated by the bathymetry on this map, the majority of that area exceeds 20 m deep. Based on foraging behaviours, gulls and tern will likely feed in the top few metres of that area, the shag species up to approximately 10 m, while penguins may utilise the entire water column within that area.

[12] Adams, R. 2013 [updated 2015]. White-faced heron. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

*Table 1: Summary of foraging and dietary information for marine avifauna breeding or wintering within the wider area and which may be impacted by the proposal.*

| ECOSYSTEM | SPECIES | CLASSIFICATION | LOCAL POPULATION | FORAGING HABITAT / RANGE | FORAGING BEHAVIOUR | DIET |
|---|---|---|---|---|---|---|
| **Coastal** | Little (white-flippered) penguin | Threatened – Nationally Vulnerable | Breeding (Lyttelton Harbour/Whakaraupō and Banks Peninsula) | Near shore (<20km from colony during breeding season; up to 150km during non-breeding season) | Visual pursuit forager in shallow waters, mostly within 15 m of surface. | Generalist feeder on small inshore species. Diet at Banks Peninsula arrow squid, slender sprat and ahuru. |
| | Yellow-eyed penguin | Threatened – Nationally Vulnerable | Breeding (Banks Peninsula) | Near shore to mid-shelf (2-25km off shore) | Bottom-foraging strategy, feeding predominantly at the seafloor. | Sprat, red cod, opal fish, ahuru, silversides, blue cod, cephalopods and crustaceans. |
| | Fairy prion | At Risk – Relict | Breeding (islets off Banks Peninsula) | Pelagic | Surface seizing, dipping or surface plunging. | Pelagic crustaceans, small fish and squid. |
| | Sooty shearwater | At Risk - Declining | Breeding (islets off Banks Peninsula) | Pelagic (up to 1970km from shore) | Plunge or dive (average 16m but >60m). | Decapod, fish, squid, euphausiid, salp and amphipod |
| | Caspian tern | Threatened – Nationally Vulnerable | No | Inshore – pelagic | Plunge dive and dipping. | Small surface-swimming fish such as yellow-eyed mullet, piper and smelt, crustacean and squid. |
| | White-fronted tern | At Risk - Declining | Breeding (Lyttelton Harbour/Whakaraupō and Banks Peninsula) | Inshore – pelagic | Plunge dive and dipping. | Coastal shoaling fish such as smelt and pilchard, crustacean and squid. |
| | Spotted shag | Not threatened | Breeding (Lyttelton Harbour/Whakaraupō and Banks Peninsula) | Coastal inshore (up to 15km from shore) | Pursuit diver | Ahuru, red cod, gudgeon, bullies, sprat and arrow squid (infrequently). |
| | Pied shag | Threatened – Nationally Vulnerable | Breeding (Lyttelton Harbour/Whakaraupō) | Coastal inshore | Pursuit diver, foraging in water less than 10 m deep. | Marine species include flounder, mullet, perch, smelt and eel. |
| | Little shag | Not threatened | Breeding (Lyttelton Harbour/Whakaraupō) | Coastal inshore | Pursuit diver in waters >3m deep. | Marine species include bullies, flounder, sole and smelt. |
| | Red-billed gull | Threatened – Nationally Vulnerable | Breeding (Lyttelton Harbour/Whakaraupō) | Inshore pelagic | Surface seizing and dipping. | Marine invertebrates and small fish during breeding season. |

| ECOSYSTEM | SPECIES | CLASSIFICATION | LOCAL POPULATION | FORAGING HABITAT / RANGE | FORAGING BEHAVIOUR | DIET |
|---|---|---|---|---|---|---|
| | Black-backed gull | Not threatened | Breeding (Lyttelton Harbour/Whakaraupō) | Inshore pelagic | Surface seizing and dipping. | Marine diet includes algae, small fish, marine invertebrates and shellfish. |
| **Intertidal** | Variable oystercatcher | At Risk - Recovering | Wintering (Lyttelton Harbour/Whakaraupō) | Sandy and rocky coastal margin | Wader. Visual feeder influenced by tidal cycle. | Littoral invertebrates, occasionally fish. |
| | NZ pied oystercatcher | At Risk – Declining | Wintering (Lyttelton Harbour/Whakaraupō) | Intertidal mudflats | Wader. Probing in mudflats during low tide. | Polychaete worms and molluscs |
| | Bar-tailed godwit | At Risk – Declining | Wintering (Lyttelton Harbour/Whakaraupō) | Intertidal mudflats | Wader. Probing in mudflats during low tide. | Mainly polychaetes (probably >70% of diet) but also small bivalves and crustaceans. |
| | Pied stilt | At Risk – Declining | Wintering (Lyttelton Harbour/Whakaraupō) | Intertidal mudflats | Wader. Probing in mudflats during low tide. | Aquatic and terrestrial invertebrates |
| | Reef heron | Threatened – Nationally Endangered | Wintering (Lyttelton Harbour/Whakaraupō) | Coastal margin | Wader. Probing in mudflats during low tide. | Mainly molluscs (especially bivalves) and estuarine worms |
| | White-faced heron | Not threatened | Breeding (Lyttelton Harbour/Whakaraupō) | Rocky coastal margin | Wader. Visual feeder in shallow waters. | Marine prey include small fish and crabs. |

# 5.0 Summary of Ecological Values & Significance

Assessment of ecological significance is a necessary test under the Resource Management Act 1991; Section 6C – *protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna*. Given the presence and reliance on the Lyttelton Harbour/Whakaraupō as a foraging habitat for a number of *Threatened* and *At Risk* species (refer to Section 4.0), this area is considered to be a significant habitat for indigenous fauna. In addition to determining ecological significance for this assessment, ecological values[13] have been assigned. For species, all New Zealand biota have been assessed by DOC against a standard set of criteria (described in Townsend *et al.* (2008)) and lists published for each taxonomic group[14]. This provides a consistent basis on which to assign ecological value for individual species (see Table 2). On this basis, the ecological value assigned to each of the marine avifauna species which are likely to forage in the areas that may be impacted by the dredging proposal, and / or have local breeding or wintering populations, are provided in Table 3.

*Table 2: Criteria for assigning ecological value to species (based on EIANZ (2015) guidelines)*

| ECOLOGICAL VALUE | SPECIES CLASSIFICATION |
|---|---|
| **Very High** | Threatened - *(Nationally Critical, Nationally Endangered, Nationally Vulnerable)* |
| **High** | At Risk - *(Declining, Recovering, Relict, Naturally Uncommon)* |
| **Medium** | Locally uncommon / rare (but not Threatened or At Risk) |
| **Low** | Native - Not Threatened |

[13] Ecological values are defined as the worth placed on ecological features (such as species, habitats, processes, ecosystems, community composition) determined by their rarity, vulnerability and role in ecosystem functioning (EIANZ, 2015)

[14] Classifications as listed in: Goodman et al. (2014) for freshwater fish; Robertson *et al.*(2013) for birds; de Lange *et al.* (2013) for plants; Hitchmough *et al.* (2013) for lizards; Sirvid *et al.* (2012) for spiders.

*Table 3: Ecological value of marine avifauna associated with Lyttelton Harbour/Whakaraupō and the wider area.*

| SPECIES | | CLASSIFICATION (H. A. Robertson et al., 2013) | ECOLOGICAL VALUE |
|---|---|---|---|
| Little (white-flippered) penguin | *Eudyptula minor albosignata* | Threatened – Nationally Vulnerable | Very High |
| Yellow-eyed penguin | *Megadyptes antipodes* | Threatened – Nationally Vulnerable | Very High |
| Fairy prion | *Pachyptila turtur* | At Risk – Relict | High |
| Sooty shearwater | *Puffinus griseus* | At Risk - Declining | High |
| Caspian tern | *Hydroprogne caspia* | Threatened – Nationally Vulnerable | Very High |
| White-fronted tern | *Sterna striata* | At Risk - Declining | High |
| Spotted shag | *Stictocarbo p. punctatus* | Not threatened | Low |
| Pied shag | *Phalacrocorax v. varius* | Threatened – Nationally Vulnerable | Very High |
| Little shag | *Phalacrocorax melanoleucos brevirostris* | Not threatened | Low |
| Red-billed gull | *Larus novaehollandiae scopulinus* | Threatened – Nationally Vulnerable | Very High |
| Black-backed gull | *Larus dominicanus* | Not threatened | Low |
| Variable oystercatcher | *Haematopus unicolor* | At Risk - Recovering | High |
| NZ pied oystercatcher | *Haematopus finschi* | At Risk – Declining | High |
| Bar-tailed godwit | *Limosa lapponica baueri* | At Risk – Declining | High |
| Pied stilt | *Himantopus h. leucocephalus* | At Risk – Declining | High |
| Reef heron | *Egretta s. sacra* | Threatened – Nationally Endangered | Very High |
| White-faced heron | *Egretta novaehollandiae* | Not threatened | Low |

# 6.0 Proposal Description

For a full description of the activities, location and methodologies proposed as part of the CDP refer to Section Two (Project Description) of the Assessment of Environmental Effects (AEE).

In summary, LPC is proposing to widen and deepen the existing navigation channel and extend it approximately 4 km beyond the harbour heads (Map 1). A depth of between 16.85 to 17.85 m below chart datum is required for the whole channel. The current channel is approximately 12.2 m below chart datum.

The deepening to serve a 14.5 m draught ship will occur in not less than two stages. If the dredging was undertaken in two stages, and assuming a vessel of around 10,000 $m^3$ is used, each stage would take approximately 9-14 months to complete with a 24 hour 7 days a week operation. Annual maintenance dredging of the channel will also be required.

It is anticipated a trailer suction hopper dredge ('TSHD') will be used for the channel deepening operation (refer to Figure 1) with a cutter suction dredge utilised for isolated areas of stiffer sediment as required. In recent years, two TSHD dredges have been used to maintain the existing channel at Lyttelton.

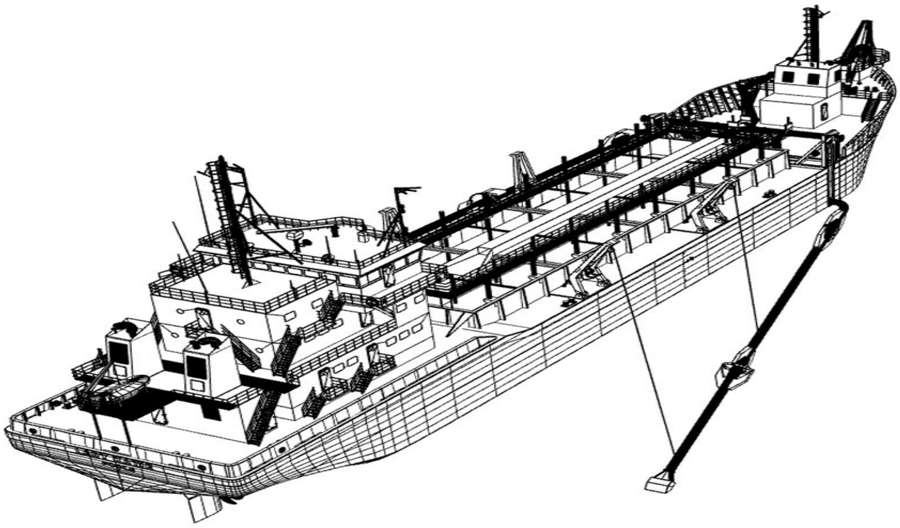

*Figure 1: Schematic diagram of a Trailer Suction Hooper Dredge*

The dredge operation comprises four main phases:

- The 'dredge run' where the dredge vessel deploys the drag head and loads the hopper with slurry;
- Steaming to the disposal ground with a load of slurry;
- Disposing of the slurry within the allocated disposal ground; and
- Steaming back to the channel to commence the next dredge run

This operation is repeated, 24 hours a day until the channel is dredged to the required depth, width and length.

In terms of the maintenance dredging, a new maintenance disposal ground is proposed for the deepened channel. The new ground is located between Godley Head and the capital dredging spoil disposal ground (refer to Map 1). The site is 1.6 km by 1.6 km and is located approximately 2.25 km offshore from Godley Head.

# 7.0 Potential Effects Considered & Assessment Methodology

The following potential adverse effects associated with CDP and associated ongoing maintenance dredging have been considered for the 17 marine avifauna species identified in Table 1:

- Direct effects of <u>disturbance</u> associated with dredging operations;

- Direct effects of bird strike with dredging vessel and equipment;
- Indirect effects of impacts on benthic and fish communities (and therefore food supply);
- Indirect effect on foraging ability due to increased water turbidity associated with dredging operations;
- Both direct and indirect effects associated with pollution.

Each of these potential effects is assessed in Section 8.0. We note that based on the description of the project in Section 6.0 (and Section Two of the AEE), there will be no direct impacts associated with the CDP on land-based habitats of the marine avifauna.

The following matrices have been used to determine the level of ecological effect associated with the CDP. The level of the effect (Table 5) was determined by considering the magnitude of the ecological effect[15] (Table 4) in association with the ecological values (Table 2). This methodology is consistent with the EIANZ guidelines for undertaking ecological impact assessments (EIANZ, 2015). A similar approach was adopted by the seabird experts during conferencing for the Chatham Rock Phosphate marine consents application as outlined in the joint statement of experts.[16]

*Table 4: Criteria for describing magnitude of effect (EIANZ, 2015)*

| MAGNITUDE[15] | DESCRIPTION |
|---|---|
| Very High | Total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR<br>Loss of a very high proportion of the known population or range of the element / feature. |
| High | Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post-development character/ composition/ attributes will be fundamentally changed; AND/OR<br>Loss of a high proportion of the known population or range of the element / feature. |
| Moderate | Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed; AND/OR<br>Loss of a moderate proportion of the known population or range of the element / feature. |
| Low | Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns; AND/OR<br>Having a minor effect on the known population or range of the element / feature. |
| Negligible | Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation; AND/OR<br>Having a negligible effect on the known population or range of the element / feature. |

[15] Magnitude takes both duration and extent of impact into consideration.

[16] Joint statement of experts in the field of seabirds, In the matter of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012, and In the matter of an application under Section 38 of the Act for Marine Consent by Chatham Rock Phosphate Limited, dated 23 September 2014
http://www.epa.govt.nz/eez/EEZ000006/EEZ000006_Joint_Witness_Statement_Seabirds_23_09_2014.pdf

*Table 5: Level of Effect Matrix (EIANZ, 2015)*

| LEVEL OF EFFECT | | Ecological / Conservation Value | | | |
|---|---|---|---|---|---|
| | | **Very High** | **High** | **Moderate** | **Low** |
| Magnitude | **Very High** | Very High | Very High | High | Moderate |
| | **High** | Very High | Very High | Moderate | Low |
| | **Moderate** | Very High | High | Low | Very Low |
| | **Low** | Moderate | Low | Low | Very low |
| | **Negligible** | Low | Very Low | Very Low | Very Low |

# 8.0 Assessment of Effects

## 8.1 Disturbance

A potential adverse effect is that of disturbance to wildlife, by way of both direct impacts (e.g. loss or degradation of habitat – including feeding, flocking, roosting and nesting sites) and indirect impacts (e.g. effective loss of habitat as a result of noise or disturbance). Cook & Burton (2010) report that the frequent flushing caused by shipping movements can lead to a displacement of birds away from the area of dredging, and thus an effective loss of habitat. Furthermore, dredging activities could present a barrier to seabird movements (Cook & Burton, 2010).

*Threatened* and *At Risk* species are generally considered to be more vulnerable to the potential impacts of disturbance due to their small population sizes and / or declining numbers. Also, the magnitude of the adverse effects associated with disturbance activities can be proportional to the extent of habitat or population affected compared to that which remains unaffected. Where habitat loss as a result of disturbance is comparatively minimal, the adverse effects are reduced since any disturbed wildlife are likely to have sufficient alternative available habitat nearby.

### 8.1.1 Assessment of effects for proposal

While nesting (land-based) activity of the Lyttelton marine avifauna species will not be directly affected by dredging operations, there is some potential for dredging operations to interrupt feeding of some species active within the harbour (e.g. penguins, shags, gulls and terns), and for dredged material disposal to interrupt feeding of some species active offshore. However, these species are all highly mobile and have relatively large foraging ranges (refer to Map 3). Furthermore, the Lyttelton Harbour/Whakaraupō currently operates as a shipping channel in which annual maintenance dredging already occurs. Thus, the potential effect of disturbance on these birds is considered to be very low due to the short term nature and restricted spatial extent.

## 8.2 Bird Strike

Cook & Burton (2010) note that dredging activity may, at least initially, attract some seabirds to the area due to the increase in shipping activity. However, this is unlikely to be the case for the Lyttelton dredging proposal given that it is already an active shipping channel in which annual maintenance dredging already occurs.

There is the potential for deck strike associated with vessel lighting as many nocturnally-active seabird species tend to be attracted to, and can be impacted directly by, a wide range of artificial light sources within marine environments (Black, 2005; Fontaine, Gimenez, & Bried, 2011; Le Corre, Ghestemme, Salamolard, & Couzi, 2003; Le Corre, Ollivier, Ribes, & Jouventin, 2002; Miles, Money, Luxmoore, & Furness, 2010; Montevecchi, Rich, & Longcore, 2006; Reed, Sincock, & Hailman, 1985; Rodriguez & Rodriguez, 2009; Rodriguez, Rodriguez, & Lucas, 2012; Wiese et al., 2001). In the case of vessels, it is generally well known that nocturnal bird strikes tend to occur when bright, artificial light sources are used at times of poor visibility, typically during bad weather, often angled outwards or upwards from the vessel and when the vessel is relatively close to large breeding aggregations of seabirds (rather than further offshore). Thompson (2013) reported that the vast majority of the New Zealand deck strikes were of small petrels, typically diving petrels, prions and storm petrels, but also including *Pterodroma* petrels.

Seabird mortalities from collision and entanglement with vessel equipment has been well reported, including warp cable strikes in trawl fisheries (Bull, 2009). Cable strikes may occur when birds are in the air or on the water, and generally increase as a function of aerial extent of the cable (Bull, 2009). Sooty shearwater are among those species which are vulnerable to collisions with vessel structures, as shown by the high numbers of bycatch associated with trawl fisheries in the East Coast South Island fisheries management area (FMA3)[17]. However, we note that seabirds are generally attracted to fishing vessels because they have learnt that vessels are potential sources of food (e.g. discards and bait), and it is this attraction that increases the risk to seabirds of interactions with fishing gear (Bull, 2009).

### 8.2.1 Assessment of effects for proposal

The CDP poses a potential risk through both deck strike associated with lighting and collision with the cables which lower the drag-head to the seabed (see Figure 1).

We note that these potential effects are already present under the current maintenance dredging operations, which uses a similar vessel set up and which operates 24/7. Thus it is the geographic extent and duration of exposure to any such effects which would differ under the CDP (including associated maintenance).

The two species considered potentially at risk, based on their known behaviours (i.e. attraction to light and collision with cables), are sooty shearwater and fairy prion. However, the number of birds exposed to this risk is likely to be extremely low for several reasons. Firstly, unlike fishing vessels, the dredging vessel will not be providing a food source (e.g. discards and bait) thereby reducing the attractiveness of the vessel and the likelihood of interactions with the dredge gear. Furthermore, during the breeding season both species are offshore pelagic feeders with very large foraging

[17] https://data.dragonfly.co.nz/psc/v20121101/birds/trawl/all-vessels/east-coast-south-island/all/

ranges (refer to Section 4.2.1.2). During the winter non-breeding period, the birds move away from the breeding colonies and migrate even greater distances (refer to Section 4.2.1.2), only returning to the area for the subsequent breeding season. Thus, the birds will only be present within the wider Banks Peninsula area during a few months of the year.

Thus, the potential effect of strike is considered to be low for fairy prion and sooty shearwater given that these species: will not be attracted to the dredging vessel as a source of food, have large foraging ranges, generally feeding in waters off the New Zealand continental shelf, and any effect would be of a short term nature (due both to the term of the project and the movement of these species away from the area during the winter months).

Penguin may also be at risk from collision with the submerged section of the cable and drag-head; however, this potential effect is also considered to be a low given the mobile nature and the large foraging area available, as well as the short term nature of the risk.

## 8.3 Food supply

Cook & Burton (2010) reported that the changes to the seabed that occur during dredging operations may alter the composition and abundance of fish species and thereby affect birds. In addition, an increase in suspended sediments in the water column and sedimentation due to dredging has the potential to decrease the abundance and distribution of benthic invertebrate communities which in turn can affect foraging intertidal avifauna.

Distribution, body condition and breeding success of marine avifauna species have been shown to be influenced by the availability of prey in marine and intertidal environments (Crawford et al., 2008; Hobday, 1992; Ropert-Coudert, Kato, & Chiaradia, 2009, p.; Velando, Munilla, & Leyenda, 2005; Henri Weimerskirch, Doncaster, & Cuenot-Chaillet, 1994). These relationships suggest that impacts to benthic communities as a result of dredging would likely to have a negative impact on marine avifauna populations, though effects will be dependent on species' preferred prey and the depth of water at which dredging occurs (Cook & Burton, 2010).

### 8.3.1 Assessment of effects for proposal

While altogether around 280 ha of seabed will be subject to future maintenance dredging, effectively preventing its complete ecological recovery to an undisturbed state, Sneddon et al. (2016) conclude that this is not likely to be significant in terms of the functioning of benthic ecosystems of the wider area. That is to say, there will be no significant effects (in terms of abundance, diversity and quality) on the benthos or shoreline ecology of the Lyttelton Harbour/Whakaraupō and wider Pegasus Bay region (Sneddon et al., 2016). According to Sneddon et al. (2016), local fish populations are expected to be naturally tolerant of elevated suspended sediment levels to some extent; avoidance of areas of particularly high suspended solids is likely to be the principle response of fin-fish species to increasing stress from turbidity plumes which are expected to be spatially limited. Consequently, there should be no discernible difference in the food supply available for the associated marine avifauna.

Even if there were some effects on food supply, these would be restricted both in the temporal and spatial extent associated with the CDP. As discussed earlier, the marine avifauna present within the

Lyttelton Harbour/Whakaraupō and wider Banks Peninsula area are highly mobile with wide geographical foraging ranges (refer to Map 3). Furthermore, a number of studies have reported levels of plasticity in the foraging strategies of seabirds to adjust changes in food availability (T. R. Cook et al., 2012; McCutcheon et al., 2011; Pettex et al., 2012; Saraux et al., 2011; Shaffer et al., 2009; Zimmer et al., 2011). As such, it is likely that any areas in which the foody supply may be affected would be avoided by the birds during that period.

Thus, though not anticipated based on investigations of the benthos or shoreline ecology of the Lyttelton Harbour/Whakaraupō and wider Pegasus Bay region (Sneddon et al., 2016), any potential effects associated with food supply for marine avifauna are determined to be negligible based on the short-term nature of the project and the avifauna's large foraging ranges and ability to adapt their foraging strategies.

## 8.4 Foraging ability

Cook & Burton (2010) purported that most significant effects of marine aggregate dredging for seabirds are likely to be related to the sediment plumes generated during dredging operations, rather than more obvious issues such as disturbance, shipping and damage to the seabed.

Potential effects of the CDP in the Lyttelton Harbour/Whakaraupō include increased sedimentation in the water column (MetOcean Solutions Ltd, 2016b, 2016c, 2016d), which may reduce visibility. Vision has been shown to be an important component in the foraging activity of a number of marine avifauna species including shags, terns and little penguin (Cannell & Cullen, 1998; Essink, 1999). As a result, water clarity may play an important role in the foraging success of these and other species (Cook & Burton, 2010). It is therefore likely that the changes in water clarity resulting from the re-suspension of sediments during dredging and maintenance operations would negatively affect the foraging capabilities of some species. However, the impact of increases in turbidity is likely to be dependent (both in scale and spatial extent) on the initial background levels. The ambient suspended sediment concentrations for three sites within the Lyttelton Harbour/Whakaraupō are provided in Table 6.

*Table 6: Ambient suspended sediment concentrations (SSC) for the Lyttelton Harbour/Whakaraupō (extracted from Table 2.6 of MetOcean Solutions Ltd (2016b))*

| LOCATION | Mean SSC ($mg.L^{-1}$) | Max SSC ($mg.L^{-1}$) |
|---|---|---|
| Lyttelton Port entrance | 17 | 110 |
| Lyttelton Harbour/Whakaraupō | 13 | 38 |
| Lyttelton Harbour/Whakaraupō midway | 18 | 42 |

Preston et al. (2008) noted that the main immediate potential effect of dredging on little penguins in the vicinity of any dredging project will be the increased water turbidity, the extent and concentration of which are likely to vary at any one time and place. Given little penguins are visual predators, it is unlikely they would be able to forage within high turbid (>5 $mg.L^{-1}$) areas of the suspended sediment plume (Preston et al., 2008). On this basis, we note that the current ambient mean suspended sediment concentration (SSC) levels within the Lyttelton Harbour/Whakaraupō are already >5 $mg.L^{-1}$ (see Table 6).

MetOcean Solutions Ltd (2016b, 2016d) report that the majority of the SSC plume generated from the release of spoil from the vessel's hopper will propagate near the bed with a much smaller plumes propagating in the middle of the water column and at the surface. Approximately 27% of the hopper load mass forms the passive plume while the remainder immediately settles to the seafloor. Of this 27%, 1% is in the near surface, 5% in midwater and the remaining 21% is near bed. In the bottom layer, the 10 mg.L$^{-1}$ contour line generally stays within 1 km of the disposal location and within 500 m in the mid-water layer. In the surface layer, SSC plumes are very limited, with typical magnitudes below 10 mg.L$^{-1}$ (MetOcean Solutions Ltd, 2016b).

On average, the 10 mg.L$^{-1}$ threshold is exceeded 10 to 20% of the time in the bottom layer within a radius of ~300 m from the discharge site. In the mid-water level, exceedance times of up to 5% are contained within a 500 m radius and become insignificant past the 1 km radius. The largest SSC threshold of 100 mg.L$^{-1}$ is typically exceeded 5-10% of the time within 100-200 m from the release position in the bottom layer but very rarely in the mid water and surface levels (MetOcean Solutions Ltd, 2016d). The elevated concentrations from disposal activity are quite constrained and the percent of time that background will be exceeded is relatively low (refer to Figure 3.17 in MetOcean Solutions Ltd (2016b)). During a typical event, 45 minutes following disposal the SSC plumes are very compact in the three depth layers and essentially consist of the residual suspended sediment that settled from the surface to mid-water layers or from the mid-water to bottom layer (MetOcean Solutions Ltd, 2016b). The concentrations fields at 120 and 180 minutes show no significant SCC plumes in the surface or mid-water layers, with only very limited SCC patches in the bottom layer due to the settling from the upper levels (MetOcean Solutions Ltd, 2016b).

Within Lyttelton Harbour/Whakaraupō, the plumes generated in association with dredging activities in the channel travel along the axis of the harbour and are expected to be largely constrained to within, or near to, the channel (MetOcean Solutions Ltd, 2016c).

The model does not predict sediment plumes extending to the rocky edges (subtidal or intertidal) of the harbour or outer coast as a result of the dredging (MetOcean Solutions Ltd, 2016c). For the proposed maintenance disposal ground, the extreme extents of the *SSC* plumes and deposition footprints extend towards Godley Head and southeast of Port Levy / Koukourārata, however MetOcean Solutions Ltd (2016d) note that in reality, SSC levels are likely to be well below ambient concentrations and sediment is not expected to settle at or near the shoreline due to the energetic nature of the coastal zone.

Sneddon et al. (2016) note that the most important factor in the tolerance of marine communities to suspended solids and turbidity is the background levels of these parameters to which they are adapted, and that the waters of Lyttelton Harbour/Whakaraupō and inshore Pegasus Bay are naturally turbid with high fine sediment inputs from riverine discharges, run-off and coastal processes.

### 8.4.1 Assessment of effects for proposal

We note that the potential effects of sedimentation in the water column are already present under the current maintenance dredging operations. Under the CDP there will be an increase in the duration and extent of exposure to any such effects.

The model predicts the plume will travel along the axis of the harbour, be largely within, or near to, the channel, and not extend to the rocky edges (subtidal or intertidal) of the harbour or outer coast. Therefore there are unlikely to be any effects on the foraging ability of the intertidal species such as godwit, pied stilt, variable and NZ pied oystercatcher, reef and white faced-heron.

In terms of those species which forage in the top 10 m of the water column, MetOcean Solutions Ltd (2016b) modelling predicts that only 5% of the passive plume will be in mid-water layer, and that the 10 mg.L$^{-1}$ contour line generally stays within 500 m of the disposal location in the mid-water layer. In the surface layer, SSC plumes are predicted to be very limited, with typical magnitudes below 10 mg.L$^{-1}$. Thus, given the predicted levels of SSC within mid-water and surface layers, the restricted location of these plumes, combined with the highly mobile nature of the marine avifauna species and their large foraging ranges, any effects on the foraging ability of those species which forage in the top 10 m of the water column will be short-term and negligible. These species include fairy prion, Caspian tern, white-fronted tern, spotted shag, pied shag, little shag, red-billed and black-backed gulls; all of which have extensive foraging habitat elsewhere within the harbour and beyond (refer to Map 3).

It is those species foraging at greater depths which have the potential to be impacted; these include little penguin, sooty shearwater and yellow-eyed penguin. Given the predicted location and duration of the plume relative to the known breeding locations of the latter two species, and the extensive foraging habitat elsewhere (refer to map 3), any such effects are considered to be negligible.

For little penguin, it is the combination of the foraging behaviours, a near shore (<20 km) visual pursuit forager mostly within 15 m of the surface, and location of breeding birds (particularly in the upper Lyttelton Harbour/Whakaraupō), which makes this species potentially the most vulnerable to impacts on foraging ability associated with sediment plume generated from the CDP activities.

Preston et al. (2008) reported that it was unlikely that little penguin would be able to forage within highly turbid (>5 mg.L$^{-1}$) areas of the suspended sediment plume. As noted earlier, the current ambient mean SSC levels within the Lyttelton Harbour/Whakaraupō already exceed 5 mg.L$^{-1}$ (see Table 6). For the CDP, the modelling predicts that the SSC plumes, while limited in extent and duration, will exceed 10 mg.L$^{-1}$ in the entire water column, mostly confined to within 2m of the seabed (MetOcean Solutions Ltd, 2016b). In the bottom layer, the 10 mg.L$^{-1}$ contour line generally stays within 1 km of the disposal location. Furthermore, MetOcean Solutions Ltd (2016b) note that during typical events, most of the circular near-bed SSC component of the passive plume will settle within 500 m of the release site in the 30-45 minutes following disposal.

The ability of little penguin to forage could be compromised in the water column above the CDP dredging and deposition works. However, the spatial extent of the impacted waters is small relative to the foraging range of little penguin from their nesting sites (refer to Map 3) and the time period that the waters would be more turbid than the ambient levels is limited.

Thus, given the restricted spatial extent and short-term duration of turbidity plumes, and the availability of extensive foraging habitat elsewhere within the harbour and beyond (refer to Map 3), any effects on the foraging ability of little penguin are considered to be low.

## 8.5 Pollution

Marine pollutants include hydrocarbons, heavy metals, hydrophobic persistent organic pollutants and small plastic debris. The location of seabirds at or near the top of the marine food web makes them particularly sensitive to these pollutants (J. Burger & Gochfeld, 2001; Furness & Camphuysen, 1997). Dredging operations can potentially release toxins into the marine environment (Nayar, Goh, & Chou, 2004; Su, Pearlman, Rothrock, Iannuzzi, & Finley, 2002; Sundberg et al., 2007); some toxins can have a range of effects on seabirds, including affecting development, physiology and behaviour, reproductive performance and survival rates (Joanna Burger & Gochfeld, 1993, p. 199; Joanna Burger, Schreiber, & Gochfeld, 1992; Finkelstein et al., 2006; Fry, 1995; Howarth, Grant, & Hulbert, 1982). Pollutants can also affect seabirds indirectly by altering their habitat structure and prey availability.

### 8.5.1 Assessment of effects for proposal

Based on historic and recent sampling of contaminants within the Lyttelton Harbour/Whakaraupō, Sneddon et al. (2016) report that the sediment deposited at the offshore spoil ground will have generally low levels of trace metals and other contaminants.

Any loss of fuel or other materials from the vessels working on the CDP has the potential to adversely affect marine avifauna. However, this potential risk already exists for any vessel operating within the Lyttelton Harbour/Whakaraupō and wider area, including the current maintenance dredging operation. The proposed vessel usage creates no greater risk than other vessels utilising the area.

As such, the potential effect of pollution associated with the CDP on the marine avifauna is considered to be negligible.

## 8.6 Summary of Assessment of Effects

The potential level of effects from the CDP (including the associated maintenance dredging), based on species value and the magnitude[18] of all potential effects identified, are summarised in Table 7 below. For the majority of the marine avifauna species assessed, the level of effect associated with the CDP will be Low or Very Low. This is due to the mobile nature of these species, the relatively large foraging area available, the restricted spatial extent and short term nature of any effects.

The species for which the level of effect may be greatest is the little penguin, for which a moderate level of effect has been determined. This is due to the combination of *Threatened* classification currently assigned to the white-flippered form, its foraging behaviours, location of breeding populations in the upper harbour above the dredging operation and the nature of the potential effects (i.e. potential to impact foraging success and therefore breeding success). However, this effect will be short term as the CDP will be completed within at least two 9-14 month stages.

[18] A determination of the overall magnitude of effect has been made based on all the potential effects considered for each species and the likely outcome of all those combined effects as defined in Table 4.

*Table 7: Summary of assessment of potential effects of the Lyttelton channel deepening project on marine avifauna species of concern.*

| SPECIES | POTENTIAL EFFECT | ECOLOGICAL VALUE[19] | MAGNITUDE[20] | LEVEL OF EFFECT[21] | DURATION OF EFFECT |
|---|---|---|---|---|---|
| Little (white-flippered) penguin | • Disturbance – Very Low<br>• Strike - Low<br>• Food supply - Negligible<br>• Foraging ability – Low<br>• Pollution - Negligible | Very High | Low | Moderate | Short term |
| Yellow-eyed penguin | • Disturbance – Very Low<br>• Strike - Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Very High | Negligible | Low | Short term |
| Fairy prion | • Strike - Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | High | Negligible | Very Low | Short term |
| Sooty shearwater | • Strike - Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | High | Negligible | Very Low | Short term |
| Caspian tern | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Very High | Negligible | Low | Short term |
| White-fronted tern | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | High | Negligible | Very Low | Short term |
| Spotted shag | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Low | Negligible | Very Low | Short term |
| Pied shag | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Very High | Negligible | Low | Short term |
| Little shag | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Low | Negligible | Very Low | Short term |
| Red-billed gull | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Very High | Negligible | Low | Short term |
| Black-backed gull | • Disturbance – Very Low<br>• Food supply - Negligible<br>• Foraging ability – Negligible<br>• Pollution - Negligible | Low | Negligible | Very Low | Short term |

[19] As determined in Table 2 and Table 3.

[20] As defined in Table 4.

[21] As determined in Table 5.

| SPECIES | POTENTIAL EFFECT | ECOLOGICAL VALUE[19] | MAGNITUDE[20] | LEVEL OF EFFECT[21] | DURATION OF EFFECT |
|---|---|---|---|---|---|
| Variable oystercatcher | • Pollution - Negligible | High | Negligible | Very Low | Short term |
| NZ pied oystercatcher | • Pollution - Negligible | High | Negligible | Very Low | Short term |
| Bar-tailed godwit | • Pollution - Negligible | High | Negligible | Very Low | Short term |
| Pied stilt | • Pollution - Negligible | High | Negligible | Very Low | Short term |
| Reef heron | • Pollution - Negligible | Very High | Negligible | Low | Short term |
| White-faced heron | • Pollution - Negligible | Low | Negligible | Very Low | Short term |

# 9.0 Avoid, Remedy & Mitigate

Very few potential adverse effects on marine avifauna associated with the CDP have been identified. As such, given the level and short term nature of the potential effects, mitigation is not anticipated. However, given that the conclusions regarding potential impacts on food supply and foraging ability are based on modelling, it is recommended that these be ground-truthed during the CDP process. If the sediment plumes are found to differ significantly from those predicted by the model, then the need for marine avifauna mitigation would need to be revisited.

In order to minimise any effects of deck strike associated with vessel lights, the following measures are recommended:

- external lighting should be kept to the minimum required for safe operation and navigation; and
- deck lighting, wherever practicable, should be directed downwards and be shielded to reduce light emanating horizontally or vertically from the vessel.

Should marine avifauna strikes with the aerial portion of the cable which lowers the dredge head be observed, then the deployment of bird scaring lines should be investigated. Such devices have been found to greatly reduce warp strike mortalities in a number of trawl fishery operations (Bull, 2009).

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# Appendix 1: Photographs of Lyttelton Harbour/Whakaraupō & the wider area

## WIDER LYTTELTON HARBOUR/WHAKARAUPŌ

*View east towards harbour mouth*

*View west towards upper harbour bays.*

*Typical inner harbour rockwall edge.*

*Rapaki Bay*

*View south towards Quail Island*

*Quail Island coastline utilised by nesting white-flippered penguin*

## WIDER LYTTELTON HARBOUR/WHAKARAUPŌ

*Black-backed gull colony on Mansons Peninsula*

*King Billy Island*

*Mudflats at Governors Bay being utilised by foraging shorebirds.*

*Mudflats at Head of Bay*

*Coastal cliffs along south-eastern edge of inner harbour*

*Diamond Harbour coastal cliffs*

| WIDER LYTTELTON HARBOUR/WHAKARAUPŌ | |
|---|---|
|  *Coastal cliffs of along north-eastern outer harbour* |  *South-eastern coastal hill edge.* |
|  *Outer harbour coastal cliffs at harbour mouth* |  *Spotted shag nesting colony in outer harbour* |
|  *Spotted shag roosting at derelict wharf at western end of Cashin Quay.* | |

| WIDER LYTTELTON HARBOUR/WHAKARAUPŌ | |
|---|---|
| <br>*Rip-rap in front of Lyttelton Port coal yard.* | <br>*Nesting penguin found in rip-rap in front of Lyttelton Port coal yard.* |
| <br>*Proposed offshore disposal site.* | <br>*Proposed offshore disposal site.* |

# Appendix 2: Lyttelton avifauna associated with the marine environment

The OSNZ data presented in the table comprises two atlas squares, which encompass the inner (248, 573) and outer (249, 573) Lyttelton Harbour/Whakaraupō. The list provided is not a complete list of all avifauna species recorded within these squares, but rather only those species for which the primary (dark green) or secondary (light green) habitat preferences are either oceanic or coastal/estuarine environments.

| SPECIES - Robertson et al. 2007 | | CONSERVATION STATUS - Robertson et al. 2013 | | HABITAT | | | OSNZ DATA | | SITE VISITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Freshwater / wetlands | Coastal / Estuary | Oceanic | Inner harbour | Outer harbour | Wider Lyttelton Harbour/Whakaraupō |
| Arctic skua | *Stercorarius parasiticus* | Migrant | Migrant[SO] | | | | x | x | |
| Australasian gannet | *Morus serrator* | Not Threatened | Not Threatened[De Inc SO] | | | | x | x | |
| Black-browed / Campbell Island mollymawk | *Thalassarche impavida* | *At Risk* | *Naturally Uncommon[IE OL]* | | | | | x | |
| Buller's shearwater | *Puffinus bulleri* | *At Risk* | *Naturally Uncommon[OL St]* | | | | | x | x |
| Cape petrel (Snares) | *Daption capense australe* | *At Risk* | *Naturally Uncommon[RR]* | | | | x | x | |
| Giant petrel | *Macronectes* spp. | *At Risk* | *Naturally Uncommon[RR SO]* | | | | x | x | x |
| Fairy prion | *Pachyptila turtur* | *At Risk* | *Relict[RR SO]* | | | | | | |
| NZ white-capped mollymawk | *Thalassarche cauta steadi* | *At Risk* | *Declining[EF RR]* | | | | | x | |
| Skua spp. | *Stercorarius parasiticus* | | | | | | x | x | |
| Sooty shearwater | *Puffinus griseus* | *At Risk* | *Declining[SO]* | | | | | | |
| Wandering albatross | *Diomedea exulans spp* | *Threatened* | *Nationally Critical* | | | | | x | |
| White flippered blue penguin | *Eudyptula minor albosignata* | *Threatened* | *Nationally Vulnerable[CD PD RR]* | | | | x | x | x |
| Asiatic black-tailed godwit | *Limosa limosa melanuroides* | Vagrant | Vagrant[SO] | | | | x | | |
| Banded dotterel | *Charadrius bicinctus bicinctus* | *Threatened* | *Nationally Vulnerable[DP]* | | | | x | | |
| Black-backed gull | *Larus d. dominicanus* | Not Threatened | Not Threatened[SO] | | | | x | x | x |
| Caspian tern | *Hydroprogne caspia* | *Threatened* | *Nationally Vulnerable[SO Sp]* | | | | x | x | x |
| Eastern bar-tailed godwit | *Limosa lapponica baueri* | *At Risk* | *Declining[TO]* | | | | x | x | |
| Lesser knot | *Calidris canutus rogersi* | *Threatened* | *Nationally Vulnerable[TO]* | | | | x | | |
| Red-billed gull | *Larus novaehollandiae scopulinus* | *Threatened* | *Nationally Vulnerable* | | | | x | x | x |
| Reef heron | *Egretta sacra sacra* | *Threatened* | *Nationally Endangered[DP SO Sp St]* | | | | x | x | x |
| Royal spoonbill | *Platalea regia* | *At Risk* | *Naturally Uncommon[Inc RR SO Sp]* | | | | x | x | |
| Spotted shag | *Stictocarbo p. punctatus* | Not Threatened | Not Threatened | | | | x | x | x |

| SPECIES - Robertson et al. 2007 | | CONSERVATION STATUS - Robertson et al. 2013 | | HABITAT | | | OSNZ DATA | | SITE VISITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Freshwater / wetlands | Coastal / Estuary | Oceanic | Inner harbour | Outer harbour | Wider Lyttelton Harbour/Whakaraupō |
| Variable oystercatcher | *Haematopus unicolor* | *At Risk* | *Recovering*[Inc] | | | | x | x | x |
| White-faced heron | *Egretta novaehollandiae* | Not Threatened | Not Threatened[SO] | | | | x | x | |
| White-fronted tern | *Sterna striata* | *At Risk* | *Declining*[DP] | | | | x | x | x |
| Wrybill | *Anarhynchus frontalis* | *Threatened* | *Nationally Vulnerable*[RR] | | | | x | | |
| Black shag | *Phalacrocorax carbo novaehollandiae* | *At Risk* | *Naturally Uncommon*[SO Sp] | | | | x | x | |
| Black swan | *Cygnus atratus* | Not Threatened | Not Threatened[SO] | | | | x | x | |
| Black-billed gull | *Larus bulleri* | *Threatened* | *Nationally Critical*[RF] | | | | x | | |
| Black-fronted tern | *Chlidonias albostriatus* | *Threatened* | *Nationally Endangered*[RF SP] | | | | x | | |
| Feral goose | *Anser anser* | Introduced | Introduced & Naturalised[SO] | | | | x | x | |
| Grey duck | *Anas s. superciliosa* | *Threatened* | *Nationally Critical*[SO] | | | | x | | |
| Grey teal | *Anas gracilis* | Not Threatened | Not Threatened[Inc SO] | | | | x | x | |
| Kingfisher | *Todiramphus sanctus vagans* | Not Threatened | Not Threatened | | | | x | x | |
| Little black shag | *Phalacrocorax sulcirostris* | *At Risk* | *Naturally Uncommon*[RR] | | | | x | | |
| Little shag | *Phalacrocorax melanoleucos brevirostris* | Not Threatened | Not Threatened[Inc] | | | | x | | x |
| Mallard | *Anas platyrhynchos* | Introduced | Introduced & Naturalised[SO] | | | | x | x | |
| NZ pied oystercatcher | *Haematopus finschi* | *At Risk* | *Declining* | | | | x | x | |
| NZ scaup | *Aythya novaeseelandiae* | Not Threatened | Not Threatened[Inc] | | | | x | x | |
| NZ shoveler | *Anas rhynchotis variegata* | Not Threatened | Not Threatened | | | | x | x | |
| Paradise shelduck | *Tadorna variegata* | Not Threatened | Not Threatened | | | | x | x | |
| Pied shag | *Phalacrocorax varius varius* | Threatened | Nationally Vulnerable | | | | x | x | x |
| Pied stilt | *Himantopus h. leucocephalus* | *At Risk* | *Declining*[SO] | | | | x | x | |
| Pukeko | *Porphyrio m. melanotus* | Not Threatened | Not Threatened[Inc SO] | | | | x | x | |


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*Data Sources:* Imagery LINZ

*Projection:* NZGD 2000 New Zealand Transverse Mercator

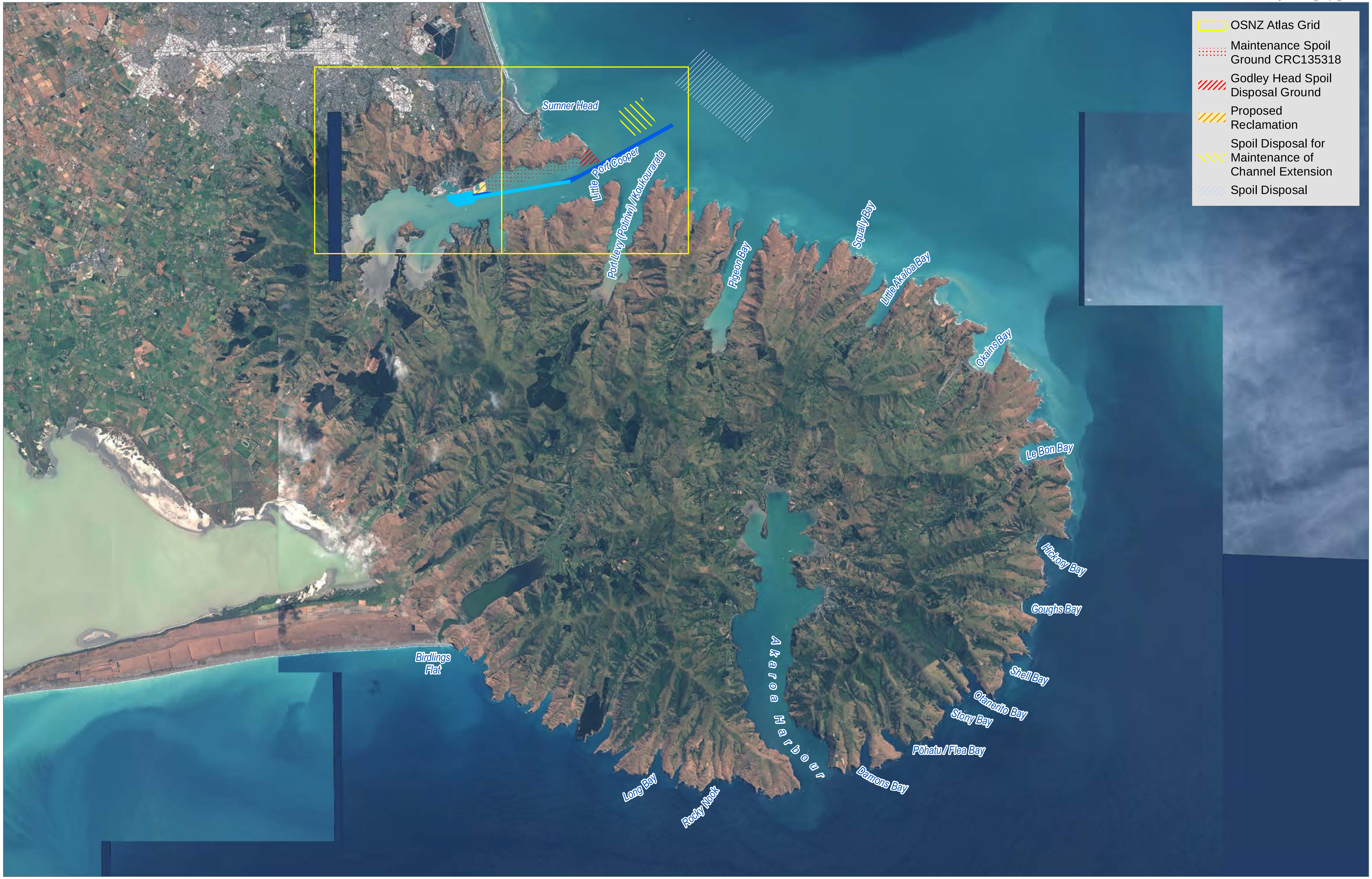
**W15057 LYTTLETON DREDGING - SEABIRD ASSESSMENT**

# MAP 1: LPC CHANNEL DEEPENING PROJECT, LYTTELTON HARBOUR

| **Date: 13 September 2016** | **Revision: 1** |

Plan prepared by Boffa Miskell Limited

*Project Manager:* **leigh.bull@boffamiskell.co.nz** | *Drawn:* MDu | *Checked:* LBu

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*Data Sources:* Imagery LINZ

*Projection:* NZGD 2000 New Zealand Transverse Mercator

**W15057 LYTTLETON DREDGING - SEABIRD ASSESSMENT**

MAP 2: LPC CHANNEL DEEPENING PROJECT, BANKS PENINSULA

**| Date: 13 September 2016 | Revision: 1 |**

Plan prepared by Boffa Miskell Limited

*Project Manager:* **leigh.bull@boffamiskell.co.nz** | *Drawn:* MDu | *Checked:* LBu

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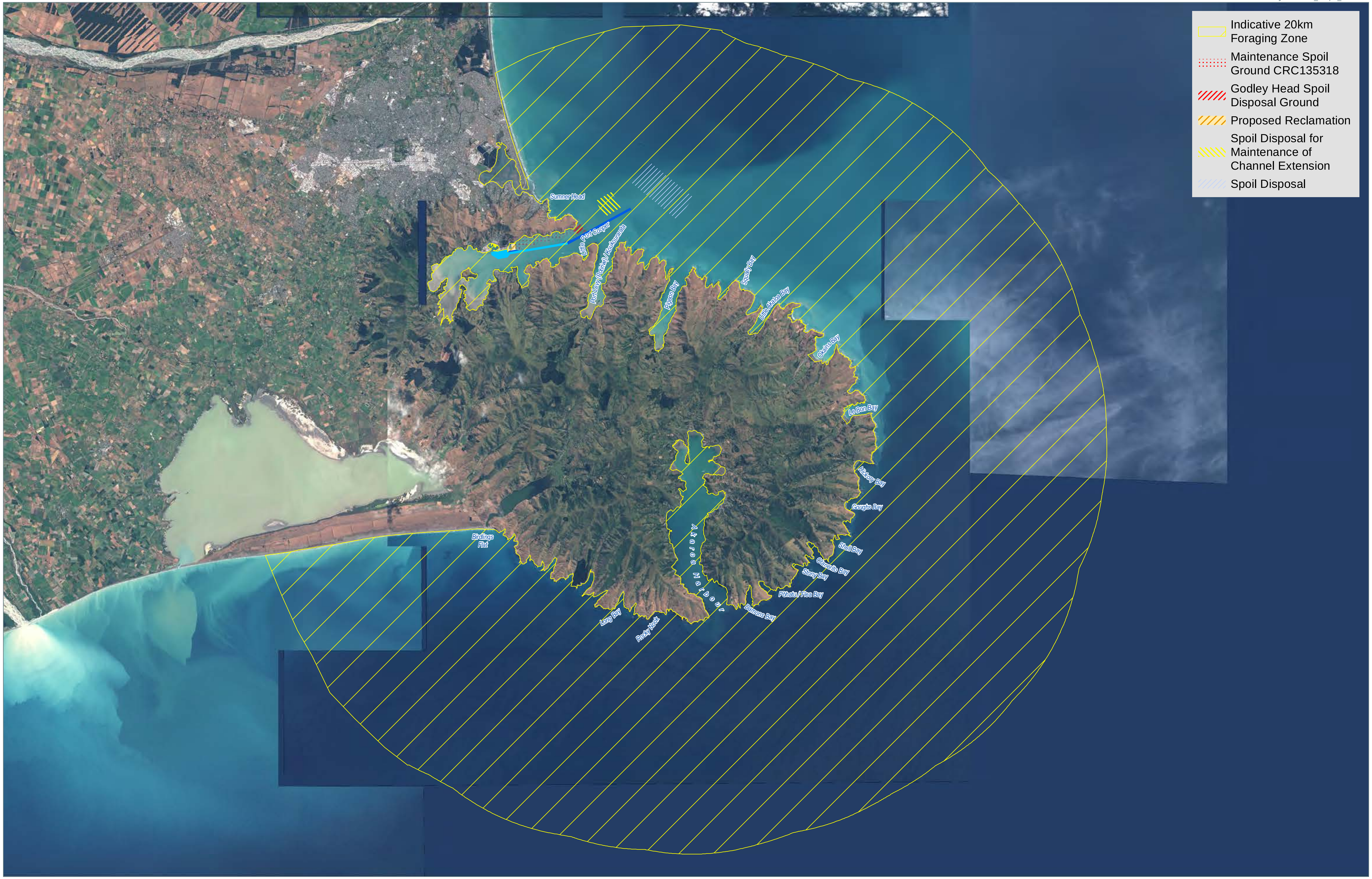


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*Data Sources:* Imagery LINZ

*Projection:* NZGD 2000 New Zealand Transverse Mercator

**W15057 LYTTLETON DREDGING - SEABIRD ASSESSMENT**

MAP 3: LPC CHANNEL DEEPENING PROJECT, INDICATIVE 20KM FORAGING ZONE

**| Date: 13 September 2016 | Revision: 1 |**

Plan prepared by Boffa Miskell Limited

*Project Manager:* **leigh.bull@boffamiskell.co.nz** | *Drawn:* MDu | *Checked:* LBu