Before the Board of Inquiry
Hauauru Ma Raki Wind Farm Proposal

Under	the Resource Management Act 1991
In the matter of	Resource consent applications by Contact Wind Limited relating to the Hauauru Ma Raki Wind Farm Proposal
And	
In the matter of	Notices of Requirement and a Resource Consent Application by Contact Energy Limited relating to the Hauauru Ma Raki Wind Farm Proposal

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Statement of evidence in chief of ***John Edward Dowding***

Dated: 27 March 2009

Date of hearing: Commencing 27 April 2009

Director-General of Conservation

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INTRODUCTION

1 My name is John Edward Dowding. I hold the degrees of BSc, MSc, and PhD in Biological Sciences and have 25 years of experience surveying, monitoring, managing and undertaking research on New Zealand birds, particularly coastal and riverbed species. For the past 19 years, I have worked as an independent wildlife scientist and ecological consultant.

2 I have undertaken extensive research on endemic New Zealand shorebirds, including detailed studies on New Zealand dotterels, wrybills, variable oystercatchers, and shore plovers. Most of these studies have been designed to assist with conservation management decisions for these Threatened or At Risk species.

3 In the case of New Zealand dotterels, I have studied many aspects of the ecology of the species, including breeding biology and success, juvenile dispersal, adult survival and movement patterns, and changes in distribution and numbers nationally, particularly in response to management. I have been science adviser to the New Zealand Dotterel Recovery Group since its inception 17 years ago. I wrote both recovery plans for the species, and in 1994 I described the North Island and Stewart Island populations as distinct subspecies (Dowding 1994). I co-ordinate national censuses and the banding programme for the species.

4 I have undertaken research on wrybills for the past 12 years, notably during a 3-year study of breeding success in relation to management in the Mackenzie Basin between 1997 and 2000. More recently, I have been advising the Department of Conservation (DOC)'s Southern Regional Office on survey methodologies for wrybills, assessing the changing breeding distribution of the species as part of the Department's Biodiversity Inventory and Monitoring Scheme, and modelling demographic data collected during the Mackenzie Basin study. I have also been closely involved with national recovery programmes for New Zealand shore plover and Chatham Island oystercatcher over the past 16 years; this work has included monitoring of survival and

breeding success, modelling of population trends for both species in response to management actions, and advising on management strategies.

5 I have also undertaken research on the ecology of introduced mammalian predators (including radio-telemetry studies of stoats, cats, ferrets and rats) and the impacts these predators have on native shorebirds.

6 The results of my research have been published in more than 30 papers in scientific journals and in about 160 reports, popular articles, statements of evidence and conference papers. Of significance here is a detailed review that I compiled of the habitat networks of indigenous shorebirds in New Zealand, published in 2006 (Dowding & Moore 2006).

7 In 2005/06, I was a member of the expert panel that DOC assembled to review biodiversity provisions as part of the review of the New Zealand Coastal Policy Statement. For the past 5 years, I have been a member of DOC's expert panel that assesses the threat classifications of all New Zealand birds. I have provided advice to the Auckland Regional Council on management of shorebirds in regional parks for many years, and to Environment Canterbury on management of threatened shorebirds in braided rivers. I conduct annual workshops on conservation management of shorebirds for regional council staff, DOC staff, and community groups.

8 I have undertaken many assessments of the potential impacts of a wide range of activities and developments on threatened shorebirds in many parts of New Zealand. Over the past 12 years I have provided evidence on many of these matters to planning hearings and Environment Court hearings. Assessments have included the potential impacts on shorebirds of subdivisions, marinas, a heliport, a marine farm, a wind farm, gravel extraction, sand extraction, motorway construction, and application of poison baits for pest eradication.

9 In particular, over the past three years I have provided advice to DOC in relation to the proposed Taharoa wind farm, located on the Waikato coast about 40 km south of Raglan. During that project, I advised on the monitoring methodology to be used, and undertook extended periods of fieldwork at

Taharoa and in the surrounding area in December 2006-January 2007, in August 2007, and in January 2008. As a member of the Advisory Group, I was closely involved in analysis of the results of that monitoring, and was one of the authors of the joint report (Fuller *et al*. 2009) that evaluated the risk of collision with turbines for various bird species at Taharoa. In particular, I undertook the shorebird population modelling included in the report.

10 I am familiar with the Hauauru Ma Raki (HMR) site. In December 2005, I surveyed the part of the coast around Waikorea and Waimai Streams, and banded New Zealand dotterels there. In March 2009, I drove around most of the public roads within the proposed site between Port Waikato and Te Akau South.

11 I have been provided with a copy of the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. I have read and agree to comply with that Code. Except where I state that I am relying on the specified evidence of another person, my evidence in this statement is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

12 I first became involved in this case in 2007, when I was asked by DOC's Waikato Conservancy to assess the potential for impacts on threatened shorebirds of the proposed HMR wind farm. I was also involved in assessing the monitoring methodology proposed by the applicant. More recently, I have been asked by the Department to review the current revised proposal, to assess the measures proposed by the applicant to address potential impacts, and to present evidence to this inquiry.

13 In making my assessment of the proposal and compiling my evidence, I have primarily considered the evidence to this inquiry of Kessels (2009), which includes the stage 1 monitoring report as Exhibit GK1A, the evidence of Seaton (2009), Tonks (2009), Daysh (2009), and Percival (2009), as well as

the Assessment of Ecological Effects (Kessels & Associates (2008), and the shorebird stage 2 monitoring report prepared by Kessels & Associates (2009). I have also used records from the scientific literature and unpublished observations from my own research. I have drawn on my experience in the Taharoa project, and on the report of the Expert Panel that assessed collision risk at Taharoa (Fuller *et al*. 2009).

14 In general, my evidence considers the numbers and conservation status of shorebird species using the proposed HMR site, and the potential impacts on them of the proposed development. It assesses the measures designed to avoid, remedy or mitigate those impacts. In particular, my evidence will focus on:

(a) the potential for collision risk to resident shorebirds, and the high level of uncertainty that exists,

(b) the population-level consequences for two migratory species (pied oystercatcher and wrybill) of the collision mortality predicted by Percival (2009), and

(c) the likely effectiveness or otherwise of the various avoidance and mitigation measures proposed by the applicant.

15 In defining the conservation status of bird taxa, I have used the revised national ranking scheme of Townsend *et al*. (2008). In this scheme, taxa may be placed (in decreasing order of threat) in one of three Threatened categories (Nationally Critical, Nationally Endangered, Nationally Vulnerable), one of four At Risk categories, or classified as Not Threatened. In conjunction with the new ranking scheme, I have used the most recent list of threat categories, compiled in May 2008 (Miskelly *et al*. 2008).

SUMMARY OF EVIDENCE

16 A range of resident shorebirds and coastal species are present on and adjacent to the proposed HMR wind farm site. Some of these, such as the northern New Zealand dotterel and the Caspian tern are Threatened. Others, such as the variable oystercatcher, pied stilt, and white-fronted tern, are considered At Risk.

17 The west coast of the North Island is a migration route for a range of internal and Arctic migrant shorebirds. Some or all of these may fly over or past the proposed HMR wind farm site. In the case of both the pied oystercatcher and the wrybill, a high proportion of the national population is involved. Other species using this route include banded dotterels, pied stilts, and bar-tailed godwits. Lesser (red) knots and a few black stilts may also use the route.

18 Assessing the potential risk of collision mortality to resident shorebirds is particularly difficult, because there is generally insufficient information on numbers, movement patterns, and behaviour.

19 Some information is available to allow a preliminary assessment of risk to migratory shorebirds. Using predicted collision rates calculated by Percival (2009), I have modelled population trends for pied oystercatchers and wrybills. These analyses indicate negative impacts of the proposed wind farm on both species.

20 Collection and analysis of further data for both resident and migratory shorebirds are essential for robust assessments of collision risk. In my opinion, there will be technical issues, mainly related to the limitations of human observers and radar, that make the collection of the required data difficult.

21 I have considered the various measures proposed by the applicant to avoid or mitigate for potential adverse impacts on shorebirds. Appropriate siting of turbines to avoid areas of high bird use is potentially a useful measure. However, in the case of migratory shorebirds, there is currently insufficient information available to identify such areas in the HMR site. Shutdown of turbines is also potentially a useful measure, but there are substantial detection issues with reactive shutdown, and proactive shutdown may result in turbines being shut down for extended periods. Off-site compensation for potentially increased mortality of birds has also been suggested. However, based on even the lower levels of mortality predicted by Percival (2009), replacement of pied oystercatchers through a management programme on the breeding grounds would be impractical, as it would require management over a very large area.

22 I conclude that there is insufficient information to assess collision risk for many resident and some migratory shorebirds. Where I have assessed population level impacts, they appear substantial. In my opinion, a decision on whether or not to grant consents at the present time would be largely an uninformed decision.

SHOREBIRDS USING THE WAIKATO COAST

23 Shorebirds using the Waikato coast can broadly be grouped into two categories - residents and migrants. Residents are those species that breed in the area and undertake local movements; these movements may be on a daily basis (e.g. to visit feeding or roosting areas), or may be seasonal, such as movements to and from post-breeding flock sites. Migrants are species that breed elsewhere and move along the Waikato coast, usually twice a year, as part of their annual migrations between their breeding and wintering areas. Migrants may be internal (i.e. species that breed and winter within New Zealand), or external (species that breed in the northern hemisphere and migrate to New Zealand for their non-breeding season). Internal migrants and resident shorebirds will be considered in my evidence, and external migrants will be considered in the evidence of Dr Battley (Battley 2009).

Resident shorebirds and coastal species

Variable oystercatcher (VOC, *Haematopus unicolor*)

24 This endemic species is found around the coastline of the North, South and Stewart Islands and their offshore islands. The current population is estimated to contain about 2000 pairs (Dowding & Moore 2006). About two-thirds of the population is found in the North Island, particularly in Northland, Coromandel Peninsula, and Bay of Plenty (Heather & Robertson 1996). The species is increasing in numbers, at least in some areas, and is classified as At Risk (Recovering A) (Miskelly *et al*. 2008), a ranking acknowledging that while it is recovering from a decline, it is still rare.

25 The total number of this species on the coast between Port Waikato and Raglan Harbour is not clear, but Kessels (2009) indicates that pairs occur an average of 1.7 km apart on part of the coast. If the same density occurs along the entire stretch of coast, there may be in the region of 20 pairs in the vicinity of the HMR site. This would constitute about 1% of the national population. While there appears to be no information on movement patterns of variable oystercatchers in the HMR area, observations of banded birds elsewhere suggest it is very likely that some oystercatchers breeding on the HMR coast will make feeding trips to nearby estuaries. They may also make seasonal movements to join post-breeding flocks, such as the one at Port Waikato. At Port Waikato on 14 March 2009, I counted 52 VOCs, including a post-breeding flock of 38 birds. Total winter counts at Port Waikato have been in the region of 70 birds (e.g. Tennyson & Lock 1998, 2000), indicating that they gather there from a considerable stretch of coastline.

Northern New Zealand dotterel (NZD, *Charadrius obscurus aquilonius*)

26 The endemic northern New Zealand dotterel is thinly spread around the coast of the North Island, mainly north of a line between Taranaki and Hawke's Bay. It is classified as Nationally Vulnerable and has the Conservation Dependent Qualifier, meaning that the taxon is likely to move to a higher threat category if current management ceases (Miskelly *et al*. 2008). In October 2004, the population numbered 1700 birds in total (Dowding & Moore 2006).

27 In the long term, NZD are dependent for their survival on management. There has been little management on the Waikato coast until recently, and the recovery plan lists management there as an 'Essential' action (Dowding & Davis 2007). In October 2004, the population between Port Waikato and Taharoa numbered 18 birds; it appears to have continued to decline and is now thought to include only 6 pairs. There appears to be little immigration from other regions, and without intensive management the taxon is facing local extirpation, which would result in a significant loss of range.

28 Like variable oystercatchers, New Zealand dotterels routinely fly overland to visit feeding, roosting or flocking sites. The observation that they "*rarely leave the beach zone*" in the HMR site (Kessels 2009, p 17) probably results from

the small number of this species in the area. It is worth noting that both VOC and NZD movements are largely governed by tidal cycles; they feed actively by day and night and their movements to and from feeding grounds occur during both day and night.

Caspian tern (*Sterna caspia*)

29 The New Zealand population of this species numbers about 3000 birds and it is classified as Nationally Vulnerable (Miskelly *et al*. 2008). Caspian terns have been recorded regularly around and over the footprint of the HMR site (Kessels 2009), but there is no indication of the current size of the local population, and therefore of the significance of the area for the species. There are records of a breeding colony at Port Waikato, e.g. 232 adults (about 7-8% of the national population) were present with nests and chicks in January 1995 (Parrish & Lock 1996).

White-fronted tern (*Sterna striata*)

30 The white-fronted tern is an endemic species that is found throughout New Zealand. Colonies change their breeding sites regularly (Heather & Robertson 1996), making monitoring difficult, and there are no reliable estimates of population size. However, there is evidence that numbers are falling (Wilson 2005) and the species is considered At Risk and classified as Declining (Miskelly *et al.* 2008). Kessels (2009) notes that “large numbers” were regularly sighted at Kaawa Beach, and that they nest there. However, there is no indication of the actual size of the local population in the HMR area, and therefore of the significance of the area for the species.

Migratory shorebirds

Pied oystercatcher (SIPO, *Haematopus finschi*)

31 The pied oystercatcher (SIPO) is an endemic species that breeds almost exclusively in the South Island. Until recently, SIPO were increasing in numbers, but counts at wintering sites show that total numbers are now falling, and the population is thought to number about 120,000 individuals (Fuller *et al*. 2009). The species is now considered At Risk, and has a threat ranking of Declining (Miskelly *et al.* 2008). After breeding, SIPO move to the coast and

migrate northwards, with about one-third of the population remaining in the South Island, and two-thirds moving north to winter in harbours in the northern North Island. Allowing for sub-adult birds that remain in North Island harbours throughout the year, it appears that about 70,000 SIPO migrate annually between the South Island and northern North Island (Fuller *et al*. 2009).

32 Earlier records of SIPO flocks on migration suggested that at least some of them migrate north following the west coast of the North Island (Dowding & Moore 2006). In fact, results from monitoring at Taharoa in 2008 confirm that a large majority of the migrating population uses this route; about 40,000 birds were flying north in summer/autumn 2008, and about 63,000 were estimated to be flying south in winter 2008 (Fuller *et al*. 2009). There can now be no doubt that the North Island west coast is the main migration route for this species.

33 Fuller *et al*. (2009) also provided particularly important information on the time of day at which SIPO were migrating. Many shorebirds depart on migration in late afternoon or early evening (e.g. Battley 1997). For SIPO leaving the South Island on northward migration and flying non-stop, this would put them over the Waikato coast the following morning; this was confirmed at Taharoa, with about 91% of flocks passing over or near the site by day, the majority of them in the morning (Fuller *et al*. 2009). Late afternoon departures on southward migration from northern harbours in winter would put flocks over the Waikato coast in the evening and at night. Again, observations at Taharoa showed that about 82% of detected SIPO flocks passed the site at night (Fuller *et al*. 2009).

34 Migration periods of SIPO are protracted. Northward migration begins in late December, peaks through January and early February, and smaller numbers of birds continue to move north in March (and possibly later in some years). Southward migration starts in mid-late June, and peaks in July and August (Marchant & Higgins 1993, Fuller *et al*. 2009).

Black stilt (*Himantopus novaezelandiae*)

35 In spite of 20 years of intensive management, the black stilt remains one of the world's most threatened shorebird species. It breeds almost exclusively in the Mackenzie Basin, South Canterbury, and in the 2004/05 season there were only 11 productive pairs in the wild. It is classified as Nationally Critical, the highest possible category of threat (Miskelly *et al*. 2008).

36 Many black stilts remain in the Mackenzie Basin year-round, but a number migrate to North Island harbours to over-winter. Black stilts have been recorded in Kawhia, Manukau and Kaipara Harbours for many years, and these are three of the most important sites for the species outside the Mackenzie Basin (Dowding & Moore 2006). Regular records from estuaries in Manawatu, Taranaki, and Waikato suggest that most black stilts migrate along the west coast of the North Island, with only occasional records from east coast sites (Dowding & Moore 2006). It therefore seems likely that very small numbers of black stilts will be migrating over or past the HMR site annually.

Pied stilt (*Himantopus himantopus leucocephalus*)

37 The New Zealand population of the pied stilt was thought to number about 28,000-30,000 birds (Heather & Robertson 1996, Sagar *et al*. 1999). However, there is evidence that numbers have fallen recently, and the species is now considered At Risk and classified as Declining (Miskelly *et al.* 2008).

38 Following breeding inland, pied stilts normally move to coastal areas, and many migrate northwards (Marchant & Higgins 1993). In particular, birds breeding in the South Island are known to migrate to harbours in northern New Zealand from Kawhia to Parengarenga; typically about half the population is found in harbours from the Firth of Thames northwards (Sagar *et al*. 1999, Dowding & Moore 2006). It seems likely that a proportion of these birds have migrated up the west coast of the North Island. Observations at Taharoa confirmed that some birds do (Fuller *et al*. 2009). For the purposes of assessing risk at the HMR, I estimate that about 3,000 birds use the west coast route; that figure (about 10% of the population) takes account of the fact that not all stilts in northern harbours are migratory; birds breeding inland in the South Island do migrate to northern North Island harbours but most birds breeding in

northern New Zealand are sedentary (R.J. Pierce, cited in Dowding & Moore 2006). Pied stilts are probably both migratory and resident/nomadic in the vicinity of the HMR site (see paragraphs 55-56 below).

Banded dotterel (*Charadrius bicinctus*)

39 The banded dotterel is an endemic plover that is widespread in New Zealand. There is no accurate estimate of the population size, but the species is declining in numbers (Dowding & Moore 2006, Southey 2009) and there are thought to be about 20,000-25,000 individuals remaining. The banded dotterel is now considered Threatened, and classified as Nationally Vulnerable (Miskelly *et al.* 2008).

40 Migration paths of banded dotterels are complex, with birds that breed in different locations using different wintering areas (Pierce 1999). Many of the birds breeding inland in the South Island migrate to Australia, while birds breeding inland in central New Zealand normally move northwards to a northern harbour. Parengarenga, Whangarei, Kaipara, Manukau, and Kawhia Harbours all have nationally significant wintering populations, suggesting that a substantial proportion of the population migrates up and down the North Island west coast. Banded dotterels were recorded migrating past or over Taharoa regularly in small numbers between January and March 2008. For the purposes of modelling collision risk at Taharoa it was assumed, based on number that winter in northern harbours, that up to 6,000 banded dotterels may use the west coast route (Fuller *et al*. 2009).

Wrybill (*Anarhynchus frontalis*)

41 The wrybill is a small, threatened, endemic plover that breeds only in the braided rivers of Canterbury and northern Otago, east of the main divide (Dowding & Moore 2006). The population numbers about 5000 individuals, and the species is classified as Nationally Vulnerable (Miskelly *et al*. 2008). Almost the entire population migrates north after breeding, with a large majority of birds wintering in the harbours around Auckland, particularly the Manukau Harbour and Firth of Thames (Riegen & Dowding 2003)

42 That the migration route for wrybills may also be along the North Island west coast was first suggested by Hay (1984) and repeated in the authoritative Handbook of Australian, New Zealand and Antarctic Birds (Marchant & Higgins 1993). As noted by Kessels (2009), wrybills are small, cryptic birds that are very difficult to detect on migration. Kessels also notes "*It is highly possible that wrybill are using a similar pathway to SIPO. SIPO might therefore provide a useful indicator species to wrybill migration routes*". This does appear to be the case. In Dowding (2006), I compiled a list of records of wrybills seen at North Island west coast sites during migration periods. That list is reproduced in Appendix 1. Monitoring at Taharoa (Fuller *et al*. 2009) and at HMR (Kessels 2009) has added further records. In addition, there is no evidence in the Atlas of Bird Distribution in New Zealand (Robertson *et al*. 2007), or elsewhere in the literature, for any other major migration route. Together, these facts provide compelling evidence that the North Island west coast is the main north-south migration route for this species. For the purposes of modelling collision risk at Taharoa it was assumed, based on the numbers of birds wintering in the Kaipara and Manukau Harbours and the Firth of Thames, that 4,500 wrybills use this west coast route (Fuller *et al*. 2009).

43 I note that Kessels (2009) refers to national wader counts between 1984 and 1994 that indicated an average of 54% of the wrybill population spent the non-breeding season on the Firth of Thames, with 32% on the Manukau Harbour. There has been a change in winter-site allegiance by wrybills since that time (Riegen & Dowding 2003), and the latest counts suggest that about 60% of the population is now found in the Manukau Harbour each winter.

44 Like pied oystercatchers, wrybills start northward migration in late December, with peak movements occurring in January and early February. Southward migration of adults occurs mainly in August and September, with a smaller number of first-year birds migrating in October and November (Riegen & Dowding 2003). Although there are fewer records, wrybills appear to follow the same diurnal pattern as pied oystercatchers, passing up the Waikato coast northwards during the day, and moving southwards in winter at night. Observations at Taharoa in summer 2008 recorded 28 observations of wrybills

by day. In winter 2008, 14 flocks were recorded; one flock of about 40 birds was seen at dusk, and 13 flocks were heard at night (Fuller *et al*. 2009)

Overall significance to birds of the HMR area

45 The HMR area is of high regional significance for New Zealand dotterels, given the very small size and threatened nature of the local population. Whether the area is significant for other resident coastal species is impossible to establish without further information on total numbers of each in the area.

46 There can now be little doubt, particularly given the observations at Taharoa (Fuller *et al*. 2009), that the west coast of the North Island is the main north-south route for migrating pied oystercatchers in New Zealand. There is also strong evidence that it is the main route for wrybills, and probably for other species. The fact that no other important North Island migration route for any New Zealand-breeding shorebird species has been identified (or even suggested) in the literature, is consistent with this view. The route therefore effectively appears to be a small-scale multi-species flyway, composed of the overlapping migration systems of a range of species and populations (e.g. Boere & Stroud 2006). Adding the numbers of pied oystercatchers, pied stilts, banded dotterels, wrybills and bar-tailed godwits estimated to use the west coast route yields an annual total in the order of 90,000 - 100,000 birds.

47 In my view, the pied oystercatcher and the wrybill are the two species that require closest consideration in this case, primarily because such a high proportion of the world population of each is involved. However, given the general lack of information for most species, I would stress that the importance of the HMR site and the migration route to the other resident and migratory shorebirds listed above should not be overlooked.

48 I note that Kessels (2009, Exhibit GK1A, section 1.4) considers 'habitat' within the proposed wind farm site, and states that "*The main habitat for resident shorebirds…within the study area is limited to the narrow beaches and small stream mouths*…". He also notes that "…*both NZ shorebirds and international waders may transit across the wind farm site, or very near to it, on migration or when moving between harbours*…". In this context, I believe

it is very important to emphasise that the airspace above and around the HMR site is part of the environment essential to the continued survival of both resident and migratory shorebirds, and must therefore be considered part of their habitat.

POTENTIAL ADVERSE EFFECTS OF THE PROPOSED DEVELOPMENT

Indirect effects

49 Wind farms may have a number of indirect impacts on birds (Powlesland 2009). These may include displacement from preferred breeding, roosting or feeding habitat, degradation of habitat leading to reduced survival or breeding success, and increased energy expenditure through avoidance behaviour. To my knowledge, there is no information available on the potential importance of these effects on New Zealand shorebirds. Given the particular life-history characteristics of New Zealand shorebirds (paragraphs 49-51 below), it is my opinion that these impacts are likely to be less important at the population level for the species of concern than mortality from collision.

Directs effects (collision)

50 The main direct impact on birds of wind farms is mortality caused by birds striking turbines, associated structures, and transmission lines, and to a lesser extent through being injured or thrown to the ground by turbulence behind turbine blades (Powlesland 2009). Bird collision rates at wind farms are often quoted in terms of collisions per turbine per year, and may appear low. However, wind farms may contain many turbines and are designed to operate for many years or in perpetuity, and low annual rates may easily become significant at the population level over time, particularly for threatened species. In a review of the impacts of wind farms on birds, Drewitt & Langston (2006) state:

"*Accepting that many wind farms result in only low levels of mortality, even these levels of additional mortality may be significant for long-lived species with low productivity and slow maturation rates, especially when rarer species of conservation concern are affected. In such cases there could be significant* *effects at the population level (locally, regionally or, in the case of rare and restricted species, nationally)...*"

51 This point is especially relevant in New Zealand, where native shorebirds are known to be long-lived, to have low productivity and to show delayed maturation compared to related species elsewhere (Dowding & Murphy 2001). In this situation, even slightly higher than normal mortality of adults can result in a disproportionate reduction in the ability of the population to sustain itself.

52 It is important to note that many of the threats currently acting on shorebirds breeding in New Zealand primarily affect reproductive success. Nests and chicks are lost to mammalian and avian predators, to flooding and severe weather, to crushing by people and vehicles, and to disturbance caused by a wide range of human recreational and commercial activities. However, as long as the adults in a population remain alive, they have the potential to continue breeding and to replace themselves. High adult survival is therefore particularly important for these species. Unlike many of the other potential threats to shorebirds in New Zealand, wind farms only affect survival, and have no direct impact on reproductive success. Wind farms therefore have the potential to affect precisely the most sensitive life-history stage of a long-lived species.

ASSESSMENT OF RISK TO SHOREBIRD SPECIES

Resident species

Variable oystercatcher

53 While variable oystercatchers are normally strictly coastal breeders, they are commonly seen inland feeding on wet pasture (Marchant & Higgins 1993). In addition, observations of colour-banded birds in my North Auckland east coast study area show the species regularly travels distances in the order of 10-15 km to feed at nearby estuaries, by day and night. The existence of a large post-breeding flock at Port Waikato also indicates that there must be seasonal movements in the area. The presence of these birds close to the site and the fact that there are at least seasonal movements in the area, indicate at least a

potential for risk. I note that VOC have been recorded flying inland over the HMR site (Kessels 2009). However, the frequency of these flights, the routes taken, and whether they occur at night, are all largely unknown. All that can be said at present is that there is a potential for collision risk but that it cannot yet be quantified. Possible impacts at the population level can therefore not be estimated either. I note that the variable oystercatcher is particularly long-lived (one of my study animals reached 32 years of age), and is therefore likely to be very susceptible at the population level to small increases in mortality.

New Zealand dotterel

54 The results reported by Kessels (2009) suggest that only one pair of New Zealand dotterels now breeds on the HMR site coastline. Because of the small numbers breeding in the area, the absolute collision risk for this species appears low. However, given the critical state of the local population, the death of either member of this pair would be highly significant at a regional level. The resident pair may not be the only birds at risk. Young New Zealand dotterels travel the coastline for the first year or 18 months of life (Dowding 2001), and breeding adults usually move from their territories to post-breeding flock sites and back annually (Dowding & Chamberlin 1991). Like variable oystercatchers, New Zealand dotterels also regularly travel to nearby estuaries to feed, and routinely do so day and night (Dowding, unpublished observations).

55 Again, there is the potential for collision mortality of this species, but without the information required to assess the risk. In the apparent absence of any other information on movements of New Zealand dotterels in the area, I note that a bird I banded at Waimai Stream mouth in December 2005 was seen in a flock in the southern Manukau Harbour in 2006, and its mate was seen in a flock at Kaiaua on the western side of the Firth of Thames. While these sightings demonstrate that seasonal movements in and out of this stretch of the coast can and do occur, they add nothing to a quantitative assessment of risk.

Pied stilt

56 Kessels (2009) records the presence of a resident population that fed inland in the Kaawa Valley. He ranks the risk to these birds as ‘medium’. What is not

clear is whether all other potential stilt habitat within the HMR site was also searched, and what the total number of stilts in the area may be. Kessels (2009, Table 5) records that 665 stilts were counted (which would represent about 2-3% of the national population), but it is not clear whether the total included repeat observations of the same individuals. Yet again there is a potential risk of collision for pied stilts, but it cannot yet be quantified.

57 It is worth noting that assessment of risk for pied stilts is probably even more difficult than for many other species. Pied stilts are highly mobile and partly nomadic, and prefer wet habitats. Large numbers commonly arrive suddenly at ephemeral wetlands (such as flooded paddocks) to forage or breed. They will also move to tidal estuaries when there is drought inland (Dowding & Moore 2006). The irregularity of these movements suggests that even prolonged observations are unlikely to assist risk assessment.

Caspian and white-fronted terns

58 Caspian terns have been seen over the footprint of the HMR site, and have been assessed as at 'medium' risk (Kessels 2009). Both species breed locally, so there is again at least the potential for collision mortality, but the level of risk is unknown.

59 I suggest that checks for possible movements of Caspian and white-fronted terns across the northern part of the site in particular should be undertaken to determine whether these birds are foraging in the Waikato River. Both species (but particularly Caspian terns) will fish over rivers and estuaries (Higgins & Davies 1996). In my opinion, it is quite possible that both species in the HMR area will use the lower reaches of the Waikato River for feeding, and there could therefore be traffic of both species across the northern part of the site. Radar is unlikely to pick up these birds, so direct observation will be required.

60 Overall, five resident shorebird species are potentially at some degree of risk from the proposed wind farm. However, in none of the five cases has risk been assessed quantitatively, nor can it be with current information. Numbers of a species alone are clearly not sufficient to assess risk – a smaller number of birds making regular trips through a wind farm or flying at a particular altitude

may be at higher risk of collision than a large group of birds than cross the site infrequently or at very low or very high altitude. Behaviour in the vicinity of turbines will also affect risk, and as far as I am aware, nothing is known of behaviour of New Zealand shorebirds around turbines. As noted by Kessels (2009), birds are less likely to detect and avoid turbines at night; the frequency and location of nocturnal flights of resident species will therefore also be important, but are currently unknown. Finally, at the settings in use, radar does not detect most of these species. This lack of information totally frustrates any current attempt at robust risk assessment. I therefore consider it premature to conclude, as Seaton (2009) does, that "*Significant effects on resident shorebirds are not, however, predicted*".

Migratory species

61 The applicant has not yet assessed collision risk to migratory shorebird species. Table 8 of Kessels (2009, p 32) lists native bird species at the Limestone Downs part of the HMR site and provides "indicative" collision risk ratings. My reading of the text suggests these ratings are largely subjective, and in some cases may be based on relatively few observations. There is no indication, either in Kessels (2009) or in Kessels & Associates (2009), of quantitative analysis of the data collected so far. Indeed, Kessels & Associates (2009, p 29) indicates that collision-risk assessments and population-level analyses will only be undertaken after three more migration periods, i.e. in 18 months time at the earliest.

62 Identification of ways to avoid, remedy or mitigate any significant risk identified by those analyses will therefore also be deferred until that time. Seaton (2009) notes that "*further descriptions of migratory shorebird movements are required before the risk to these species can be fully established*". Kessels (2009) states that "*A collision risk model may be useful to determine the level at which the predicted cumulative effect of collision is likely to cause a 'significant' impact on the population of…South Island pied oystercatcher and wrybill*".
In my opinion, collision-risk modelling is essential in this case, rather than useful.

63 I note that Seaton (2009) also states

"*The applicant is in the process of establishing the numbers and routes that migrant shorebirds take through this region so as to provide a more rigorous basis for risk assessment. These investigations are ongoing and it would be premature to form definite conclusions on the degree of the potential effect that wind farm construction at this site may have*."

In my view, deferring risk assessment for at least 18 months is unsatisfactory for two main reasons. First, a decision to grant consents to construct and operate the wind farm may have been made well before the risks are adequately assessed by the applicant. In my opinion, there is no guarantee, given the size of the wind farm and the large number of birds potentially involved, that the predicted impacts could actually be effectively avoided, remedied or mitigated, based on the measures suggested by the applicant to date.

64 In fact, I believe it is already possible to provide a preliminary quantitative assessment of the risk to two of the key migratory species, using data from Kessels & Associates (2009) and from Fuller *et al*. (2009). In his evidence, Dr Percival has calculated collision risk for five species and provided predictions of the numbers of casualties annually. I have used those predictions to model population trajectories for two of the species, namely pied oystercatcher and wrybill (we do not currently have adequate demographic data to model the other three species). Population trends modelled with and without the additional mortality predicted by Dr Percival for the HMR wind farm show the potential impact on these two species in the medium term.

65 To be clear about our respective roles in this process, I note that Dr Percival has calculated the average, upper and lower 95% confidence limits, and ranges of the numbers of predicted collisions. I have then converted the numbers of collisions to annual mortality rates for each age class and used these rates to calculate population trajectories, including percentage rates of decline.

Pied oystercatcher

66 Dr Percival has predicted a mean number of 203 pied oystercatcher collisions annually, with lower and upper 95% confidence limits of 55 and 389 collisions respectively. Using the same demographic data used in Fuller *et al*. (2009), I have calculated decline rates for the pied oystercatcher population in the absence of the proposed wind farm (the *Baseline* scenario), assuming 203 casualties annually (the *Mean* scenario), and assuming 55 and 389 casualties annually (the L95 and U95 scenarios respectively). Three different models were used in the Taharoa analyses; all gave essentially the same results, and one of them (the Lotka equation) was used here (Fuller *et al*. 2009).

67 The resulting population trends are shown in Figure 1 (page 37). As shown in Figure 1, the *Baseline* scenario predicts that the pied oystercatcher population will decline by about 4% in the next 50 years. With the predicted additional mortality from the proposed wind farm, this will rise to about 7-20% (the range between the L95 and U95 scenarios), with an average decline of about 13% under the *Mean* scenario. Thus the modelling suggests that the decline rate in the presence of the wind farm would be about three times greater than without it. In absolute terms, the *Mean* scenario suggests that there would be about 10,000 less pied oystercatchers in the population in 50 years in the presence of the wind farm than without it.

Wrybill

68 I have undertaken a similar analysis for wrybills, using Dr Percival's predictions of an annual mean of 10.9 collisions and lower and upper 95% confidence limits of 3.1 and 22.6 collisions respectively. The results are shown in Figure 2 (p 39). In this case, the *Baseline* scenario predicts that the wrybill population will decline by about 20% in the next 50 years. With the predicted additional mortality from the proposed wind farm, this rises to 26-43% (the range between the L95 and U95 scenarios),with an average decline of 33% under the *Mean* scenario. This represents a major increase in decline rate, and one that would require significant resources and expertise to reduce or reverse. Given the Threatened status and relatively small size of the wrybill population, this result is of particular concern.

Black stilt

69 Detection of these birds in the vicinity of the HMR site is very unlikely, and assessing the risk posed to this species by the wind farm is therefore virtually impossible. Because of the very small numbers involved, the probability of strike must be low, but with such a small and threatened wild population, the loss of even a single black stilt would be significant. I note that Seaton (2009) has reached similar conclusions for this species.

70 **Other species**

As noted above, there are insufficient demographic data to model population trends for bar-tailed godwits, banded dotterels or pied stilts. However, Dr Percival's analyses suggest that casualties would be similar in absolute numbers to those of wrybills. Whether population trends would decline in the same way cannot be assessed without the relevant demographic data, but the fact that smaller proportions of the national populations of these species are likely to be involved, suggests that the impact at the population level may not be as high as for wrybills. That does not mean that it may not be significant for any of the three species, however.

71 I believe the analyses that Dr Percival and I have conducted are the best that can be undertaken with the available data. Inevitably, it would be possible to refine them with further data, but it is my firm opinion that some attempt must be made to assess risk before a decision is made on the grant of consents. We have undertaken such an assessment, because some data from the applicant were available (Kessels & Associates 2009). I believe it has been an informative exercise, and has provided at least some measure of the risks present in this case. The population modelling has also served to confirm that New Zealand shorebird populations are indeed highly sensitive to small changes in adult survival.

72 Our preliminary assessments indicate a risk of substantial negative impacts at the population level for both pied oystercatchers and wrybills. This is not surprising. A large number of turbines are proposed, and the long axis of the site is oriented north-south, the same as the migration route. In the order of

100,000 shorebirds are thought to migrate north past or over the site in summer, and the same number return south in winter, largely at night..

COLLECTION AND ANALYSIS OF FURTHER DATA

73 The applicant proposes to collect further data over three migration periods and assess risk to a range of species. There will still be no certainty that adequate data for some species (notably the smaller ones like wrybill and banded dotterel, or the rarer ones like black stilt) can actually be collected. Fuller *et al*. (2009) used a higher density of observers at Taharoa than has been used at HMR to date, and were still forced to conclude that risks for many species could not be assessed accurately

74 While the continued use of radar, as proposed by Seaton (2009), is essential, it is important to recognise that radar has a number of substantial limitations (see Fuller *et al*. 2009). At Taharoa, radar detected only 39% of all SIPO flocks, and only about 50% of the SIPO flocks that were seen by observers. At the distance settings used at Taharoa (6NM), species smaller than SIPO were not recorded by radar (Fuller *et al*. 2009).

75 Seaton (2009) also proposes radio-telemetry of wrybills, banded dotterels and black stilts. Aside from practical issues (such as how black stilts in northern harbours will be caught), it is by no means clear that this approach will actually provide the required information. As noted above, southward migration of wrybills at Taharoa, like that of SIPO, appeared to occur primarily at night (Fuller *et al*. 2009). While it is possible to detect a transmitter at night, and record an approximate location, the record will provide no information on the number of birds in the flock, or the altitude of the flock. These are both variables that are required for a robust assessment of collision risk.

76 In summary, unless novel and effective techniques are used, particularly for the detection and enumeration of smaller species, and for night records, I am not convinced that the measures proposed to collect further data will

necessarily provide all the information required. If that is the case, I suspect that some of the uncertainties that are inherent in Dr Percival's modelling will still be present in two years, and that many of the same assumptions will need to be made when the data are analysed at that time. This possibility also appears to have been recognised by the applicant; I note that Seaton (2009, section 10.4) has already suggested that for wrybills and banded dotterels "*modelling a range of potential scenarios of collision risk will also provide some insight*", and in section 11.11 has suggested that the collision risk to godwits should be modelled using "*a range of scenarios based on hypothetical numbers likely to be passing or crossing the site*". Obviously, modelling using potential scenarios and hypothetical numbers does not need to be deferred and could be undertaken now.

77 While there is a focus in Kessels (2009) and Seaton (2009) on gathering more data on migratory shorebirds, in my view it is also essential that further information is gathered on resident shorebirds at the HMR site. This includes pied stilts, New Zealand dotterels, variable oystercatchers, Caspian terns and white-fronted terns at a minimum. For all these species, there is simply insufficient information currently on numbers, distribution, or movement patterns at different temporal scales to assess collision risk objectively. Given the very large size of the site, the number of observers used to date, and the fact that radar will not detect most of these species, collection of the data that are required to make robust assessments will present a substantial challenge.

MEASURES TO AVOID OR MITIGATE POTENTIAL IMPACTS

78 Seaton (2009) states

"*In order to ensure that any effects on birdlife resulting from wind farm construction and operation are suitably mitigated, ongoing targeted monitoring of at risk species of birds is necessary*".

and

"*As a result it is important in my opinion that further monitoring of migratory shorebirds is completed before the wind farm commences operation to allow any potential effects to be avoided*"

I believe there is an implicit assumption in these statements that any and all effects on shorebirds *can* actually be avoided or mitigated effectively. I now wish to examine some of the measures proposed.

79 From Seaton (2009)

"*Should it be established that migratory shorebirds pass through the site and that there is a significant risk that these birds will be negatively affected, several options are available to avoid these effects:*

(a) Do not build turbines in areas where high densities of migratory birds are passing through;

(b) Ensure wide "corridors" with no turbines are available for migrating birds to pass through the wind farm;

(c) Switch off high risk turbines at times of high bird migration;

(d) Switch off high risk turbines at times when high bird migration and inclement weather conditions coincide.

80 Adjusting the layout of turbines to avoid areas of high bird activity is an obvious means of reducing risk. The stage 2 report (Kessels & Associates 2009) suggests that there may be a higher concentration of flight paths along the coastal strip, particularly in the northern radar sector, than elsewhere. Removing turbines from a strip 1-2 km wide along that section of the coast may, for example, reduce risk. However, I would note that a great deal more information is required before turbines could be reliably located to minimise bird strike at the HMR site.

81 The known migration front in the vicinity of the site is already 15-20 km wide in places (Kessels & Associates 2009, Figure 9), and there is no measure yet of inter-annual variation in flight paths. Kessels (2009, page 22) also indicates that flock numbers over land may depend on wind direction. Together these factors suggest that there may not be well-defined routes through the site that are regularly used, and that flight paths may vary over short time scales due to changing environmental conditions. Areas where birds are at high density one year (or week, or day) may not be the same areas with high concentrations at another time. If this is the case, option *a* is unlikely to reduce risk. Leaving wide corridors through the site (option *b*) may or may not be effective. There is

no guarantee they will be sited appropriately (i.e. there is presently no objective basis on which to locate them), and therefore no guarantee that significant numbers of birds will actually use them. Fixing the locations of turbine clusters at this point clearly runs a risk that further collection of information on flight paths could show that some are in inappropriate locations with respect to bird movements

82 Shutdown of high-risk turbines (options *c* and *d*) will only reduce risk usefully if any turbines (or groups of turbines) are consistently identified as significantly higher-risk than others; this may take years to establish. Again, given the width of the migration front, the wide variety of flight paths used, and the potential impact of weather on routes, it is quite possible that mortality may be spread evenly among the turbines.

83 Shutdown may be either reactive or proactive. Reactive shutdown requires systems to detect approaching flocks, with turbines being shut down until these flocks have passed. At present, human observers and radar appear to provide the only practical means of detecting flocks, and both have their limitations. Human observers can only perform well for limited periods, their detection range is much less than that of radar, they probably miss most flocks of small birds, and they miss some flocks of larger birds. Radar has greater range and can operate as long as required, but has substantial limitations; it does not detect small birds, it missed about 61% of flocks of larger birds (SIPO) at Taharoa in 2008 (Fuller *et al*. 2009), and its detection ability is substantially compromised by rain, surf/wave action, movement of vegetation, and steep terrain. In winter, the situation is commonly worse - radar may be more compromised because rain, wind, and rough seas are more common (e.g. Fuller *et al*. 2009), and human observers are of less use if most activity is at night. Reactive shutdown also has the distinct disadvantage that it requires radar units and observers to be on site for peak migration periods twice a year for the life of the wind farm.

84 Proactive shutdown involves identifying peak migration periods and shutting down turbines each year during those periods. In the New Zealand context, this is likely to result in long periods of shutdown; the peak northward migration for SIPO and wrybills normally covers about 5 weeks from late December to

early February, the peak southward migration for SIPO probably covers at least 5-6 weeks from late June to mid-August, and the peak southward wrybill migration covers about 3-4 weeks in August and September. This suggests that shutdown for about 3-4 months of the year would be required. Refinement of proactive shutdown is possible, however. Within peak migration periods, there are strong diurnal patterns of activity (Fuller *et al*. 2009). On southward migration, shutdown at night (when risk is likely to be highest) would avoid about 85% of SIPO flocks and so reduce risk significantly. Similarly on northward migration, shutdown during daylight hours would avoid about 90% of flocks. Overall, proactive shutdown is likely to be more effective at reducing risk, but would require longer (and possibly unacceptable) periods of shutdown. Once additional information on flight paths has been collected, it may be possible to refine and reduce shutdown periods further; if, for example, it emerges that migration is regularly concentrated close to the coast, turbines further inland may be able to operate.

85 Seaton (2009) also states
"*... suitable off-site mitigation may better achieve a net conservation gain. Further research on the movements of migratory birds through the area is required before the suitability of each of these options can be fully discussed*."
Given the number of birds predicted to be killed (Percival 2009), an off-site programme that seeks to replace those losses appears to be totally impractical in the case of SIPO, given the huge number of pairs that would have to be managed. Taking into account the fact that only a proportion of chicks produced survive to adulthood, I calculate that about 520 additional fledglings would be required to replace 203 adult birds; this would require effective management on the breeding grounds of roughly 1500 pairs of oystercatchers. Even adopting the lower 95% confidence limit value of 55 collisions per year (Percival 2009), effective management of about 400 pairs would be required. Given that pied oystercatchers breed in large, dispersed territories, hundreds of metres to kilometres apart in riverbeds (Marchant & Higgins 1993), this is still completely impractical.

86 Tonks (2009) proposes the option of off-set mitigation to compensate for losses due to bird strike. In the case of migratory birds, I note that Tonks

(2009, Exhibit MT1) assumes they "*will follow what appears to be the logical migratory course (seaward of the coastal cliffs*)" As shown by the width of the migration route (which is up to 20 km in places), and the presence of many flocks well inland (Kessels 2009), that assumption is clearly erroneous.

Tonks continues

"*…and that the rate of turbine strike involving migratory waders will therefore be either nil or so low as to be undetectable. If the latter is true then an annual rate of 1.8 bird strikes has been assumed (based on 0.01 strikes per turbine per annum)*."

This is more than two orders of magnitude lower than the 200-250 strikes of migratory shorebirds per year predicted by Percival (2009). I note again that even the lower 95% confidence limit in Percival's calculations predicted 55 annual collisions of SIPO alone.

87 Tonks (2009) also states

"*As replacement for these assumed fatalities it is proposed that funding could be directed toward species protection and recovery work either in the area or elsewhere in New Zealand and that the minimum scale of funding should be sufficient to achieve at least a 10 times replacement for the assumed loss. Sufficient effort and funding would therefore be required to ensure, as a minimum, the survival of 18 more birds (preferably migratory wading birds) per annum. The cost of achieving this minimum target is estimated to be about $7,000 a year if focussed on migratory waders*".

It is not clear how this figure was reached. A similar calculation to that shown in paragraph 85 suggests that about 46 additional fledglings would be required to replace 18 adults; even this apparently modest target would require effective management on the breeding grounds of roughly 120 pairs of oystercatchers. As noted above (paragraph 85), SIPO are highly dispersed during the breeding season, and managing 120 pairs would require management (and particularly effective predator control) over a huge area.

88 My calculations for wrybills suggest that replacement of the mean number of collisions (10.9 per annum) predicted by Percival (2009) would require effective management of roughly 60-65 pairs of wrybills on the breeding grounds at a minimum. While wrybill territories are smaller and generally less

dispersed than those of SIPO, management of this number of pairs would still involve a very large area. For example, numbers of birds in Mackenzie Basin rivers (Maloney *et al.* 1997) suggest that in most cases entire riverbeds (or several smaller rivers) would need to be managed to include this number of pairs. A recent survey of the entire lower Waimakariri River recorded a total of about 55-60 pairs of wrybills (J. Van Hal, *pers. comm*), spread over roughly 50 km of a wide braided riverbed.

CONSENT CONDITIONS

Monitoring

89 In my view, monitoring of shorebird movements to collect further information during the next three migration periods, as proposed by the applicant, is essential. Because the presence of turbines may well affect flight paths, some movement monitoring is also necessary during the early operational phase to inform possible re-location of problem turbines or shutdown of particular turbines or clusters at times of high risk.

90 Collision monitoring during the operational phase of a wind farm on the HMR site would be essential; the programme should contain robust methodologies for establishing searcher efficiency and scavenging rates, and for correcting these as necessary when search areas or scavenger densities may have changed. At a wind farm of 180 turbines, it may be impractical to search all turbines on a regular basis. However, early in the operational phase, the sample should be as large as possible, and it would be vital that searches are rotated around the site to include all turbines, so that any problem turbines or clusters (i.e. those with significantly higher collision rates) are identified.

91 I note that Daysh (2009) includes conditions requiring collision monitoring for resident birds and bats, but not for migratory shorebirds. In my view, given the numbers of birds using the migration route, and the scale of predicted collisions, collision monitoring for migratory shorebirds is absolutely essential. Mortality of migratory shorebirds is likely to be highly episodic. There will probably be relatively few casualties in many years but if, for example, thick fog covers a wind farm during southwards migration at night, there could be

many casualties in a short time. Even a single event like this would have a marked influence on average annual collision rates, which are required for an accurate assessment of the true impact of the wind farm; this assessment is required in turn to determine what levels of avoidance and mitigation measures might be required. An extended period of collision monitoring is therefore required to obtain accurate average annual values. In my opinion, a 10-year collision-monitoring programme should be a minimum requirement at a site, like the HMR site, which is located on a shorebird migration route. In addition, I suggest that the Expert Panel should be able to extend that period if they consider it appropriate.

92 From Daysh (2009, Exhibit SGD1)

"*6.14 Following completion of the baseline avifauna monitoring survey prepared under condition 6.11 above and prior to any electricity production, the consent holder shall submit a report prepared by a qualified ornithologist:*

a) predicting the number of migratory shorebirds that may strike wind turbines within the wind farm area and assessing the impact at the species population level.

b) reporting to Waikato District Council on ways in which any significant identified risk might be avoided, remedied or mitigated, including any specific measures proposed to be implemented by the consent holder.

6.15 Following and within two months of receipt of the risk assessment report prepared under condition 6.14 above, and after consultation with the Ecology Peer Review Panel, the Waikato District Council may commence a review of conditions under section 128 (1) of the Resource Management Act 1991, for the following purpose:

• To put in place additional measures to ensure that any significant adverse effects of the exercise of the consents on migratory shorebird species are appropriately avoided, remedied or mitigated."

Again, the assumption is that all possible adverse effects *can* be avoided or mitigated, and no consideration is given to the case where it may not be feasible or practical to avoid or mitigate for effects on a species.

CONCLUSIONS

93 The proposed HMR site is used by a range of resident shorebirds; some of these are Threatened species, and some are considered At Risk. There is potential for collisions with turbines to increase mortality for any of these species, but in most cases there is currently a lack of information with which to assess the level of risk accurately.

94 The proposed HMR wind farm site lies on the main north-south migration route used by many species of New Zealand shorebirds. In the order of 90,000 - 100,000 shorebirds are estimated to move along the Waikato coast on northward migration in late summer, and again southwards in winter, mainly at night.

95 At present, there are insufficient data to assess risk for some of the migratory species accurately. However, preliminary collision-risk and population modelling suggest that there are likely to be substantial negative effects on both pied oystercatcher and wrybill populations.

96 While there are proposals to collect further data and assess risk to shorebirds more accurately, there may be practical difficulties in collecting information on some of the smaller or rarer species.

97 The evidence provided by the applicant appears to assume that all potential impacts on shorebirds can be avoided or mitigated. Appropriate siting of turbines may reduce risk, but further information is required on that point. Because of the large number of predicted collisions for pied oystercatchers, off-site mitigation in the form of a management programme designed to replace birds killed, appears to be impractical, for that species at least. In the

case of wrybills, replacement of predicted losses would involve a very large management area and may also be impractical.

98 There appears to be agreement that at present there is insufficient information to enable a quantitative risk assessment for most of the resident and some of the migratory shorebird species that use the site. However, the results of my population-level assessments for pied oystercatchers and wrybills do indicate substantial impacts on those species. In view of these facts, it is questionable whether or not there can be appropriate measures put in place to adequately avoid, remedy or mitigate the potential effects of this wind farm.

John Edward DOWDING
27 March 2009

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Figure 1 Population projections for pied oystercatchers

PIED OYSTERCATCHER SCENARIOS & INPUT DATA							
All assume 16% turbine downtime, 95% avoidance northwards, 90% avoidance southwards							
Risk corridor width 6000 m							
Summary		**age**	**max**	**1st yr**	**2nd yr**	**adult**	**extra birds**
	prod/pair	**1st br**	**age**	**surv/mort**	**surv/mort**	**surv/mort**	**killed by WF**
Basic	0.64	4	30	0.550/0.450	0.800/0.200	0.892/0.108	0
L95	0.64	4	30	0.54984/0.45016	0.800/0.200	0.89149/0.10851	55
Mean	0.64	4	30	0.54941/0.45059	0.800/0.200	0.89012/0.10988	203
U95	0.64	4	30	0.54887/0.45113	0.800/0.200	0.88840/0.11160	389
	Total population 120 000, of which about 40 000 remain in SI, 80 000 migrate to NI						
	Of NI popn, about 10 000 are sub-adults & remain in NI harbours; do not migrate						
	Remaining 70 000 birds migrate along west coast						
Baseline	No WF, background mortality						
		Start no				*Ann deaths*	
	1st years	10000	of which 0.450 die annually =			4500	
	2nd years	5000	of which 0.200 die annually =			1000	
	Adults	105000	of which 0.108 die annually =			11340	
							16840
L95	Lower 95%CL from Monte Carlo simulation						
	MC says WF kills 55 birds/yr (18.3 summer, 36.7 winter)						
		Start no				*Ann deaths*	
	1st years	10000	of which 0.45016 die annually =			4501.6	
	2nd years	5000	of which 0.200 die annually =			1000	
	Adults	105000	of which 0.10851 die annually =			11393.4	
							16895
Mean	Mean from Monte Carlo simulation						
	MC model says WF kills 203 birds/yr (67.7 summer, 135.3 winter)						
		Start no				*Ann deaths*	
	1st years	10000	of which 0.45059 die annually =			4505.9	
	2nd years	5000	of which 0.200 die annually =			1000	
	Adults	105000	of which 0.109877 die annually =			11537.1	
							17043
U95	Upper 95%CL from Monte Carlo simulation						
	MC says WF kills 389 birds/yr (129.7 summer, 259.3 winter)						
		Start no				*Ann deaths*	
	1st years	10000	of which 0.45113 die annually =			4511.3	
	2nd years	5000	of which 0.200 die annually =			1000	
	Adults	105000	of which 0.111597 die annually =			11717.7	
							17229
	Note adjustments for fact that 1st year birds only migrate N						
	Scenario			*Proportion of*	*Raw number*	*Adj number*	
				popn at risk	*killed*	*killed*	
	L95						
	1st years			0.087	4.8	1.6	
	2nd years			0.000	0	0	
	Adults			0.913	50.2	53.4	
	Mean						
	1st years			0.087	17.7	5.9	
	2nd years			0.000	0	0	
	Adults			0.913	185.3	197.1	
	U95						
	1st years			0.087	33.8	11.3	
	2nd years			0.000	0	0	
	Adults			0.913	355.2	377.7	

Population projections for PIED OYSTERCATCHER

Baseline					
r		-0.0008461			
λ		0.99915426			
L95					
r		-0.00142			
λ		0.99858101			
Mean					
r		-0.002745			
λ		0.99725876			
U95					
r		-0.004417			
λ		0.99559274			
	Baseline	*L95*	*Mean*	*U95*	
λ	**0.999154**	**0.998581**	**0.99726**	**0.995593**	
years					
0	120000	120000	120000	120000	
10	118989	118308	116750	114815	
20	117987	116640	113588	109855	
30	116993	114995	110511	105108	
40	116007	113374	107518	100567	
50	115030	111775	104606	96222	
% decline in 50 yrs	**4.1**	**6.9**	**12.8**	**19.8**	

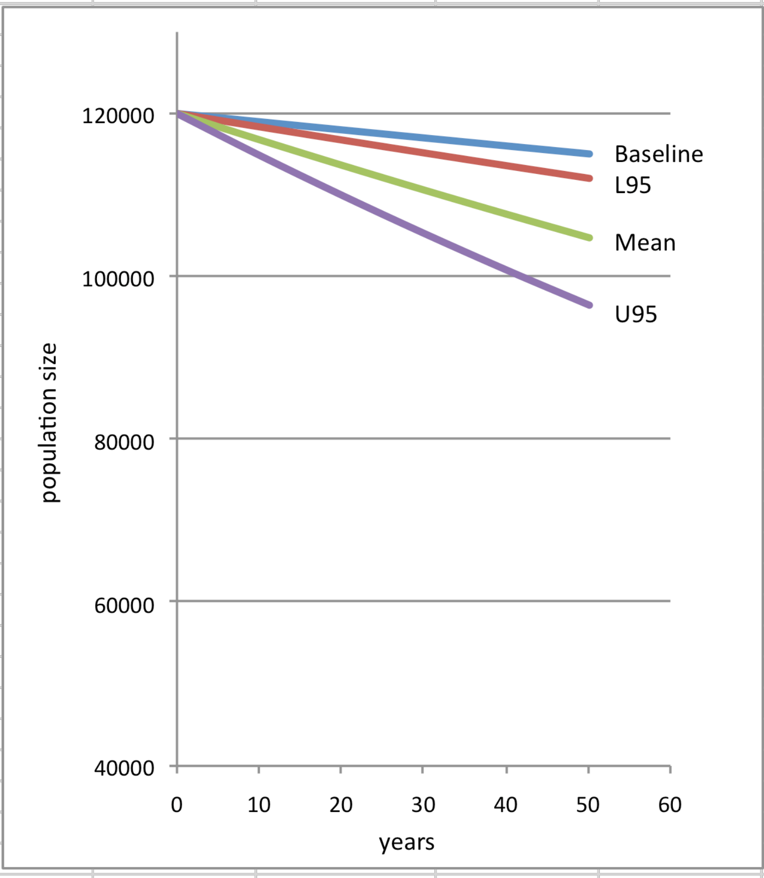


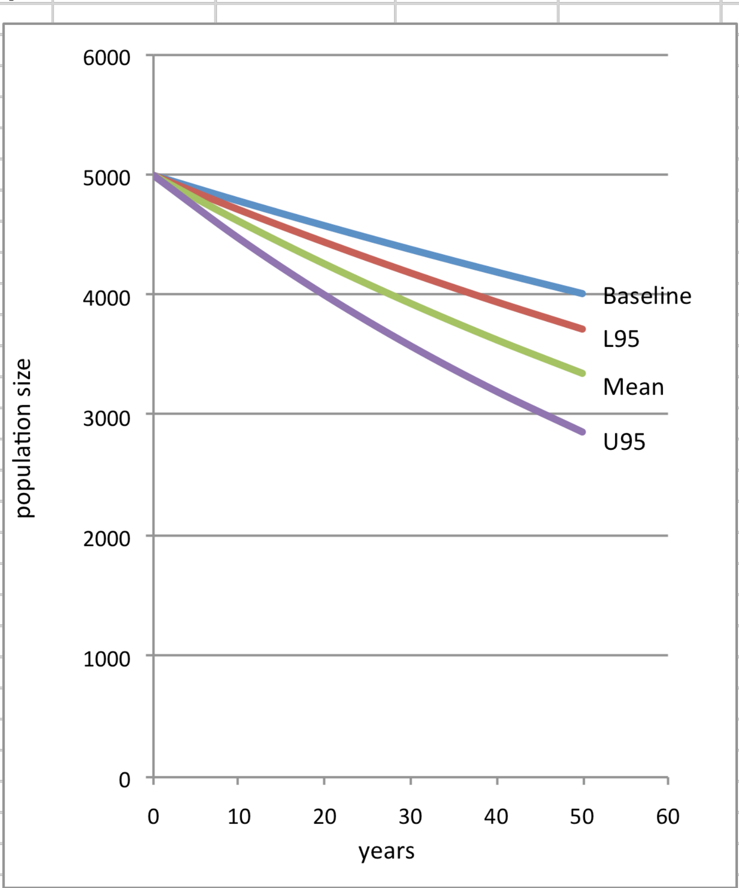
Figure 2 Population projections for wrybills

WRYBILL SCENARIOS & INPUT DATA						
All assume 16% turbine downtime, 95% avoidance northwards, 90% avoidance southwards						
Risk corridor width 6000 m						
Summary		**age**		**1st yr**	**adult**	**extra birds**
	prod/pair	**1st br**	**max age**	**surv/mort**	**surv/mort**	**killed by WF**
Baseline	0.79	2	25	0.500/0.500	0.832/0.168	0
L95	0.79	2	25	0.49938/0.50062	0.83138/0.16862	3.1
Mean	0.79	2	25	0.49782/0.502180	0.82982/0.17018	10.9
U95	0.79	2	25	0.49548/0.50452	0.82748/0.17252	22.6
	Total population 5000, of which 500 are 1st years, 4500 are adults					
	4500 birds (90% of population) migrate along west coast					
Baseline	No WF, background mortality					
		Start no			*Ann deaths*	
	1st years	500	of which 0.500 die annually =		250	1006
	Adults	4500	of which 0.168 die annually =		756	
L95	Lower 95%CL from Monte Carlo simulation					
	MC model says WF kills 3.1 birds/yr; assume 0.31 are 1st years, 2.79 are adults					
		Start no			*Ann deaths*	
	1st years	500	of which 0.500 die annually =		250.31	1009.1
	Adults	4500	of which 0.168 die annually =		758.79	
Mean	Mean from Monte Carlo simulation					
	MC model says WF kills 10.9 birds/yr; assume 1.09 are 1st years, 9.81 are adults					
		Start no			*Ann deaths*	
	1st years	500	of which 0.50218 die annually		251.09	1016.9
	Adults	4500	of which 0.17018 die annually		765.81	
U95	Upper 95%CL from Monte Carlo simulation					
	MC model says WF kills 22.6 birds/yr; assume 2.26 are 1st years, 20.34 are adults					
		Start no			*Ann deaths*	
	1st years	500	of which 0.50452 die annually		252.26	1028.6
	Adults	4500	of which 0.17252 die annually		776.34	

Population projections for WRYBILL

Baseline		
r		-0.004453
λ		0.9955569
L95		
r		-0.00594
λ		0.99407761
Mean		
r		-0.007995
λ		0.99203688
U95		
r		-0.0111
λ		0.98896138

	Baseline	*L95*	*Mean*	*U95*
λ	**0.995557**	**0.994078**	**0.992037**	**0.988961**
years				
0	5000	5000	5000	5000
10	4782	4712	4616	4475
20	4574	4440	4261	4005
30	4375	4184	3934	3584
40	4184	3943	3631	3207
50	4002	3715	3352	2870
% decline in 50 yrs	**20.0**	**25.7**	**33.0**	**42.6**



Appendix 1 Records of wrybills from North Island west coast sites during the northward and southward migration periods. References to *Notornis* give the volume and part number containing Classified Summarised Notes.

Date	Observation	Reference
22-10-72	Rangitikei Estuary: 20	*Notornis* 20 (4)
17-02-73	Aotea Harbour: 1	*Notornis* 20 (4)
29-07-73	Waikanae River mouth: 2 in breeding plumage	*Notornis* 20 (4)
24-08-74	Waikanae Estuary: 4, gone by 29 Aug	*Notornis* 21 (4)
04-07-76	Kawhia Harbour: 8	*Notornis* 23 (4)
10-09-78	Port Waikato: 6	*Notornis* 26 (4)
18-02-79	Rangitikei Estuary: 2	*Notornis* 26 (4)
15-10-79	Ohau Estuary: 4	*Notornis* 26 (4)
28-10-79	Bell Block, New Plymouth: 1 (in breeding plumage)	*Notornis* 29 (1)
June 1981	Kawhia Harbour: 3	Plant (1987)
June 1983	Kawhia Harbour: 2	Plant (1987)
08-01-86	Taharoa: 1	*Notornis* 34 (2)
21-02-87	Ruapuke: 1	*Notornis* 35 (4)
1988/89	Wanganui Estuary: occasional visitor on passage, 2 on 02-01-89, 1 on 27-01-89, 1 on 13-02-89	*Notornis* 37 (3/4)
25-10-89	Kawhia Harbour: 1	*Notornis* 38 (4)
20-12-89	Taharoa Beach: 6	*Notornis* 38 (4)
19-01-91	Manawatu Estuary: 10 took off calling, circled to gain height and headed north	*Notornis* 39 (3)
13-01-96	Wanganui River mouth: 2	*Notornis* 44 (2)
06-09-97	Wanganui South Beach: 4	*Notornis* 47 (4)
27-09-97	Waiongana: 4	*Notornis* 47 (4)
19-02-98	Turakina Estuary: 1	*Notornis* 47 (4)
26-12-98	Pungaereere Stream, Rahotu: 1	*Notornis* 47 (4)
01-02-99	Waiongana Estuary: 3	*Notornis* 47 (4)
29-08-01	Taharoa: 1	*Notornis* 50 (2)
15-12-02	Pungaereere Stream, Rahotu: max 10 flying north	*Notornis* (unpubl)
23-01-03	Waiongana Estuary: 1	*Notornis* (unpubl)
05-01-09	Foxton: Influx of 125, well above normal levels of 3-20	J. Conklin, *pers. comm.*