ASSESSMENT OF EFFECTS ON MARINE MAMMALS

Oceania Dairy Limited - Wastewater Ocean Outfall

Prepared for:

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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1 Introduction

Oceania Dairy Limited (**ODL**) owns and operates a milk processing plant that is located 4 km north of Glenavy in South Canterbury (**Figure 1**). The factory produces whole- and infant-milk powders, ultra-high temperature milk, and anhydrous milk fat products and began operating in 2014.

The ODL factory produces both ‘clean’ and ‘factory’ wastewater streams at a rate of 1,740 m^3 per day that is currently discharged to land (via irrigation). However, ODL has struggled to meet its wastewater discharge consent conditions during winter and spring and there are also plans to expand their production. These plans of growth include the generation of greater volumes of wastewater than what is currently allowed under ODL’s current resource consent for irrigation disposal. On this basis, as part of the expansion, and to mitigate non-compliance issues with the existing consent conditions, ODL has had to seek alternative options for the discharge of factory wastewater and is proposing to install an ocean outfall into the Pacific Ocean to discharge up to 10,000 m^3 of factory wastewater per day.

To undertake both the installation of the outfall and discharge of wastewater into the Coastal Marine Area (**CMA**), ODL require a discharge permit from Environment Canterbury (**ECAN**). ODL are currently undertaking a number of studies into the potential environmental effects from the wastewater discharge and will submit a Coastal Permit application in accordance with the Resource Management Act, 1991 (**RMA**) to construct and install the outfall structure and discharge the wastewater into the CMA.

SLR Consulting NZ Limited (**SLR**) has been engaged to evaluate the potential effects of the proposed ocean outfall discharge on marine mammal populations and marine mammal habitat in the vicinity of the outfall (**Figure 1**). This Assessment of Effects will be submitted as part of the Coastal Permit application to ECAN and is structured as follows:

Section 2: Project Description;

Section 3: Description of Marine Mammal Populations and Habitat;

Section 4: Assessment of Potential Effects on Marine Mammals;

Section 5: Summary; and

Section 6: References.

Figure 1 Location of the Oceania Dairy Limited Factory and Proposed Ocean Outfall

2 Project Description

The ODL factory produces the following two wastewater streams:

- 'Clean' wastewater (principally condensate) which comes from the evaporation of liquid in the milk powder process, truck wash activities and general outside water use. This wastewater stream typically has low levels of contaminants; and
- 'Factory' wastewater which comes from cleaning the factory equipment and includes milk residues and cleaning products. This wastewater stream has a pH that deviates significantly from neutral (alkaline), harbours the majority of contaminants (phosphorus, nitrogen, sodium) and generates a high oxygen demand in the receiving environment.

Both 'clean' and 'factory' wastewater streams are currently discharged to land (via irrigation). However, ODL now has plans to expand their production and expand the factory. These plans will result in the generation of greater volumes of wastewater than allowed under ODL's current consents for irrigation disposal. In addition, during winter and spring, when the soils are waterlogged and ponding occurs, and there is a limited availability of clean-water to 'flush' the irrigation lines, ODL has struggled to meet its wastewater discharge consent conditions. There is a lack of available land nearby to expand the wastewater irrigation scheme for future factory stages, which is what has prompted ODL to seek alternatives for the discharge of the wastewater from the factory.

Following an assessment of alternatives, as part of future growth for the factory, and to mitigate the non-compliance issues during winter and spring, ODL's preferred discharge option is a pipeline and ocean outfall to the Pacific Ocean of Archibald Road (as illustrated in **Figure 1**).

The proposed outfall will comprise of a 300-450 mm diameter pipeline from the factory to the coastline and will then extend offshore as a 500 m long submerged outfall, so the total length from the factory to the end of pipe will be approximately 7.5 km long. Three diffusers will radiate from the end of the submerged outfall pipe and will discharge the 'clean' wastewater and 'factory' wastewater into the ocean.

The water depth at the diffusers will be approximately 8 m and the outfall will be designed to discharge up to 10,000 m^3 of wastewater per day (116 L/s). Stormwater and sewage from the factory will be handled by separate systems and will not be discharged to sea.

'Clean' wastewater will not be treated prior to discharge; however, 'factory' wastewater discharged via the ocean outfall will be subject to the following treatment regime on the factory premises prior to discharge into the marine environment:

- Primary treatment with Dissolved Air Flotation (**DAF**) to remove fats and suspended matter;
- Secondary treatment with biological reactor tanks (aerobic and anaerobic) to remove organic and nutrient constituents;
- Tertiary treatment to filter the effluent (most likely using membrane systems); and
- Finally, ultraviolet (**UV**) treatment will be used as an added precaution to guarantee no detectable bacteria in the discharge.

The target water quality values for treated wastewater from the proposed ocean outfall are provided in **Table 1,** and modelling predicts that a dilution of >300x occurs within a 10 - 50 m radius depending on oceanographic conditions (Mead et al., 2019). Hence for the purpose of this assessment a 'mixing zone' of 50 m has been used around each diffuser as indicated in **Figure 2**. **Table 1** also indicates the expected concentration of each of the parameters after reasonable mixing in calm conditions and compares this to the Water Quality Guidelines as described in Babbage (2019).

The surf-zone and near shore section of the submerged outfall will be installed via micro-tunnelling or a similar trenchless technique. The extent of marine works for the installation of the rest of the outfall and diffusers is yet to be decided, but will be either 1) underwater trenching with suction dredging, or 2) the use of a self-trenching anchor. The installation of the diffusers will most likely be handled by a team of commercial divers working from a moored barge over a period of days to weeks. No temporary structures, pile driving or explosives will be required during the construction phase.

Figure 2 Cumulative Mixing Zones in Relation to the Three Diffusers

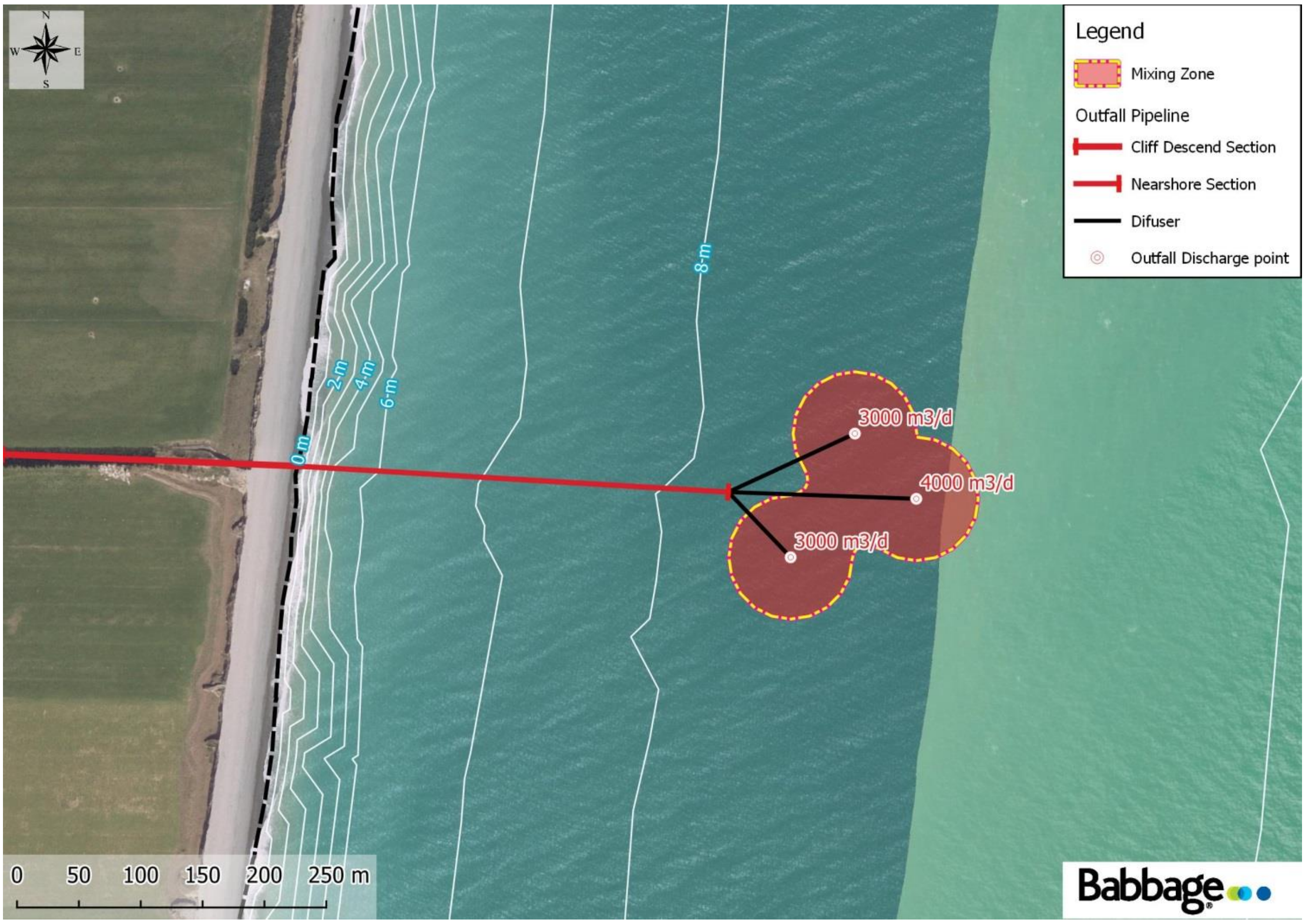


Table 1 Target Water Quality Parameters for Treated Wastewater and their Expected Concentration following Reasonable Mixing in Calm Conditions

Parameter	Discharge Target - Median	Discharge Target - 95th Percentile	Guideline limit as described in Babbage (2019)	Expected conc. following reasonable mixing in calm conditions
Chemical Oxygen Demand (**COD**)	150 g O_2/m^3	300 g O_2/m^3	-	<1 g O_2/m^3
Biological Oxygen Demand (**BOD**)	30 g O_2/m^3	50 g O_2/m^3	<2 g O_2/m^3	<1 g O_2/m^3
Total Suspended Solids (**TSS**)	50 g/m^3	70 g/m^3	35.8 g/m^3	17 g/m^3
Total Nitrogen	15,000 mg N/m^3	20,000 mg N/m^3	260 mg N/m^3	230 mg N/m^3
Nitrate-N	10,000 mg N/m^3	15,000 mg N/m^3	79 mg N/m^3	67 mg N/m^3
Dissolved Inorganic Nitrogen (**DIN**)	12,000 mg N/m^3	15,000 mg N/m^3	91 mg N/m^3	**94 mg N/m^3**
Ammonium-N	< 2,000 mg N/m^3	4,000 mg N/m^3	15.6 mg N/m^3	14.6 mg N/m^3
pH	Range of 7-9			-
Total Phosphorus	2,000 mg P/m^3	4,000 mg P/m^3	37 mg P/m^3	29 mg P/m^3
Dissolved Reactive Phosphorus (**DRP**)	2,000 mg P/m^3	4,000 mg P/m^3	9 mg P/m^3	**11 mg P/m^3**
Arsenic	<50 mg/m^3		50 mg/m^3	*
Cadmium	<2 mg/m^3		2 mg/m^3	*
Chromium	<50 mg/m^3		50 mg/m^3	*
Copper	<10 mg/m^3		5 mg/m^3	**
Lead	<5 mg/m^3		5 mg/m^3	*
Nickel	<15 mg/m^3		15 mg/m^3	*
Zinc	<100 mg/m^3		50 mg/m^3	**

Bold text indicate exceedances of guideline values

** Uncalculated, but even undiluted discharge will meet guideline limits*

*** Uncalculated, but the guideline limits will be met after two-fold dilution (much less than will actually occur)*

Source: Babbage (2019)

3 Description of Marine Mammal Populations

Knowledge of marine mammal distribution is typically amassed over long temporal periods using a combination of data collection techniques (e.g. stranding data, opportunistic sightings and systematic survey data). For this reason, it is important to assess multiple data sources when considering marine mammal distribution in any one location. For the purpose of this impact assessment the following data sources were used:

- Sightings data from the vicinity of the proposed outfall as recorded in the Department of Conservation (**DOC**) Marine Mammals Sightings Database;
- Stranding data from the coastline surrounding the proposed outfall as recorded in the DOC Marine Mammals Stranding Database; and
- Knowledge of migration paths and habitat preferences of each species which overlap with or are in close proximity to the outfall (obtained from published literature).

Despite these data sources representing the best possible information, it is important to note that a) data gaps in sighting data do not necessarily indicate an absence of cetaceans, but typically reflect a lack of observation effort; and b) although stranding data gives a broad indication of species occurrence, dead animals can wash ashore well away from where they died; and prior to death, sick or diseased animals may be outside their normal distributional range.

A preliminary evaluation of these data sources highlighted that Hector's dolphins were the primary species that regularly utilises waters in the vicinity of the proposed outfall. Hence, for the purpose of this project an Area of Interest (**AOI**) has been defined to encompass the home range of this species: 50 km alongshore to the north and south (following Rayment et al., 2009), and 25 nm (~47 km) offshore (following Mackenzie and Clement, 2016). This broader AOI also ensures that other species that may occasionally come into contact with the proposed outfall can also be identified and their presence in the mixing zone can be assessed in context of their wider habitat use.

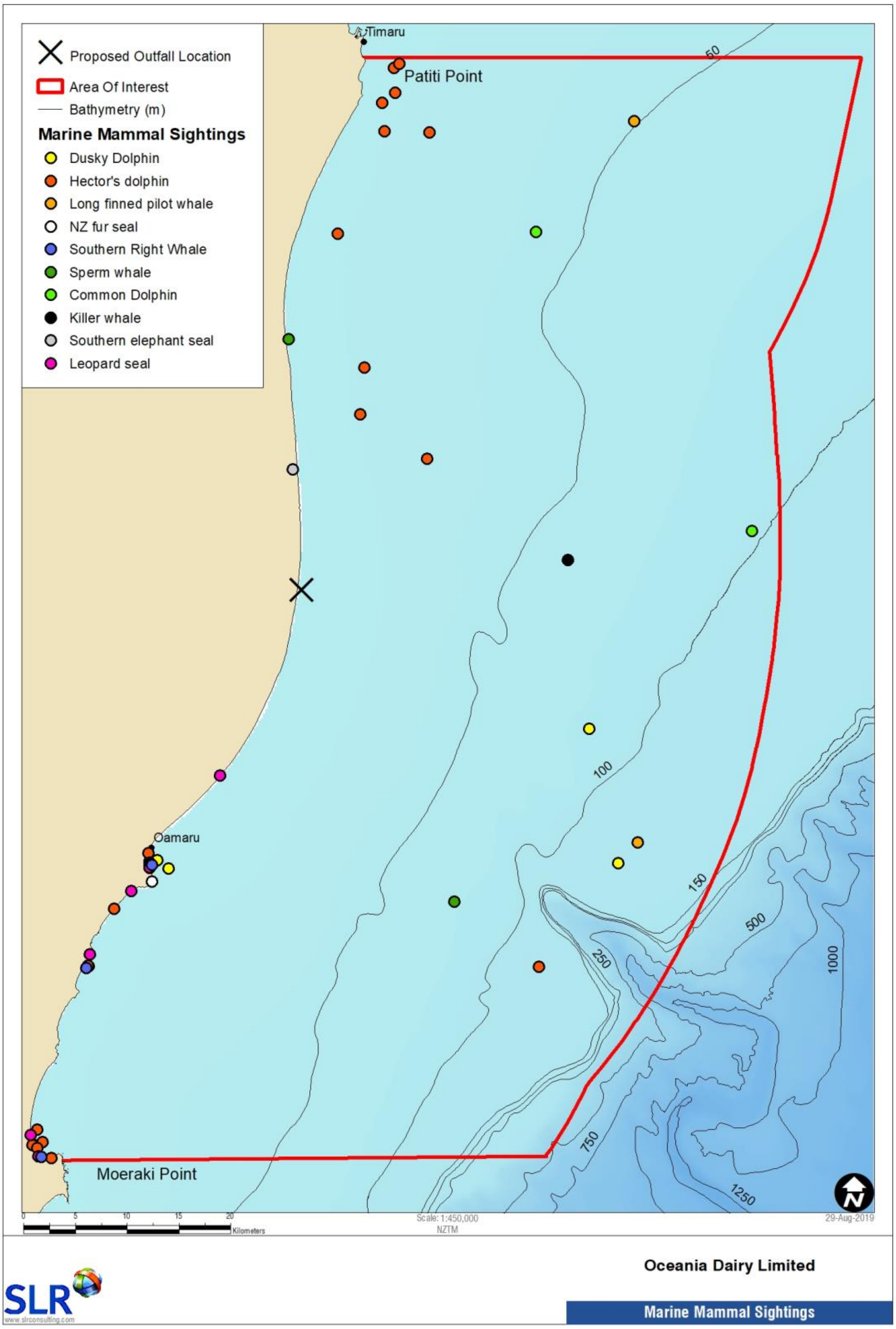
The extent of the AOI, which extends from Patiti Point to Moeraki Point, is illustrated in **Figure 3**, along with a summary of all marine mammal sightings from the DOC Marine Mammal Sightings Database within the AOI. **Figure 4** provides a summary of the DOC stranding records within the AOI, and **Table 2** summarises sightings and stranding data for all species and predicts the likelihood of each species being present in the immediate vicinity of the outfall (i.e. within the 50 m mixing zone).

Our assessment predicted that only two species, Hector's dolphins and New Zealand fur seals, were likely to be frequently present in the immediate vicinity of the proposed outfall. For Hector's dolphins this conclusion is based on the relatively high number of sightings (23) and strandings (20) for this species in the AOI (**Table 2**), coupled with the fact that this species demonstrates an inshore distribution (Slooten et al., 2006) with a preference for shallow turbid waters (Brager et al., 2003). The significance of Hector's dolphins in the area is also reinforced by the reported presence of calves (from four of the 23 sighting records) and that this species is considered as 'Nationally Vulnerable' under the New Zealand Threat Classification System (Baker et al., 2019).

The reporting level for New Zealand fur seal sightings and strandings within the DOC databases is an underestimate as this species is commonly observed on the shoreline and in coastal waters yet opportunistic sightings are not typically reported to DOC on account of their relative frequency. Although fur seals typically forage in deeper waters of the continental shelf and shelf break (Page et al., 2005), they regularly transit through the inshore coastal zone on their way to and from breeding colonies and haul-out locations. The closest breeding colonies to the AOI are Moeraki to the south and Banks Peninsula to the north (Baird, 2011); however, New Zealand fur seals commonly haul-out at rocky headland locations along the coastline of the AOI (e.g. Cape Wanbrow and Lookout Bluff) (ORC, 2012). The New Zealand fur seal is listed as 'Not Threatened' by the New Zealand Threat Classification System (Baker et al., 2019).

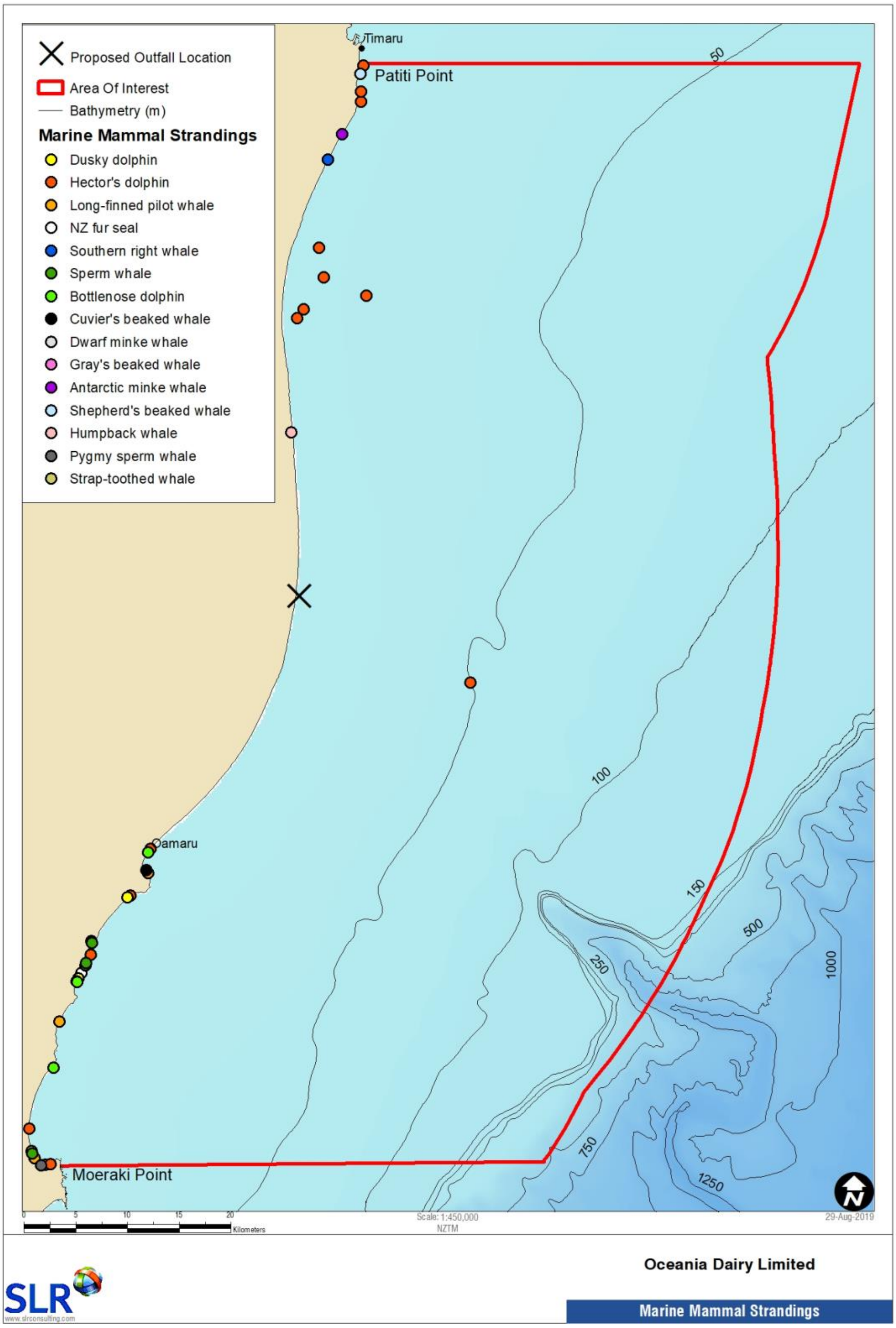
Five other species could possibly be present on an occasional basis: southern right whales, killer whales, common dolphins, dusky dolphins and leopard seals; although the relatively large home-ranges of these species mean that any potential presence around the proposed outfall is predicted to be highly infrequent and transitory. All other species listed in **Table 2** are unlikely to be present in the vicinity of the proposed outfall.

Figure 3 Marine Mammal Sightings in the Area of Interest



Each point represents a single sighting event; where each event may include one or more animals. Two sightings were recorded without identification to species level; these records have not been included.

Figure 4 Marine Mammal Stranding Events in the Area of Interest



Each point represents a single stranding event; where each event may include one or more animals. One stranding event was recorded without identification to species level; this record has not been included.
Events offshore denote dead animals observed at sea.

Table 2 Summary of Marine Mammal Sightings and Strandings in the Area of Interest & Likelihood of Presence in the 50 m Mixing Zone

	Common Name	Scientific Name	NZ Conservation Status (Baker *et al.*, 2019)	Qualifier *	IUCN Conservation Status www.redlist.org	DOC Stranding database (No. of events in AOI)	DOC Sightings database (No. of reports in AOI)	Ecological Considerations and Likelihood of Presence in Mixing Zone
Mysticetes (baleen whales)	Antarctic minke whale	*Balaenoptera bonaerensis*	Data deficient	DP, SO	Data deficient	✓ (1)	×	Antarctic minke whales and dwarf minke whales have a sympatric range and are difficult to distinguish at sea; hence both are considered together here. The majority of minke whale sightings around New Zealand occur in spring over the continental shelf; however coastal sightings of minke whales are rare off the east coast of the South Island (Berkenbusch et al., 2013). For this reason it is **unlikely** that minke whales will be present in the immediate vicinity of the proposed outfall.
	Dwarf minke whale	*Balaenoptera acutorostrata*	Data deficient	DP, SO	Least concern	✓ (1)	×	
	Humpback whale	*Megaptera novaeangliae*	Migrant	SO	Least concern	✓ (1)	×	Humpback whales migrate northwards up the east coast of the South Island from May to August (Gibbs & Childerhouse, 2000). During migrations they typically use continental shelf waters (Jefferson et al 2008) and although commonly visible with binoculars from shore when passing headlands of through confined waters (e.g. Gibbs et al., 2017) no sightings of this species have occurred in the AOI. For this reason it is **unlikely** that humpback whales will be present in the immediate vicinity of the proposed outfall; however if it did occur any presence would be transitory.
	Southern right whale	*Eubalaena australis*	Recovering	OL, RR, SO	Least concern	✓ (1)	✓ (3)	Coastal waters around mainland New Zealand represent a historic calving ground for this species, with recent evidence suggesting a slow recolonization of this breeding range (Carroll et al., 2014). Southern right whales utilise shallow coastal waters as their winter calving and nursery grounds (Patenaude, 2003). In this respect, this species is exceptional amongst baleen whales in that they are commonly observed with the naked eye from shore. Three sightings of this species have occurred in the AOI; although no calves have been reported. On this basis, it is **possible** that southern right whales will be seasonally present in the immediate vicinity of the proposed outfall.
Odontocetes (toothed whales)	Sperm whale	*Physeter macrocephalus*	Data deficient	DP, TO	Vulnerable	✓ (4)	✓ (2)	Sperm whales have a wide geographical and latitudinal distribution, but are predominantly found in deep waters (> 1,000 m) in the open ocean over the continental slope (Berkenbusch et al., 2013). Despite there being two sightings recorded from the AOI, it is **unlikely** that this species would be present in the immediate vicinity of the proposed outfall.
	Pygmy sperm whale	*Kogia breviceps*	Data deficient	DP, S?O	Data deficient	✓ (3)	×	Pygmy sperm whales are seldom seen at sea on account of their low profile in the water and lack of a visible blow; for this reason, little information is available on this species. They are, however, known to be a deep-water species (Taylor et al., 2012a). Hence, it is **unlikely** that pygmy sperm whales will be present in the immediate vicinity of the proposed outfall.
	Cuvier's beaked whale	*Ziphius cavirostris*	Data deficient	SO	Least concern	✓ (1)	×	This species is found in deep waters (> 200 m) and is thought to prefer steep bathymetry near the continental slope in water depths greater than 1,000 m (Taylor et al., 2008b). It is **unlikely** that Cuvier's beaked whales will be present in the immediate vicinity of the proposed outfall.
	Gray's beaked whale	*Mesoplodon grayi*	Not threatened	S?O	Data deficient	✓ (1)	×	This species has a circumpolar distribution south of 30° and occurs in deep waters beyond the shelf edge (Taylor et al., 2008c). It is **unlikely** that Gray's beaked whales will be present in the immediate vicinity of the proposed outfall.
	Strap-toothed whale	*Mesoplodon layardii*	Data deficient	S?O	Data deficient	✓ (3)	×	This species occur between 35-60°S in cold temperate waters and prefers deep waters beyond the shelf edge (Taylor et al., 2008d). It is **unlikely** that strap-toothed whales will be present in the immediate vicinity of the proposed outfall.
	Shepherd's beaked whale	*Tasmacetus shepherdi*	Data deficient	SO	Data deficient	✓ (1)	×	This species occur in deep water usually well offshore (Taylor et al., 2008), but has recently been recorded in waters of the Taiaroa and Saunders Canyons in coastal Otago (Gibb, 2016). It is **unlikely** that Shepherd's beaked whales will be present in the immediate vicinity of the proposed outfall.
	Long-finned pilot whale	*Globicephala melas*	Not threatened	DP, S?O	Data deficient	✓ (3)	✓ (2)	Pilot whale sightings occur in New Zealand waters year round (Berkenbusch et al., 2013). Long-finned pilot whales commonly strand on New Zealand coasts; with the stranding rate peaking in spring and summer (O'Callaghan et al., 2001). Because pilot whales forage at depth (i.e. several hundred metres; Berkenbusch et al., 2013), they do not routinely occur in very shallow coastal waters. Hence despite the sightings of this species in the AOI, they are **unlikely** to be present in the immediate vicinity of the proposed outfall.
	Killer whale	*Orcinus orca*	Nationally critical	DP, S?O	Data deficient	×	✓ (2)	Small groups of killer whales are typical seen around New Zealand where they travel an average of 100 – 150 km per day (Visser, 2000). Some groups of are thought to feed predominantly on rays which can bring them into very shallow coastal waters (Visser, 2000). Two sightings have been recorded from within the AOI. Based on this information it is **possible** that killer whales will be occasionally present in the immediate vicinity of the proposed outfall.

	Common Name	Scientific Name	NZ Conservation Status (Baker *et al.*, 2019)	Qualifier *	IUCN Conservation Status www.redlist.org	DOC Stranding database (No. of events in AOI)	DOC Sightings database (No. of reports in AOI)	Ecological Considerations and Likelihood of Presence in Mixing Zone
	Bottlenose dolphin	*Tursiops truncatus*	Nationally endangered	De, PF, SO, Sp	Least concern	✓ (4)	×	While four genetically distinct 'in-shore' populations of bottlenose dolphins are recognised in New Zealand (Baker et al, 2010; Brough et al., 2015), none occur on the east coast of the South Island. Offshore bottlenose dolphins do occur right around New Zealand, but (as the name suggests) sightings are typically well offshore (Zaeschmar et al., 2013). On this basis bottlenose dolphins are **unlikely** to be present in the immediate vicinity of the proposed outfall.
	Common dolphin	*Delphinus delphis*	Not threatened	DP,SO	Least concern	×	✓ (2)	Common dolphins often form large groups that include thousands of individuals and occur in water depths ranging from 6 – 141 m (Constantine & Baker, 1997). Two sightings of this species have been recorded from the AOI; both of groups containing less than 10 individuals, with one group containing a calf. Based on this information it is **possible** that common dolphins will be occasionally present in the immediate vicinity of the proposed outfall.
	Dusky dolphin	*Lagenorhynchus obscurus*	Not threatened	S?O	Data deficient	✓ (3)	✓ (4)	Dusky dolphins are present in New Zealand waters year-round (Berkenbusch *et al.*, 2013), but tend to spend more time in offshore waters during winter months. They are a coastal species that occur in waters above the continental slope and shelf in water depths less than 2,000 m, usually in the cooler waters of the South Island and lower North Island (Wűrsig *et al.*, 2007). Of the four sightings recorded from the AOI, three were reported to contain 100 or more individuals; however no calves were noted. Based on this information it is **possible** that common dolphins will be occasionally present in the immediate vicinity of the proposed outfall.
	Hector's dolphin	*Cephalorhynchus hectori hectori*	Nationally vulnerable	CD, DP, PF	Endangered	✓ (20)	✓ (23)	The East Coast South Island Hector's dolphin population extends from Farewell Spit to Nugget Point and is of direct relevance to the AOI. This population is estimated to consist of around 9,000 individuals (Mackenzie & Clement, 2016). While Hector's dolphins are generally regarded as a coastal species occurring within the 100 m isobaths (Slooten et al., 2006), almost half of the East Coast South Island population in summer and three-quarters in winter occur beyond 4 NM from the coast (Mackenzie & Clement, 2014). Based on the sightings records Hector's dolphins are the only species that regularly utilises waters in the AOI. Most sightings reported were of small groups of animals, some containing calves. Given the relatively high number of sightings for this species in the AOI and the fact that this species demonstrates a preference for shallow turbid waters (Brager et al., 2003), it is **likely** that Hector's dolphins will be frequently present in the immediate vicinity of the proposed outfall.
Pinnipeds (seals & sea lions)	New Zealand fur seal	*Arctocephalus forsteri*	Not threatened	*Inc, SO*	Least Concern	✓ (1)**	✓ (1)**	New Zealand fur seals are widespread around rocky coastlines on the mainland and offshore islands. Breeding occurs from mid-November to mid-January (Crawley & Wilson, 1976). The closest breeding colony to the AOI occurs at Moeraki in North Otago (Lalas & Bradshaw, 2001) with additional breeding locations at Banks Peninsula to the north of the AOI (Baird, 2011). While this species undertakes long, deep dives (Mattlin et al., 1998) with females foraging over the continental shelf, and males using deeper continental shelf breaks and pelagic waters (Page *et al.*, 2005), they return to shore every few days to rest at haul-out locations (including within the AOI) and in doing so are common in the inshore coastal environment. Based on this information it is **likely** that New Zealand fur seals will be frequently present in the immediate vicinity of the proposed outfall.
	Leopard seal	*Hydrurga leptonyx*	Naturally Uncommon	De, SO	Least concern	×	✓ (7)	Throughout spring and summer leopard seals are typically found around the Antarctic pack ice; however, in autumn and winter they disperse northwards where they are occasionally observed along New Zealand's coastline. It has been suggested that at least some leopard seals reside around the New Zealand coast for months at a time (Leopard Seals, 2018). Based on this information and the reasonable number of sightings reported for the AOI, it is **possible** that leopard seals will be occasionally present in the immediate vicinity of the proposed outfall.
	Southern elephant seal	*Mirounga leonina*	Nationally critical	RR, SO	Least concern	×	✓ (1)	Southern elephant seals are resident on New Zealand's subantarctic islands, but occasionally visit the mainland (DOC, 2019). Elephant seals are the deepest diving of all pinnipeds with a mean dive depth of 400 m (Harcourt, 2001; McIntrye *et al.*, 2010). As only one sighting has been recorded from the AOI, it is **unlikely** that elephant seals would be present in the immediate vicinity of the proposed outfall.

* Qualifiers to the New Zealand Threat Classification System are as follows: Secure Overseas (SO), Threatened Overseas (TO), Data Poor (DP), Conservation Dependent (CD), Sparse (Sp), Range Restricted (RR), Increasing (Inc)

** The reporting level for New Zealand fur seal sightings and strandings within the DOC databases is an underestimate as this species is commonly observed on the shoreline and in coastal waters

4 Assessment of Potential Effects on Marine Mammals

4.1 Methodology

Following the findings from **Section 3**, where Hector's dolphins and New Zealand fur seals are the only marine mammal species that are likely to be routinely present in the immediate vicinity of the proposed outfall, the assessment of effects focuses on these species unless otherwise stated.

Throughout this section, the actual and potential adverse effects of the proposed discharge on marine mammals are discussed. The magnitude of each actual and potential adverse effect is assessed and ranked using the 'Magnitude' terms (left-hand column) presented in **Table 3**. **Table 3** also provides an explanation of the respective magnitude descriptors and the 'RMA equivalent'.

Table 3 Magnitude of Effects

Magnitude	Explanation	RMA equivalent
No effect	The activity would have no effect on marine mammals	No effect
Negligible	The activity would have an effect which may or may not be detectable. The effect is considered to be of biological insignificance to marine mammals	Less than minor effect under the RMA
Low	The activity would have a detectable effect, but the effect is considered to be of low biological significance to marine mammals	Minor effect under the RMA
Moderate	The activity would have a detectable effect, and the effect is considered to be of moderate biological significance to marine mammals	Effects of some significance under the RMA
High	The activity would have a detectable effect, and the effect is considered to be of high biological significance to marine mammals	Significant effect under the RMA

4.2 Potential Effects during Outfall Construction

4.2.1 Boat strike

Collisions between vessels and marine mammals are recognised as an increasing conservation concern globally (IWC, 2014). A number of factors influence the likelihood of collisions, these are:

- Vessel size – larger vessels (> 80 m) are more frequently involved in collisions with marine mammals than smaller vessels (Laist et al., 2001; Jensen & Silber, 2003);
- Vessel speed – most lethal marine mammal collisions involve vessels travelling at faster speeds (> 12 knots) (Laist et al., 2001; Vanderlaan & Taggart, 2007);
- Species – large whales are the most common victims of collisions (e.g. fin whales, right whales, humpback whales, minke whales and sperm whales) (Laist et al., 2001; Jensen & Silber, 2003; Van Waerebeek et al., 2007); and
- Behaviour - species that remain at or near the sea surface for extended periods are particularly vulnerable to collisions (Constantine et al. 2012); as are species that are attracted to vessels (Bejder et al. 1999; Wursig et al., 1998).

All marine mammal species potentially present in the AOI are potentially at risk of collision with operational vessels. However, data indicates that large whales are at greater risk than smaller marine mammal species (Laist et al., 2001; Jensen & Silber, 2003). The size and agility of dolphins and seals means that these groups are more successful at avoiding potential collisions.

Despite that fact that both Hector's dolphins and New Zealand fur seals are often attracted to vessels (Bejder et al. 1999; Lalas & McConnell, 2016), the potential effects of boat strike on marine mammals during outfall construction is considered to be negligible for the following reasons:

- The slow operational speed of the work barge;
- The short-term duration of the construction phase; and
- The fact that dolphins and seals are highly agile.

4.2.2 Noise

Marine mammals produce sound not only for communication with conspecifics (e.g. Quick & Janik, 2012), but also for foraging, navigation, reproduction, parental care, avoidance of predators, and to gain an overall awareness of the surrounding environment (Thomas et al., 1992; Johnson et al., 2009). Toothed whales and dolphins use echolocation to forage and navigate, whilst all marine mammals are believed to use passive listening to gather useful navigational cues (e.g. the sound of waves breaking on coastline etc.). On this basis underwater noise generated by human activity has the potential to have effects on marine mammals. Effects are typically perceptual, behavioural or physical as discussed below.

The main perceptual effect is auditory 'masking' of important biological sounds (i.e. the reduced ability of marine fauna to perceive natural acoustic signals used by conspecifics for communication, navigation, predator avoidance, foraging etc.). Marine mammals must be able to perceive and effectively respond to biologically important sounds. Anthropogenic noise can interfere with the perception of these sounds. Such interference is referred to as 'masking'. The likelihood of masking is determined by how much overlap occurs between the frequency of animal vocalisations and the frequency of anthropogenic sounds (Richardson et al., 1995). Low frequency noises (e.g. engine noise from large ships) are more likely to lead to masking as these noises travel more readily through water than high frequency noises; however, these low frequencies typically impact baleen whales that predominantly use low frequency sounds to communicate (Simmonds et al., 2004). Even activities that emit relatively low intensity underwater noise can cause masking, but the biological significance of any effect will largely depend on the significance of the habitat affected and the duration of the effect, where ongoing masking in habitat that is of high importance will have the greatest biological significance.

The main potential behavioural effects observed in response to underwater noise are the interruption of behavioural patterns (e.g. feeding, breeding, migrating or resting) and the displacement from important habitat. Temporary avoidance is the most commonly reported behavioural response by marine mammals in the vicinity of high intensity acoustic disturbance (Stone & Tasker, 2006); however, some species appear to be attracted to low/medium intensity disturbance (e.g. Wursig et al., 1998; Simmonds et al., 2004). Avoidance behaviours may culminate in marine fauna being displaced from habitat and detrimental effects could be expected if this displacement occurs from optimal habitat in the long-term.

Potential physical effects to marine mammals from underwater noise include organ damage and permanent or temporary hearing loss (DOC, 2013). However, the sound intensity (energy levels, frequencies and duration) required to produce these physical effects is unknown for most marine fauna (Richardson et al., 1995), but physical damage to date has only been associated with high intensity underwater noise such as military sonar (Cox et al., 2006; Ketten, 2014). Most mobile species, if given the opportunity, are thought to avoid the range in which physical effects occur.

The potential effect of underwater noise on marine mammals during outfall construction is considered to be low for the following reasons:

- The operational noise from trenching will be comparable to routine dredging that occurs in many restricted coastal waters of New Zealand;
- No pile driving will occur and no explosives will be used during construction;
- The construction phase will be short-term in duration (days to weeks), hence any masking or behavioural effects (e.g. displacement or attraction) will be short-term in nature; and
- The operational noise from the barge is likely to be less intense than other small fishing vessels which may be in the area.

4.2.3 Turbidity

Construction-related turbidity will occur only for a few days and for this reason, no significant effects are predicted. **Section 4.3.1** (below) provides further discussion of long-term turbidity related to on-going discharges.

4.3 Potential Direct Effects from Waste Water Discharge

4.3.1 Reduced visibility

The discharge from the diffusers will occur on the seabed at a depth of 8 m and, on account of the increased TSS level in the treated wastewater (**Table 1**), increased turbidity in the surrounding water column is expected within the mixing zone. However, Mead et al. (2019) noted that background visibility in at the proposed outfall location is generally low, and it is predicted that reductions in water clarity outside of the mixing zone as a result of wastewater discharge will be no greater than 10% (Babbage, 2019). Turbidity may lead to reduced visibility for marine mammals which for some species could lead to reductions in foraging efficacy; however, turbidity effects are predicted to be negligible for the following reasons:

- This coast typically has relatively low water clarity (Mead et al., 2019);
- The area of turbidity caused by wastewater discharge will be largely restricted to the mixing zone (Babbage, 2019);
- No marine mammal species is entirely reliant on the immediate vicinity of the proposed outfall as foraging habitat;
- Hector’s dolphins are accustomed to foraging in turbid waters (Brager et al., 2003); and
- New Zealand fur seals mostly feed further offshore (Page et al., 2005) and seals are typically accustomed to foraging at low light levels; hence, are not heavily reliant on vision for locating prey (Dehnhardt et al., 1998).

4.3.2 Exposure to Chemical Contaminants from Waste Water

Contaminants in the marine environment are widespread and at high levels can pose health risks to marine mammals. Bioaccumulation describes the accumulation and enrichment of contaminants in organisms, relative to that in the environment. Where marine mammals at the top of the food chain are particularly susceptible to bioaccumulating contaminants (Moeller, 2003) and those in coastal environments are often exposed to higher levels of contaminants than those which occupy deep water open ocean habitat (Fossi & Panti, 2018). On this basis, the discharge of any contaminants into the coastal environment should be carefully considered with respect to potential effects on marine mammals.

Those contaminants of primary concern to marine mammals are: organochlorines (such as PCBs, DDT etc.), hydrocarbons (namely PAHs), and heavy metals (such as mercury, cadmium and lead) (De Guise et al., 2003); where the following serious health implications have been linked to contaminant exposure: immunosuppression, reproductive and developmental effects and endocrine disruption (Vos et al., 2003). The source of these pollutants is varied; however, stormwater is often a ubiquitous source of all of these types of contaminants (Barbosa et al., 2012). In general terms, contaminant concentrations detected in New Zealand marine mammals are considerably lower than concentrations in northern hemisphere species (Jones, 1998); however, relatively few published studies are available on this topic.

The potential effects of chemical contaminants from the treated wastewater discharged from the ODL factory on marine mammals are predicted to be negligible for the following reasons:

- Concentrations of chemical contaminants within the wastewater discharge are expected to be low, with no organochlorines or hydrocarbons predicted to be present in the wastewater (see **Table 1**);
- Heavy metal concentrations will be very low and, with the exception of copper and zinc even undiluted wastewater will not trigger any guideline exceedances (Babbage, 2019). For copper and zinc, the guideline limits will be met after two-fold dilution (much less than will actually occur) (Babbage, 2019);
- No stormwater will be discharged via the proposed outfall;
- High rates of dilution, within a 50 m radius ‘mixing zone’, as modelling predicts a dilution of at least 300:1 will occur (Mead et al., 2019). This is largely driven by the highly dispersive nature of the receiving waters; and
- Although Hector’s dolphins and New Zealand fur seals are likely to be present around the discharge point, both species have home ranges that are vastly larger than the mixing zone; hence the overall degree of exposure for any individual animal is likely to be low.

4.3.3 Exposure to Biological Contaminants from Waste Water

Some microorganisms (e.g. bacteria, viruses, fungi or parasites) that enter the coastal environment can be harmful to marine species and ecosystems. These ‘pathogens’ typically enter the ocean via untreated sewage or the discharge of waste from farm, domestic or wild animals (Ocean Health Index, 2019).

Pathogenic diseases of potential terrestrial origin that have been identified in New Zealand marine mammals include:

- Toxoplasmosis: a parasitic disease spread by cat faeces that can be fatal or have serious sub-lethal effects on Hector's dolphins (Roe et al., 2013). The exposure of east coast South Island Hector's dolphins to this pathogen is estimated to be highest around the estuary of the Waitaki River (Roberts et al., 2019);
- *Klebsiella pneumoniae*: a bacterial disease that causes high pup mortality of New Zealand sea lions which has been detected in individuals both in the subantarctic and at Otago and for which anthropogenic exposure has not been ruled out (Castinel et al., 2007); and
- Tuberculosis: a bacterial disease that has been detected in New Zealand sea lions, New Zealand fur seals and a Hector's dolphin; where the strain detected in the Hector's dolphin had only previously been detected in New Zealand cattle (Roe et al., 2019).

As no sewage or stormwater will be discharged via the ocean outfall, the risk of biological contaminants being present in the treated discharge is low (Babbage, 2019). The risk is even further reduced by the strict hygiene standards that underpin all aspects of food production at the ODL factory and the proposed treatment regime; specifically the membrane reactor and the UV which are expected to remove any bacterial content. On this basis the potential effects on marine mammals from biological contaminants is negligible.

4.3.4 Noise

No information is available on the underwater noise that will be generated from the discharge of wastewater into the coastal environment. Hence it is difficult to predict how any noise generated will affect marine mammals. Surf-generated noise (which is generally below 100 Hz in frequency) is predicted to dominate in coastal environments (Haxel et al., 2013). Given the high energy nature of the inshore coastal environment, wastewater discharge noise is likely to be of no greater intensity than the noise of breaking waves on the nearby shoreline or the noise associated with other riverine inputs nearby (e.g. the Waitaki River). Coastal marine mammal species (e.g. Hector's dolphins) are likely to be well habituated to foraging and navigating in coastal environments with relatively high levels of ambient underwater noise. On this basis the effects of underwater noise from wastewater discharge are predicted to be negligible.

4.4 Potential Indirect Effects from Waste Water Discharges

4.4.1 Bioaccumulation of contaminants in prey species

Marine mammals may be indirectly exposed to chemical and biological contaminants through the ingestion of contaminated prey species. However, while this is possible, the potential effects of bioaccumulation from the proposed ocean outfall discharge are considered to be negligible for the following reasons:

- Chemical contaminants within the wastewater discharge are expected to be low (Babbage, 2019); and
- Although Hector's dolphins and New Zealand fur seals are likely to be present around the discharge point(s), both species forage over areas that are vastly larger than the mixing zone and are generalist foragers; hence the degree of exposure to contaminated prey for any individual animal is likely to be low.

4.4.2 Changes in abundance and distribution of prey species

Of the two species that are likely to be routinely present in the immediate vicinity of the proposed outfall, Hector's dolphins are the only species that is likely to routinely forage in and around the mixing zone. Hector's dolphins are generalist foragers that consume prey from throughout the water column, with demersal and bentho-pelagic prey being most prevalent (Miller et al., 2013). The diet of Hector's dolphins on the east coast of the South Island includes red cod, ahuru (a species of morid cod), yellow-eyed mullet, arrow squid, sprat, sole and stargazer; with red cod and ahuru having the greatest contribution (Miller et al., 2013). New Zealand fur seals mostly feed further offshore (Page et al., 2005) so are unlikely to be exposed to any indirect effects from changes to prey distribution or abundance.

While some Hector's dolphin prey species (red cod in particular) are predicted to be present at the proposed outfall location, and the discharge of wastewater may cause some fish species to move out of the mixing zone (Bioresearches, 2019); any such displacement of fish is predicted to be negligible as there is sufficient alternative habitat nearby (Bioresearches, 2019). On this basis some changes in prey distribution and abundance are possible; however, indirect effects on marine mammals are considered to be negligible as:

- Any area of fish avoidance (i.e. reduced abundance) is likely to be highly localised around the point of discharge; and
- No marine mammal species is entirely reliant on the immediate vicinity of the proposed outfall as foraging habitat, and given the relative homogeneity of the nearshore habitat (characterised by a lack of permanent hard substrate features; Mead, 2019) it is reasonable to assume that any marine mammal species that do forage in the area will have plenty of nearby alternative foraging habitat.

4.4.3 Exposure to biotoxins

Harmful algal blooms (**HAB**) can occur naturally or as a result of anthropogenic eutrophication of coastal waters. HABs act as neurotoxins and have been known to cause disease or death in marine mammals (Van Dolah et al., 2003); for example domoic acid toxicity in California sea lions (caused primarily by the diatom *Pseudo-nitzschia spp*.) (Gulland et al. 2002) and Brevetoxicosis in bottlenose dolphins in Florida (caused by the dinoflagellate *Karenia brevis*) (Flewelling et al., 2005).

To date, no HAB related toxicity has been diagnosed in any marine mammals from New Zealand (Dr. W. Roe, Massey University; pers. comm.). However deaths in New Zealand fur seals along the Kaikoura coast during the summer of 1998 coincided with blooms of *Gymnodinium mikimotoi* (Chang, 1998), a saxitoxin associated with paralytic shellfish poisoning in humans. Although these deaths were not investigated, it perhaps suggests that biotoxins can play a role in marine ecosystem health in New Zealand.

HABs may coincide with unusual climatic conditions associated with El nino events (Camacho et al., 2007); therefore, areas of anthropogenic eutrophication may be more susceptible to HABs at these times.

Elevated concentrations of some nutrients (namely DIN, Total Nitrogen, DRP and Total Phosphorus) are predicted outside of the mixing zone (see **Table 1**; following Babbage, 2019). The principle driver of algal blooms in marine environments is DIN (Babbage, 2019); however nitrogen elevations are only predicted to occur in conjunction with persistent calm sea conditions and a 95th percentile discharge quality event (Babbage, 2019). On this basis, the risk of increased algal blooms forming as a result of the proposed discharge is very low (Babbage, 2019). Therefore, the potential effect of subsequent toxicosis in marine mammals is considered to be negligible.

5 Summary

ODL is proposing to install an ocean outfall and will submit a Coastal Permit application to ECAN in accordance with the RMA to discharge clean and treated wastewater into the Pacific Ocean via a 500 m long submerged outfall 4 km north of Glenavy in South Canterbury. The outfall will be designed to discharge up to 10,000 m^3 of wastewater per day. This assessment of effects evaluated the potential effects of the proposed ocean outfall on marine mammals.

Our assessment determined that only two species, Hector's dolphins and New Zealand fur seals, were likely to be frequently present in the immediate vicinity of the proposed outfall. Hector's dolphins are predicted to forage in the area and sightings of mother and calf pairs are not uncommon from the AOI. This species is considered 'Nationally Vulnerable' under the New Zealand Threat Classification System.

New Zealand fur seals typically forage in deeper waters; however, transit through the inshore coastal zone on their way to and from breeding colonies and haul-out locations. The New Zealand fur seal is listed as 'Not Threatened' by the New Zealand Threat Classification System. Five other species could possibly be present on an occasional basis: southern right whales, killer whales, common dolphins, dusky dolphins and leopard seals.

The potential effects during outfall construction were identified and assessed as described below:

- The potential effects of boat strike on marine mammals is considered to be negligible on account of:
  - the slow operational speed of the work barge;
  - the short-term duration of the construction phase; and
  - the fact that dolphins and seals are highly agile.
- The potential effect of underwater noise on marine mammals is considered to be low as:
  - the operational noise from trenching will be of relatively low intensity and no pile driving or explosions will occur;
  - the construction phase will be short-term in duration; and
  - the operational noise from the barge is likely to be of low intensity.

Turbidity may occur both during outfall construction and in an ongoing manner during discharge; however effects of turbidity on marine mammals are predicted to be negligible as the area of reduced water clarity resulting from the wastewater discharge is small, no marine mammal species is entirely reliant on the immediate vicinity of the proposed outfall as foraging habitat, and Hector's dolphins are accustomed to foraging in turbid waters.

In addition to turbidity, the potential ongoing effects of wastewater discharge into the CMA were identified and assessed as described below:

- Effects of chemical contaminants on marine mammals are predicted to be negligible as:
  - no organochlorines or hydrocarbons are predicted to be present and no significant elevations in heavy metals are predicted;
  - no stormwater will be discharged;
  - high rates of dilution will occur; and

  - Hector's dolphins and New Zealand fur seals have home ranges much larger than the mixing zone; hence the overall degree of exposure for any individual animal is likely to be low.
- Effects of biological contaminants from the wastewater discharge on marine mammals are predicted to be negligible as:
  - no sewage or stormwater will be discharged; and
  - UV treatment means that pathogens should not be present in the wastewater.
- Effects of underwater noise on marine mammals generated by the wastewater discharge plume itself are predicted to be negligible, as the discharge noise is likely to be of no greater intensity than the noise of breaking waves on the nearby shoreline or the noise associated with riverine inputs nearby.
- Bioaccumulation effects on marine mammals are considered to be negligible as:
  - concentrations of chemical contaminants within the wastewater are expected to be low; and
  - Hector's dolphins and New Zealand fur seals are generalist foragers; hence the degree of exposure to contaminated prey for any individual animal is likely to be low.
- Although some changes in prey distribution and abundance are possible, any subsequent indirect effects on marine mammals are considered to be negligible as:
  - any area of fish avoidance is likely to be highly localised around the points of discharge; and
  - no marine mammal species is entirely reliant on the immediate vicinity of the proposed outfall as foraging habitat.
- Despite the elevated levels of nutrients in the treated wastewater, it is unlikely that discharge from the proposed outfall will result in algal blooms. Therefore any potential effect on marine mammals from toxicosis is considered to be negligible.

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