Impact of proposed Port of Hastings expansion on the birdlife of Western Port

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Executive summary

Victorian National Parks Association (VNPA), with the support of the Westernport & Peninsula Protection Council, commissioned BirdLife Australia to produce this report outlining the potential impacts of an expansion of the existing Port of Hastings on the birdlife of Western Port. The report outlines the significance of Western Port for aquatic birds, the extent of these species in Western Port and the existing major threats to aquatic birdlife in Western Port. It then considers the likely impacts on Western Port's birdlife caused by:

a. An oil spill along the lines of each of three scenarios outlined in Asia-Pacific Applied Science Associate's report (2013);

b. Wash from the increase in vessel use of Western Port as a result of the expansion of the Port of Hastings; and

c. Land reclamation and dredging works associated with the expansion of the Port of Hastings.

Western Port is a site of international significance for aquatic birds. It regularly supports more than 10,000 migratory shorebirds and 10,000 waterfowl and is listed under the Ramsar Convention (1971) as a wetland of international importance. Its importance to migratory shorebirds is reflected in its inclusion in the East Asian-Australasian Shorebird Site Network and its designation by BirdLife International as an Important Bird Area (IBA). Western Port regularly supports more than one per cent of the world population of [1]Eastern Curlew, Red-necked Stint and Pied Oystercatcher, small numbers of the critically endangered Orange-bellied Parrot and declining numbers of the vulnerable Fairy Tern.

Important bird foraging habitat includes the extensive intertidal mudflats and wetlands that cover around 270 km^2; around 57 per cent of this area is covered by seagrass beds. The high tide roost sites of Western Port occupy around 248.7 hectares (2.5 km^2) which represents around 0.35 per cent of the total area of Western Port. High tide roost sites allow shorebirds to access foraging resources, particularly those associated with intertidal mudflats. Any loss of or damage to these high tide roost sites would have a disproportionate, negative impact on the number of migratory shorebirds using Western Port.

Current potential threats to the aquatic birds of Western Port include: loss of roosting and foraging habitat (all species); disturbance to roosting and foraging birds (particularly shorebirds) from human recreational activity; seagrass loss (most aquatic bird species); and predation by cats, Red Foxes and Black Rat.

Key concerns relating to the proposed expansion of the Port of Hastings include:

1. An increased risk of oil spills and impacts from vessel wash.

2. Important shorebird foraging and roosting habitat in the vicinity of Long Point, Middle Spit and the western and north-western shorelines of French Island (including Barrallier Island) are at high risk of short- and long-term impacts from oil spills originating at either Long Island Point jetty or McHaffie's reef.

[1] Throughout this report, underlining of a species name indicates that the species is listed under the Commonwealth *Environment, Protection and Biodiversity Conservation Act 1999*.

3. Seabirds such as cormorants and grebes foraging in the waters of Lower North Arm would be at high risk of oiling from spills at either Long Island Point jetty or McHaffie's reef. It is likely that large numbers of these birds would die. Large numbers of swans and ducks would also be at high risk of partial oiling. Hooded Plover on the northern beaches of Phillip Island are also susceptible to oil spills, particularly from spills at McHaffie's reef.

4. Typically penguins are the birds most affected by oil spills. Little Penguin are at high risk of oiling and subsequent death from oil spills at McHaffies reef.

5. The 270 km^2 of intertidal mudflats of Western Port that provide foraging resources for thousands of shorebirds and waterbirds, are at high risk of extensive, long-term contamination from any oil spill. In particular, the potential for a single oil spill to have serious short- and long-term impacts on migratory shorebird populations in Western Port is of great concern because: Western Port is one of the most important sites for these birds in Victoria; this group is under considerable pressure throughout their range and their populations are known to be declining.

6. Vessel generated waves can lead to sustained increases of turbidity in the near shore region, reducing the productivity of seagrass beds and eroding shorelines. Any reduction in the productivity of seagrass beds as a result of vessel generated waves is likely to have an impact on the foraging resources of aquatic birds in western Western Port including swans, ducks, fishers and shorebirds.

7. Vessel generated waves may erode Middle Spit and important shorebird foraging and roosting sites along the western shoreline of French Island and at Long Point. In particular, erosion of the high tide roost at Long Island Spit would impact on Eastern Curlew and Red-necked Stint. Australian Pied Oystercatcher may lose both breeding and foraging habitat through erosion impacts in the vicinity of Long Island, Middle Spit and the western shoreline of French Island.

8. Land reclamation and dredging are likely to reduce productivity of seagrass beds and populations of benthic fauna, which would then impact on foraging resources for aquatic birds. It is highly likely that waterfowl (particularly Black Swan) and fishers would be affected by any decrease in the extent and productivity of seagrass beds associated with dredging, increased turbidity and disposal of dredge spoil.

Significance of Western Port to birdlife

Western Port is a site of international significance for aquatic birds. It regularly supports more than 10,000 migratory shorebirds and 10,000 waterfowl and is listed under the Ramsar Convention (1971) as a wetland of international importance. Western Port supports a diverse range of aquatic birds (Table 2, see Appendix). Its importance to migratory shorebirds is reflected in its inclusion in the East Asian-Australasian Shorebird Site Network and its designation by BirdLife International as an Important Bird Area (IBA). IBAs are areas recognised as globally important for bird conservation because they provide habitat for key bird species that are vulnerable to global extinction or whose populations are otherwise irreplaceable. Western Port regularly supports more than one per cent of the world population of Eastern Curlew, Red-necked Stint and Pied Oystercatcher, small numbers of the critically endangered Orange-bellied Parrot and declining numbers of the vulnerable Fairy Tern.

The aquatic birds of Western Port have been the subject of Australia's longest running survey of bird utilisation of a coastal area in Australia. The Western Port Survey (1973-present) continues to provide a wealth of information on the abundance, diversity and distribution of aquatic birds at key sites in Western Port. Numerically significant species include Australian Pied Oystercatcher, Black Swan, Eastern Curlew and Red-necked Stint.

This report uses the groupings of aquatic birds adopted by Dann (2012): seabirds, waterbirds and shorebirds. These groups are based partly on phylogeny and partly on foraging guilds. 'Shorebirds' (waders) are species that commonly feed on intertidal areas in Western Port and includes Holarctic shorebirds (transequatorial, migratory shorebirds) and Australasian shorebirds (resident shorebirds and Double-banded Plover). 'Waterbirds' is a mixed group of species other than shorebirds that feed in intertidal areas including ducks, swans, ibises, herons, spoonbills and grebes. 'Seabirds' refers to gulls and species that largely feed on fish (piscivores) in the marine water column such as terns, cormorants, penguins, gannets and shearwaters.

Habitat values

In a major study of aquatic bird utilisation of Western Port, Hansen *et al* (2011) mapped important roosting sites and primary and secondary foraging habitat in Western Port (Fig. 1). Important foraging habitat includes the extensive intertidal mudflats and wetlands that cover around 270 km^2; around 57 per cent of this area is covered by seagrass beds. Channels, saltmarsh and swamps also provide important foraging habitat and Western Port has extensive fringing saltmarsh habitat. In many places this is accompanied by mangrove *Avicennia marina*.

The most extensive primary foraging habitat for shorebirds and waterbirds (by area) occurs on the western, north-western and south-western shorelines of French Island, the western shoreline of Western Port (including Hanns Inlet and Hastings Bight), Middle Spit and the north-eastern coast of Phillip Island (Fig. 1). Important foraging habitat may also occur in the upper north arm of Western Port (see Fig. 2 for regional distinctions within Western Port) however this area is under-surveyed as it is difficult to access at low tide (Dann 2012, Hansen *et al* 2011). Important foraging habitat for seabirds includes the subtidal areas in the western, northern and eastern arms and the confluence of the three arms (Dann 2012).

Seagrass is an important driver of productivity in the Western Port ecosystem and the extent and health of seagrass beds is thought to influence the population dynamics of many aquatic birds (BOCA 2003). Seagrass is the major food source for Black Swan, is important for fish production (acts as a fish nursery) and for benthic productivity. Major losses of seagrass beds in the late 1970s and early 1980s are thought to have resulted in declines in a number of aquatic birds in Western Port including Black Swan and a number of fishers. Populations of Little Pied Cormorant, Pied Cormorant and Australian Pelican have never fully recovered (Hansen *et al* 2011). Hansen *et al* (2011) also found a significant relationship between commercial fish catch and population trends in Whimbrel, Eastern Curlew, Common Greenshank and Grey-tailed Tattler.

Hansen *et al* (2011) found that populations of most groups of aquatic birds had declined over the (then) 37 years of the Western Port Survey, and the total aquatic bird population had declined significantly. Of the 38 species with consistent count data, 25 had declined (with 16 declines statistically significant), ten were variable, two were stable and only one species, the Australian Pied Oystercatcher, had significantly increased.

Figure 1: Mapping showing all available habitat for waterbird (aquatic bird) roosting, foraging or breeding. (From: Hansen *et al* (2011))

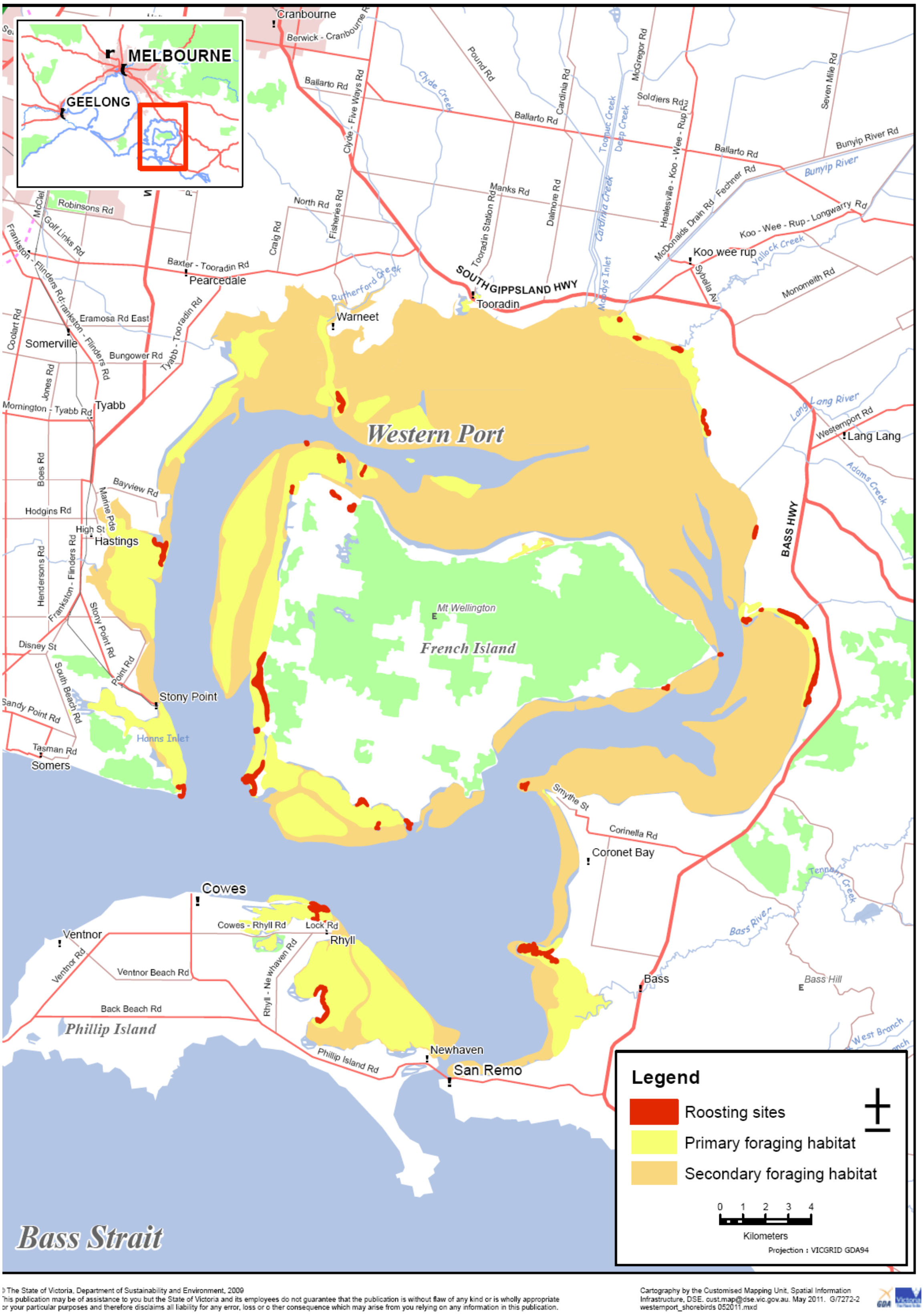
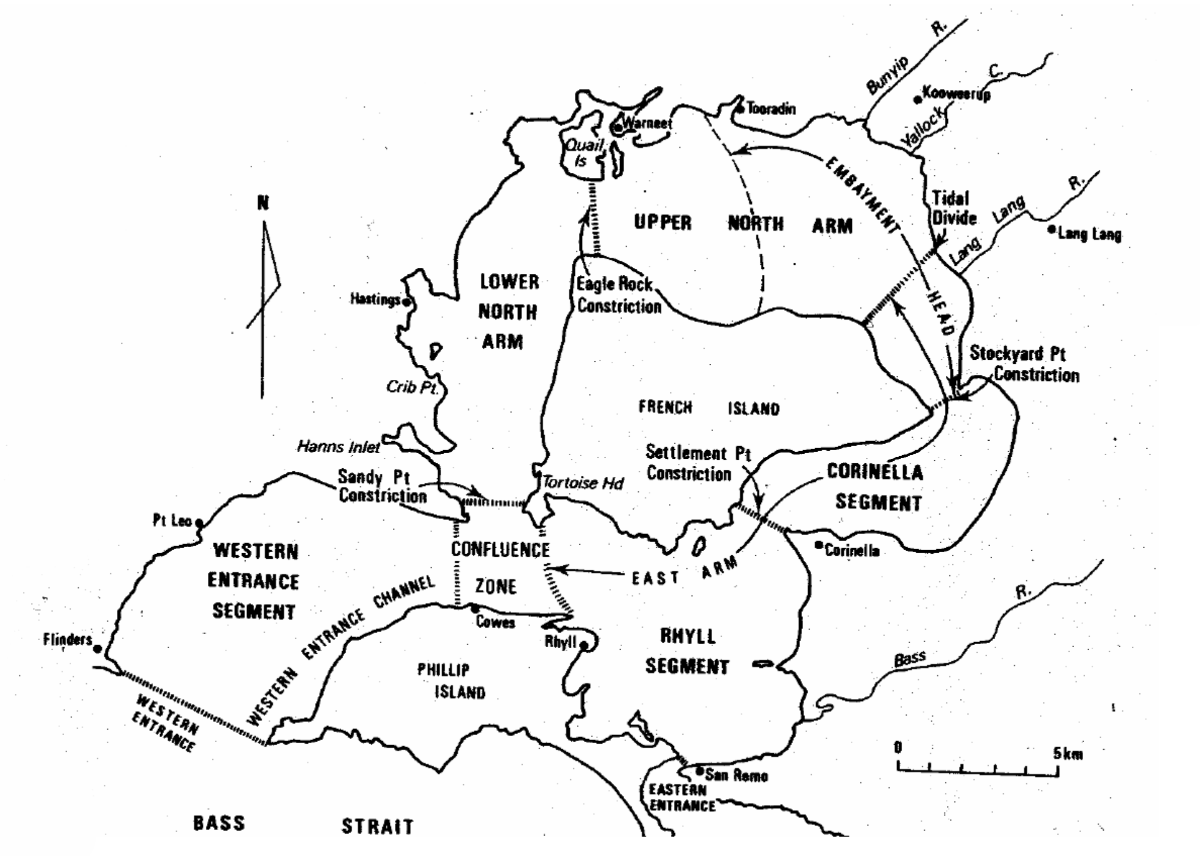


Figure 2: Regional distinctions of Western Port Bay (from Marsden *et al*, 1979).



Distribution

Shorebirds

Western Port is a migration end point for many Holarctic shorebirds, providing critical foraging and roosting habitat during their non-breeding season. Birds arrive in southern Australia in late August and spend large amounts of time feeding to replenish fat reserves that will fuel their migration to their breeding grounds in the northern hemisphere. Most birds depart by April.

Shorebirds require exposed, open high-tide roosts in close proximity to the intertidal mudflats that provide important foraging habitat at low-tide. Important high-tide roost sites include sandy spits and islands, rocky points, exposed mud banks, mangroves, artificial structures, the edges of streams and nearby wetlands (Hansen *et al* 2011).

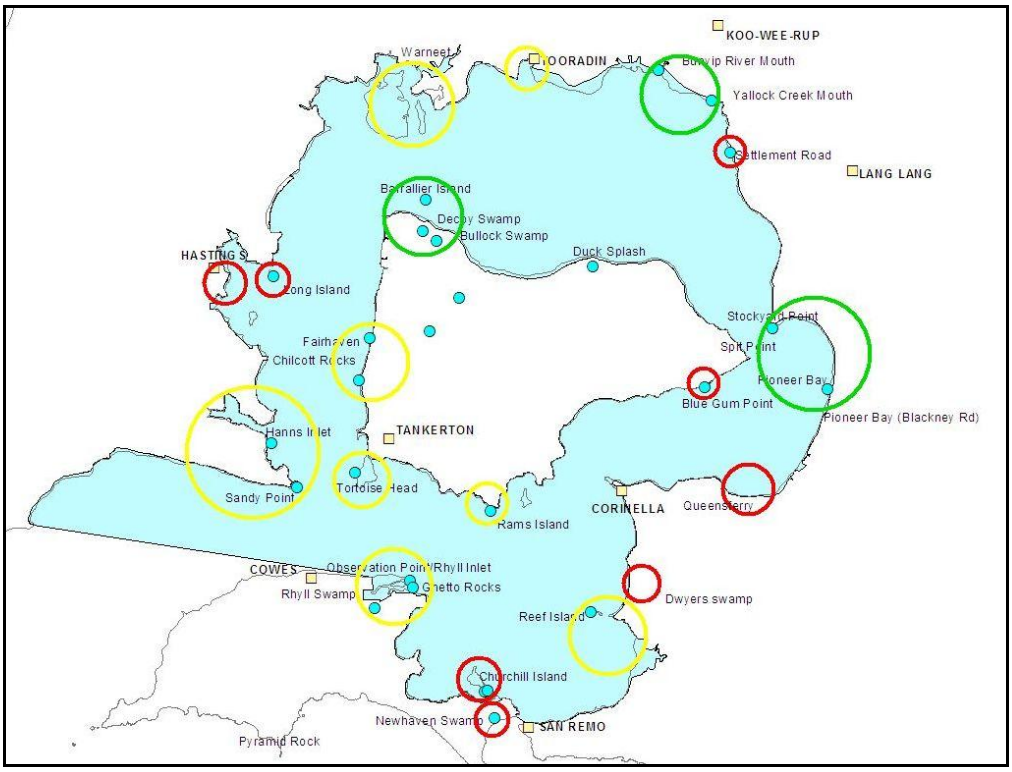
High-tide roost sites are crucial in allowing shorebirds to access foraging resources. High tide roosts such as Barrallier Island and Stockyard Point allow shorebirds to access intertidal areas on and near Middle Spit and in the Upper North arms of Western Port. In contrast, very few shorebirds utilise the extensive intertidal mudflats along the western shoreline of Western Port because the shoreline is fringed with mangroves and there are no suitable high tide roosts nearby.

The high tide roost sites of Western Port occupy around 248.7 hectares (2.5 km^2) which represents around 0.35 per cent of the total area of Western Port. Any loss of or damage to these sites would have a disproportionate, negative impact on the number of migratory shorebirds using Western Port.

Hansen *et al* (2011) ranked high tide roosts for their relative importance to aquatic birds. The three most important aquatic bird roosting areas are Pioneer Bay/Stockyard Point, Bunyip/Yallock and Barrallier Island/North-west French Island. Reef Island/Bass Bay, Fairhaven, Tortoise Head, Rams Island and Observation Point were found to be of moderate importance as high tide roosts (Fig. 3).

Australasian shorebirds such as Australian Pied Oystercatcher, Hooded Plover and Red-capped Plover have been recorded breeding on Phillip and French Islands. Sooty Oystercatcher have been recorded breeding on the southern shore of Phillip Island.

Figure 3: Distribution of high tide roost sites in Western Port and their relative 'importance', based upon rankings of total abundance and number of species.
Green circles show the three highest-ranked sites, red circles the eight lowest-ranked sites, and the yellow circles are sites intermediate in importance. Blue shading indicates the Ramsar site. (From: Hansen *et al* 2011)



Waterbirds

Western Port provides habitat for large numbers of waterbirds including waterfowl (e.g. Black Swan, Chestnut Teal), Straw-necked and Australian White Ibis, Royal Spoonbill and Australian Pelican.

Waterbirds are generally less constrained by their habitat requirements than shorebirds and occur on most intertidal habitats in Western Port. Many are able to use a variety of freshwater and marine habitats (flooded saltmarsh, intertidal mudflats, pasture). Consequently waterbirds are more widespread and more resilient to changes in the local environment than shorebirds. Ducks and Black Swan can roost on shore or while floating on open water. Waterbirds may also use a variety of coastal features such as rocky or sandy points, mangroves, saltmarsh, jetties and rocky reefs.

Black Swans forage in seagrass beds and are both widespread and numerous within Western Port. Ducks may be found in high numbers at GMH drain, Bunyip/Yallock Creek and north-west French Island. Hansen *et al* (2011) found that Black Swan was most plentiful at Reef Island/Bass Bay, Fairhaven to northwest French Island, and Tortoise Head.

Large wading birds such as ibis, Royal Spoonbill and White-faced Heron are found in their highest numbers at north-west French Island high-tide sites, which has intertidal mudflats, saltmarsh, wetlands and mangrove habitats. Many large wading birds are able to roost in mangroves, allowing them to forage on intertidal mudflats along the western shoreline of Western Port – an area that is largely inaccessible to shorebirds due to an absence of suitable high-tide roost sites (Hansen 2011).

Seabirds

Fishers such as cormorants and terns can be found in most places where there are natural or artificial roost sites close to water that is deep enough to allow fishing and where there are suitable roost sites. Hansen *et al* (2011) found that these groups are evenly distributed around the bay with the largest numbers occurring at Observation Point and Barrallier Island. However, Dann *et al* (2003) found that cormorants and grebes are mostly found in the shallower eastern and northern arms. Dann *et al* (2003) also found that the deeper western arm of Western Port and the confluence of the three arms are important for seabirds that seize their prey on the surface, such as albatrosses, and for 'plunging' species such as Crested Tern, Australasian Gannet and Short-tailed Shearwater.

Dann *et al* (2003) found that Western Port supports very high numbers of Short-tailed Shearwater, Silver Gull, Little Penguin and Crested Tern. However they observed seasonal shifts in abundance, with peak numbers occurring in late summer/early autumn for most of these species. This coincides with the reported influx of juvenile clupeiod fish into Western Port.

The major breeding site for Little Penguin (around 28-32,000 breeding birds) in the Western Port region is on the Summerland Peninsula at the western end of Phillip Island. While Western Port is a relatively unimportant foraging area for Little Penguin, birds are known to forage in the western and northern arms of Western Port. Peak numbers occur in late summer and autumn, coinciding with the latter part of the seasonal occurrence of juvenile pilchards and anchovies (Dann 2012).

Other seabird species that breed in Western Port include: Fairy Tern which breed at Rams Island and occasionally at Tortoise Head and Observation Point; Short-tailed Shearwater which breed at Cape Woolamai and many other sites on Phillip Island and at Tortoise Head (French Island); and Crested Tern which breed on the Nobbies on Phillip Island (the largest colony in Victoria).

Importance of western Western Port and the Port of Hastings for aquatic birds

While the Western Port survey and other work has provided important information on the aquatic birds in Western Port, there are substantial gaps in our understanding of the abundance, distribution and movement of aquatic birds at a finer scale.

In 2011, the Port of Melbourne Corporation commissioned the Arthur Rylah Institute to complete a more detailed study of the waterbirds of the Port of Hastings and western region of Western Port (Hansen 2011). Key points from this study are given below:

- *A total of 9530 birds make up the annual waterbird population in the western region of Western Port.*

- *Black Swan, Red-necked Stint and Silver Gull collectively made up nearly 62% of this total, which is consistent with their general abundance in south-eastern Australia. Two threatened species, Eastern Curlew and Curlew Sandpiper, were represented in nationally significant numbers, emphasising the disproportionate importance of this area for waterbirds in a national context* (pg 2).

- Significantly, Hansen (2011) noted that '*While the western region of Western Port represents around one quarter of the embayment area, it holds nearly half of 1% of the flyway population of Eastern Curlew and a slightly lower proportion of Curlew Sandpiper, which emphasises the importance of this area for these species*.'

- *Overall, 24 species collectively compromised 99.5% of the total waterbird count* (pg 16). (Black Swan, Australian Pied Oystercatcher, Double-banded Plover, Masked Lapwing, Red-capped Plover, Australian Shelduck, Chestnut Teal, Pacific Black Duck, Australian Pelican, Caspian Tern, Crested Tern, Little Pied Cormorant, Pied Cormorant, Pacific Gull, Silver Gull, Australian White Ibis, Royal Spoonbill, Straw-necked Ibis, White-faced Heron, Bar-tailed Godwit, Curlew Sandpiper, Eastern Curlew, Red Knot, Red-necked Stint).

- *French Island consistently held the largest numbers of birds, especially in summer when flocks of migratory shorebirds congregated on high-tide roosts there, or dispersed to nearby mud flats to forage at low tide. Middle Spit held moderate numbers of foraging birds at low tide and appeared to exchange birds over the tidal cycle with both French Island and Long Island* (pg 1).

- High tide roost sites at Barrallier Island, Fairhaven and Chilcott Rocks allow birds to access foraging resources along the north-west and western coastline of French Island and on Middle Spit at low tide.

- Middle Spit mud banks, Barrallier Island tidal flats and the western Tooradin tidal flats were found to be important for large wading birds.

- Watson Inlet is an important foraging and roosting area for large wading birds and some migratory shorebirds (e.g. Common Greenshank). No migratory shorebirds were recorded on the western shoreline of Western Port.

- Birds made extensive usage of intertidal mudflats and low usage of open water and shallow water habitats.

- Relatively large counts of Eastern Curlew, Australian Pied Oystercatcher and Crested Tern were made on Long Island Spit.

- Australian Pied Oystercatcher and Eastern Curlew were both common in the Long Island area, although both were counted in greater numbers around French Island and Middle Spit mud banks.

- Australian Pied Oystercatcher was recorded breeding along the shorelines of north-western French Island and western French Island in November.

- Long Island and the Port of Hastings had maximum counts of Little Tern, Pied Cormorant and Red-necked Avocet.

- The highest concentration of birds (birds per unit area) were found in the Long Island and Port of Hastings area and this area held the greatest number of birds over all survey areas.

Current threats

Hansen *et al* (2011) and Dann (2012) considered that the major threats operating at key sites in Western Port are:

- loss of roosting and foraging habitat (all species);
- disturbance to roosting and foraging birds (particularly shorebirds) from human recreational activity;
- seagrass loss (most species); and
- predation by cats, foxes and Black Rat.

High tide roost sites play a key role in allowing aquatic birds to access foraging resources in Western Port and any threats operating on these sites will have a disproportionate impact on aquatic bird populations.

Hansen *et al* (2011) found that sea-level rise associated with climate change will lead to losses of both foraging and roosting sites. The area between 1.56 and 2.38 m above mean sea level is at risk from sea level rise of 0.8 m by 2100 and virtually all (99.83%) of the high tide roost sites will be inundated, with eight of the fourteen sites having limited or no capacity for natural migration inland.

The current risk of oil spill impacts was identified as a major threat at sites along the western coastline of French Island (Barrallier Island/Chicory Lane reef, Tortoise Head, Fairhaven/Chilcott Heads and Mick's Beach) and at Hastings and Long Reef (south of Warneet) (Hansen *et al* 2011).

Likely impacts associated with the expansion of the Port of Hastings

This report considers the potential impacts of the proposed expansion of the Port of Hastings on birdlife in Western Port as a result of:

a. An oil spill along the lines of each of the three scenarios outlined in Asia-Pacific Applied Science Associate's report (2013);

b. Wash from the increase in vessel use of the Western Port; and

c. Any other relevant impacts which would result from the proposed expansion of the Port of Hastings such as impacts from damage to seagrass, mangroves and saltmarsh on bird species and impacts from dredging works.

Overview of potential oil spill impacts on birdlife

Oil spills may affect birds directly through impacts on individual birds or indirectly through impacts on bird foraging, roosting and breeding habitat. Direct impacts occur through oiling of feathers or ingestion of oil that can lead to high mortality levels. Long-term impacts occur through the persistence of hydrocarbons, especially within sediments or within the tissues of the birds themselves (Schlacher *et al* 2010). Oil spills may also impact on the productivity of ecosystems, reducing foraging resources. Of direct relevance to the birds of Western Port is the impact of oil spills on the productivity of intertidal mudflats (with or without seagrass), mangroves and saltmarsh.

While there have been numerous studies of the direct, short-term impacts of oil spills on birds and other animals, such as mortality in the weeks and months after a spill, there have been relatively few studies to examine the long-term direct and indirect impacts of oil spills on individuals, populations and ecosystems.

Direct impacts

The main direct impact of oil on birds is through matting of waterproof feathers which allows water to displace air trapped between the feathers and skin, reducing buoyancy and insulation (Samiullah 1985). Birds which do not sink and drown must increase their metabolic rate to reduce heat loss. Severely oiled birds may be unable to forage efficiently, causing rapid depletion of fat reserves and muscular energy resources, leading to death. Birds often suffer higher casualties than other vertebrates. For example, Antonio *et al* (2011) found that birds suffered higher mortality rates than turtles or mammals as a result of the 2010 Deep Water Horizon oil spill in the Gulf of Mexico.

Fumes from freshly spilled oil are often toxic and birds may ingest sufficient amounts of oil in preening attempts to cause intestinal irritation, damage to the liver and kidneys, reduced reproduction and immunosuppression. However, Samiullah (1985) noted that many oiled seabirds are likely to drown or die from hypothermia before these pathological changes occur. A species' chance of surviving plumage oiling is largely determined by the amount of time it must spend foraging and living near the surface of the water (Jenssen 1994). Diving birds (e.g. penguins, grebes, cormorants, diving ducks) have been shown to suffer greater direct impacts than surface feeding taxa (e.g. shorebirds) and nearshore groups have been shown to suffer greater impacts than offshore groups (Lance *et al* 2001). Ducks and swans that congregate in estuaries and intertidal areas are also particularly vulnerable to oil spills.

Typically penguins are the birds most affected by oil spills as: they spend greater amounts of time in the water than flying birds; are possibly less able to detect oil at sea; and even small amounts of oil on the plumage causes water logging, reducing insulation and buoyancy (Goldsworthy *et al* 2000). Goldsworthy *et al* (2000) examined the impacts on wildlife of a 325 tonne spill of bunker fuel oil from the *Iron Baron* at the mouth of the Tamar River in northern Tasmania in 1995. They estimated that between 10 000 and 20 000 Little Penguin were killed. They also commented that despite the relatively small amount of oil spilt by the *Iron Baron*, the impact on penguin populations was extensive.

The long-term impacts of oil consumption on the health of individual birds and on bird populations are not well understood. Shorebirds may ingest oil by foraging in contaminated habitats and may consume contaminated prey leading to a range of lethal or sub-lethal effects (Henkel *et al* 2012). Aside from the long-term sub-lethal impacts, Henkel *et al* (2012) hypothesized that migratory birds foraging in oil-affected areas might also delay migration as reductions in food availability increase the time taken to accumulate the fat reserves necessary for migration. Delayed migration will then impact on subsequent breeding success as birds arrive late to their breeding grounds.

Indirect impacts

The recovery of ecosystems impacted by spills requires re-colonisation of species once the toxicity or other damaging properties of the oil have declined to tolerable levels (Kingston 2002). In general, exposed shores recover more quickly than sheltered shores because wave action removes oil. Reports of full recovery occurring within three to four years are not uncommon for rocky shores. However, saltmarsh and subtidal ecosystems may take as long as 15 years to recover (Kingston 2002).

Schlacher *et al* (2010) studied the impact of a 270 tonnes spill of heavy fuel oil from the *Pacific Adventurer* off Moreton Island, Queensland in 2009 on the macrobenthos of sandy beaches. They found that sandy beaches that were affected by oil had significantly lower total abundance, density and diversity of benthic invertebrates than non-oil affected beaches three months after the spill, despite the fairly rapid removal of oil. While no detectable oil remained in the sediments three months after the spill, ecological recovery had not occurred.

In a related study of the impacts of the *Pacific Adventurer* oil spill on birds, Wells (2010) found that oil affected beaches on Moreton and Bribie Island supported fewer species of bird than non-oil affected beaches up to 21 months after the spill. Overall, oil affected beaches on Moreton and Bribie Islands supported an average of six and five species, respectively, compared with non oil affected beaches that supported an average of fourteen and twelve species, respectively. Wells (2010) hypothesised that the reduction in the diversity of species present on oil-affected beaches was most likely due to disruption of the food chain resulting from the combined impacts of the oil spill and subsequent efforts to remove oil from the beaches.

In 2002, the oil tanker *Prestige* sank off the Galician coast (north-west Spain), spilling 77,000 tonnes of heavy oil. Huz *et al* (2005) examined the diversity and abundance of animals (polychaetes, molluscs, marine crustaceans, semi terrestrial crustaceans, insects and others) in the top 15 cm of beach sand. Of the seventeen beaches analysed, the most affected beaches lost up to 66.7 per cent of species richness after the oil spill and a decrease in the number of species was observed on all but one of the beaches studied.

Oil spills may have long-lasting impacts on bird populations. In a study of the impacts of the *Exxon Valdez* oil spill in Prince William Sound, Alaska, Lance *et al* (2001) found that populations of most bird species that had been impacted by the spill had not recovered nine years after the spill. They found that oil persisted in some areas of Prince William Sound, some of it in a relatively unweathered state that was a source of contamination for mussel and other intertidal organisms. They considered that a number of mechanisms might be operating to impede the recovery of bird populations, including persistent direct oil spill effects and lowered productivity of the environment.

Impacts on seagrass

Kirkman (2013) states that while oil will adhere to seagrass, leading the loss of oiled blades, most seagrasses will grow new leaves unless sediments are heavily oiled. However, many animals that are directly dependent on seagrass are highly sensitive to oil and may suffer high mortality rates, leading to a reduction in food resources for many birds that forage in intertidal areas.

Impacts on mangroves

Samiullah (1985) states that severe oiling can result in the death of mangroves in 48 to 72 hours. This is reiterated in Kirkman (2013) who states that oil will immediately kill mangrove seedlings, and pneumatophores covered in oil can lead to the death of mangrove trees. Kirkman (2013) also notes that as mangroves in Western Port are at the southern limit of their distribution, they are already under stress and an oil spill could have serious consequences. Samiullah (1985) also notes that mangroves and their attendant fauna may suffer long-term, chronic effects of oil pollution. In this stressed condition, mangroves are more vulnerable to any additional environmental stressors.

Likely impacts of oil spills on birdlife in Western Port

It is difficult to make definitive statements about the potential impact of an individual oil spill scenario on fauna because a range of climatological, physical, biological and chemical factors, aside from the total volume and type of oil spilled, will determine the extent and nature of impacts. However, we have made a relative assessment of the potential impact of three oil spill scenarios on bird habitat in Western Port based on the modelling of Asia-Pacific ASA (2013).

Methodology

The potential impact of an oil spill on birds and their habitat at a particular site was assumed to be a function of:

- the spatial distribution of bird habitat within Western Port;
- the relative importance of habitat to birds (categorised as Higher, Moderate or Lower based on the work of Hansen *et al* (2011), Hansen (2011) and Dann (2012)); and
- the probability (P) that bird habitat would be exposed to surface oil (Heavy Fuel Oil or diesel) at a level exceeding 25 g/m^2 according to the modelling of Asia-Pacific ASA (2013), where: high = P>50%, moderate = 20%<P<49%, low = 1%<P<19%, very low = P<1%.

Each site was then allocated a likely impact score based on the combination of its value to birds and the probability that it would be exposed to surface oil exceeding 25 g/m^2 under each scenario (Table 1).

Table 1: Scoring system used to indicate the potential impact of exposure to surface oil exceeding 25 g/m^2 at sites in Western Port.

Relative importance of habitat to birds	Probability of exposure to surface oil exceeding 25 g/m^2	Likely level of impact on birdlife
Higher	High	Very High
Higher	Moderate	High
Higher	Low	Moderate – High
Higher	Very Low	Moderate – Low
Moderate	High	High
Moderate	Moderate	Moderate – High
Moderate	Low	Moderate – Low
Moderate	Very Low	Low
Lower	High	Moderate – High
Lower	Moderate	Moderate – Low
Lower	Low	Low
Lower	Very Low	Very Low

The results of this analysis are shown in the Appendix (Table 3). For example, the Long Island Spit is known to be an important roost site for Eastern Curlew (Hansen 2011). There is a high probability (H) that the site would become contaminated by oil exceeding 25 g/m^2 if an oil spill occurred at Long Point jetty. Therefore the Eastern Curlew population of Western Port is at very high risk of being impacted under this scenario. However, Long Island Spit is of lower value for other migratory shorebirds, so despite the high probability (H) of Long Island Spit becoming contaminated by oil exceeding 25 g/m^2, migratory shorebirds other than Eastern Curlew are only at a moderate-high risk under this scenario.

This should be seen as a qualitative, subjective assessment to indicate levels of concern about the potential risk to birdlife under each oil spill scenario. It is primarily an assessment of short-term risk because the oil spill modelling considers the movement of oil in the first two weeks of a spill and not the potential for contamination over the longer term. Thus, the risk to high value shorebird sites that are more distant from Long Point jetty or McHaffie's Reef, such as those in the Upper North Arm (e.g. Yallock Creek Mouth) and the Corinella Segment (e.g. Pioneer Bay), may be greater than indicated in this analysis. The results of this analysis are shown in the Appendix (Table 3).

Spill of Heavy Fuel Oil at Long Point Jetty

A spill of Heavy Fuel Oil at Long Point jetty in summer would pose a high risk to important shorebird foraging and roosting habitat in the vicinity of Long Point, Middle Spit and along the western and north-western coastline of French Island, including Barrallier Island. Shorebirds that continue to forage in intertidal areas after the spill would be at high risk of ingesting contaminated food which may have lethal or sub-lethal impacts. They would also be at risk of partial oiling. Migratory shorebirds that forage in contaminated sediments or that experience oiling of feathers are likely to have reduced fitness for migration i.e. they would be less likely to undergo a successful migration back to their breeding grounds and/or may have reduced reproductive fitness. Species at risk include Red-necked Stint, Eastern Curlew, Curlew Sandpiper, Crested Tern and Australian Pied Oystercatcher.

It is possible that migratory shorebirds would abandon areas affected by oil and move to other sites in Western Port such as Stockyard Point. This would increase pressure on the foraging and roosting resources at these sites.

Seabirds such as cormorants and grebes foraging in the waters of Lower North Arm would be at high risk of oiling. It is likely that large numbers of these birds would die because not all oiled birds would be caught for rehabilitation (Goldsworth *et al* 2000). Large numbers of swans and ducks would also be at high risk of partial oiling. This would have a range of impacts including the need for birds to increase their intake of food to reduce the risk of hypothermia. Partial oiling can lead to a slow decline as oiled birds are unable to forage efficiently, causing rapid depletion of fat reserves and muscular energy resources, leading to death.

A spill of Heavy Fuel Oil at Long Point jetty in winter would have similar impacts on seabirds and waterbirds as a summer spill. However, seabirds foraging in the Confluence zone and Rhyll segment would be at increased risk from a winter spill in comparison with a summer spill as oil is more likely to move south out of Lower North Arm in winter.

A spill of Heavy Fuel Oil at Long Point jetty in winter also poses a high risk to shorebird foraging and roosting areas in the vicinity of Long Point, Middle Spit and along the western and north-western coastline of French Island, including Barrallier Island. While numbers of migratory shorebirds would be low, overwintering (usually juvenile) migratory shorebirds and Double-banded Plover and resident shorebirds such as Australian Pied Oystercatcher would be at risk.

Long term contamination of sediments and impacts on seagrass beds would lead to long-term impacts on the productivity of these important foraging and roosting sites (see below).

Spill of Heavy Fuel Oil at McHaffie's Reef

A spill of Heavy Fuel Oil at McHaffie's Reef (western coastline of Phillip Island) in summer would pose a high risk to shorebird foraging and roosting habitat in the vicinity of Middle Spit and along the western and north-western coastline of French Island, including Barrallier Island. It would also pose a high risk to seabirds foraging in Lower North Arm, the Confluence Zone, the Western Entrance Segment and the Rhyll Segment and to Little Penguin in the waters and on the beaches of Summerland Peninsula. While these waters are not important foraging grounds for Little Penguin, birds must use these waters when travelling to and from their burrows on Summerland Peninsula for much of the year (except the moulting period between February and April). As such, a summer spill of Heavy Fuel Oil at McHaffie's Reef is likely to affect a large number of Little Penguin, particularly if the oil travels along the northern shore of the Summerland Peninsula.

A spill of Heavy Fuel Oil at McHaffie's Reef in winter would have a moderate risk of impacting on important shorebird foraging sites in Lower North Arm because the oil is more likely to move south under the influence of southerly winds. A winter spill would also pose a high risk to seabirds foraging in Lower North Arm, the Confluence Zone, the Western Entrance Segment and the Rhyll Segment and to Little Penguin off Summerland Peninsula.

Spills of Heavy Fuel Oil at McHaffie's Reef in winter or summer would present a moderate risk to Black Swan and other waterfowl. This would have a range of impacts including the need for birds to increase their intake of food to reduce the risk of hypothermia. Partial oiling can lead to a slow decline as oiled birds are unable to forage efficiently, causing rapid depletion of fat reserves and muscular energy resources, leading to death.

A spill of Heavy Fuel Oil at McHaffie's Reef in winter or summer would also affect resident Hooded Plover on the northern beaches of Phillip Island. These are important breeding areas for Hooded Plover, so an oil spill in spring or summer may have a large impact on their breeding success.

Diesel Spill at Long Point Jetty

A diesel spill at Long Point jetty would pose a high risk to shorebird foraging and roosting habitat in the vicinity of Long Point and a moderate risk to shorebird foraging and roosting habitat at Middle Spit and along the western and north-western coastline of French Island, including Barrallier Island. While a summer spill would present an immediate, high risk to large numbers of migratory shorebirds, small numbers of overwintering (usually juvenile) migratory shorebirds would be at risk from a winter spill and there is a high risk of long-term of contamination of important foraging sites on the western and north-western coastline of French Island for these species.

Seabirds such as cormorants and grebes foraging in the waters of Lower North Arm would be at high risk of oiling. It is likely that large numbers of these birds would die if not taken to rehabilitation centres quickly. Large numbers of swans and ducks would also be at high risk of partial oiling. This would have a range of impacts including the need for birds to increase their intake of food to reduce the risk of hypothermia.

A spill of diesel at Long Point jetty in winter would have similar impacts on seabirds and waterbirds as a summer spill. Seabirds foraging in the Confluence zone and Rhyll segment would be at increased risk from a winter spill in comparison with a summer spill as oil is more likely to move south out of Lower North Arm in winter.

Long-Term Impacts

Previous studies indicate that oil spills can have long-term impacts on foraging resources in intertidal areas, leading to a decreased diversity of birds at oiled sites (see discussion above). There is potential for both summer and winter spills to have long-term, negative impacts on bird populations in Western Port, particularly at Long Point, Middle Spit and along the western and north-western coastline of French Island, including Barrallier Island.

It is likely that any oil spill will lead to the loss of mangroves along the western shoreline and the western and north-western coastline of French Island (Kirkman 2013), leading to the loss of mangrove-associated invertebrates. This may impact on foraging resources for large wading birds, particularly in the intertidal areas near Watson Inlet. Any loss of mangroves may also make the associated saltmarsh more vulnerable to erosion.

Asia-Pacific ASA (2013) discusses the potential for long-term contamination of sediments from both Heavy Fuel Oil and diesel, indicating that the low volatility and high viscosity of Heavy Fuel Oil mean that it can persist in the environment for decades (pg 94).

Previous attempts to conduct such clean-ups after major spills of heavy oils that resulted in contamination of soft-sediment habitats and other shorelines have proven to be limited in effectiveness, even with very high resourcing and associated costs (Bryner 2010). Past events of a similar nature to those represented in the modelling also indicate the high potential for long term legacy effects lasting multiple decades due to slow leaching of oil from contaminated sediments that remain despite these efforts (e.g. Peterson 2003).

The indications from the modelling that large areas of shoreline might be affected by a single spill event suggests that the effort and cost of this effort would also be high in the setting of Western Port Bay, while the nature of the sensitive habitats suggest that long term contamination of areas that receive heavy fuel oil would be highly likely.

The 270 km^2 of intertidal mudflats of Western Port, that provide foraging resources for thousands of shorebirds and waterbirds, are at high risk of extensive, long-term contamination from any oil spill. In particular, the potential for a single oil spill to have serious short- and long-term impacts on migratory shorebird populations in Western Port is of great concern because: Western Port is one of the most important sites for these birds in Victoria; this group is under considerable pressure throughout their range and their populations are known to be declining.

Even a moderate oil spill such as those described in the Asia-Pacific ASA report is likely to have a significant, negative impact on the productivity of Western Port, reducing its value as an important site for aquatic birds.

Impacts from increased vessel use of Western Port

As discussed in Kirkman (2013), any increase in vessel use of Western Port will lead to an increase in vessel generated waves on either side of the channel. Vessel generated waves can lead to sustained increases of turbidity in the near shore region, reducing the productivity of seagrass beds and eroding shorelines. Areas of concern include Crib Point, western French Island and the western entrance channel on Phillip Island (Kirkman 2013).

Any reduction in the productivity or extent of seagrass beds is likely to have an impact on the foraging resources of aquatic birds in western Western Port including swans, ducks, fishers and shorebirds. Given the strong link between the loss of seagrass beds in Western Port in the late 1970s and early 1980s and the decline in a number of aquatic birds in Western Port including Black Swan and a number of fishers, any loss of seagrass beds (e.g. through reclamation, increased turbidity, erosion, oil spills) associated with the proposed expansion of the Port of Hastings is of concern.

Of major concern is the potential for vessel generated waves to have erosion impacts on Middle Spit and important shorebird foraging and roosting sites along the western shoreline of French Island and at Long Point. Any loss of the high tide roost at Long Point through erosion would impact on Eastern Curlew and Red-necked Stint. Australian Pied Oystercatcher may lose both breeding and foraging habitat through erosion impacts on Long Island, Middle Spit and western French Island. As noted by Hansen *et al* (2011), any loss of or damage to high tide roost sites would have a disproportionate, negative impact on shorebirds using Western Port.

Impacts of land reclamation and dredging in Western Port

The areas likely to be reclaimed at Stage 1 of the Port Expansion are described in the report prepared by AECOM for the Port of Hastings Corporation (AECOM 2009). CEE (2009) states that Stage 1 will result in the removal of between 1.8 and 3 million cubic metres of surplus dredge material which will most likely be composed of clay and fine sediments. Reclamation and dredging may also expose acid sulphate soils leading to fish kills, heavy-metal contamination and long-term denudation of exposed areas (Kirkman 2013).

Dredging is likely to result in large dredge plumes that may reduce light to benthic habitats (Kirkman 2013), reducing productivity of seagrass beds and populations of benthic fauna, which would impact on foraging resources for aquatic birds. The magnitude of the impact on aquatic birds is difficult to assess with the information currently available. However it is highly likely that waterfowl (particularly Black Swan) and fishers would be affected by any decrease in the extent and productivity of seagrass beds associated with dredging and disposal of dredge spoil. As noted by Kirkman (2013), seagrasses are renowned for their inability to be regrown or restored, so any reduction in the extent and productivity of seagrass beds is likely to lead to a decline in a number of aquatic birds in Western Port including Black Swan and a number of fishers.

Options for disposal of the surplus dredge material include Western Port or offshore. Disposal of dredge spoil within Western Port would cover 100 hectares of seafloor and will lead to higher levels of turbidity and associated reductions in seagrass bed productivity within Western Port than offshore disposal. While offshore disposal of dredge spoil is less likely to impact on the birdlife of Western Port it could have profound effects on ecosystems in Bass Strait.

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Appendix

Table 2: Aquatic birds recorded in Western Port between 1998 and 2013, including information on species' listing under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC), Victoria's *Flora and Fauna Guarantee Act 1988* (FFG), on the *Advisory List of Threatened Vertebrate Fauna in Victoria 2013* (Advisory List) and under international agreements including Australia's bilateral migratory bird agreements with Japan (JAMBA), China (CAMBA), Republic of Korea (ROKAMBA) and the Bonn Convention. Source: BirdLife Australia's *Atlas of Australian Birds*.

Common Name	Scientific Name	EPBC	FFG	Advisory List	JAMBA, CAMBA, ROKAMBA, Bonn
Magpie Goose	*Anseranas semipalmata*		L	NT	
Musk Duck	*Biziura lobata*			VU	
Freckled Duck	*Stictonetta naevosa*		L	EN	
Cape Barren Goose	*Cereopsis novaehollandiae*				
Black Swan	*Cygnus atratus*				
Australian Shelduck	*Tadorna tadornoides*				
Australian Wood Duck	*Chenonetta jubata*				
Pink-eared Duck	*Malacorhynchus membranaceus*				
Australasian Shoveler	*Anas rhynchotis*			VU	
Grey Teal	*Anas gracilis*				
Chestnut Teal	*Anas castanea*				
Northern Mallard	*Anas platyrhynchos*				
Pacific Black Duck	*Anas superciliosa*				
Hardhead	*Aythya australis*			VU	
Blue-billed Duck	*Oxyura australis*		L	EN	
Australasian Grebe	*Tachybaptus novaehollandiae*				
Hoary-headed Grebe	*Poliocephalus poliocephalus*				
Great Crested Grebe	*Podiceps cristatus*				
Short-tailed Shearwater	*Ardenna tenuirostris*	M			J R
Fluttering Shearwater	*Puffinus gavia*				
Little Penguin	*Eudyptula minor*				
Australasian Gannet	*Morus serrator*				
Australasian Darter	*Anhinga novaehollandiae*				
Little Pied Cormorant	*Microcarbo melanoleucos*				
Great Cormorant	*Phalacrocorax carbo*				
Little Black Cormorant	*Phalacrocorax sulcirostris*				
Pied Cormorant	*Phalacrocorax varius*			NT	
Black-faced Cormorant	*Phalacrocorax fuscescens*			NT	
Australian Pelican	*Pelecanus conspicillatus*				
Australasian Bittern	*Botaurus poiciloptilus*	EN	L	EN	
Australian Little Bittern	*Ixobrychus dubius*		L	EN	
White-necked Heron	*Ardea pacifica*				

Common Name	Scientific Name	EPBC	FFG	Advisory List	JAMBA, CAMBA, ROKAMBA, Bonn
Great Egret	*Ardea alba*	M	L	VU	J C
Intermediate Egret	*Ardea intermedia*		L	EN	
Cattle Egret	*Ardea ibis*	M			J C
White-faced Heron	*Egretta novaehollandiae*				
Little Egret	*Egretta garzetta*		L	EN	
Nankeen Night-Heron	*Nycticorax caledonicus*			NT	
Australian White Ibis	*Threskiornis molucca*				
Straw-necked Ibis	*Threskiornis spinicollis*				
Royal Spoonbill	*Platalea regia*			NT	
Yellow-billed Spoonbill	*Platalea flavipes*				
Purple Swamphen	*Porphyrio porphyrio*				
Lewin's Rail	*Lewinia pectoralis*		L	VU	
Buff-banded Rail	*Gallirallus philippensis*				
Baillon's Crake	*Porzana pusilla*		L	VU	
Australian Spotted Crake	*Porzana fluminea*				
Black-tailed Native-hen	*Tribonyx ventralis*				
Dusky Moorhen	*Gallinula tenebrosa*				
Eurasian Coot	*Fulica atra*				
Australian Pied Oystercatcher	*Haematopus longirostris*				
Sooty Oystercatcher	*Haematopus fuliginosus*			NT	
Black-winged Stilt	*Himantopus himantopus*				
Red-necked Avocet	*Recurvirostra novaehollandiae*				
Banded Stilt	*Cladorhynchus leucocephalus*				
Pacific Golden Plover	*Pluvialis fulva*	M		VU	B J C R
Grey Plover	*Pluvialis squatarola*	M		EN	B J C R
Red-capped Plover	*Charadrius ruficapillus*				
Double-banded Plover	*Charadrius bicinctus*	M			B
Lesser Sand Plover	*Charadrius mongolus*	M		CR	B J C R
Greater Sand Plover	*Charadrius leschenaultii*	M		CR	B J C R
Black-fronted Dotterel	*Elseyornis melanops*				
Hooded Plover	*Thinornis rubricollis*		L	VU	
Red-kneed Dotterel	*Erythrogonys cinctus*				
Banded Lapwing	*Vanellus tricolor*				
Masked Lapwing	*Vanellus miles*				
Latham's Snipe	*Gallinago hardwickii*	M		NT	B J C R
Black-tailed Godwit	*Limosa limosa*	M		VU	B J C R
Bar-tailed Godwit	*Limosa lapponica*	M			B J C R
Whimbrel	*Numenius phaeopus*	M		VU	B J C R

Common Name	Scientific Name	EPBC	FFG	Advisory List	JAMBA, CAMBA, ROKAMBA, Bonn
Eastern Curlew	*Numenius madagascariensis*	M		VU	B J C R
Terek Sandpiper	*Xenus cinereus*	M	L	EN	B J C R
Common Sandpiper	*Actitis hypoleucos*	M		VU	B J C R
Grey-tailed Tattler	*Tringa brevipes*	M	L	CR	B J C R
Common Greenshank	*Tringa nebularia*	M		VU	B J C R
Ruddy Turnstone	*Arenaria interpres*	M		VU	B J C R
Great Knot	*Calidris tenuirostris*	M	L	EN	B J C R
Red Knot	*Calidris canutus*	M		EN	B J C R
Sanderling	*Calidris alba*	M		NT	B J C R
Little Stint	*Calidris minuta*	M			B R
Red-necked Stint	*Calidris ruficollis*	M			B J C R
Pectoral Sandpiper	*Calidris melanotos*	M		NT	B J R
Sharp-tailed Sandpiper	*Calidris acuminata*	M			B J C R
Curlew Sandpiper	*Calidris ferruginea*	M		EN	B J C R
Arctic Jaeger	*Stercorarius parasiticus*	M			J R
Little Tern	*Sternula albifrons*	M	L	VU	B J C R
Fairy Tern	*Sternula nereis*	VU	L	EN	
Gull-billed Tern	*Gelochelidon nilotica*		L	EN	
Caspian Tern	*Hydroprogne caspia*	M	L	VU	J C
Whiskered Tern	*Chlidonias hybrida*			NT	
Common Tern	*Sterna hirundo*	M			J C R
Crested Tern	*Thalasseus bergii*				
Pacific Gull	*Larus pacificus*			NT	
Kelp Gull	*Larus dominicanus*				
Franklin's Gull	*Leucophaeus pipixcan*				
Silver Gull	*Chroicocephalus novaehollandiae*				

M = listed migratory species, L = listed, CR = Critically Endangered, EN = Endangered, V = Vulnerable, NT = Near Threatened, J = JAMBA, C = CAMBA, R = ROKAMBA, B = Bonn Convention.

Table 3: Potential impacts of three oil spill scenarios modelled by APASA (2013) on birdlife in Western Port. The relative values of each site or area to birdlife (2nd column) are based on the work of [A]Hansen *et al* (2011), [B]Hansen (2011) and [C]Dann (2012). In columns 4 to 9, letters indicates the probability (P) of oil films >25 g/m^2 arriving at the site according to the oil spill modeling of Asia-Pacific ASA (2013) where H = high (P>50%), M = moderate (20%<P<49%), L = low (1%<P<19%), VL = very low (P<1%).
The colour of cells in columns 4 to 9 indicate the overall risk of impact on relevant habitat and/or bird values under each oil spill scenario where:

Very High	High	Moderate – High	Moderate – Low	Low	Very Low

Shoreline or intertidal area			HFO Spill Long Point		HFO Spill McHaffies Reef		Diesel Spill Long Point	
Higher Value Sites	**Habitat value**	**Affected bird group/species**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
Long Island & Port	[B]High tide roost	Eastern Curlew, Australian Pied Oystercatcher, Crested Tern	H	H	L	L	M	M
Long Island & Port	[B]Low tide foraging	Red-necked Stint, Double-banded Plover, White-faced Heron	H	H	L	L	M	M
Long Island & Port	[B]Roost	Pied Cormorant, Little Pied Cormorant	H	H	L	L	M	M
Western Shoreline	[B]Roost sites (Yaringa)	Pacific & Silver Gulls	M	L	L	VL	L	L
Middle Spit	[B]Low tide roost	Pied Cormorant, Little Pied Cormorant	M	M	M	L	L	L
Middle Spit	[B]Low tide foraging/roosting	Migratory shorebirds, Australian Pied Oystercatcher (Max)	M	M	M	L	L	L
Western French Island	[B]Foraging	Black Swan, Chestnut Teal, Australian Shelduck	M	M	M	L	L	L
Western French Island	[B]Low tide foraging	Red-necked Stint, Straw-necked Ibis (Max)	M	M	M	L	L	L
Western French Island	[B]Breeding habitat	Australian Pied Oystercatcher	M	M	M	L	L	L
Barrallier Island	[A]High tide roost	Migratory shorebirds, particularly Curlew Sandpiper	M	M	M	L	L	L
NW French Island	[B]Foraging	Black Swan, Chestnut Teal, Pacific Black Duck, Australian Shelduck	M	M	M	L	L	L
NW French Island	[B]Low tide foraging	Red-necked Stint, Curlew Sandpiper, Straw-necked Ibis (Max)	M	M	M	L	L	L
NW French Island	[B]Breeding habitat	Australian Pied Oystercatcher	M	M	M	L	L	L
Pioneer Bay/Stockyard Point	[A]High tide roost	Migratory shorebirds	L	L	VL	VL	VL	VL
Pioneer Bay/Stockyard Point	[A]Low tide foraging	Migratory shorebirds	L	L	VL	VL	VL	VL
Bunyip River/Yallock Creek	[A]High tide roost	Migratory shorebirds	L	VL	VL	VL	VL	VL
Bunyip River/Yallock Creek	[A]Low tide foraging	Migratory shorebirds	L	VL	VL	VL	VL	VL
Summerland Peninsula	[C]Breeding habitat	Little Penguin	L	L	M	M	VL	VL

Table 3 (cont'd): Potential impacts of three oil spill scenarios modelled by APASA (2013) on birdlife in Western Port. The relative values of each site or area to birdlife (2nd column) are based on the work of [A]Hansen *et al* (2011), [B]Hansen (2011) and [C]Dann (2012). In columns 4 to 9, letters indicates the probability (P) of oil films >25 g/m^2 arriving at the site according to the oil spill modeling of Asia-Pacific ASA (2013) where H = high (P>50%), M = moderate (20%<P<49%), L = low (1%<P<19%), VL = very low (P<1%).
The colour of cells in columns 4 to 9 indicate the overall risk of impact on relevant habitat and/or bird values under each oil spill scenario where:

Very High	High	Moderate – High	Moderate – Low	Low	Very Low

Shoreline or intertidal area	Habitat value	Affected bird group/species	HFO Spill Long Point		HFO Spill McHaffies Reef		Diesel Spill Long Point	
			Summer	Winter	Summer	Winter	Summer	Winter
Moderate Value Sites								
Western Shoreline	[B]Low tide foraging	Large waders	M	M	L	L	L	L
Western French Island (Fairhaven/Chilcott Rocks)	[A]High tide roost	Australian Pied Oystercatcher, Red-necked Stint	M	M	L	L	L	L
Reef Island/Bass Bay	[A]High tide roost	Migratory shorebirds	L	L	L	L	VL	VL
Tortoise Head	[A]High tide roost	Migratory shorebirds	L	M	M	L	L	L
Observation Point/Ghetto Rocks/Rhyll Inlet	[A]High tide roost	Migratory shorebirds	L	L	M	M	VL	VL
Warneet channel & Long reef	[A]High tide roost	Migratory shorebirds	M	L	L	L	L	L
Rams Island	[A]High tide roost	Migratory shorebirds	L	L	M	L	VL	VL
Tooradin	[A]High tide roost	Migratory shorebirds	M	L	L	VL	VL	VL
Sandy Point/Hanns Inlet	[A]High tide roost	Migratory shorebirds	L	M	L	VL	VL	VL
Lower Value Sites								
Hasting Bight	[A]High tide roost	Migratory shorebirds	M	M	L	L	L	L
Hasting Bight	[B]Low tide foraging	Migratory shorebirds	M	M	L	L	L	L
Long Island & Port	[A]High tide roost	Migratory shorebirds (excluding Eastern Curlew)	H	H	L	L	M	M
Warneet	[B]High tide roost	Migratory shorebirds	M	M	L	L	L	L
Western Shoreline	[B]High tide roost	Migratory shorebirds	M	L	L	L	L	L
Western Shoreline	[B]Low tide foraging	Migratory shorebirds	M	L	L	L	L	L
Settlement Road	[A]High tide roost	Migratory shorebirds	L	VL	L	VL	VL	VL
Churchill Island	[A]High tide roost	Migratory shorebirds	L	M	L	L	VL	VL
Bluegum Point	[A]High tide roost	Migratory shorebirds	L	L	L	VL	VL	VL
Queensferry	[A]High tide roost	Migratory shorebirds	L	L	L	VL	VL	VL

Table 3 (cont'd): Potential impacts of three oil spill scenarios modelled by APASA (2013) on birdlife in Western Port. The relative values of each site or area to birdlife (2nd column) are based on the work of [A]Hansen *et al* (2011), [B]Hansen (2011) and [C]Dann (2012). In columns 4 to 9, letters indicates the probability (P) of oil films >25 g/m^2 arriving at the site according to the oil spill modeling of Asia-Pacific ASA (2013) where H = high (P>50%), M = moderate (20%<P<49%), L = low (1%<P<19%), VL = very low (P<1%).
The colour of cells in columns 4 to 9 indicate the overall risk of impact on relevant habitat and/or bird values under each oil spill scenario where:

Very High	High	Moderate – High	Moderate – Low	Low	Very Low

Water based values - foraging seabirds		**HFO Spill Long Point**		**HFO Spill McHaffies Reef**		**Diesel Spill Long Point**	
Higher Value Area	**Affected bird group/species**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
Western Entrance Segment	[C]Seabirds e.g. albatrosses, Crested Tern, Australasian Gannett, Short-tailed Shearwater	L	L	H	H	L	L
Confluence Zone	[C]Cormorants, grebes	L	M	H	H	L	L
Rhyll segment	[C]Seabirds e.g. albatrosses, Crested Tern, Australasian Gannett, Short-tailed Shearwater	L	M	M	M	L	L
Lower North Arm	[C]Cormorants, grebes	H	H	M	L	M	M
Upper North Arm	[C]Cormorants, grebes	L	L	VL	VL	L	L
Corinella Segment	[C]Cormorants, grebes	VL	VL	VL	VL	VL	VL
Lower Value Area							
Western Entrance Segment	[C]Little Penguin	L	L	H	H	L	L
Confluence Zone	[C]Little Penguin	L	M	H	H	L	L
Lower North Arm	[C]Little Penguin	H	H	M	L	M	M