Sand Extraction from the Mangawhai-Pakiri Embayment: Assessment of Effects on Seabirds

Prepared for McCallum Brothers Ltd

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Executive summary

This desktop report, commissioned by McCallum Brothers Limited, assesses the potential effects on seabirds and shorebirds of sand extraction from within a proposed new area approximately 1 to 2 km offshore within the Mangawhai-Pakiri embayment located on the east coast of North Island between Cape Rodney and Bream Tail.

The objectives of this assessment were to:

- Summarise the seabird and shorebird assemblage that is likely to occur in the vicinity of the proposed sand extraction area and along the shore adjacent to the proposed sand extraction area
- identify potential effects of sand extraction activity on seabirds and shorebirds, and
- assess the likely impact of potential effects of sand extraction activity on seabirds and shorebirds.

A conservative total of 26 seabird taxa could potentially occur within the area of interest, including 21 taxa (or 81% of all taxa) that are classified as either ‘threatened’ or ‘at risk’ in the New Zealand threat classification system. Additionally, a conservative total of nine shorebird taxa, all classified as either ‘threatened’ or ‘at risk’ could breed or occur regularly along the shoreline adjacent to the proposed sand extraction area.

Physical undermining of the coastline and fuel or oil spills from the sand extraction vessel were considered as potential effects from sand extraction activities that could impact shorebirds. For both potential effects, the impact on shorebirds was considered to be negligible.

All seabird taxa were assessed against four potential effects of sand extraction: interaction with the sand extraction vessel, reduced prey abundance or availability, exclusion from the proposed sand extraction area, and fuel or oil spill from the sand extraction vessel.

Taking account of the conservation status of seabirds, the likely magnitude of potential effects and the overall level or significance of effects, it is concluded that the proposal would have a negligible effect on seabirds generally. It is noteworthy that the greater Hauraki Gulf area supports significant and important populations of seabirds, including some extremely rare and threatened taxa (for example, New Zealand fairy tern). Nevertheless, consideration of particularly sensitive taxa also indicated that while there is potential for deleterious effects to occur, the likelihood of this happening was considered to be extremely small.

1 Background to the report

McCallum Brothers Ltd. (MBL) have dredged sand for more than 75 years from the Mangawhai-Pakiri embayment located on the east coast of North Island between Cape Rodney and Bream Tail. MBL is seeking resource consent to dredge sand from a new area slightly further offshore from an existing consented area within the Mangawhai-Pakiri embayment, in water between 15 and 25 m deep. The proposed consent area, in keeping with the existing consented area, extends northwest and southeast roughly parallel with the shoreline in a ‘band’ centred approximately on Te Arai Point (Figure 1-1). The proposed consent area extends 10.4 km alongshore, with a total extraction area covering 6.6 km^2.

In short, sand extraction activities involve dredging and pumping of a sand slurry from the seabed to a MBL dredge vessel travelling at 2.0-2.5 knots within the proposed extraction area. MBL estimate that the dredge vessel will be able to operate during 99% of days on an annual basis, with dredging proposed to take place at night. Once the vessel’s hopper is full of sand the vessel will return to MBL’s Port of Auckland depot for unloading. A round trip is estimated to take between 16 and 18 hours, with ten to 12 hours spent transiting to and from the proposed sand extraction area.

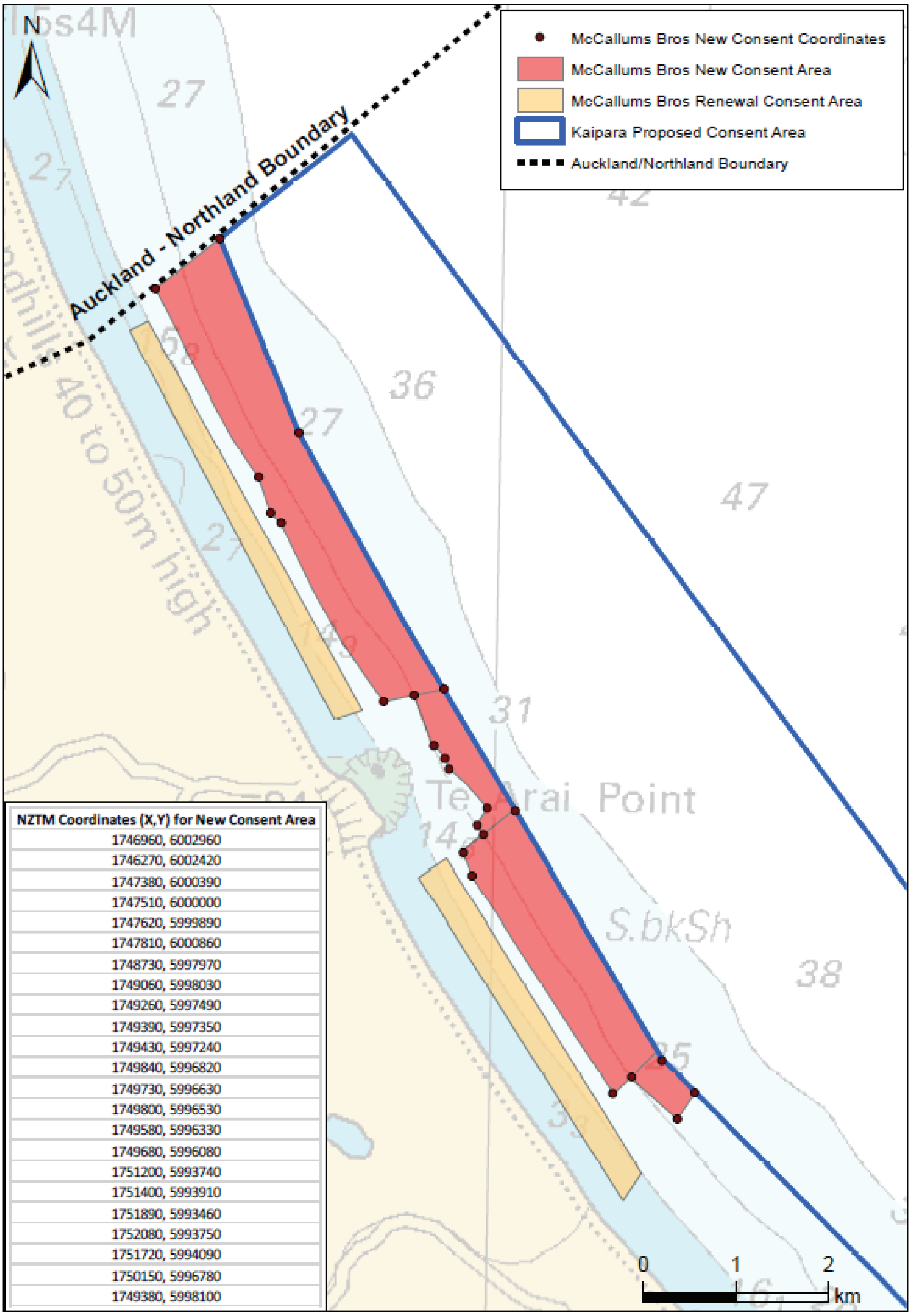

Figure 1-1: **Location of proposed sand extraction area within the Mangawhai-Pakiri embayment, centred approximately on Te Arai Point.**

2 Objectives

The objectives of this report are to:

- Summarise the seabird and shorebird assemblage that is likely to occur in the vicinity of the proposed sand extraction area and along the shore adjacent to the proposed sand extraction area
- identify potential effects of sand extraction activity on seabirds and shorebirds, and
- assess the likely impact of potential effects of sand extraction activity on seabirds and shorebirds.

3 Introduction

3.1 Seabirds: status in New Zealand

In New Zealand, all species of seabirds are protected under the Wildlife Act 1953, except southern black-backed gull *Larus dominicanus*, which can pose a risk of bird strike to aircraft, and a small number of species that are taken as part of traditional harvesting, for example sooty shearwater *Puffinus griseus* and grey-faced petrel *Pterodroma macroptera gouldi*.

Additionally, New Zealand's Department of Conservation (DoC) has developed the New Zealand Threat Classification System (NZTCS; Townsend et al. 2008), which has been used to assign a conservation status to all New Zealand birds, including seabirds and shorebirds, and which is updated regularly (every four years). The most recent application of the NZTCS occurred in 2016 (Robertson et al. 2017). The NZTCS aims to allocate all birds to a conservation status based primarily upon three criteria: 1. a taxon's population size in New Zealand, 2. whether the taxon's population trajectory is upwards, stable or downwards, and 3. the taxon's area of occupancy. Higher conservation status is generally assigned to taxa with relatively small populations that are also declining, and which occupy relatively small areas.

Complementary to the NZTCS, the International Union for Conservation of Nature (IUCN) produces a list of threatened species, known as the 'Red List' (see http://www.iucnredlist.org/). Although the Red List classifications are at the global scale, similar criteria to those used in the NZTCS are applied (in general terms, population size, population trajectory and area occupied). For endemic seabird taxa (i.e., those taxa that only breed within New Zealand), the Red List classifications are broadly similar to those assigned using the NZTCS. For example, the Red List classification for black-billed gull *Larus bulleri* (a New Zealand endemic species) is 'endangered', while the New Zealand conservation status for this species is 'threatened - nationally critical' (Robertson et al. 2017). For taxa that have widespread distributions, or which have relatively large populations outside New Zealand, the Red List classifications are often lower than those assigned using the NZTCS. For example, the Red List classification for Caspian tern *Hydropogne caspia* (a species with a very large distribution and population, and with an overall increasing population trend), is 'least concern', while the NZTCS conservation status for this species is 'threatened - vulnerable', based on a moderate New Zealand population with a declining trend (Robertson et al. 2017). It should be noted that the NZTCS has three 'threatened' classifications and four 'at risk' classifications, whereas the Red List has three 'threatened' classifications but no 'at risk' classifications.

3.2 Seabird diversity in New Zealand and the area of interest

New Zealand supports the most diverse seabird assemblage on Earth. Robertson et al. (2017) listed 168 taxa (species and sub-species) that have been recorded in New Zealand and its Exclusive Economic Zone, including 84 breeding species of which 36 (43%) are endemic (breeding is confined to New Zealand). Not all groups of seabirds are equally represented among New Zealand species: for example, New Zealand is home to a significant number of species of albatrosses, penguins and shags, but supports relatively few species of gulls and terns and no species of auks. Overall, New Zealand's seabird fauna is dominated by taxa in the order Procellariiformes (albatrosses, petrels and shearwaters): Robertson et al. (2017) included a total of 93 procellariiform taxa or 55% of all taxa recorded in New Zealand.

While New Zealand is clearly important to a wide range of seabird taxa, relatively little is known about how seabirds utilise marine resources in both space and time. Seabirds are highly mobile and occupy relatively large, and in the case of many procellariform taxa, extremely large, ranges and have widespread distributions. These attributes make defining the use of a specific area by seabirds, and how this use varies both temporally and in terms of abundance of seabirds, extremely challenging. Ideally, these challenges can be met by structured, systematic and temporally-resolved at-sea observational surveys of seabirds in an area of interest. However, considerable resources are required to undertake such surveys and to date in New Zealand these have been completed only within relatively small spatial extents (see for example Fisher & Boren 2012). The Hauraki Gulf forms part of the North Eastern North Island 'Important Bird Area' for seabirds, based primarily upon seaward extensions of seabird distributions from breeding sites (Forest & Bird 2014). Although there have been no systematic seabird surveys across the Hauraki Gulf or more specifically encompassing the area of interest within the Mangawhai-Pakiri embayment, Gaskin (2017) reported at-sea seabird observations made on an opportunistic basis within the Hauraki Gulf and also included seabird observations in the same region acquired through an aerial survey (as part of the 'Hauraki Gulf Mega-fauna Survey'). Furthermore, Gaskin & Rayner (2013) provided a comprehensive compilation of information relating to seabirds in the Hauraki Gulf, including breeding sites.

Although there is no available definitive list of seabird species occurrence for the area of interest, Table 3-1 includes seabird species that could potentially occur within the area, based upon proximity to breeding sites (Taylor 2000a, b, Gaskin & Rayner 2013), trigger species for the North Eastern North Island 'Important Bird Area' (Forest & Bird 2014), seabird layers resulting from predictive modelling for the Hauraki Gulf Marine Spatial Plan – Sea Change Tai Timu Tai Pari (see http://seachange.org.nz/ and associated metadata), and seabird occurrence information available at New Zealand eBird (see http://ebird.org/content/newzealand/), a publicly-available database of bird sightings. Additional sources of information used in compiling the seabird species that could potentially occur within the area are identified in Table 3-1. It should be noted that the list of taxa in Table 3-1 is conservative and represents the most likely species that could potentially occur at some time in the area of interest. Additional species, not listed in Table 3-1, could occur in the Hauraki Gulf and area of interest from time to time. Furthermore, no assessment has been made of the abundance of particular taxa that could occur in the area of interest, but taxa with relatively large local populations and/or taxa that breed relatively close to the area of interest will be more likely to occur in the area, compared to rare taxa or to taxa that visit the Hauraki Gulf relatively infrequently. No account has been made of temporal variation in occurrence of taxa noted in Table 3-1. However, for some taxa that migrate out of the New Zealand following breeding, occurrence in the area of interest will be strongly seasonal. For example, sooty shearwaters migrate to the northern Pacific Ocean for the austral winter (Shaffer et al. 2006) from approximately June to September, during which time occurrence in the area of interest is highly unlikely.

Table 3-1 includes 26 taxa that could potentially occur within the area of interest. Of these, 21 (81%) breed within the greater Hauraki Gulf (Table 3-1: Gaskin & Rayner 2013, Frost 2017). A total of six 'threatened' taxa are listed: two 'nationally critical' taxa (black-billed gull and New Zealand fairy tern *Sternula nereis davisae*), and four 'nationally vulnerable' taxa (New Zealand storm petrel *Fregetta maoriana,* Caspian tern, black petrel *Procellaria parkinsoni* and flesh-footed shearwater *Puffinus carneipes*). In addition, Table 3-1 includes a further 15 taxa that are classified as one of four 'at risk' categories. Overall, Table 3-1 includes 21 taxa (or 81% of all taxa listed in Table 3-1) that are classified as either 'threatened' or 'at risk' (Robertson et al. 2017). The remainder of taxa listed includes one classified as 'migrant' (Arctic skua *Stercorarius parasiticus*), and four as 'not threatened' (southern black backed gull, Australasian gannet *Morus serrator*, little shag *Phalacrocorax melanoleucos brevirostris* and black-winged petrel *Pterodroma nigripennis*: Table 3-1).

3.3 New Zealand fairy tern

Of the taxa included in Table 3-1, New Zealand fairy tern is arguably New Zealand's rarest and most threatened seabird taxon, confined when breeding to sites north of Auckland. The New Zealand fairy tern is an endemic subspecies to New Zealand and breeds regularly at only four North Island sites: Papakanui Spit (South Head, Kaipara Harbour), Mangawhai and Waipu estuaries, and at Pakiri river mouth, towards the south of the the Mangawhai-Pakiri embayment (Pulham & Wilson 2013). Since 2012, New Zealand fairy terns have also occasionally nested at the Te Arai Stream mouth (Pulham & Wilson 2013), immediately to the west of the proposed consent area. Additionally, Te Arai Stream mouth is well-known as a post-breeding flocking site for New Zealand fairy terns (Preddey & Pulham 2017).

Ismar et al. (2014), citing DoC internal reports, reported an annual average of nine breeding pairs across all sites between 2008-2009 and 2011-2012. Ferreira et al. (2005) estimated a total population of between 30-35 individuals from 2000-2002, whereas Hansen (2006) suggested the overall population numbered 35-40 individuals, a similar total to that noted by Pulham & Wilson (2013). These relatively low population estimates are reflected in the relative abundance score of '1' (less than 250 mature individuals) for this taxon in Table 3-1.

New Zealand fairy terns appear to prefer primarily estuarine and very nearshore foraging habitats, including coastal lagoons and lakes, where they feed on small and juvenile fish and crustaceans (Ismar et al. 2014, Jeffries et al. 2016, Preddey & Pulham 2017). The studies of Ismar et al. (2014) and Jeffries et al. (2016), which recorded the numbers of foraging dives in different habitats, found that only two of 405 dives and 27 of 193 dives occurred in nearshore coastal habitats, respectively.

3.4 Shorebirds adjacent to the area of interest

In addition to the seabird taxa identified in Table 3-1 that could potentially occur in the proposed area for sand extraction, the shoreline immediately adjacent to this area supports breeding or regularly-occurring populations of threatened or at risk shorebirds: typically, but not exclusively, wading birds (waders), which generally feed in the inter-tidal zone, and some of which breed along the coastal fringe (for example, northern New Zealand dotterel *Charadrius obscurus aquilonius* and variable oystercatcher *Haematopus unicolor* (Jeffries et al. 2016)).

Based on data available at eBird, the assemblage of threatened or at risk shorebirds utilising the coast to the west of the area of interest includes: Australasian bittern *Botaurus poiciloptilus* ('threatened – nationally critical'), reef heron *Egretta sacra* ('threatened – nationally endangered'), banded dotterel *Charadrius bicinctus*, lesser knot *Calidris canutus rogersi* and wrybill *Anarhynchus frontalis* (all 'threatened – nationally vulnerable'), eastern bar-tailed godwit *Limosa lapponica baueri* and South Island pied oystercatcher *Haematopus finschi* (both 'at risk – declining'), and northern New Zealand dotterel and variable oystercatcher (both 'at risk – recovering'). All conservation status classifications are provided in Robertson et al. (2017). This list is unlikely to be comprehensive and other taxa of shorebirds could occur along the coast of the Mangawhai-Pakiri embayment from time to time.

Table 3-1: Summary information on the conservation status and relative abundance of seabirds that could occur in the area of interest. Common names marked with * are those taxa that are known to breed within the greater Hauraki Gulf (equivalent to the area identified as the 'Wider Hauraki Gulf Region' by Gaskin & Rayner (2013), and incorporating the Hauraki Gulf Marine Park: see Gaskin & Rayner (2013) for further information on these areas) based on information in Gaskin & Rayner (2013), and Frost (2017). Taxonomy (scientific name) and NZTCS conservation status follow Robertson et al. (2017). Taxa are ranked according to NZTCS conservation status, and then alphabetically by scientific name. IUCN Red List classifications were derived from http://www.iucnredlist.org/ (accessed January 2020). Relative abundance scores follow Townsend et al. (2008), whereby a score of 1 = < 250 mature individuals (defined as an individual capable of reproduction and here calculated as double the best estimate of number of annual breeding pairs for each taxon), 2 = 250-1,000, 3 = 1,000-5,000, 4 = 5,000-20,000, 5 = 20,000-100,000 and 6 = > 100,000 mature individuals. Abundance scores are based on information available at http://nzbirdsonline.org/ (accessed January 2020) and are provided for those taxa that breed in New Zealand. The list of seabirds included here is based primarily on information provided by Taylor (2000a, b), Gaskin & Rayner (2013), Forest & Bird (2014) or available at http://ebird.org/content/newzealand/, together with Robertson et al. (2017), Frost (2017) and references cited within these sources.

Common Name	Scientific Name	NZTCS Conservation Status	IUCN Red List Classification	Relative Abundance
Black-billed gull*	*Larus bulleri*	Threatened – Nationally Critical	Endangered	5
New Zealand fairy tern*	*Sternula nereis davisae*	Threatened – Nationally Critical	Vulnerable	1
New Zealand storm petrel*	*Fregetta maoriana*	Threatened – Nationally Vulnerable	Critically Endangered	2
Caspian tern*	*Hydropogne caspia*	Threatened – Nationally Vulnerable	Least Concern	3
Black petrel*	*Procellaria parkinsoni*	Threatened – Nationally Vulnerable	Vulnerable	3
Flesh-footed shearwater*	*Puffinus carneipes*	Threatened – Nationally Vulnerable	Near Threatened	4
Northern little penguin*	*Eudyptula minor iredalei*	At Risk - Declining	Least Concern	4
Red-billed gull*	*Larus novaehollandiae scopulinus*	At Risk - Declining	Least Concern	5
Sooty shearwater*	*Puffinus griseus*	At Risk - Declining	Near Threatened	6
White-fronted tern*	*Sterna striata*	At Risk - Declining	Near Threatened	5
Northern giant petrel	*Macronectes halli*	At Risk – Recovering	Least Concern	3
Pied shag*	*Phalacrocorax varius*	At Risk – Recovering	Least Concern	3
Pycroft's petrel*	*Pterodroma pycrofti*	At Risk - Recovering	Vulnerable	4
Fairy prion	*Pachyptila turtur*	At Risk - Relict	Least Concern	6
White-faced storm petrel*	*Pelagodroma marina maoriana*	At Risk - Relict	Least Concern	6
Northern diving petrel*	*Pelecanoides urinatrix*	At Risk - Relict	Least Concern	6
Cook's petrel*	*Pterodroma cookii*	At Risk - Relict	Vulnerable	6
Fluttering shearwater*	*Puffinus gavia*	At Risk - Relict	Least Concern	5
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk – Naturally Uncommon	Least Concern	3

Common Name	Scientific Name	NZTCS Conservation Status	IUCN Red List Classification	Relative Abundance
Little black shag	*Phalacrocorax sulcirostris*	At Risk – Naturally Uncommon	Least Concern	3
Buller's shearwater*	*Puffinus bulleri*	At Risk – Naturally Uncommon	Vulnerable	6
Arctic skua	*Stercorarius parasiticus*	Migrant	Least Concern	
Southern black-backed gull*	*Larus dominicanus*	Not Threatened	Least Concern	6
Australasian gannet*	*Morus serrator*	Not Threatened	Least Concern	5
Little shag*	*Phalacrocorax melanoleucos brevirostris*	Not Threatened	Least Concern	5
Black-winged petrel*	*Pterodroma nigripennis*	Not Threatened	Least Concern	6

4 Potential effects of sand extraction at the Mangawhai-Pakiri embayment on avifauna

4.1 Shorebirds

Shorebirds, as their name suggests, primarily occupy the coastal fringe, including when foraging in inter-tidal areas at low tide. Shorebirds rarely occur at sea and are usually encountered flying over open water when travelling between feeding and roosting sites over high tide or when embarking upon larger-scale migratory movements either within New Zealand or when transiting internationally.

For sand extraction operations to affect shorebirds, removal of sand would need to generate physical effects along the shoreline running approximately parallel with the proposed sand extraction area, approximately 1 km offshore. If sand extraction resulted in undermining of the shoreline with loss of shoreline habitat, nesting birds that use the upper shoreline as breeding habitat would be affected. It is worth noting that New Zealand fairy tern also nests in upper shore habitats, above the extreme high-water mark (Pulham & Wilson 2013) and can be grouped with shorebirds in considering this potential effect.

Todd (2019) compiled and assessed coastal process data from within the Mangawhai-Pakiri embayment and concluded that foreshore beach volumes showed positive growth over the last 35-40 years and that while there was some coastal erosion in some places these were the result of coastal processes and could not, with any certainty, be attributable to sand extraction. It would seem reasonable to conclude, therefore, that on the basis of information presented by Todd (2019), sand extraction has a negligible detrimental effect on the physical nature of the coastal fringe and that shorebirds, including New Zealand fairy tern, are similarly negligibly affected.

Shorebirds could potentially be impacted by an unplanned loss of diesel or oil from the sand extraction vessel (this potential effect on New Zealand fairy tern is covered in section 5.3.3 below). For this effect to eventuate, lost fuel or oil would need to reach the adjacent shoreline to the sand extraction area, which in turn would depend upon the type of fuel or oil lost (diesel, for example, is relatively volatile and would, over time, be lost to the atmosphere once released to the sea), the volume of fuel or oil released and the prevailing weather conditions at the time of the release. An offshore wind, for example, at the time of release would result in relatively less fuel or oil reaching the shoreline. Furthermore, the time of year at which a loss of fuel or oil occurred would also influence whether shorebirds were impacted. A substantial loss of fuel or oil that reached the shore and which was transported by wave action relatively high up the shoreline would be more likely to have a detrimental effect on shorebirds during the summer months when birds are breeding. It is possible that under such a scenario nests containing eggs could be coated with fuel or oil. However, even though the Mangawhai-Pakiri embayment supports breeding at-risk shorebirds (for example, northern New Zealand dotterel and variable oystercatcher, Jeffries et al. (2016)), there would likely be sufficient time to position physical barriers to prevent fuel or oil from the sand extraction area reaching nest sites that would be located towards the upper reaches of the beach. Additionally, there is evidence to suggest that even in relatively large fuel or oil-loss events, nearby shorebirds tend not to be impacted. For example, following the grounding of the vessel *Rena* on Astrolabe Reef off

Tauranga in 2011 in which approximately 350 tonnes of heavy fuel oil were released to the marine environment, all 1364 oiled birds collected from Bay of Plenty beaches were seabirds, predominantly common diving petrels *Pelecanoides urinatrix* and fluttering shearwaters *Puffinus gavia* (Miskelly et al. 2012).

Furthermore, significant fuel or oil loss in vessels at sea is a relatively rare occurrence, and the likelihood of this happening during normal sand extraction activities is extremely low. Therefore, I consider the potential impact of fuel or oil loss into the marine environment from a sand extraction vessel on shorebirds to be negligible. As noted above, the potential for fuel or oil loss to affect New Zealand fairy terns is considered below in section 5.3.3. The effects of sand extraction on shorebirds are not considered further in this report.

4.2 Seabirds

Sand extraction could potentially affect seabirds negatively in several ways, both directly and indirectly. Potential effects include: disturbance from routine sand extraction activity, interaction with sand extraction vessels, reduced prey abundance or prey availability within and around the extraction area, exclusion from habitat within the extraction area and effects of spilled fuel or oil from sand extraction vessel(s).

4.2.1 Disturbance

Generally, seabirds are more prone to disturbance at times when they are spatially constrained. For example, seabirds have to spend time at a nest site when breeding and need to spend extended periods of time resting, often at a preferred roost site. Disturbance at these times can result in breeding failure or increased energy expenditure. At other times, seabirds tend to be less constrained in where they occur, and so the potential for disturbance at a specific location within a species' range is reduced.

Among seabirds, it is widely accepted that shags, in general, are particularly susceptible to human disturbance. For example, reduced foraging activity in European shags *Phalacrocorax aristotelis* has been linked to increased boat traffic (Velando & Munilla 2011), and human disturbance at nesting sites is likely limiting population recovery in some double-crested cormorant *Phalacrocorax auritus* populations in western North America (Adkins et al. 2014). In New Zealand, the DoC has proposed buffer zones of 1000 and 500 m around New Zealand king shag *Leucocarbo carunculatus* breeding sites, and roosting sites, respectively (Davidson et al. 1995), in order to minimise disturbance in this particularly disturbance-prone species (Butler 2003, Fisher & Boren 2012).

With respect to the proposed extraction of sand, primarily at night, disturbance from routine operations is likely to have a negligible to non-existent effect on seabirds. The nearest seabird colonies are located at Mangawhai to the north of the extraction area and at Goat Island to the south of the extraction area, with other major seabird colonies at Little Barrier Island to the east and Sail Rock and Taranga Island to the north (Gaskin & Rayner 2013). Although some of these seabird breeding locations are within a few kilometres of the proposed sand extraction area, the presence of the extraction vessel, and the associated noise from that vessel, are very unlikely to have any detrimental disturbance effect on seabirds breeding at the locations noted above.

This potential negative effect is not considered further in this report.

4.2.2 Interaction with sand extraction vessels

The proposed sand extraction activity is to occur at night. Seabirds can be attracted to, and disorientated by, ships' lights (and indeed other artificially-illuminated human structures at sea). It is well known that some seabirds collide with ships and rigs at sea having become attracted to artificial lights, but this tends to be a problem in poor visibility, with lights directed upwards or outwards and when the light source is relatively close to seabird breeding colonies (for example, Black 2005).

Vessels operating at night would necessitate the use of artificial lighting. Several mitigation measures can be employed to minimise the risk of seabird collision, these include: the use of minimal deck lighting (other than that required for safe operations and navigation), which should be directed downwards wherever possible (as opposed to outwards or upwards from the vessel), and screens or blinds over port holes and windows to prevent light spill (see Black 2005).

4.2.3 Reduced prey abundance or prey availability

Sand extraction could potentially and indirectly affect seabird prey abundance by altering the ecology of the seabed and/or the water column within the extraction area. These effects could potentially extend beyond the immediate vicinity of the extraction area, depending on the magnitude of any effect and the prevailing oceanographic conditions. Additionally, increased turbidity in the water column below the extraction vessel, and extending away from the vessel, resulting from the return of unwanted dredged material to the sea, has the potential to reduce the foraging efficiency in diving seabirds that capture prey from the water column or near the seabed (for example, penguins and shags). Although diving seabirds tend to forage during daylight hours, sand extraction is proposed to occur at night and the effects of increased turbidity could 'carry-over' from the previous night's extraction activity into the following day.

Gibbs & Kubale (2019) measured total suspended solids (TSS) and turbidity in the fine sediment plume derived from water discharged from the sand extraction vessel 'Coastal Carrier' at various depths in the water column. Gibbs & Kubale (2019) found that TSS and turbidity levels both fell to ambient levels within 200 m from the point of discharge over a timeframe of a few minutes.

All species of seabirds that are likely to occur in the area of interest have relatively large distributions and have the potential to forage over relatively large areas. Even if water column turbidity levels were sufficient to result in seabirds moving elsewhere to forage it would seem reasonable to conclude that this would have a negligible effect.

4.2.4 Exclusion from habitat

It is possible that some seabird taxa that are active during the night (for example, some species of petrels and shearwaters) will be excluded from the sand extraction area through the presence of the extraction vessel, potentially removing access for seabirds to preferred habitat, or preventing seabirds from foraging efficiently within the extraction area. This would be a significant issue if the proposed extraction area was relatively important for a particular species, either because a seabird relied on prey that were only available at that site or if the area was a significant proportion of the foraging range of a particular seabird. I am unaware of any scientific evidence in support of either of these two scenarios. As noted in 4.2.3, all species of seabirds that occur in the area of interest have relatively large distributions and have the potential to forage over relatively large areas, and so it would seem reasonable to conclude that even complete exclusion from the proposed extraction area would have a negligible effect on seabirds.

4.2.5 Fuel or oil spills from the sand extraction vessel(s)

The accidental spill of diesel, or potentially other fuels or oils, from the sand extraction vessel is relatively unlikely, and in the case of spilled diesel, which is very volatile, will degrade rapidly. Nevertheless, spilled fuel or oil could potentially affect seabirds at sea if they were to come into contact with such spills. The primary direct impacts on seabirds include external effects, such as the contamination of their feathers, and internal toxic effects, which would occur if they were to ingest any spilled material. The detrimental effects of such a spill would be dependent upon, amongst other variables, the scale of the spill, the response to the spill, the movement of the spilled material following the spill (which will be dependent upon weather and sea conditions at the time), and the time of year the spill occurred. Species that are likely to be more at risk from a fuel spill include those that spend a relatively large amount of time on the sea surface or those which dive to capture prey underwater. These would include little penguin *Eudyptula minor iredalei*, diving petrel and all shag species. However, even species of seabird that spend relatively more time flying than those mentioned above could potentially be affected by a spill.

5 Assessment of potential effects on seabirds

5.1 Potential effects considered

Each of the potential negative effects described above (4.2) has been considered for each seabird taxon identified in Table 3-1, except for disturbance (4.2.1). Disturbance of seabirds by routine sand extraction operations is extremely unlikely for the reasons outlined in section 4.2.1.

For each of the remaining potential negative effects, a 'worst-case' approach has been adopted. The effects considered translate to the following potential outcomes affecting seabirds.

5.1.1 Interaction with sand extraction vessel

The effect of an individual seabird becoming disorientated by artificial nocturnal lighting on the sand extraction vessel during any night-time operations and striking the vessel structure resulting in death has been considered further. This potential effect has been considered only for those taxa that are active at night (petrels and shearwaters).

5.1.2 Reduced prey abundance or prey availability

This potential effect considers a reduction in prey abundance or availability within the proposed sand extraction area. Here I consider the extreme scenario whereby the proposed activity affects the proposed sand extraction area such that seabird prey is affected to an extent as to be effectively unavailable to seabirds. In this scenario the effect is analogous to exclusion from the sand extract area (5.1.3).

5.1.3 Exclusion from the sand extraction area

The potential effect here is complete exclusion from the proposed sand extraction area including the water column. Essentially this effect is similar to that described for reduced prey abundance or prey availability above (5.1.2) – seabirds are unable to capture prey from within the sand extraction area and must search for and capture food elsewhere.

5.1.4 Fuel or oil spill

This potential effect considers an individual seabird becoming acutely contaminated through fuel or oil ingestion or through coating of the plumage resulting in death, from an accidental loss of fuel or oil from a sand extraction vessel.

5.2 Assessment process

The assessment methodology is based on that outlined by the Environment Institute of Australia and New Zealand (EIANZ 2015) and is consistent with the EIANZ guidelines for undertaking ecological impact assessments. The methodology involves a four-step process.

Firstly, all taxa are assigned a numerical 'conservation value' on a scale of one to five, where five is equivalent to 'very high' conservation value, and one is equivalent to 'very low' conservation value (Table 5-1). This scoring is based upon the NZTCS conservation status categories (see Robertson et al. 2017), as recommended by EIANZ (2015), and here places greater emphasis on those taxa with 'threatened' classifications (i.e., those taxa classified as 'nationally critical', 'nationally endangered' or 'nationally vulnerable'), which are scored five ('nationally critical'), four ('nationally endangered') and three ('nationally vulnerable'), respectively. All four 'at risk' categories are scored two, with all remaining categories scored one (Table 5-1). Assigning conservation value scores was subjective and does not imply that taxa scored as two or one (low and very low conservation value) are equivalent to ‘no value’. Potentially, taxa of low conservation value may still be at risk of adverse effects, if the magnitude of those effects are relatively large, and require mitigation action.

Table 5-1: Conservation values, numerical equivalents and corresponding NZTCS conservation categories. At risk categories comprise 'declining', 'recovering', 'relict' and 'naturally uncommon'. All remaining categories, here assigned a conservation value of 'Very Low', comprise ‘migrant’, ‘coloniser’ and ‘not threatened’. For further information on the NZTCS see Townsend et al. (2008).

Conservation Value	Numerical Equivalent	NZTCS Conservation Status
Very High	5	Threatened – Nationally Critical
High	4	Threatened – Nationally Endangered
Medium	3	Threatened – Nationally Vulnerable
Low	2	At Risk – all categories
Very Low	1	All remaining categories

Secondly, the magnitude of the potential effect is assigned a numerical score also on a scale of one to five, where five is equivalent to a ‘very high/severe’ magnitude, whereby an effect would result in the loss of a very high proportion of the known population or range of a taxon, and one is equivalent to a ‘negligible’ magnitude, whereby an effect would result in a similarly negligible effect on the population or range of a taxon (Table 5-2).

Table 5-2: Magnitude of effect categories, numerical equivalents and corresponding descriptions (EIANZ 2015).

Magnitude of Effect	Numerical Equivalent	Description
Very high/severe	5	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	4	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate/medium	3	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low/minor	2	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature.

Magnitude of Effect	Numerical Equivalent	Description
Negligible	1	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.

Thirdly, a level of effect matrix is constructed whereby conservation value scores are multiplied by magnitude of effect scores to produce level of effect scores (Table 5-3). For example, the level of effect score would be 25 when a taxon with a conservation value score of five (conservation status of 'threatened – nationally critical') was affected by some effect with a magnitude score also of five ('very high/severe' magnitude). The matrix of level of effects produced scores ranging from one to 25, but not all values in this range could be produced. Level of effect scores of 1-3 represent 'very low' levels of effect, 4-5 represent 'low' levels of effect, 6-9 represent 'moderate' levels of effect, 10-12 represent 'high' levels of effect and 15-25 represent 'very high' levels of effect. Again, this assignment was subjective, but results in a 'balanced' outcome in that 40% of possible levels represent 'very low' or 'low' levels of effect, 20% represent 'moderate' levels of effect, and 40% represent 'high' or 'very high' levels of effect.

Table 5-3: Levels of effect matrix. Levels are the product of the conservation value (see Table 5-1) and magnitude of effect (see Table 5-2). Scores of 1-3 (yellow) represent 'very low' levels of effect, scores of 4-5 (purple) represent 'low' levels of effect, scores of 6-9 (blue) represent 'moderate' levels of effect, scores of 10-12 (green) represent 'high' levels of effect and scores of 15-25 (red) represent 'very high' levels of effect. In this matrix, 40% of outcomes (scores) represent 'very low' or 'low' levels of effect, 20% represent 'moderate' levels of effect and 40% represent 'high' or 'very high' levels of effect. See also Table 5-4.

	Magnitude of Effect				
Conservation Value	**5**	**4**	**3**	**2**	**1**
5	25	20	15	10	5
4	20	16	12	8	4
3	15	12	9	6	3
2	10	8	6	4	2
1	5	4	3	2	1

Finally, and fourthly, each taxon is assessed against each of the four potential effects: a taxon's conservation value score is multiplied by the magnitude of effect score for a particular potential effect to produce a level of effect score. Level of effect scores for all taxa and potential effects are presented in Table 5-4.

For all taxa, the assessment was based on the potential effects impacting the New Zealand population, primarily because it is at this scale that the New Zealand conservation status of taxa is considered.

Table 5-4: Assessment of seabird taxa against identified potential effects. Seabird taxa likely to occur in the area of interest and corresponding NZTCS conservation status (from Table 3-1), NZTCS conservation value (from Table 5-1 and shaded yellow), magnitude of effects (M, from Table 5-2 and shaded green) and level of effects (L, from Table 5-3 and shaded blue), level of effect being the product of conservation value and magnitude of effect. NA: not assessed.

Common Name	NZTCS Conservation Status		Conservation Value	Vessel Interaction		Reduced Foraging		Exclusion		Fuel or Oil Spill	
				M	L	M	L	M	L	M	L
Black-billed gull		Nationally Critical	5	NA	NA	1	5	1	5	1	5
New Zealand fairy tern		Nationally Critical	5	NA	NA	1	5	1	5	4	20
New Zealand storm petrel	Threatened	Nationally Vulnerable	3	2	6	1	3	1	3	2	6
Caspian tern		Nationally Vulnerable	3	NA	NA	1	3	1	3	1	3
Black petrel		Nationally Vulnerable	3	1	3	1	3	1	3	1	3
Flesh-footed shearwater		Nationally Vulnerable	3	1	3	1	3	1	3	1	3
Northern little penguin		Declining	2	NA	NA	1	2	1	2	1	2
Red-billed gull		Declining	2	NA	NA	1	2	1	2	1	2
Sooty shearwater		Declining	2	1	2	1	2	1	2	1	2
White-fronted tern		Declining	2	NA	NA	1	2	1	2	1	2
Northern giant petrel		Recovering	2	1	2	1	2	1	2	1	2
Pied shag		Recovering	2	NA	NA	1	2	1	2	1	2
Pycroft's petrel		Recovering	2	1	2	1	2	1	2	1	2
Fairy prion	At Risk	Relict	2	1	2	1	2	1	2	1	2
White-faced storm petrel		Relict	2	1	2	1	2	1	2	1	2
Northern diving petrel		Relict	2	1	2	1	2	1	2	1	2
Cook's petrel		Relict	2	1	2	1	2	1	2	1	2
Fluttering shearwater		Relict	2	1	2	1	2	1	2	1	2
Black shag		Naturally Uncommon	2	NA	NA	1	2	1	2	1	2
Little black shag		Naturally Uncommon	2	NA	NA	1	2	1	2	1	2
Buller's shearwater		Naturally Uncommon	2	1	2	1	2	1	2	1	2
Arctic skua		Migrant	1	NA	NA	1	1	1	1	1	1
Southern black-backed gull		Not Threatened	1	NA	NA	1	1	1	1	1	1
Australasian gannet	Other Categories	Not Threatened	1	NA	NA	1	1	1	1	1	1
Little shag		Not Threatened	1	NA	NA	1	1	1	1	1	1
Black-winged petrel		Not Threatened	1	1	1	1	1	1	1	1	1

5.3 Assessment of effects results

5.3.1 Interaction with sand extraction vessel

Level of effect scores of one to three were determined for all but one taxon when considering the effect of death of a single bird through collision resulting from attraction to nocturnal lighting, corresponding to 'very low' levels of effect (Table 5-4). The death of a single bird would have a negligible effect at the population level. The exception for this effect was New Zealand storm petrel, where the magnitude score for this effect was conservatively considered to be two (Table 5-2), resulting in a 'moderate' level of effect score of six (Table 5-4). The only known breeding site for this species is Little Barrier Island (Gaskin & Rayner 2013), so while it is possible that birds could range to the west of Little Barrier Island to the area of interest, the majority of at-sea sightings of New Zealand storm petrel to date have been predominantly in the outer Hauraki Gulf area, to the north and northeast of Little Barrier Island (see http://ebird.org/content/newzealand/). Conservatively, the death of a single bird through collision would have an effect at the level of the population that might extend to 'minor' magnitude if the individual killed was a particularly productive breeding bird. However, the New Zealand storm petrel population is thought to number hundreds, possibly thousands, of birds (Gaskin 2013), so a magnitude score of two resulting in a level of effect score of six might be over-estimating the collision effect.

However, standard mitigation measures to reduce light spill from vessels operating at night, including reducing deck lighting to the minimum required for safe vessel operation and navigation, directing lighting downwards, as opposed to outwards or upwards, from the vessel and shielding port holes and windows with blinds wherever practicable, will serve to reduce the risk of this effect.

5.3.2 Reduced foraging and exclusion

For both the 'reduced foraging' and 'exclusion' effects, all taxa scored one for magnitude of effect (Table 5-4). Reducing prey availability or eliminating foraging completely (exclusion) from a 6.6 km^2 area where sand extraction could occur is likely to have a negligible effect on seabirds, since all taxa have ranges and distributions that greatly exceed the area of the proposed extraction area. Of note here is whether seabirds would be completely excluded from foraging within the sand extraction area. Since sand extraction is proposed to occur at night, it is possible that some seabird taxa could forage in the area during daylight hours. Magnitude of effect scores of one for all taxa for the 'reduced foraging' and 'exclusion' effects (Table 5-4) resulted in level of effect scores of one to five (reflecting conservation value scores), equivalent to low or very low level of effects (Table 5-4).

5.3.3 Fuel or oil spill

The effect of an accidental diesel spill, or other fuel or oil spill, resulting in the death of a single individual was considered to be of magnitude one ('negligible': Table 5-2) for all but two taxa, resulting in level of effect scores from five to one, 'low' or 'very low' levels of effect (Table 5-4). As for the collision effect from nocturnal lighting, the death of a single bird would have a negligible effect at the population level. New Zealand storm petrel was assigned a magnitude score of two ('low/minor', having a minor effect on the known population) for this effect, resulting in a 'moderate' level of effect score of six (Table 5-4). See section 5.3.1 for further discussion on New Zealand storm petrel and the likelihood that an individual bird would be close to the area of interest. New Zealand fairy tern was assigned a magnitude score of four ('high', potentially resulting in the loss of a high proportion of the known population) for this effect, resulting in a 'very high' level of effect score of 20 (Table 5-4). The relatively elevated magnitude score of four is based on the less than 12 breeding pairs (Pulham & Wilson 2013), with the death of a single bird representing a significant proportion of the New Zealand population, especially so if that individual happened to be a productive breeding bird. While the death of a single New Zealand fairy tern would be detrimental to the population, and by extension the deaths of multiple individuals more so, it is reasonable to conclude that the likelihood of this effect occurring (i.e., a relatively significant loss of fuel or oil into the marine environment) is relatively small, which would coincidentally also apply to all other vessels operating throughout the area specifically and the Hauraki Gulf more generally. Therefore, while this effect could potentially have a large level of effect for New Zealand fairy tern, there is an extremely low likelihood of the effect occurring.

5.4 Potential effects on seabirds – conclusions

The greater Hauraki Gulf area supports significant and important populations of seabirds, including some rare and threatened taxa that occur relatively close to the proposed sand extraction area. Considering the results of the assessment of a range of potential effects taking account of the conservation status of seabirds, the likely magnitude of potential effects and the overall level or significance of effects, it is concluded that the proposal would have a negligible effect on seabirds. Consideration of particularly sensitive taxa also indicated that while there is potential for deleterious effects to occur, the likelihood of this happening was considered to be extremely small.

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