





Development of an Offshore Wind Farm in Hong Kong

EIA Study

EIA Report
(Volume 2 – Sections 8 to 15)

January 2010

Environmental Resources Management
21/F Lincoln House
Taikoo Place, 979 King's Road
Island East, Hong Kong
Telephone 2271 3000
Facsimile 2723 5660

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21/F Lincoln House
979 King's Road
Taikoo Place
Island East
Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

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CONTENTS

8 TERRESTRIAL ECOLOGY

8.1 INTRODUCTION

This section presents the ecological baseline information for terrestrial ecological resources (particularly avifauna) gathered from the literature review and focussed vessel-based surveys, which covered a period of 9 months of both wet and dry seasons (covering February to October) to establish the avifaunal baseline ecological conditions of the proposed Wind Farm Development Site (hereafter called Project Site) in southwestern waters of Lamma Island in Hong Kong.

This section also presents the results of an assessment of the ecological importance of the avifauna resources of the Study Area in southwestern waters of Lamma Island and the potential impacts on avifauna from the construction and operation of the proposed wind farm, particularly on migratory bird/seabird population. The assessment has been based on the preliminary design of the Southwestern Lamma wind farm as discussed in the Project Description (*Section 5*). Measures required to mitigate adverse impacts are recommended, where appropriate.

8.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

Relevant legislative requirements and evaluation criteria for the protection of species and habitats of terrestrial ecological importance are as follows:

1. *Wild Animals Protection Ordinance (Cap 170);*
2. *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586);*
3. *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO-TM);*
4. *United Nations Convention on Biodiversity (1992); and,*
5. *PRC Regulations and Guidelines.*

8.2.1 *Wild Animals Protection Ordinance (WAPO) (Cap 170)*

Under the *Wild Animals Protection Ordinance (WAPO)* (Cap 170), designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals, including all cetaceans, are protected under this Ordinance, as well as certain reptiles, amphibians and invertebrates. The *Second Schedule* of the Ordinance that lists all the animals protected was last revised in June 1997.

8.2.2 *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586)*

The *Protection of Endangered Species of Animals and Plants Ordinance* (Cap 586) was enacted to align Hong Kong to control regime with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). With effect from 1 July 2006, it replaces the *Animals and Plants (Protection of Endangered Species) Ordinance* (Cap 187). The purpose of the *Protection of Endangered Species of Animals and Plants Ordinance* is to restrict the import and export of species listed in CITES Appendices so as to protect wildlife from overexploitation or extinction. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them.

8.2.3 *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance*

Annex 16 of the *EIAO-TM* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating ecological impacts.

8.2.4 *United Nations Convention on Biological Diversity*

The Peoples' Republic of China (PRC) is a Contracting Party to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The Government of the Hong Kong SAR has stated that it will be "committed to meeting the environmental objectives" of the Convention (Planning, Environment and Lands Branch 1996).

8.2.5 *PRC Regulations and Guidelines*

In 1988 the PRC ratified the *Wild Animal Protection Law*, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 96 animal species in Class I and 156 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

8.3 STUDY AREA

The proposed wind farm development site is located approximately 2 km away from the nearest shoreline at southwestern Lamma Island (Ha Mei Tsui). In order to assess the potential impacts of the proposed wind farm on the avifauna in particular migratory bird/seabird, the Study Area was defined to include not only the direct footprint area but also the waters around Lamma Island, including East and West Lamma Channel (*Figure 8.1*).

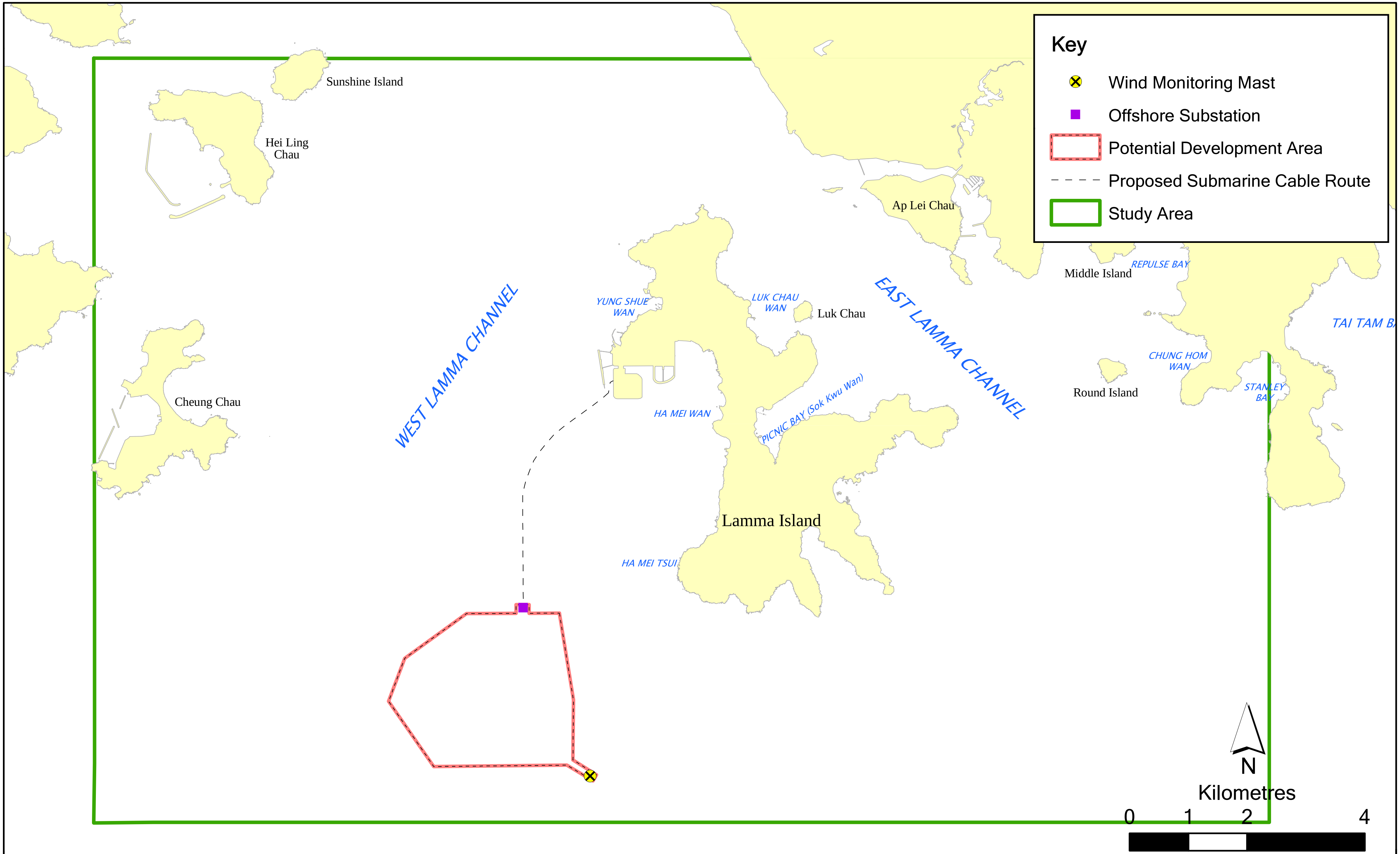

Figure 8.1

Study Area for Avifauna

File: Bird Survey\0088440_study area_Lamma.mxd
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It should be noted that the works areas for land-based works including the transmission cable landing and onshore cable installation are not included in the Study Area. All land-based construction works will be undertaken at the Lamma Power Station Extension which has been a restricted area and managed by the Hong Kong Electric Co. Ltd. since the commencement of operation in 2006 (1). The site is reclaimed land that is urbanised and subject to a high degree of disturbance related to existing quay and Power Station activities. The terrestrial ecological resources (vegetation, terrestrial habitats and wildlife) within the Lamma Power Station Extension are expected to be very limited and are considered of minimal ecological concern. Impact assessment of the land-based construction on terrestrial habitats and wildlife resources at the Lamma Power Station Extension is therefore considered not required and is not discussed further in this section of the EIA.

8.4 LITERATURE REVIEW OF AVIFAUNA

8.4.1 *Methodology*

A preliminary desktop study and literature review has been conducted to determine the existing conditions of avifauna in particular migratory seabird within the Study Area. The literature review included a review of the following:

- Hong Kong Biodiversity (Agriculture, Fisheries and Conservation Department Newsletters) (2);
- Annual Report of the Hong Kong Bird Watching Society (HKBWS) (3);
- The Avifauna of Hong Kong (4);
- Pilot Project to Increase Awareness of the Ecological Importance of the Breeding Colonies of Terns in Hong Kong (5);
- Seabird Migration Survey in Southern and South-eastern Hong Kong, Spring 2006 (6);
- Renewable Energy by a Wind Turbine System on Lamma Island - Environmental Impact Assessment (EIA) Report (1);

(1) Hong Kong Electric Co. Ltd. Lamma Power Station Extension Project Website. *http://lammaextension.hec.com.hk/*

(2) Agriculture, Fisheries and Conservation Department Newsletters.

(3) Hong Kong Bird Watching Society (1990 -2000). Annual Reports.

(4) Carey, G.J., Chalmers, M.L., Diskin, D.A., Kennerley, P.R., Leader, P.J., Leven, M.R., Lewthwaite, R.W., Melville, D.S., Turnbull, M., and Young, L. (2001). The Avifauna of Hong Kong. Hong Kong Bird Watching Society, Hong Kong.

(5) Hong Kong Bird Watching Society. (2003). Pilot Project to Increase Awareness of the Ecological Importance of the Breeding Colonies of Terns in Hong Kong. ECF Project 23/2002

(6) Hong Kong Bird Watching Society. (2006). Seabird migration survey in southern and south-eastern Hong Kong, spring 2006 (ECF Project 2005-10). Unpublished report by the Hong Kong Bird Watching Society. The Hong Kong Bird Watching Society Limited. Hong Kong.

- Helipad at Yung Shue Wan, Lamma Island – EIA Study [(2)];

- A Commercial Scale Wind Turbine Pilot Demonstration at Hei Ling Chau – EIA Study [(3)]; and,

- Hong Kong Offshore Wind Farm in Southeastern Waters - Environmental Impact Assessment Report [(4)].

8.4.2 *Results*

Species Occurrence

Results from the baseline surveys, conducted previously as part of various EIA studies at or around Lamma Island, recorded 10 species of conservation interest as shown in *Table 8.1*.

Table 8.1 Species of Conservation Interested Recorded in and around Lamma Island from Previous Survey

Species	Commonness in Hong Kong	PRC Protection Status	China Red Data Book	CITES Appendix
Pacific Reef Egret	Uncommon but localised	II	Rare	II
Black-eared Kite	Widespread and common	II		II
Common Buzzard	Widespread and common	II		II
Crested Goshawk	Uncommon but localised	II	Rare	II
Chinese Goshawk	Uncommon but localised	II		II
White-bellied Sea Eagle	Uncommon but localised	II	Indeterminate	II
Common Kestrel	Widespread and common	II		II
Greater Coucal	Widespread and common	II	Vulnerable	
Lesser Coucal	Widespread and common	II	Vulnerable	
Emerald Dove	Scarce but widespread		Vulnerable	

It has also been suggested that Bonelli's Eagle *Hieraaetus fasciatus* is present in Lamma [(5)] but sighting records have not been reported in recent years. The eagle is listed as rare species in the China Red Data Book, Class II protected species in PRC and CITES Appendix II.

(1) ERM-Hong Kong, Ltd (2004). Renewable Energy by a Wind Turbine System on Lamma Island - EIA Report prepared for Hong Kong Electric Co. Ltd.

(2) BMT Asia Pacific (2005). Helipad at Yung Shue Wan, Lamma Island – EIA Study. Final EIA Report prepared for CEDD.

(3) ERM-Hong Kong, Ltd (2006). A Commercial Scale Wind Turbine Pilot Demonstration at Hei Ling Chau - EIA Report prepared for Hong Kong Electric Co. Ltd.

(4) BMT Asia Pacific (2009). *Hong Kong Offshore Wind Farm in Southeastern Waters - Environmental Impact Assessment.* EIA Report - Section 7 Avifauna.(Ref: ESB-146/2006).

(5) AFCD (2006). Hong Kong Online Biodiversity Database. http://www.afcd.gov.hk/english/conservation/hkbiodiversity/database/search.asp

Migratory Seabird Population

It has been documented that approximately 38 species of seabirds have been recorded in Hong Kong [(1)]. Further survey results and the latest checklist provided by HKBWS have added 6 additional seabird species such as Wedge-tailed Shearwater *Puffinus pacificus*, Short-tailed Shearwater *Puffinus tenuirostris* and Masked Booby *Sula dactylatra* [(2)] (see *Table 1* of *Annex 8*).

A total of 8,750 individuals in 23 of these recorded seabird species were recorded during the migratory spring season (March to May) in 2006 in southern and south-eastern Hong Kong waters, including Lamma Island (*Table 8.2*) [(3)]. Red-necked Phalaropes *Phalaropus lobatus* were the largest group of seabirds observed during the survey (~75% of total numbers). Other key species recorded included White-winged Tern *Chlidonias leucoptera*, Black-naped Tern *Sterna sumatrana*, Aleutian Tern *Sterna aleutica* and Greater Crested Tern *Sterna bergii*. Spatial variation in bird sightings record was also found in which more terns occurred in the southern waters (i.e. area between Po Toi and Lamma Island), while more Red-necked Phalaropes occurred in the south-eastern waters (i.e. area near the Ninepins) (*Figure 8.2*).

Table 8.2 ***Total Number of Seabirds Recorded during HKBWS Surveys (Total of 22 surveys days during March to May 2006) and its Percentage Contribution*** [(4)]

Seabirds	Number (% of Total)
Family Scolopacidae (Sandpipers)	
Red-necked Phalarope *Phalaropus lobatus*	6,618 (75.63)
Sub-total	*6,618 (75.63)*
Family Sternidae (Terns)	
Whiskered Tern *Chlidonias hybridus*	6 (0.07)
White-winged Tern *Chlidonias leucopterus*	754 (8.61)
Aleutian Tern *Sterna aleutica*	200 (2.28)
Bridled Tern *Sterna anaethetus*	55 (0.63)
Gull-billed Tern *Sterna nilotica*	5 (0.06)
Caspian Tern *Sterna caspia*	4 (0.05)
Common Tern *Sterna hirundo*	212 (2.42)
Roseate Tern *Sterna dougallii*	2 (0.02)
Black-naped Tern *Sterna sumatrana*	258 (2.95)
Sooty Tern *Sterna fuscata*	1 (0.01)
Little Tern *Sterna albifrons*	1 (0.01)
Greater Crested Tern *Sterna bergii*	10 (0.11)
Unidentified Tern *Chlidonias* sp. / *Sterna* sp.	219 (2.50)
Sub-total	*1,727 (19.73)*
Family Laridae (Gulls)	
Yellow-legged Gull *Larus cachinnans*	2 (0.02)
Black-tailed Gull *Larus crassirostris*	2 (0.02)

(1) Carey, G.J., Chalmers, M.L., Diskin, D.A., Kennerley, P.R., Leader, P.J., Leven, M.R., Lewthwaite, R.W., Melville, D.S., Turnbull, M., and Young, L. (2001). The Avifauna of Hong Kong. Hong Kong Bird Watching Society, Hong Kong.

(2) Hong Kong Bird Watching Society (2009). List of Hong Kong Bird Record (March 2009). http://hkbws.org.hk/BBS/viewthread.php?tid=7730&extra=page%3D1

(3) Hong Kong Bird Watching Society (2006). *Op cit.*

(4) Hong Kong Bird Watching Society (2006). *Ibid.*

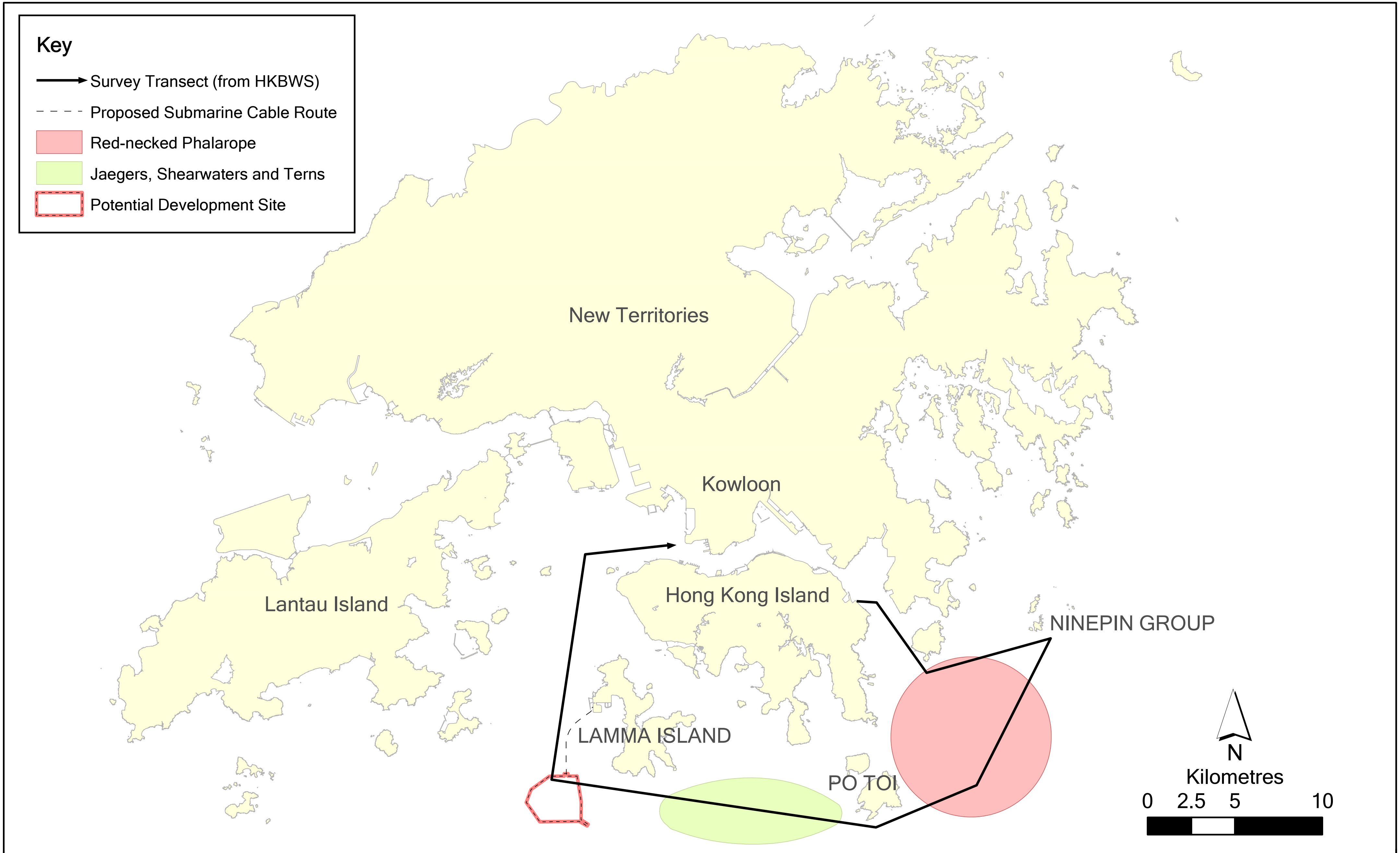

Figure 8.2

Survey Transects and Approximate Area with High Abundance of Red-necked Phalarope, Jaegers, Shearwaters and Terns (March to May 2006, a total of 22 survey trips) (Reference: HKBWS 2006)

File: Bird_survey\May09\comparison\0088440_survey transects_L.mxd
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Seabirds	Number (% of Total)
Heuglin's Gull *Larus heuglini*	158 (1.81)
Slaty-backed Gull *Larus schistisagus*	1 (0.01)
Unidentified Gull *Larus* sp.	8 (0.09)
Sub-total	*171 (1.95)*
Family Stercorariidae (Jaegers and Skua)	
Long-tailed Jaeger *Stercorarius longicaudus*	113 (1.29)
Parasitic Jaeger *Stercorarius parasiticus*	13 (0.15)
Pomarine Jaeger/Skua *Stercorarius pomarinus*	17 (0.19)
Unidentified Jaeger *Stercorarius* sp.	18 (0.21)
Sub-total	*161 (1.84)*
Family Procellariidae (Shearwaters)	
Streaked Shearwater *Calonectris leucomelas*	52 (0.59)
Short-tailed Shearwater *Puffinus tenuirostris*	15 (0.17)
Unidentified Shearwater *Puffinus* sp.	3 (0.03)
Sub-total	*70 (0.80)*
Family Alcidae (Auks)	
Ancient Murrelet *Synthliboramphus antiquus*	3 (0.03)
Sub-total	*3 (0.03)*
Grand Total	**8,750 (100)**

As part of the EIA Study for another proposed wind farm development project in the eastern waters in Hong Kong, focussed surveys were conducted from May 2006 to August 2006, from December 2006 to May 2007, and August 2007 to December 2007 (1). The surveyed area was located at least 30 km northeast from the Project site. A total of 57 bird species and six unidentified species were recorded over 59 survey days. Nine species were considered to be of relatively higher sensitivity due to their conservation significance, distribution and/ or abundance within their Study Area, including White-bellied Sea Eagle, Roseate Tern, Black-naped Tern, Bridled Tern, Aleutian Tern, White-winged Black Tern, Red-necked Phalarope, Black-tailed Gull and Cattle Egret. Results also revealed that the majority of the birds recorded were restricted to nearshore coastal waters and all bird species recorded belong to surface-feeding species.

Breeding Tern Population

The breeding bird survey conducted by Hong Kong Bird Watch Society (HKBWS) have recorded three breeding bird species within Hong Kong waters (2) as shown in *Table 8.3*.

(1) BMT Asia Pacific (2009). *Hong Kong Offshore Wind Farm in Southeastern Waters - Environmental Impact Assessment.* EIA Report - Section 7 Avifauna.(Ref: ESB-146/2006).

(2) Carey, G.J., Chalmers, M.L., Diskin, D.A., Kennerley, P.R., Leader, P.J., Leven, M.R., Lewthwaite, R.W., Melville, D.S., Turnbull, M., and Young, L. (2001). The Avifauna of Hong Kong. Hong Kong Bird Watching Society, Hong Kong.

Table 8.3 *Breeding Tern Species Recorded in Hong Kong by Carey* et al *(2001)* [1]

Common Name	Species Name	HK Status	Commonness in Hong Kong [2]
Gulls & Terns			
Roseate Tern	*Sterna dougallii*	SV	• Uncommon but localised in Hong Kong
Black-naped Tern	*Sterna sumatrana*	SV	• Common in Hong Kong
Bridled Tern	*Sterna anaethetus*	SV	• Uncommon but localised in Hong Kong

Figure 8.3 shows the distribution of the recorded breeding tern colonies in Hong Kong. For the three summer breeding tern species recorded (ie Black-napped Tern, Roseate Tern and Bridled Tern), regular monitoring programme and the breeding tern surveys in 2003 has revealed that breeding colonies were mainly found on islands in northeastern and eastern waters such as Shek Ngau Chau, Ninepin Group and Waglan Island [3]. Within the Study Area, breeding individuals of Black-naped Tern were recorded at Round Island only.

Distribution of White-bellied Sea Eagle (WBSE)

White-bellied Sea Eagles (WBSE), *Haliaeetus leucogaster*, have been classified as one of the species of conservation interest in Hong Kong due to its protection status (PRC Class II protected and CITES Appendix II species) and uncommon population in Hong Kong (see *Table 8.1)*. Study conducted in 2003 estimated that there were a total of 39 WBSEs in Hong Kong including 23 adults and 16 immatures/juveniles [4]. Survey results have showed that the distribution of these birds was predominantly in the eastern waters and southern waters of Hong Kong and harbour areas, whereas western waters supported fewer WBSEs (*Figure 8.4*). Within the Study Area, WBSEs were sighted in the central part of Lamma Island.

WBSEs are also known to have nesting colonies in Hong Kong, particularly in eastern waters. In southern waters, south Lamma Island was designated as a Site of Special Scientific Interest (SSSI) in 1980, aiming to protect the nesting habitats of this eagle near Mount Stenhouse. Regular monitoring conducted by AFCD has identified a total of 12 nesting locations including Tsim Chau, Yeung Chau, Tai Ngam Hau, Tsang Pang Kok, Wang Chau, Steep Island and Ninepin Group [5] (*Figure 8.4*). A nesting location was not found in Lamma Island. A study also revealed that their foraging distance could reach as far

(1) Carey, G.J. et al. (2001). *Op Cit.*.

(2) AFCD (2006). Hong Kong Online Biodiversity Database. http://www.afcd.gov.hk/english/conservation/hkbiodiversity/database/search.asp

(3) Hong Kong Bird Watching Society (2006). *Op cit.*

(4) Tsim ST, Lee WH, Cheung CS, Chow KL, Ma YN, Liu KY (2003) *The Population and Breeding Ecology of white-bellied Sea-eagles in Hong Kong*. Hong Kong Biodiversity, AFCD Newsletter: Issue 5.

(5) Agriculture, Fisheries and Conservation Department (AFCD) (2007) Unpublished data adopted from BMT Asia Pacific (2009).

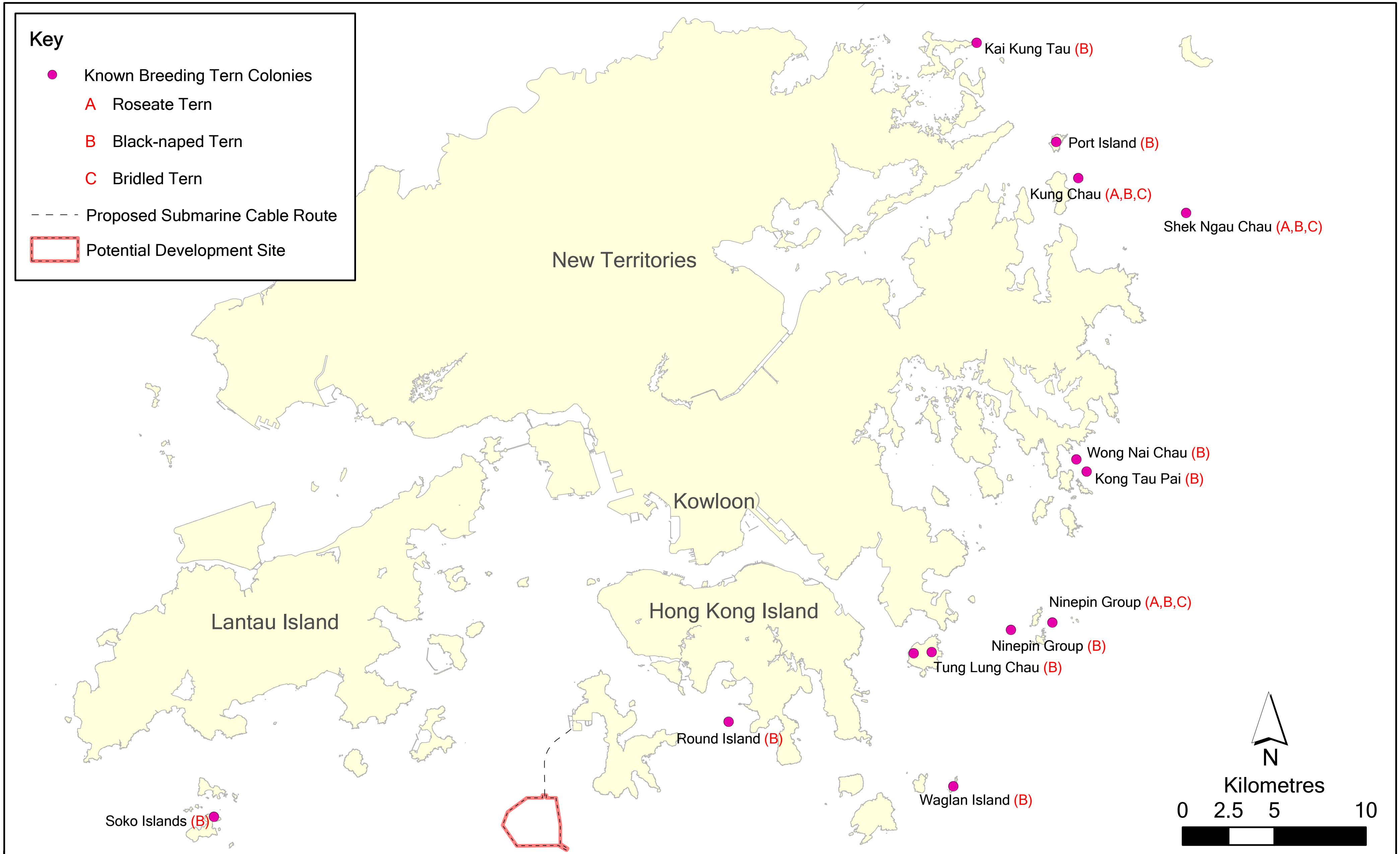

Figure 8.3

Known Breeding Tern Colonies in Hong Kong
(Reference: HKBWS 2006)

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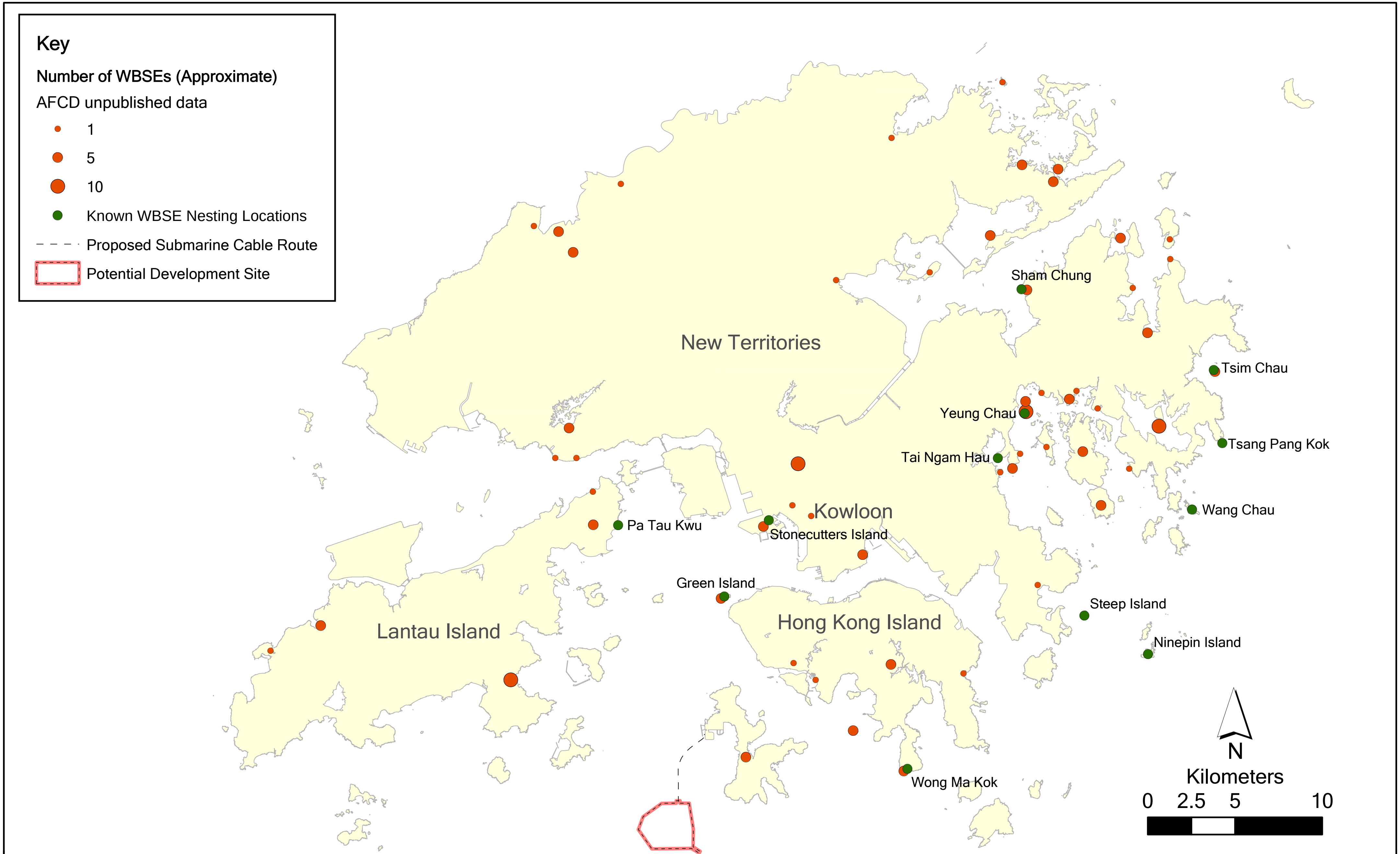

Figure 8.4

Sighting and Nesting Locations of White-bellied Sea Eagle (WBSE)
(Reference: BMT Asia 2009)

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as 2km from nesting locations with the peak foraging period occurring between 5pm and 7pm [(1)].

8.5 IDENTIFICATION OF INFORMATION GAP

The literature review discussed in the above section revealed that baseline information of migratory birds/seabird is available but not specific to the Study Area or the Project Site.

To supplement and update the available baseline information, vessel-based avifauna surveys were undertaken three days per month from July 2008 to June 2009 for 9 months (excluding November 2008 to January 2009) covering both wet and dry seasons around Lamma Island and the offshore waters along west Lamma Channel.

8.6 ECOLOGICAL BASELINE SURVEYS

8.6.1 *Methodology*

Nine months of avifauna vessel surveys (as required in the *Study Brief*) were conducted using the quantitative line transect method. Vessel-based surveys were undertaken three times per month from July to October 2008 and from February to June 2009 at the selected transect lines which were the same as the marine mammal survey transects which are standardised in Hong Kong and adopted by AFCD (*Figure 8.5*). The survey periods were designed to cover mainly the migratory and breeding seasons. Seasonality of birds in Hong Kong follows the HKBWS [(2)]:

- Spring (March to May) – Migratory Season
- Summer (June to August) – Breeding Season
- Autumn (September to November) – Migratory Season
- Winter (December to February)

During each survey, the vessel transited the transect lines at a relatively constant speed of 13-15 km/hr, observations were made using 8x binoculars and all birds seen within 1 km both sides along the transect lines were counted and identified to species where possible. Detailed information on bird species, sex and age where feasible, abundance, observed coordinates, bird activities/behaviour, flying height and path were recorded during the survey. Activities/behaviour of the birds were categorised into five classes:

(1) Tsim *et al* (2003) *Op cit.*

(2) HKBWS (2006*) Op cit.*.

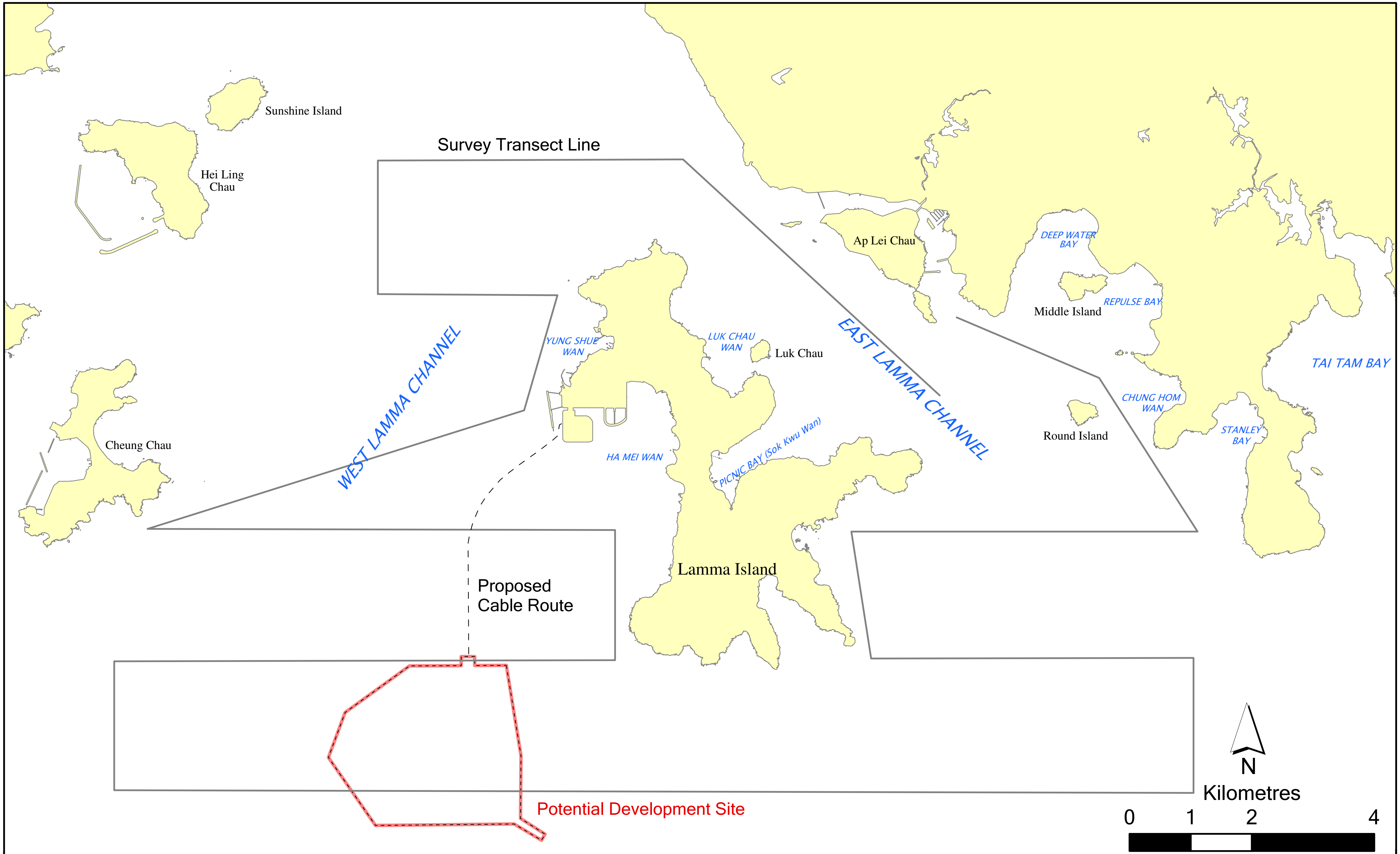

Figure 8.5

Survey Transect of Avifauna Vessel Survey
(Transect location followed marine mammal surveys)

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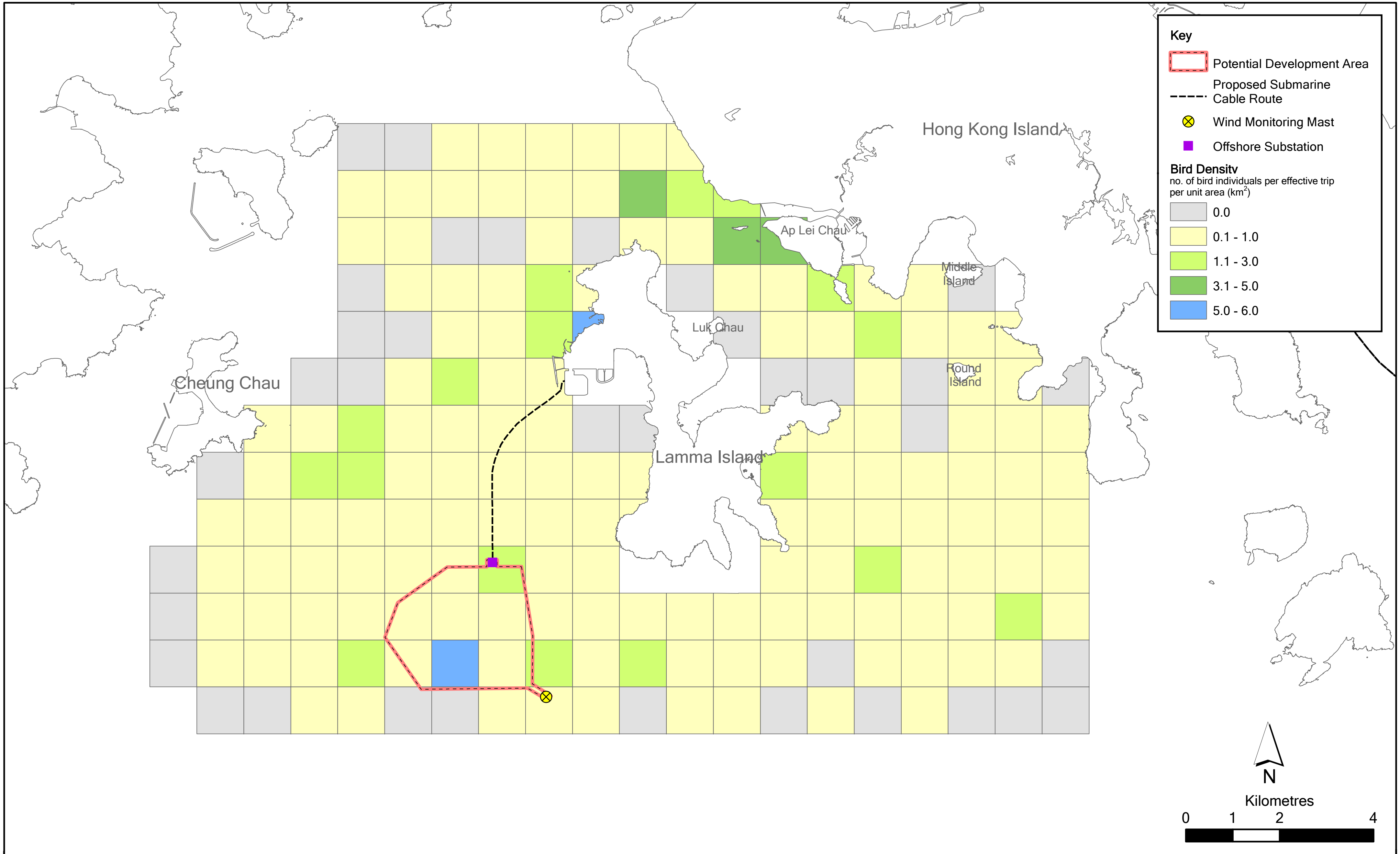

Figure 8.6

Overall Bird Density in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27, under sea condition of Beaufort <= 5)

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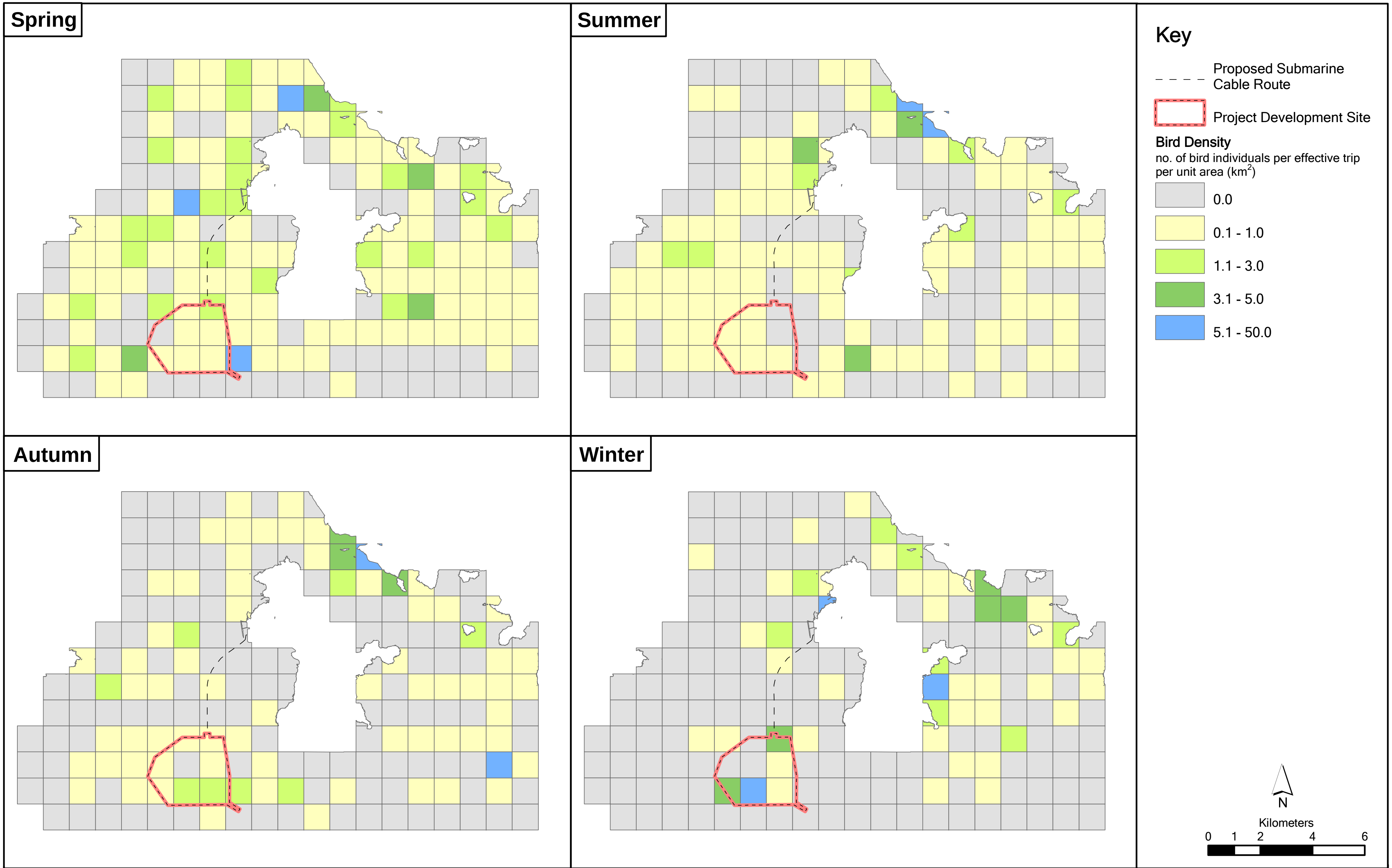

Figure 8.7

Seasonal Variation of Bird Density in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27, under sea condition of Beaufort <= 5)

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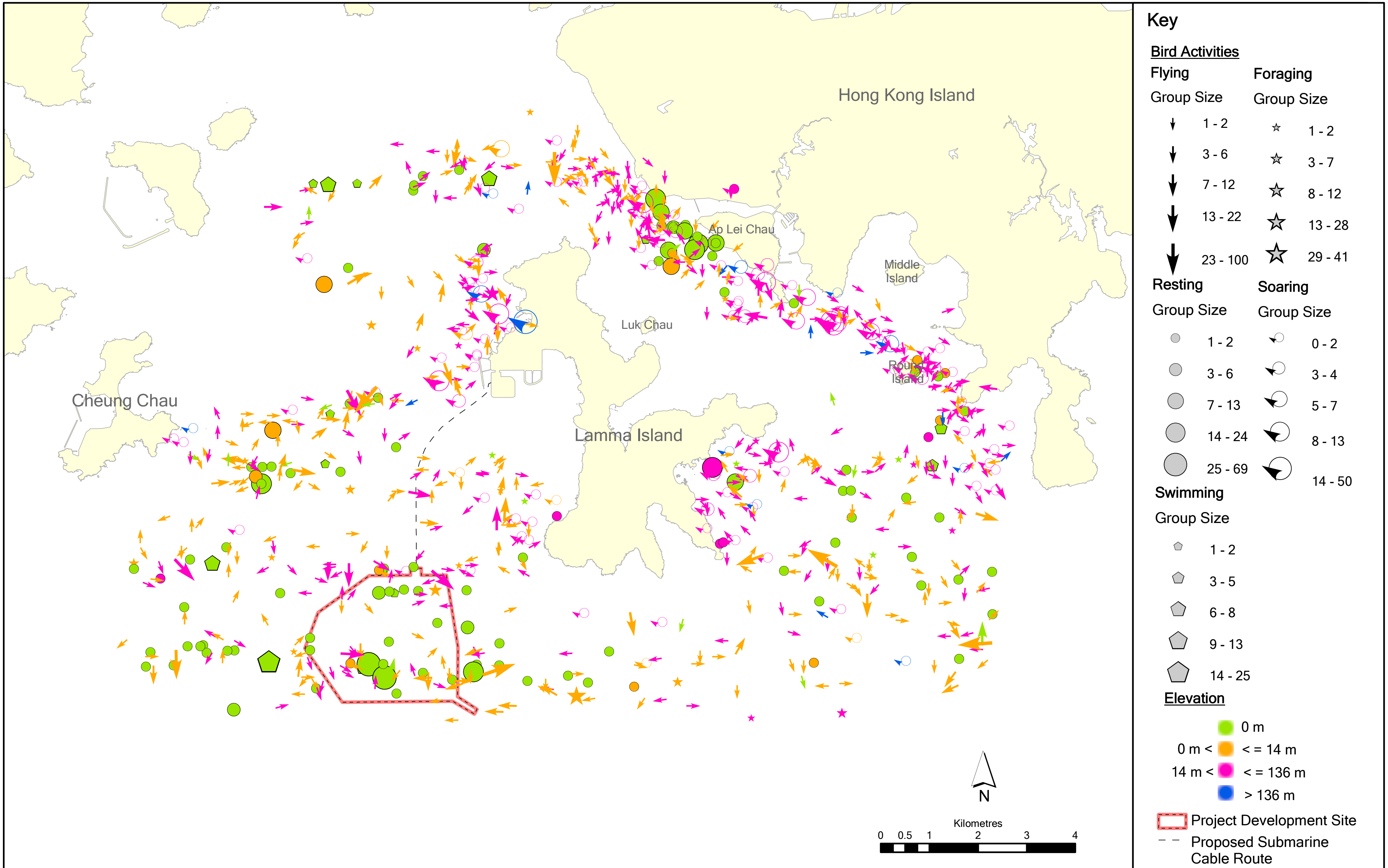

Figure 8.8

Distribution of All Birds in Waters around Lamma Island during July 08 to June 09
(Total Effective Survey Trips = 27)

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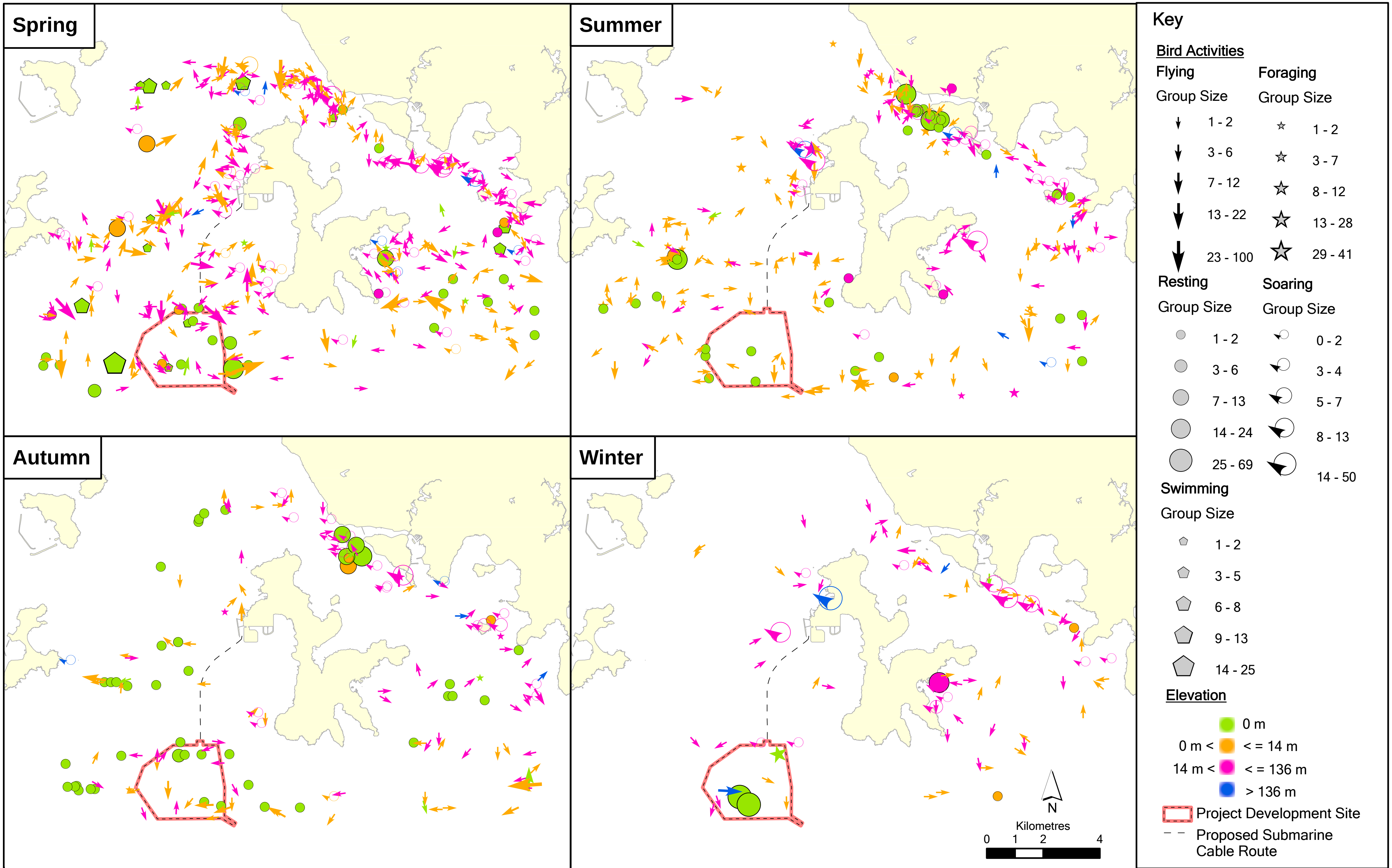

Figure 8.9

Seasonal Variation of the Distribution of All Birds in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

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- Flying - Birds moving in the air following a particular direction without conducting any of the other activities as below.
- Soaring - Birds moving in the air usually making a form of circular movement.
- Resting – Birds do not move, remain in the same location in certain period of time (eg Birds of Prey perching on trees, Egrets standing on rock, Tern standing on floating objects).
- Foraging/Feeding - Birds seen attacking, collecting, pecking or carrying food with their bill or feet could be defined as foraging or feeding.
- Swimming – Birds making movements on a water surface or floating on the sea.

Surveys were conducted during daylight hours only and night survey was not undertaken. Although night surveys are considered to be useful to track nocturnal migrants, in an open sea environment, surveys can only be done by radar tracking system as seabirds seldom make calls (as in owls). However, such a system cannot collect detailed information on birds such as species identify and abundance. It is considered the current survey findings sufficient to determine the ecological significance of the Study Area.

Quantitative Grid Analysis

Raw sightings records plotted on maps are generally not a good guide to ascertaining bird densities because different areas/seasons are not given the same amount of survey effort. In order to quantify the habitat use of bird within the Study Area, with reference to data analysis on bird density from other EIA studies [(1)(2)], corrected sighting densities have been calculated in terms of number of bird individuals per effective trip per unit area (the survey area mapped using a 1 km by 1 km grid (km^2)). All surveys were conducted under sea conditions of Beaufort <=5 and therefore all bird sightings were used for data analysis.

8.6.2 Results

Bird Density (Grid Analysis)

Taking into account of all effective bird sighting records, the grid analysis revealed that relatively higher bird density (one to six bird individuals per effective trip per 1 km^2) was observed near shore, at Yung Shue Wan and the open sea southwest of Lamma Island within the Project Site (*Figure 8.6*).

(1) British Trust for Ornithology (2005) The Potential Effects on Birds of Greater Gabbard Offshore Wind Farm Report for February 2004 to March 2005. Ornithological Baseline Report and Environmental Impact Assessment prepared for Greater Gabbard Offshore Winds Limited. BTO Research Report No. 419.

(2) National Environmental Research Institute (NERI), Ministry of Environment and Energy (2000) Effects on birds of an offshore wind park at Horns Rev: Environmental impact assessment.

Similar pattern was generally found in all seasons but more birds were distributed over the open sea in Spring (one to three bird individuals per effective trip per 1 km^2, *Figure 8.7)* during the migratory season.

Abundance and Distribution

A total of 2,214 individuals of 33 identified and four unidentified bird species were recorded during the surveys (see *Figures 8.8 & 8.9, Table 2* of *Annex 8*). The recorded bird species were classified in 6 groups, including Birds of Prey, Egrets & Herons, Shorebirds (excluded Egrets & Herons), Gulls & Terns, Seabirds (excluded Gulls & Terns) and Others (*Table 8.4*). About half of the identified species are common and widely distributed in Hong Kong such as Chinese Pond Heron *Ardeola bacchus*, Large-billed Crow *Corvus macrorhynchus* and Barn Swallow *Hirundo rustica*.

Table 8.4 Bird Species Recorded within the Study Area during the Surveys

Bird Group	Family	Common Name	Species Name
Birds of Prey	Accipitridae	Black Kite	*Milvus migrans*
	Accipitridae	Common Buzzard	*Buteo buteo*
	Accipitridae	White-bellied Sea Eagle	*Haliaeetus leucogaster*
Egrets & Herons	Ardeidae	Cattle Egret	*Bubulcus ibis*
	Ardeidae	Chinese Pond Heron	*Ardeola bacchus*
	Ardeidae	Great Egret	*Ardea alba*
	Ardeidae	Little Egret	*Egretta garzetta*
	Ardeidae	Pacific Reef Egret	*Egretta sacra*
	Ardeidae	Unidentified Egrets	Family Ardeidae
	Ardeidae	Schrenck's Bittern	*Ixobrychus eurhythmus*
Shorebirds (excluded Egrets & Herons)	Scolopacidae	Eastern Curlew	*Numenius madagascariensis*
	Glareolidae	Oriental Pratincole	*Glareola maldivarum*
	Scolopacidae	Red-necked Phalarope	*Phalaropus lobatus*
Gulls & Terns	Laridae	Black-headed Gull	*Larus ichthyaetus*
	Laridae	Black-legged Kittiwake	*Rissa tridactyla*
	Laridae	Black-tailed Gull	*Larus crassirostris*
	Laridae	Heuglin's Gull	*Larus heuglini*
	Sternidae	Aleutian Tern	*Sterna aleutica*
	Sternidae	Black-naped Tern	*Sterna sumatrana*
	Sternidae	Bridled Tern	*Sterna anaethetus*
	Sternidae	Common Tern	*Sterna hirundo*
	Sternidae	Greater Crested Tern	*Sterna bergii*
	Sternidae	Little Tern	*Sterna albifrons*
	Sternidae	Roseate Tern	*Sterna dougallii*
	Sternidae	Whiskered Tern	*Chlidonias hybridus*
	Sternidae	White-winged Tern	*Chlidonias leucopterus*
	Sternidae	Unidentified Terns	*Sterna* sp.
Seabirds (excluded Gulls & Terns)	Alcidae	Ancient Murrelet	*Synthliboramphus antiquus*
	Stercorariidae	Arctic Skua	*Stercorarius parasiticus*
	Fregatidae	Lesser Frigatebird	*Fregata ariel*
Others	Columbidae	Feral Pigeon	*Columbia livia*

Bird Group	Family	Common Name	Species Name
	Corvidae	Large-billed Crow	*Corvus macrorhynchus*
	Corvidae	Unidentified Crow	*Corvus* sp.
	Hirundinidae	Barn Swallow	*Hirundo rustica*
	Motacillidae	Unidentified Pipit	*Anthus* sp.
	Motacillidae	Yellow Wagtail	*Motacilla flava*
	Sturnidae	Crested Myna	*Acridotheres cristatellus*

The detailed of the quantitative bird data are shown in *Tables 2* and *3* of *Annex 8*. Mean abundance and number of species calculated for each bird group within the Study Area are presented in *Table 8.5*.

Table 8.5 Total and Mean Abundance of Birds within Study Area during the Surveys

Bird Group	Total no. of Individuals Recorded				
	Spring	**Summer**	**Autumn**	**Winter**	**Overall**
Birds of Prey	328	184	75	136	723
Egrets & Herons	122	106	108	15	351
Shorebirds	229	0	1	0	230
Gulls & Terns	327	208	118	139	792
Seabirds	14	1	0	0	15
Others	27	36	22	18	103
Total	**1,047**	**535**	**324**	**308**	**2,214**

Bird Group	Mean Abundance (No of Individuals per Survey Trip)					
	Spring (n = 9)	**Summer (n = 9)**	**Autumn (n = 6)**	**Winter (n = 3)**	**Overall (n = 27)**	**%**
Birds of Prey	36.4	20.4	12.5	45.3	26.8	**33%**
Egrets & Herons	13.6	11.8	18.0	5.0	13.0	**16%**
Shorebirds	25.4	0.0	0.2	0.0	8.5	**10%**
Gulls & Terns	36.3	23.1	19.7	46.3	29.3	**36%**
Seabirds	1.6	0.1	0.0	0.0	0.6	**1%**
Others	3.0	4.0	3.7	6.0	3.8	**5%**
Total	**116.3**	**59.4**	**54.0**	**102.7**	**82.0**	**100%**

Bird Group	Total no. of Species Recorded*				
	Spring	**Summer**	**Autumn**	**Winter**	**Overall**
Birds of Prey	3	2	2	1	**3**
Egrets & Herons	6	3	5	2	**7**
Shorebirds	3	0	1	0	**3**
Gulls & Terns	11	6	4	3	**14**
Seabirds	2	1	0	0	**3**
Others	2	2	4	4	**7**
Total	**27**	**14**	**16**	**10**	**37**

*Note: the total number of species recorded includes both identified and unidentified species.

Seabirds in particular Gulls and Terns had the highest mean abundance (~36%) and number of species (14 observed species including identified and unidentified species) during the surveys. Birds of Prey and Egrets and Herons had the second highest mean abundance and number of observed species respectively. The five most abundant species recorded were Black Kite *Milvus migrans* (~32%), Little Egret *Egretta garzetta* (~11%), Red-necked Phalarope *Phalaropus lobatus* (~9%), Heuglin's Gull *Larus heuglini* (~8%) and White-winged Tern *Chlidonias leucopterus* (~8%).

Seasonal variation in overall abundance and number of observed species was also apparent in which numbers were highest in Spring and lowest in Winter. Mean abundance was highest in Spring and lowest in Autumn (*Figure 8.9 & Table 8.5)*. Birds of Prey, Egrets and Heron, Gulls and Terns were present all year within the Study Area while Seabirds and Shorebirds were observed mainly in Spring (*Figures 8.10 – 8.15*).

Bird Activities and Elevation

Details of the activities and elevation data of each bird species are shown in *Table 4* of *Annex 8*. *Tables 8.6* and *Table 8.7* presented the total number of individuals recorded under each bird activities and at different elevation within the Study Area.

Table 8.6 Bird Activities observed within Study Area during the Surveys

	Total No. of Individuals Recorded				
	Flying	**Soaring**	**Foraging**	**Resting**	**Swimming**
Bird Group					
Birds of Prey	344	298	56	21	4
Egrets & Herons	213	3	10	125	0
Shorebirds	137	0	1	34	58
Gulls & Terns	453	0	73	265	1
Seabirds	11	0	0	2	2
Others	88	1	0	14	0
Total	**1,246**	**302**	**140**	**461**	**65**
Season					
Spring	741	121	9	111	65
Summer	249	63	115	108	0
Autumn	175	38	6	105	0
Winter	81	80	10	137	0
Total	**1,246**	**302**	**140**	**461**	**65**

During the surveys, most of the bird species observed were either flying (~56%) or resting (~21%) within the Study Area. Small numbers of birds were seen soaring (~14%), foraging (~6%) and swimming (~3%) in the area (*Figure 8.8)*. Noticeable seasonal variation was also observed in which more flying and swimming birds were seen in Spring during the migratory season while more foraging activities were observed in Summer during the breeding season (*Figure 8.9)*.

Table 8.7 Bird Elevation observed within Study Area during the Surveys

	Total No. of Individuals Recorded			
	Sea-level **0 m**	**Below Rotor Height** **(>0 – 14 m)**	**Within Rotor Height*** **(>14 - 136m)**	**Above Rotor Height** **(> 136m)**
Bird Group				
Birds of Prey	18	132	506	67
Egrets & Herons	113	174	64	0
Shorebirds	97	105	28	0
Gulls & Terns	239	439	114	0
Seabirds	7	5	3	0
Others	3	79	21	0
Total	**477**	**934**	**736**	**67**
Season				
Spring	154	505	375	13
Summer	99	254	168	14
Autumn	103	129	87	5
Winter	121	46	106	35
Total	**477**	**934**	**736**	**67**

*Note: the current data analysis has taken into consideration that a maximum rotor diameter of 111 m maybe adopted so that the number of bird individuals that fall within the range of rotor strike shall represent a worse case. The actual number of individuals affected would reduce should a smaller diameter rotor be adopted for the final wind turbine design. Based on the latest design information the actual rotor swept height will be within the 24-136m range. Consequently, the assessment presented here (ie assuming a rotor swept height of 14-136m) is conservayive.

Elevation of observed bird individuals were categorised according to the rotor height (see *Section 5* for wind turbine specification). Within the Study Area, over half (~ 64%) of the total birds observed were either resting/below the rotor height indicating that these bird species were generally staying/flying low over the sea surface. More individuals flying with an elevation range of 14 to 136m above sea level were observed in the open sea in Spring while birds flying/soaring above 136m above sea level (mainly Birds of Prey) were typically found close to the shoreline (see also *Figure 8.9 & 8.10)*.

Individual bird groups also exhibited clear behavioural patterns. Birds of Prey, mainly the Black Kite, were generally seen flying/soaring particularly along East Lamma Channel with height of 14 to 136m above sea level while more individuals with this height were observed over the open sea in spring (*Figure 8.10)*. Most Egrets and Herons observed were low-flying (<14m above sea level) near the coastline and over open sea while some individuals were flying of height of 14 to 136m above sea level (*Figure 8.11)*. Usually seen over open sea in Spring, Shorebirds (excluded Egrets and Herons), composed mainly of Red-necked Phalarope, exhibited more resting/swimming activities and also low-flying during the surveys (*Figure 8.12)*. Gulls and terns were found in both near shore and offshore waters and were usually seen flying below the rotor height. Most foraging activities and large resting groups (> 25 individuals) were observed in the southwestern waters in Lamma during

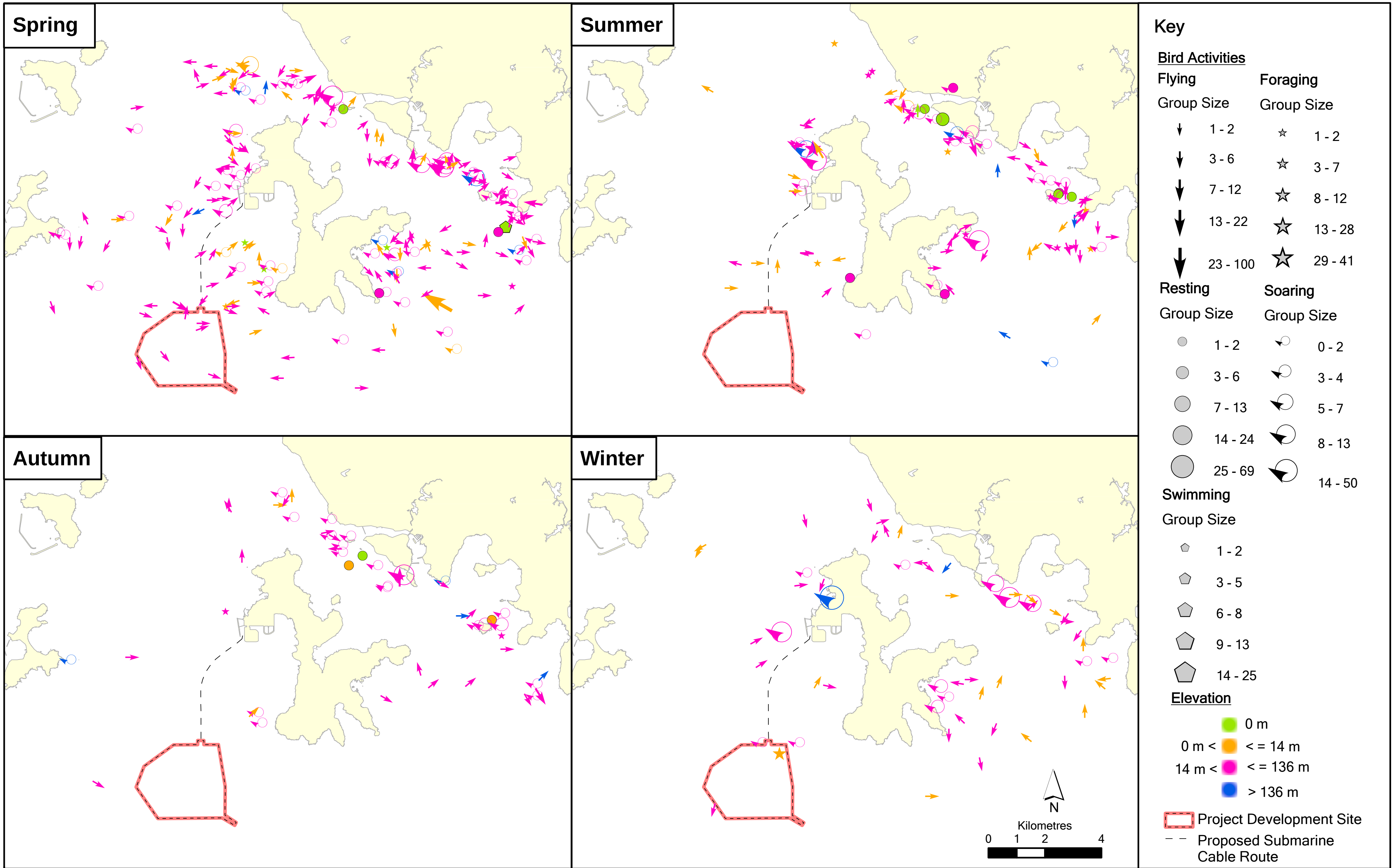

Figure 8.10 Seasonal Variation of the Distribution of Birds of Prey in Waters around Lamma Island during July 08 to June 09 (Total effective survey trips = 27, 98% of sightings from Black Kite)

File: Bird Survey\May_09\0088440_GP1_L.mxd
Date: 20/08/2009

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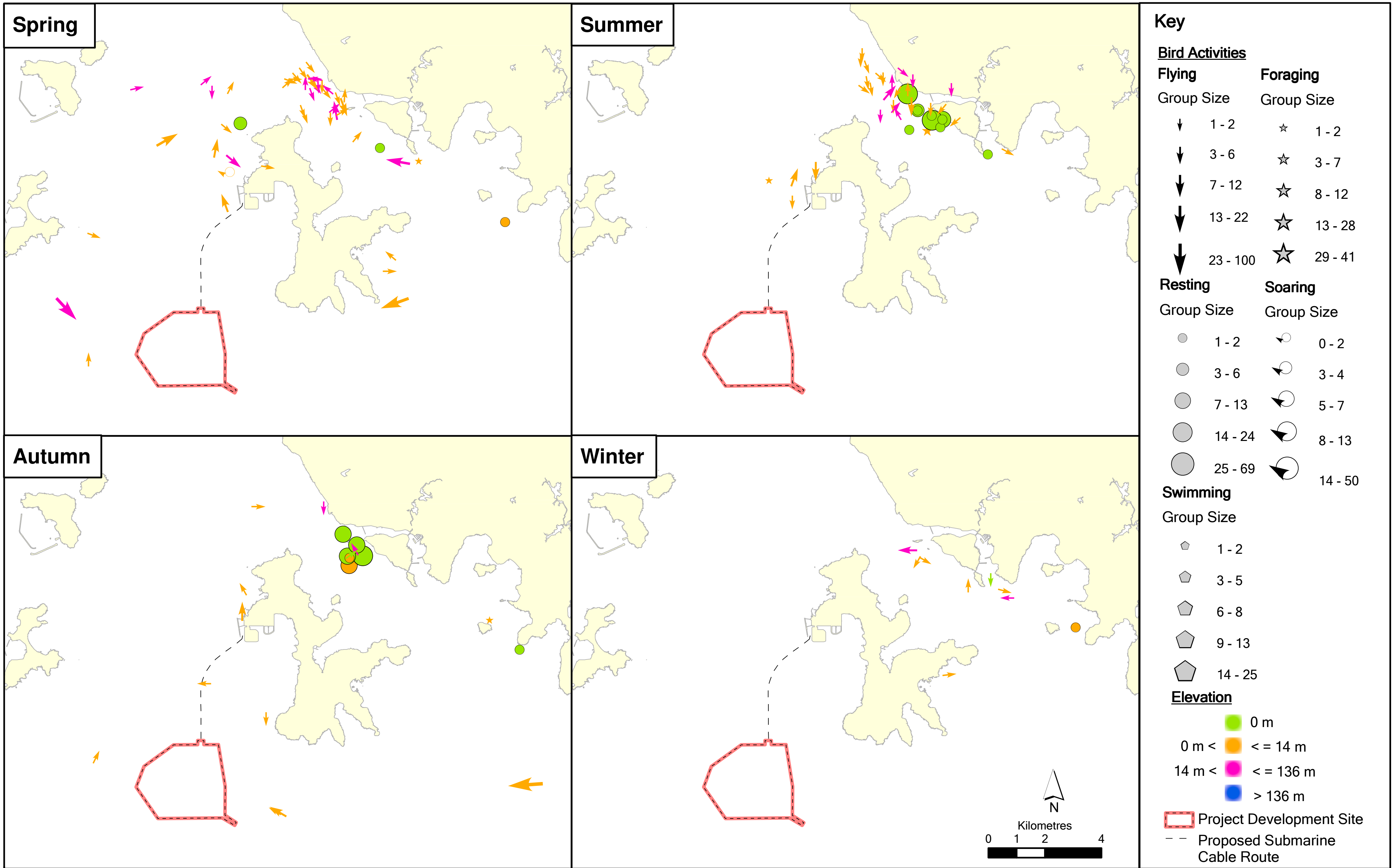

Figure 8.11

Seasonal Variation of the Distribution of Egrets and Herons in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27, 71% of sightings from Little Egret)

File: Bird Survey\May_09\0088440_GP2_L.mxd
Date: 20/08/2009

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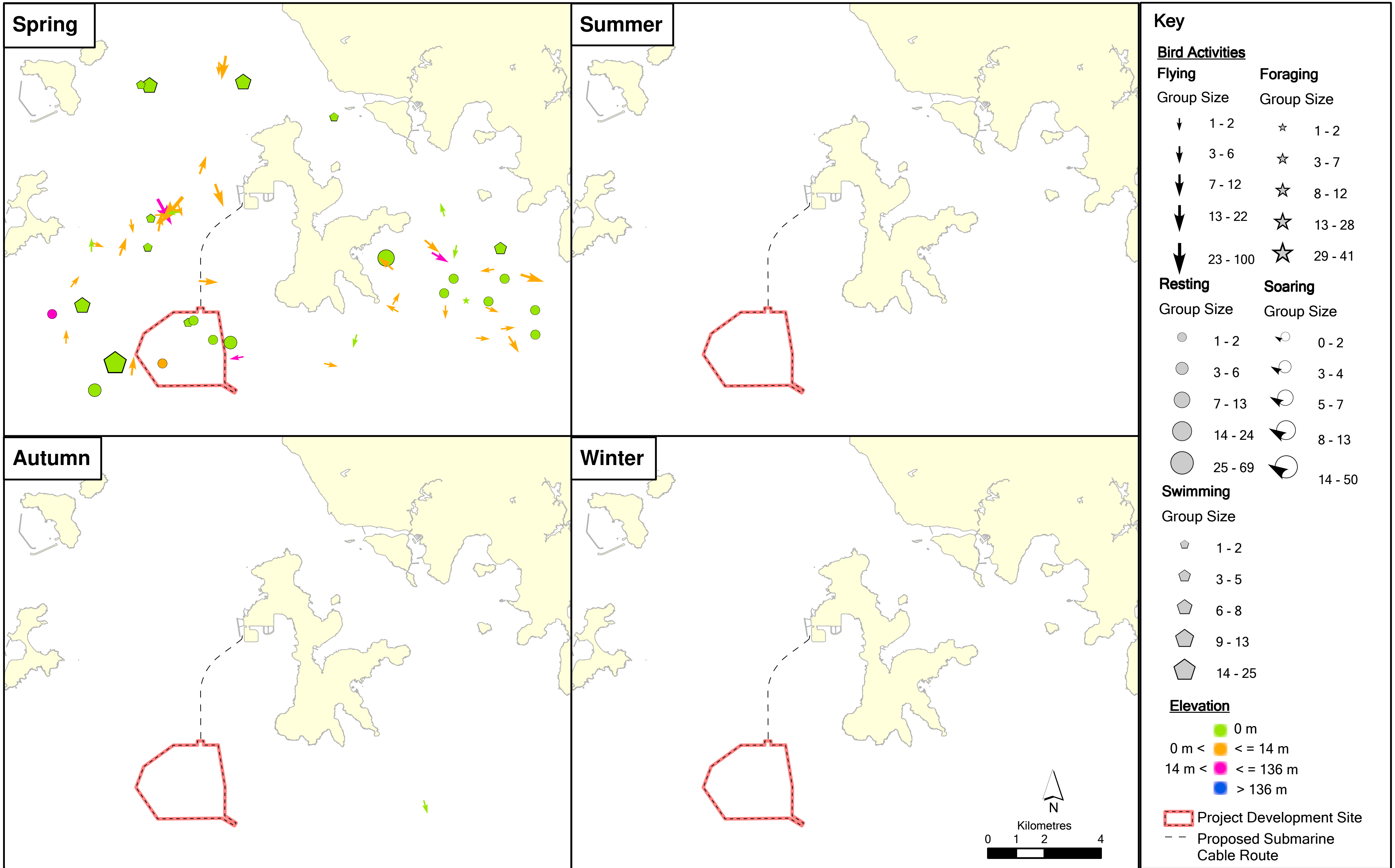

Figure 8.12

Seasonal Variation of the Distribution of Shorebirds (excluded Egrets & Herons) in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27, 90% of sightings from Red-necked Phalarope)

File: Bird Survey\May_09\0088440_GP3_L.mxd
Date: 20/08/2009

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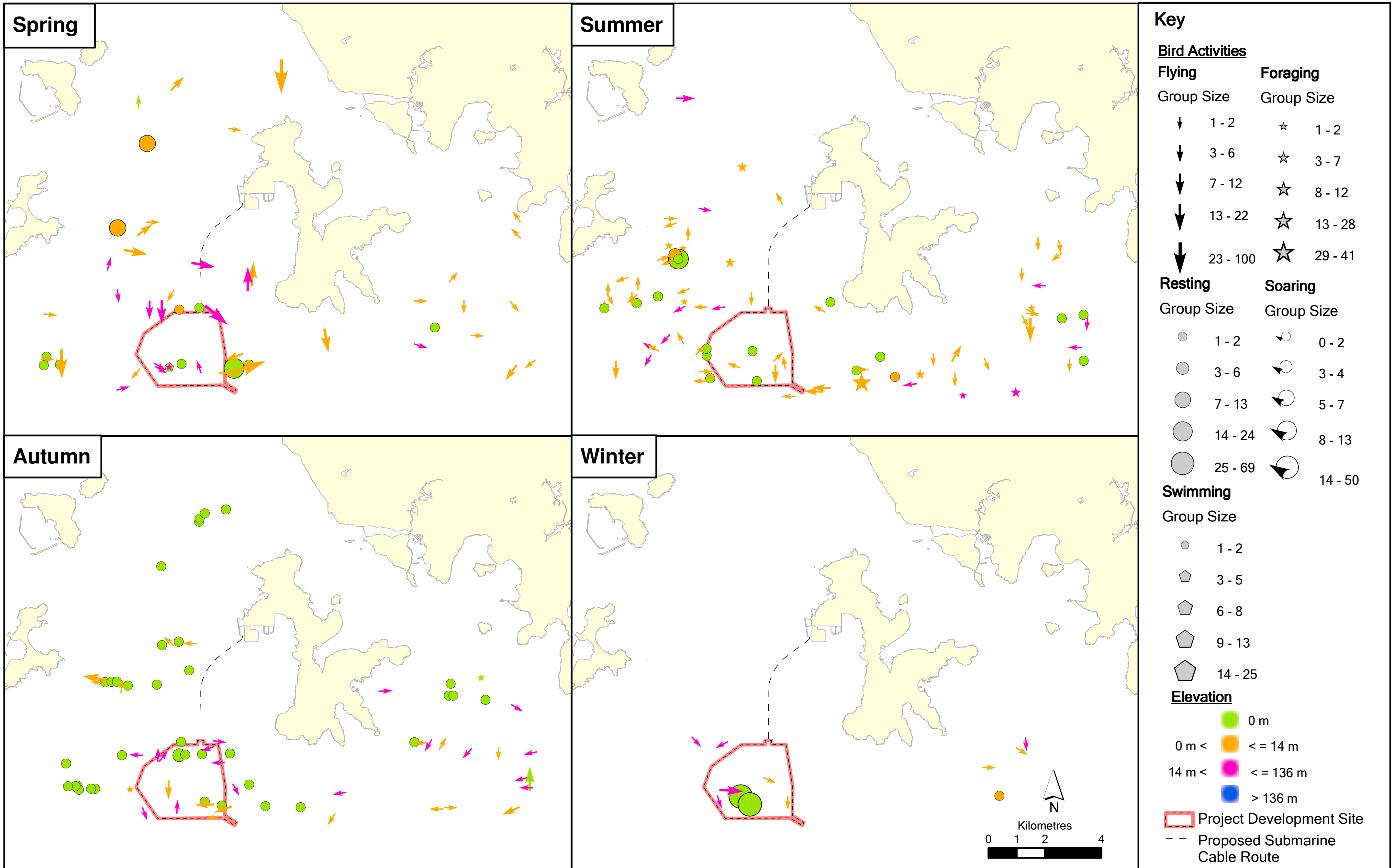

Figure 8.13

Seasonal Variation of the Distribution of Gulls and Terns in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\0088440_GP4_L.mxd
Date: 20/08/2009

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Figure 8.14

Seasonal Variation of the Distribution of Seabirds (excluded Gulls & Terns) in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

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Date: 20/08/2009

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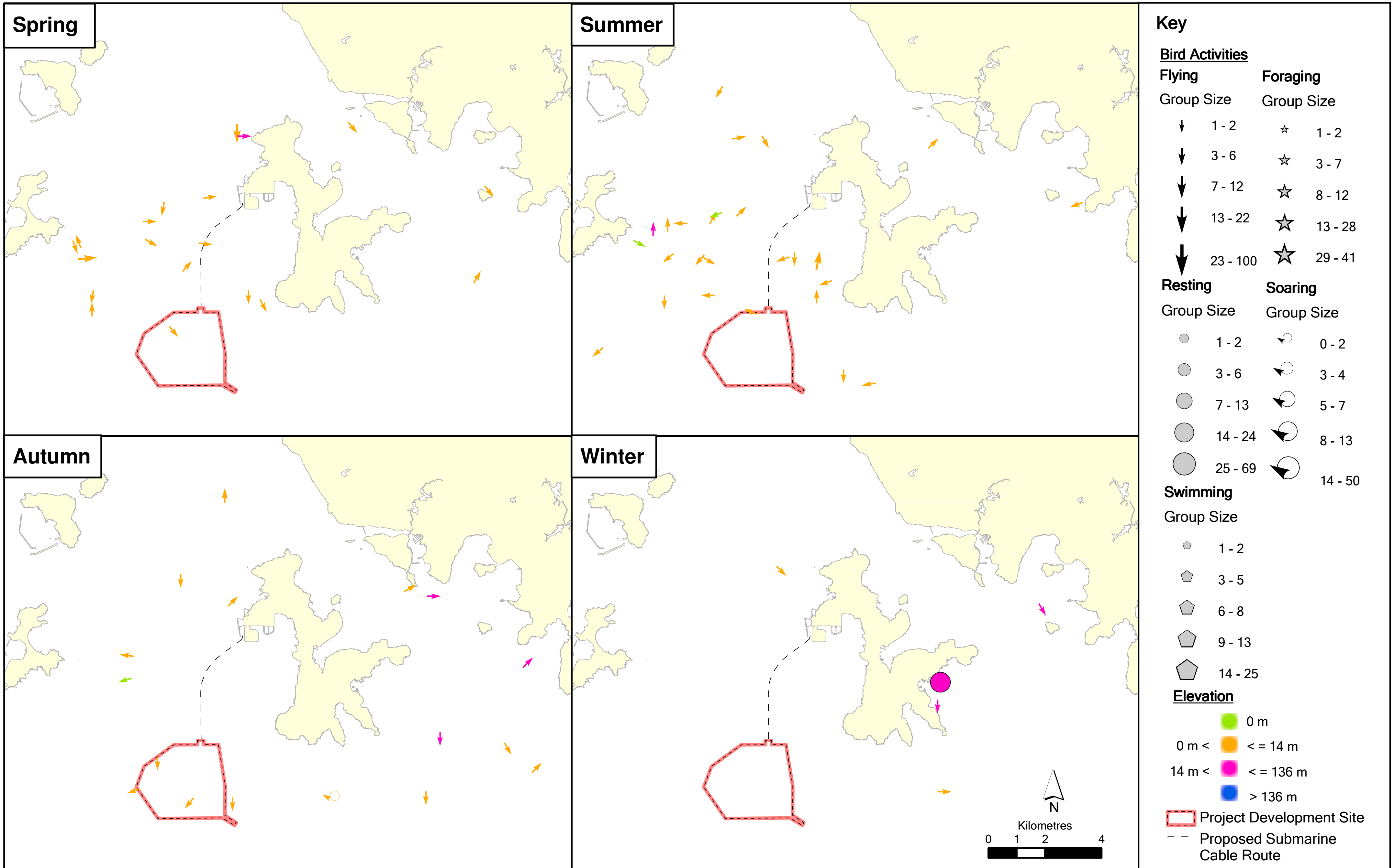

Figure 8.15

Seasonal Variation of the Distribution of Others in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\0088440_GP6_L.mxd
Date: 20/08/2009

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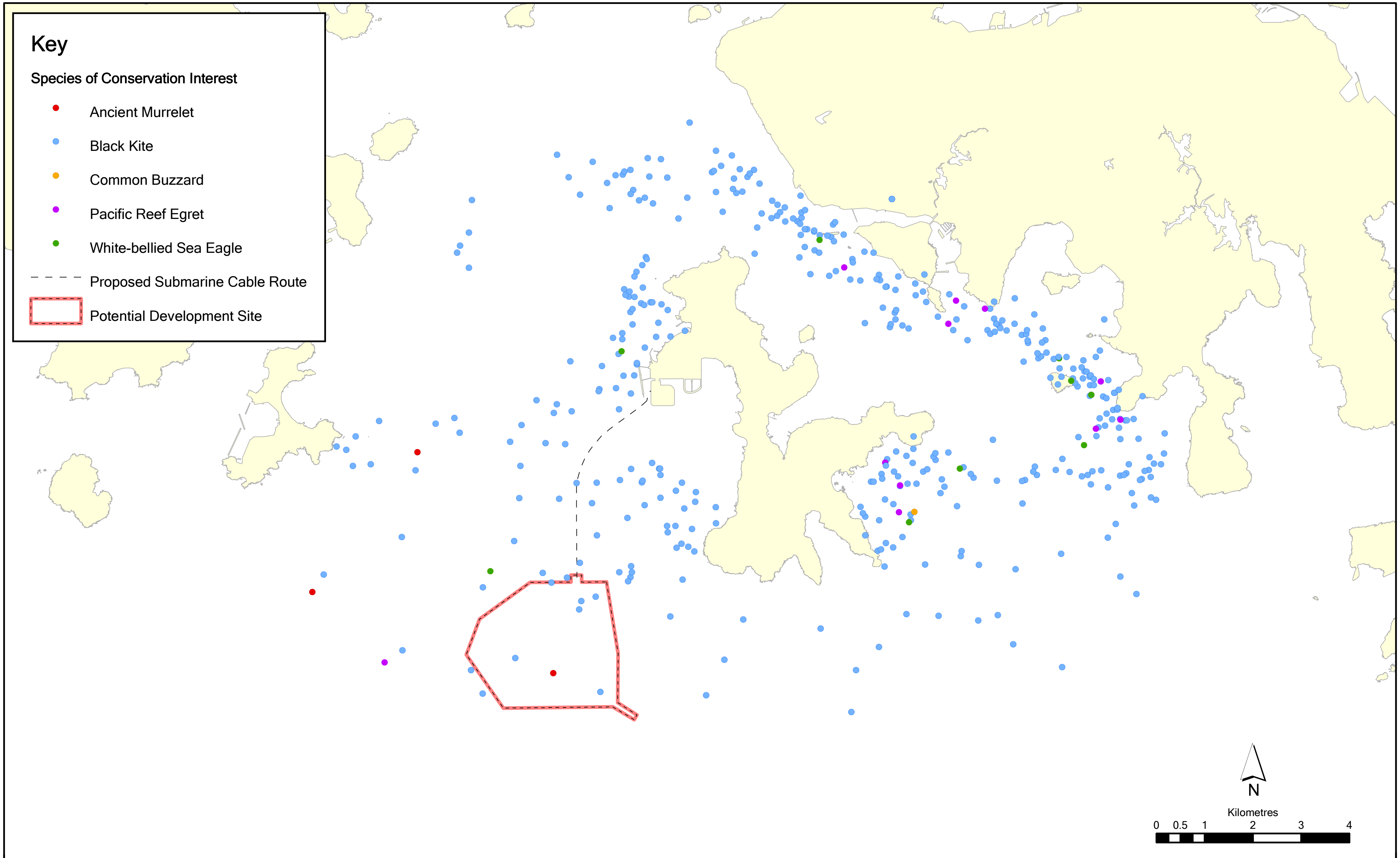

Figure 8.16

Locations of Species of Conservation Interest Recorded in the Study Area

File: Bird Survey\May_09\
0088440_species of conservation interest_L.mxd
Date: 19/10/2009

Environmental Resources Management

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Summer months (*Figure 8.13*). The remaining bird groups were mostly flying with elevations below the rotor height (*Figures 8.14 – 8.15*).

Bird Species of Conservation Interest/ Selected Sensitive Species for Further Assessment

There were five bird species of conservation interest recorded within the Study Area during the surveys (see *Table 2* of *Annex 8*). The distribution of these species is shown in *Figure 8.16*.

- White-bellied Sea Eagle *Haliaeetus leucogaster* – recognised as Class II protected species in the PRC, listed as an indeterminate species in the China Red Data Book and CITES Appendix II. It is an uncommon resident in Hong Kong. This eagle was only recorded in relatively low numbers in Spring, Summer and Autumn within the Study Area during the surveys. Most of the bird activities were observed along the East Lamma Channel with one individual flying at 15m above sea level north of the Project Site. They usually fly with height of 14 to 136m above sea level (see also *Figure 8.17*).

- Black Kite *Milvus migrans* – recognised as Class II protected species in the PRC and CITES Appendix II. It is a common and widespread resident in Hong Kong. This bird was the most abundant species recorded during the surveys (a total of 712 individuals and ~ 98% of the total number of Birds of Prey recorded, maximum group size was 34) and more individuals were recorded in Spring. Most of the birds were seen flying/soaring with the height of 14 to 136 m above sea level and they were mainly distributed around the shoreline. A group of 10 individuals were found foraging northeast of the Project Site (see also *Figure 8.18*).

- Common Buzzard *Buteo buteo* – recognised as Class II protected species in the PRC and CITES Appendix II. It is a common and widespread winter visitor in Hong Kong. Only one individual was seen in Spring soaring at 150m above sea level nearshore at Tung O Wan.

- Pacific Reef Egret *Egretta sacra* – recognised as Class II protected species in the PRC and CITES Appendix II. It is an uncommon resident but widely distributed in coastal areas throughout Hong Kong. This bird was present all year and most of them were seen resting/flying below 14 m above sea level nearshore along East Lamma Channel and Shek Pai Wan.

- Ancient Murrelet *Synthliboramphus antiquus* – listed as a vulnerable species in the China Red Data Book. This winter visitor was only recorded in spring during the surveys and all individuals recorded were flying over open sea with three individuals observed below rotor height within the Project Site.

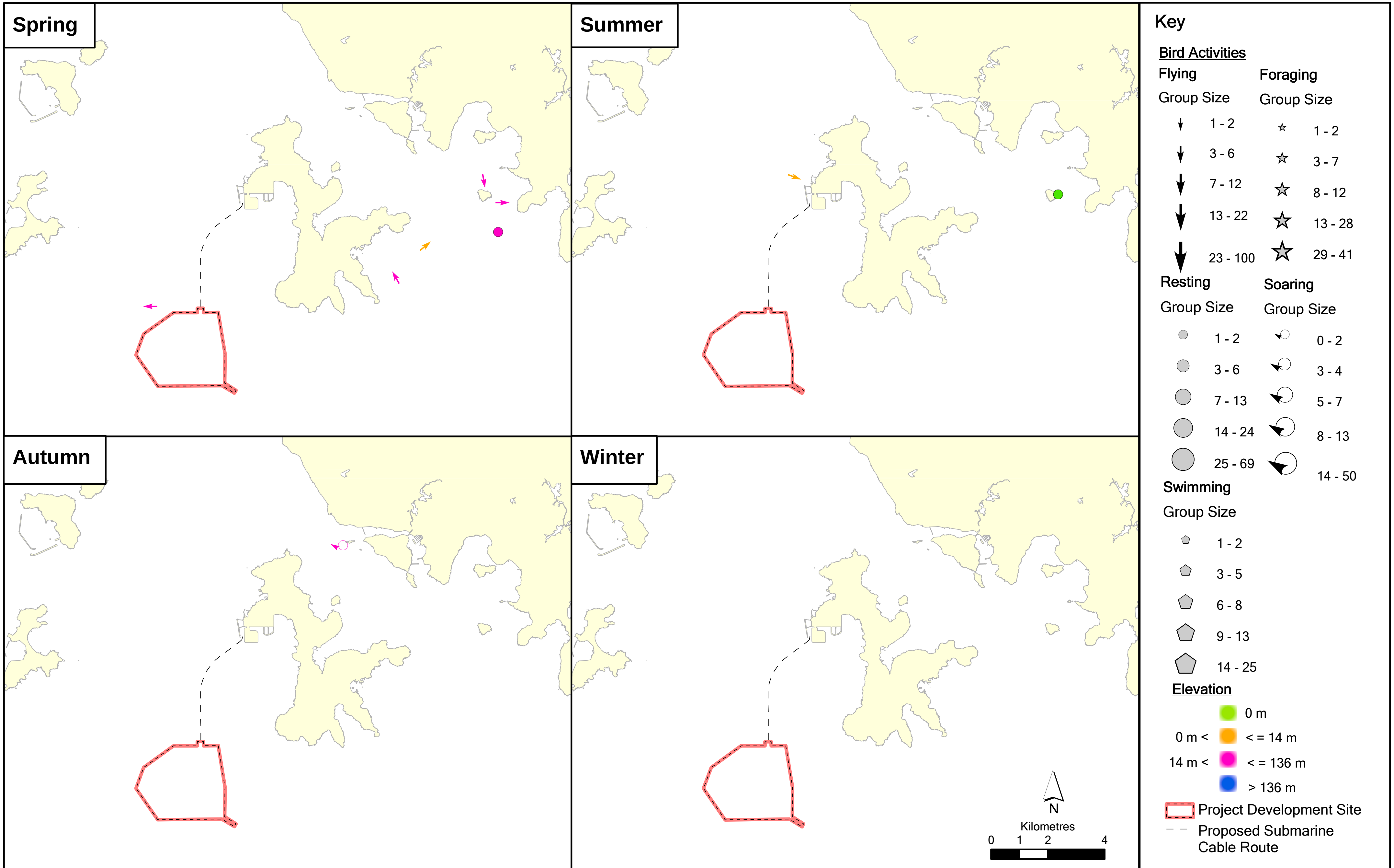

Figure 8.17
Seasonal Variation of the Distribution of White-bellied Sea Eagle in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_White-bellied Sea Eagle_L.mxd
Date: 20/08/2009

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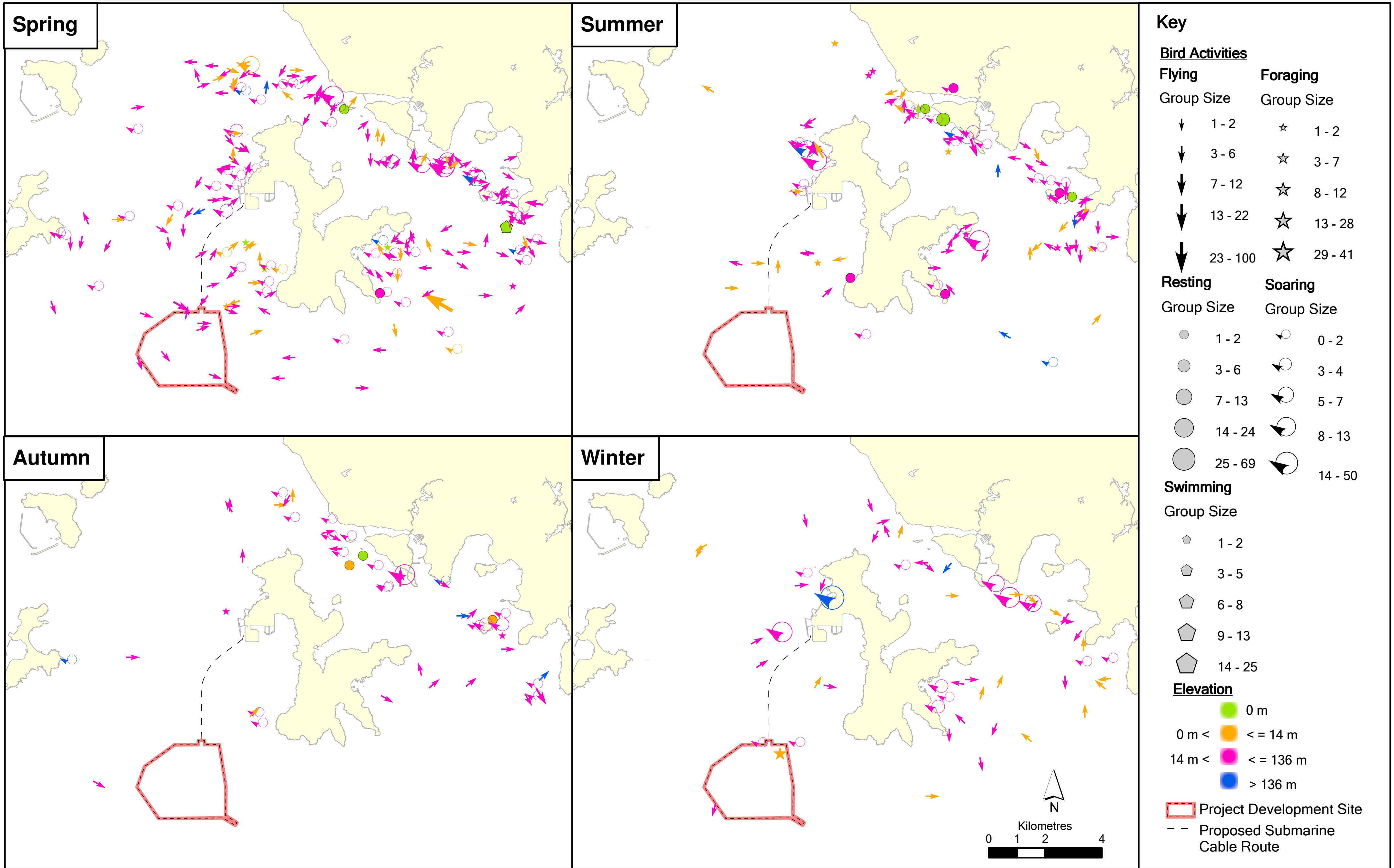

Figure 8.18

Seasonal Variation of the Distribution of Black Kite in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\by species\0088440_black-kite_L.mxd
Date: 20/08/2009

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In addition, a number of indicative bird groups have been identified to be particularly sensitive, or potentially so, to wind farms [(1)] and these are listed as follows:

- Gaviidae divers
- Podicipedidae grebes
- Sulidae gannets & boobies
- Ciconiiformes herons & storks
- Anserini swans and geese
- Anatinae ducks
- Accipitridae raptors
- Sternidae terns
- Alcidae alcids/auks
- Strigiformes owls
- Gruidae cranes
- Passeriformes especially nocturnal migrants

Based on the above list, as well as the flying height, the abundance and the location of the bird species recorded, an additional 16 species were selected for further assessment. The following subsection summarised the results of each selected species (except for those species of conservation interest already listed above). Their distribution is shown in *Figures 1 – 14* of *Annex 8*.

- Chinese Pond Heron *Ardeola bacchus* – a common and widespread resident in Hong Kong. Although this resident bird was observed in the vicinity of the Project Site, they were all flying below rotor height of 14 m above sea level (*Figure 1* of *Annex 8*).

- Little Egret *Egretta garzetta* – a common and widespread resident in Hong Kong. This resident bird was second most abundant bird species recorded during the surveys (a total of 232 individuals, maximum group size was 18). They were mainly distributed near shoreline at northern Lamma and along the East Lamma Channel. About 14% of the individuals were flying within the rotor height (*Figure 2* of *Annex 8*).

(1) BirdLife International (2003) Windfarms and Birds : An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues. Paper presented in Convention On The Conservation Of European Wildlife And Natural Habitats.

- Red-necked Phalarope *Phalaropus lobatus* – a common passage migrant in Hong Kong. They were observed in relatively high number during the surveys (a total of 207 individuals, maximum group size was 25). Almost all sightings were recorded in Spring with only one individual recorded flying in Autumn. They spent most of their time swimming/resting over large area of the Study Area. Within the Project Site, most of them were resting and swimming with a number of individuals flying in the vicinity of the Project Site (*Figure 3* of *Annex 8*).

- Aleutian Tern *Sterna aleutica* – an uncommon passage migrant in Hong Kong. They were mostly seen in Autumn along the West Lamma Channel and usually resting and flying below rotor height over the open sea. Within the Project Site, they were resting and flying within the rotor height during the surveys (*Figure 4* of *Annex 8*).

- Black-headed Gull *Larus ichthyaetus* (common winter visitor and passage migrant), Black-tailed Gull *Larus crassirostris* (uncommon winter visitor), and Black-legged Kittiwake *Rissa tridactyla* (rare winter visitor) – all species were recorded in low number during the surveys. The gulls were observed within the Project Site below the rotor height while the Black-legged Kittiwake was seen flying within the rotor height (*Figure 5* of *Annex 8*).

- Black-naped Tern *Sterna sumatrana* – a common summer visitor in Hong Kong. They were present in Spring and Summer flying and foraging alone West Lamma Channel during the surveys. They were found foraging in open sea southeast of Cheung Chau. All individuals recorded within the Project Site were flying with three individuals of rotor height (*Figure 6* of *Annex 8*).

- Bridled Tern *Sterna anaethetus* – a common summer visitor and breeding in Hong Kong. Most of the sightings were recorded in Summer. They were mainly flying/foraging in open sea in southern Lamma waters. Five individuals were observed resting/flying within and in the vicinity of the Project Site below 14 m above sea level (*Figure 7* of *Annex 8*).

- Common Tern *Sterna hirundo* – a common passage migrant in Hong Kong. Higher sightings were recorded in Summer and Autumn. About 19% of the individuals recorded were flying with the height of 14 to 136m above sea level. They were found foraging west of the Project Site Boundary and south of Round Island. Most of the individuals were flying below risk height within the Project Site (*Figure 8* of *Annex 8*).

- Heuglin's Gull *Larus heuglini* – a common winter visitor and passage migrant in Hong Kong. They occurred in relatively high number (a total of 183 individuals, maximum group size was 69) within the Study Area during the surveys and sightings were recorded in Spring and Winter only. They were usually found flying/resting/foraging within and in the vicinity of the Project Site and most of the flying activities were within the rotor height (*Figure 9* of *Annex 8*).

- Roseate Tern *Sterna dougallii* – an uncommon summer visitor and breeding in Hong Kong. They were recorded in relatively low number in Summer and Spring during the surveys and all individuals were flying below the rotor height (*Figure 10* of *Annex 8*).

- Whiskered Tern *Chlidonias hybridus* – an uncommon passage migrant in Hong Kong. Only four individuals were recorded in Autumn during the surveys and two of which were flying at 10 m above sea level at the southern boundary of Project Site (*Figure 11* of *Annex 8*).

- White-winged Tern *Chlidonias leucopterus* – an uncommon passage migrant in Hong Kong. A total of eight sightings were recorded in May 2009 and they were in large group (maximum group size was 100). They were mainly resting and flying below the rotor height in the vicinity of the Project and one group of 20 individuals flying (at 20m above sea level) within the rotor height (*Figure 12* of *Annex 8*).

- Unidentified Terns *Sterna* sp. – some unidentified terns were observed in Spring, Summer and Autumn, usually flying below 14m and from 14 to 136m (*Figure 13* of *Annex 8*).

- Barn Swallow *Hirundo rustica* – a common and widespread passage migrant and summer visitor in Hong Kong. Most sightings of this bird were recorded in Spring and Summer with some recorded in Autumn. All of them were flying in open sea along the West Lamma Channel. They were mostly below the rotor height with three individuals within the rotor height near shoreline. Within the Project Site, all individuals were observed flying below 14m (*Figure 14* of *Annex 8*).

8.6.3 *Existing Condition of the Wind Farm Site*

The proposed Project Site is located at least 2 km away from the nearest shoreline (Ha Mei Tsui) with a total area of approximately 6 km^2. A total of 35 wind turbines, a wind monitoring mast and an offshore substation [(1)] will be constructed. The turbines will be separated in distances of about 650 m (East-West) and 360m (North-South). Preliminary dimensions are not expected to exceed a maximum tip height of 136 m above mean sea level with a maximum rotor diameter of 111 m.

Results of the literature review have indicated that White-bellied Sea Eagle, Red-necked Phalarope, and the three summer breeding terns (ie Black-naped Tern, Roseate Tern and Bridled Tern) were distributed in the southeastern

(1) It should be noted that construction of an onshore substation in the Lamma Power Station Extension has also been considered (see *Section 5*). This assessment adopted a conservative approach in which the maximum area of Project Development Site including the offshore substation was used.

waters of Hong Kong and potentially utilised the open sea. Further field surveys showed that a total of 14 identified bird species and one unidentified bird species were recorded within the Project Site including Aleutian Tern, Ancient Murrelet, Barn Swallow, Black Kite, Black-headed Gull, Black-naped Tern, Black-tailed Gull, Bridled Tern, Common Tern, Heuglin's Gull, Little Tern, Red-necked Phalarope, Whiskered Tern, White-winged Tern and unidentified Terns (*Table 8.8*).

Heuglin's Gull was the most abundant species recorded within the Project Site, followed by White-winged Tern and Common Tern. Although more individuals were sighted in Spring, two large groups of Heuglin's Gull (group sizes of 49 and 59) were recorded in February 2009 resting within the Project Site. Most of the species recorded were flying while 10 individuals of Black Kite and one individual of Heuglin's Gull were foraging in the area (*Figure 8.18* and *Figure 9* of *Annex 8*). Most of the flying activities were below/above rotor height (<14m or >136m above sea level) with 44 individuals recorded within the rotor height (see also *Figure 8.9*).

Table 8.8 Bird Species observed within the Project Site during the Surveys

Bird Species	**Total no. of individuals recorded**				
Season	**Spring**	**Summer**	**Autumn**	**Winter**	***Total***
Aleutian Tern	0	2	13	0	*15*
Ancient Murrelet	3	0	0	0	*3*
Barn Swallow	2	0	3	0	*5*
Black Kite	6	0	0	10	*16*
Black-headed Gull	0	0	0	2	*2*
Black-naped Tern	2	5	0	0	*7*
Black-tailed Gull	1	0	0	0	*1*
Bridled Tern	0	3	0	0	*3*
Common Tern	1	2	14	0	*17*
Heuglin's Gull	2	0	0	129	*131*
Little Tern	1	0	0	0	*1*
Red-necked Phalarope	7	0	0	0	*7*
Unidentified Terns	0	0	1	0	*1*
Whiskered Tern	0	0	2	0	*2*
White-winged Tern	20	0	0	0	*20*
Bird Activity	**F**	**S**	**Fo**	**R**	**S**
Aleutian Tern	6	0	0	9	0
Ancient Murrelet	3	0	0	0	0
Barn Swallow	5	0	0	0	0
Black Kite	6	0	10	0	0
Black-headed Gull	0	0	0	2	0
Black-naped Tern	7	0	0	0	0
Black-tailed Gull	0	0	0	0	1
Bridled Tern	2	0	0	1	0
Common Tern	15	0	0	2	0
Heuglin's Gull	12	0	1	118	0
Little Tern	0	0	0	1	0
Red-necked Phalarope	0	0	0	5	2
Unidentified Terns	1	0	0	0	0
Whiskered Tern	2	0	0	0	0
White-winged Tern	20	0	0	0	0
Elevation	**0m**	**>0 – 14m**	**>14 – 136m**	**> 136m**	
Aleutian Tern	9	4	2	0	

Bird Species	Total no. of individuals recorded				
Ancient Murrelet	3	0	0	0	
Barn Swallow	0	5	0	0	
Black Kite	0	10	6	0	
Black-headed Gull	2	0	0	0	
Black-naped Tern	0	5	2	0	
Black-tailed Gull	1	0	0	0	
Bridled Tern	1	2	0	0	
Common Tern	2	13	2	0	
Heuglin's Gull	118	2	11	0	
Little Tern	1	0	0	0	
Red-necked Phalarope	5	2	0	0	
Unidentified Terns	0	0	1	0	
Whiskered Tern	0	2	0	0	
White-winged Tern	0	0	20	0	

*Note: Bird Activities: F = Flying, S = Soaring, Fo = Foraging, R = Resting, S = Swimming

Of the five species of species of conservation interest, Black Kite and Ancient Murrelet, were the only two recorded species within the Project Site during the surveys.

8.7 *SUMMARY OF TERRESTRIAL ECOLOGICAL RESOURCES*

The avifauna habitats of the Study Area include nearshore and offshore marine waters in southwest Lamma Island with a total area of approximately 25,800 ha. A total of 33 identified species and four unidentified species were recorded during the surveys. Half of the species recorded are common and widespread in Hong Kong. Five species of conservation interest were recorded including White-bellied Sea Eagle, Black Kite, Common Buzzard, Pacific Reef Egret and Ancient Murrelet. Survey results showed that relatively higher bird density was found nearshore coastal waters along East Lamma Channel and Yung Shu Wan and in Spring.

The Project Site has an area of approximately 600 ha and comprises offshore waters located about 2 km away from the nearest shoreline. Literature reviews suggested that the area could be within the flying route of migratory birds and focussed surveys revealed relatively high abundance of birds south of the Project Site especially in Winter. This implies that the migratory pathway of some species could pass through the Project Site. A few species also showed potential usage of the Project Site by foraging/resting. A total of 14 identified and one unidentified species was recorded with Heuglin's Gull, White-winged Tern and Common Tern having relatively higher abundance. Two species of conservation interest were recorded including Black Kite and Ancient Murrelet.

The lists and evaluations of the bird species of ecological interest recorded within the Study Area, according to the *EIAO-TM*, are given in *Table 8.9*.

Table 8.9 ***Bird Species with Ecological Interest Recorded within the Study Area***

Species	Location	Protection Status	Distribution	Rarity
White-bellied Sea Eagle *Haliaeetus leucogaster*	Flying/soaring and resting around Round Island and in the vicinity of Project Site	Protected under WAPO (Cap 170) in HK, Class II Protected Animal of PRC, CITES Appendix II	Found in coastal area of Hong Kong, Oriental and Australasian	Uncommon resident in Hong Kong
Black Kite *Milvus lineatus*	Mainly flying/soaring over large area within Study Area; found flying/foraging within Project Site	Protected under WAPO (Cap 170) in HK, Class II Protected Animal of PRC, CITES Appendix II	Found in many types of habitats; Eurasia	Common and widespread in Hong Kong
Common Buzzard *Buteo buteo*	Soaring in open sea around Tung O Wan	Protected under WAPO (Cap 170) in HK, Class II Protected Animal of PRC, CITES Appendix II	Found in open area in Hong Kong, Eurasia	Common and widespread in Hong Kong
Pacific Reef Egret *Egretta sacra*	Resting/flying/foraging along shoreline within the Study Area	Protected under WAPO (Cap 170) in HK, Class II Protected Animal of PRC	Found in coastal habitats in Hong Kong	Uncommon but widespread in Hong Kong
Ancient Murrelet *Synthliboramphus antiquus*	Flying over open sea	Protected under WAPO (Cap 170) in HK, Vulnerable in China Red Data Book	Found in offshore waters in Hong Kong	Scare winter visitor in Hong Kong

8.8 *ASSESSMENT METHODOLOGY*

A desktop literature review and extensive avifauna field surveys (see *Sections 8.4 – 8.6*) were conducted in order to establish the ecological resources for avifauna within and surrounding the Study Area. The importance of potentially impacted avifauna resources identified within the Study Area was assessed using the methodology defined in the *EIAO-TM*. The potential impacts due to the construction and operation of the wind farm were then assessed (following the *EIAO-TM Annex 16* guidelines) and the impacts evaluated (based on the criteria in *EIAO-TM Annex 8*).

In addition, where necessary, assessment will make reference to other EIAs conducted elsewhere for wind farm development projects, particularly in Europe.

8.9 *POTENTIAL SOURCES OF IMPACTS ON BIRDS*

In this section of the report, the potential for avifauna associated with various marine works and activities involved in the proposed project are examined in detail. The significance of a potential impact from works or activities on birds can be determined by examining the consequences of the impact on the affected bird species.

Habitat loss, habitat fragmentation/isolation and disturbance to wildlife are the typical ecological impacts due to the development projects. International EIAs and scientific studies conducted by Birdlife International and Royal Society for the Protection of Birds (RSPB) have also identified the following potential impacts identified on birds and their movement due to the development of wind farm (1)(2)(3):

- Habitat loss/ avoidance/ disturbance;
- Creation of a barrier effect to bird movement including displacement or exclusion; and,
- Collision mortality.

Each of the potential impacts on birds mentioned above is discussed detailed below.

8.9.1 *Construction Phase*

Habitat Loss

- Permanent loss of open water habitats (approximately 0.16 ha footprint area) due to the construction of wind turbine foundations, offshore substation and offshore monitoring mast (details see *Section 9.5.1*).
- The physical loss of habitat due to the Project could potentially affect some individuals of the frequently sighted bird species that utilise the southwest Lamma waters. This may potentially reduce the species abundance/diversity in the area.
- Based on the vessel-based survey findings, although a comparatively higher density was recorded within the Project Site (231 individuals in 14 identified and one unidentified species, mean density was 1.4 individuals per effective survey trip per km^2), most species recorded were flying over the area (11 identified species) or resting (7 identified species) with limited

(1) BirdLife International (2003) Windfarms and Birds : An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues. Paper presented in Convention On The Conservation Of European Wildlife And Natural Habitats.

(2) Royal Society for the Protection of Birds (RSPB) (2005) Information - Wind Farms and Birds.

(3) DONG Energy, Vattenfall, The Danish Energy Authority and The Danish Forest and Nature Agency (2006) Danish offshore Wind – Key Environmental Issues.

number foraging and swimming (2 identified species) in the area. The affected southwest Lamma waters in the vicinity of the Project Site are not used as important foraging area. For this reason, the relatively small scale loss of approximately 0.16 ha of open waters within the Project Site is not expected to be significant for bird/migratory bird populations. The loss of these open waters would represent a very minor loss of marine habitat in the context of the size of marine areas in the range of these birds. Provided the recommended mitigation measures are followed during construction, no unacceptable adverse impacts on bird individuals that utilise southwest Lamma waters are anticipated.

- Information from the fisheries impact assessment (*Section 10*) indicates that the permanent loss of a small area of marine habitat due to the construction works are not predicted to adversely impact fisheries resources. As a result, impacts to birds through the loss of small area of feeding ground (the fisheries resources in the marine habitat serve as bird's food prey) are not predicted to be significant.

- Direct impacts due to cable installation works to the birds are not expected to be severe as the construction works would not cause any permanent loss of the marine water habitats in the area.

- Other International EIAs conducted elsewhere also reached similar conclusions that impacts on birds through the loss of food resources by direct habitat loss are considered negligible/small-scale for the bird populations using the area [1][2].

Other Impacts

- Secondary impacts to birds may arise from the potential of increased noise impact through piling for foundations of turbines, monitoring mast and offshore substation, human activities and disturbance, and disposal of construction waste. The impacts are expected to be low owing to the temporary nature of the construction works. It should also be noted that the marine traffic volume in this part of Hong Kong waters is relatively high. Previous study has shown that no significant effects on birds due to noise disturbance were recorded during the construction phase of an offshore wind farm [3]. With the implementation of general environmental management measures and regular checks on construction practices, impacts are not expected to be unacceptable.

(1) British Trust for Ornithology (2005) The Potential Effects on Birds of Greater Gabbard Offshore Wind Farm Report for February 2004 to March 2005. Ornithological Baseline Report and Environmental Impact Assessment prepared for Greater Gabbard Offshore Winds Limited. BTO Research Report No. 419.

(2) National Environmental Research Institute (NERI), Ministry of Environment and Energy (2000) Effects on birds of an offshore wind park at Horns Rev: Environmental impact assessment.

(3) Christensen, T.K., Hounisen, J.P., Clausager, I. & Petersen, I.K. (2004) Visual and radar observations of birds in relation to collision risk at the Horns Rev offshore wind farm - annual status report 2003. NERI Report, 53pp.

8.9.2 *Operational Phase*

Habitat Avoidance/Disturbance

Barrier Effect

It is suggested that wind turbines may act as barriers to bird movement such that instead of flying between the turbines, the birds may fly around the outside of the cluster (1). This may consequently displace the bird movement/flight path and subsequently disrupt the ecological links between feeding, breeding and roosting areas.

The spacing of turbines may alleviate any barrier effect by allowing wide corridors. It has been suggested that gulls have been able to regularly fly between turbines spaced 200 m apart (2). At present, the preliminary wind farm design will allow distances of 650 m (East-West) and 360m (North-South) between turbines. Surveys results also revealed that flying routes of most birds tended to be near coastal areas (especially those along East Lamma Channel) and only occasionally passed through offshore waters ie the proposed Project Site.

It is generally believed that the local flying path of the migratory species such as gulls and terns follow coastal areas from the south when arriving to breed, and there exist many corridors of entry to the HKSAR coastline and these birds will travel around the coastline away from exposed offshore areas (3).

In view of there being similar marine water habitats in the vicinity of Project Site as flying corridor and limited usage by avifauna around the waters in close proximity to and within the Project Site, it is anticipated that the barrier effect due to the operation of the wind turbines and wind monitoring mast will not cause any unacceptable impacts to the migratory bird species.

Glare/Noise Disturbance

Potential disturbance on the vision of flying birds will be minimised by the use of non-reflective colour scheme of the wind turbines and wind monitoring mast, which would not cause glare during operation.

Noise generated by the wind turbine may potentially cause disturbance on bird movement. Experiments on the detectability of wind turbine blades noise by birds revealed that the sound level generated under windy environment is probably less audible to birds than humans (4). The noise produced by the operating wind turbine and monitoring mast will be at a low,

(1) BirdLife International (2003) *Op cit.*

(2) Painter, S., Little, B. & Lawrence, S. (1999) Continuation of Bird Studies at Blyth Harbour Wind Farm and the Implications for Offshore Wind Farms. ETSU W/13/00485/00/00. Contractor: Border Wind Limited.

(3) BMT Asia Ltd (2009) *Op cit.*

(4) Doolin R (2002) Avian Hearing and the Avoidance of Wind Turbines. Technical Report (NREL/TP-500-30844). National Renewable Energy Laboratory.

constant and predictable sound level to minimise the noise disturbance. Since the wind turbine site is not considered to be an important bird habitat, the noise impacts to bird are expected to be low.

Collision Risk

Mortality due to collisions between birds and wind farm structures including turbines and monitoring mast remains the major concern in impact assessment, although actual collision rate is low in operating wind farms due to avoidance [(1)(2)]. Such risk is species-dependent, site-specific and can be easily influenced by weather conditions. Evidence suggests that the risk of collision increases during periods of bad weather and poor visibility [(3)].

Collision risk was estimated for the identified species recorded within the Assessment Area including the Project Site (*Figure 15* of *Annex 8*), with a total area of 2,000 ha. This assessment adopted the worse-case scenario by assuming that all birds sighted within the assessment area will pass through the Project Site (~600 ha). This may lead to an over-estimation in the predicted collision risk and consequently should be noted when interpreting the results. Within the Assessment Area, all bird species recorded were selected for individual assessment of its collision risk. However, some bird species were not included in the assessment because all individuals recorded within the Assessment Area were below the rotor height during the surveys and thus the risk cannot be determined by the adopted calculations (*Table 5* of *Annex 8*. This included Ancient Murrelet, Artic Skua, Barn Swallow, Black-headed Gull, Black-tailed Gull, Bridled Tern, Greater Crested Tern, Little Tern and Whiskered Tern. The bird species assessed include:

- Aleutian Tern
- Black Kite
- Black-legged Kittiwake
- Black-naped Tern
- Common Tern
- Heuglin's Gull
- Red-necked Phalarope
- White-bellied Sea Eagle
- White-winged Tern

(1) DONG Energy, Vattenfall, The Danish Energy Authority and The Danish Forest and Nature Agency (2006) Danish offshore Wind – Key Environmental Issues.

(2) Percival SM (2001) Assessment of the Effects of Offshore Wind Farms on Birds. Prepared for Ecology Consulting.

(3) BirdLife International (2003) *Op cit.*

In this assessment, Collision Risk Model (CRM) developed for Scottish National Heritage is used to calculate the collision risk (see *Annex 8* for detailed methodology adopted) [(1)]. CRM has been generally accepted to estimate bird collision risk in impact assessment of bird for various wind farm development projects [(2)(3)(4)]. In addition, we have estimated the risk in two different situations. The first situation is that birds fly as if the wind turbine structures and rotors were not there and take no avoiding action (ie death). In reality most birds do take avoiding action and therefore the collision risk is usually adjusted by the avoidance factor. It is suggested that an avoidance rate of 95% is conservative enough for collision risk assessment [(5)].

The following presents the results of individual assessment for each species, followed by an overall assessment of the impact. The calculations of collisions are detailed in *Tables 6 - 7* of *Annex 8* and *Table 8.10* presents the summary results of the number of collisions predicted in each season for each species.

Table 8.10 Number of Bird Collisions Predicted (Number per Season) within the Assessment Area (a total of 20 km²)

Species	No. of Collision 95% Avoidance (No Avoidance)			
	Spring	Summer	Autumn	Winter
Aleutian Tern	0 (0)	0 (0)	0.19 (3.76)	0 (0)
Black Kite	2.97 (59.5)	0 (0)	0 (0)	0.69 (13.87)
Black-legged Kittlewake	0 (0)	0 (0)	0 (0)	0.03 (0.64)
Black-naped Tern	0.02 (0.43)	0 (0)	0 (0)	0 (0)
Common Tern	0.18 (3.69)	0.07 (1.5)	0.18 (3.69)	0 (0)
Heuglin's Gull	0.22 (4.49)	0 (0)	0 (0)	0.15 (3.01)
Red-necked Phalarope	0.16 (3.17)	0 (0)	0 (0)	0 (0)
White-bellied Sea Eagle	0.01 (0.28)	0 (0)	0 (0)	0 (0)
White-winged Tern	0.04 (0.76)	0 (0)	0 (0)	0 (0)

<u>Aleutian Tern</u>

Within the Assessment Area, Aleutian Tern were sighted in Autumn only during the surveys and number of collisions predicted was 3.76 birds per season under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted is 0.19 birds per season (only in Autumn). The number predicted under 95% avoidance is considered negligible when compared with the total number of individuals recorded during the surveys (~0.2% of 85 individuals) and the highest daily peak count

(1) Band W (2000) Windfarms and Birds: Calculating a theoretical collision risk assuming no avoiding action. Guidance Note Series. Scottish Natural Heritage.

(2) British Trust for Ornithology (2005) *Op cit.*

(3) National Environmental Research Institute (NERI), Ministry of Environment and Energy (2000). *Op cit.*

(4) Whitefield DP (2009). Collision Avoidance of Golden Eagles at Wind Farms under the 'Band' Collision Risk Model

(5) Scottish Natural Heritage (2009) Guidance & Information Specific to Bird Interests – Avoidance Factor.

documented in Hong Kong [(1)] (~0.1% of 190 individuals). The impact of collision to this bird species is therefore not considered adverse.

Black Kite

Within the Assessment Area, Black Kite were sighted in Spring and Winter only during the surveys and the number of collisions predicted is 59.5 birds per season in Spring and 13.87 birds per season in Winter under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted is 2.97 birds per season and 0.69 birds per season in Spring and Winter respectively. The numbers predicted under 95% avoidance are considered negligible when compared with the total number of individuals recorded during the surveys (<0.4% of 712 individuals) and the highest daily peak count documented in Hong Kong [(2)] (<0.24% of 1,220 individuals). In addition, the majority of Black Kite was distributed nearshore. The impact of collision to this bird species is therefore not considered adverse.

Black-legged Kittiwake

Within the Assessment Area, Black-legged Kittiwake were sighted in Winter only during the surveys and the number of collision predicted is 0.64 birds per season (only in Winter) under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted is 0.03 birds per season (only in Winter). The number predicted under 95% avoidance is considered low when compared with the total number of individuals recorded during the surveys (~3% of one individual). Information of the observation records for this species was however not available. The impact of collision to this bird species is therefore not considered adverse.

Black-naped Tern

Within the Assessment Area, Black-naped Tern were sighted in Spring only during the surveys and the number of collisions predicted is 0.43 birds per season (only in Spring) under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted is 0.02 birds per season (only in Spring). The number predicted under 95% avoidance is considered negligible when compared with the total number of individuals recorded during the surveys (~0.02% of 101 individuals) and the estimated breeding population in Hong Kong [(3)] (~0.01% of over 200 individuals). The impact of collision to this bird species is therefore not considered adverse.

Common Tern

Within the Assessment Area, Common Tern were sighted in Spring, Summer and Autumn during the surveys. Numbers of collisions predicted in Spring,

(1) Carey et al (2001) *Op cit.*

(2) Carey et al (2001) *Ibid.*

(3) HKBWS (2003) *Opcit.*

Summer and Autumn are 3.69 birds per season, 1.50 birds per season and 3.69 birds per season respectively under no avoidance situation. After applying the 95% avoidance factor, the numbers of collisions predicted in Spring, Summer and Autumn are 0.18 birds per season, 0.07 birds per season and 0.18 birds per season respectively. The numbers predicted under 95% avoidance are considered negligible when comparing with the total number of individuals recorded during the surveys (<0.17% of 107 individuals) and the highest daily peak count documented in Hong Kong [(1)] (<0.05% of 400 individuals). The impact of collision to this bird species is therefore not considered adverse.

Heuglin's Gull

Within the Assessment Area, Heuglin's Gull were sighted in Spring and Winter only during the surveys and the numbers of collisions predicted in Spring and Winter are 4.49 birds per season and 3.01 birds per season respectively under no avoidance situation. After applying the 95% avoidance factor, the numbers of collisions predicted in Spring and Winter are 0.22 birds per season and 0.15 birds per season respectively. The numbers predicted under 95% avoidance are considered negligible when compared with the total number of individuals recorded during the surveys (<0.12% of 183 individuals) and the highest daily peak count documented in Hong Kong [(2)] (<0.03% of 707 individuals). The impact of collision to this bird species is therefore not considered adverse.

Red-necked Phalarope

Within the Assessment Area, Red-necked Phalarope were sighted in Spring only during the surveys and the number of collisions predicted in Spring is 3.17 birds per season under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted in Spring is 0.16 birds per season. The number predicted under 95% avoidance is considered negligible when compared with the total number of individuals recorded during the surveys (~0.08% of 207 individuals) and the highest daily peak count documented in Hong Kong [(3)] (~0.02% of 952 individuals). The impact of collision to this bird species is therefore not considered adverse.

White-bellied Sea Eagle

Within the Assessment Area, White-bellied Sea Eagle were sighted in Spring only during the surveys and the number of collisions predicted in Spring is 0.28 birds per season under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted is 0.02 birds per season (only in Spring). The number predicted under 95% avoidance is considered negligible when compared with the total number of individuals recorded

(1) Carey et al (2001) *Ibid.*

(2) Carey et al (2001) *Ibid.*

(3) HKBWS (2006) *Opcit.*

during the surveys (~0.14% of 10 individuals) and the estimated breeding population in Hong Kong [1] (~0.04% of 39 individuals). The impact of collision to this bird species is therefore considered insignificant.

White-winged Tern

Within the Assessment Area, White-winged Tern were sighted in Spring only during the surveys and the number of collisions predicted is 0.76 birds per season under no avoidance situation. After applying the 95% avoidance factor, the number of collisions predicted is 0.04 birds per season (only in Spring). The number predicted under 95% avoidance is considered negligible when compared with the total number of individuals recorded during the surveys (<0.02% of 178 individuals) and the highest daily peak count document in Hong Kong [2] (~0.001% of 3,000 individuals). The impact of collision to this bird species is therefore not considered adverse.

Based on the above assessment, Black Kite has the highest number of collisions with 2.97 birds per season (only in Spring and Winter) under 95% avoidance rate. It should be noted that the calculated numbers are likely to be over-estimated based on the conservative assumptions included in the assessment. Nonetheless, the predicted numbers of collisions in each species is generally low, which is probably attributable to the low numbers of individuals recorded flying within the rotor risk height.

Numbers of bird collision/strike predicted in other studies/international EIAs varied greatly due to different assumptions, methodology and population estimates used. Some revealed the range of 0.6 to 37 birds per turbine per year [3][4] while others expressed the risk as the annual number ranging from 0.01 to 4.6 per turbine per year [5][6]. In terms of seasonal prediction, the number ranges from 0.102 birds per turbine per season (under 99.8% avoidance rate) [7] to 45 birds per season (accounting for 0.02% of total population of the selected species) [8]. Although information on mortality rate and population estimates is not readily available in Hong Kong, it could be expected that the predicted collision numbers contributed a minor proportion at the population level based on a comparison with past sighting records.

In addition, monitoring of operating wind farms has shown that birds do exhibit of avoidance behaviour [9], resulting in generally low collision

(1) Tsim et al (2003) *Opcit.*

(2) HKBWS (2006) *Opcit.*

(3) EPF Energy (Northern Offshore Win) Ltd (2004) Teesside Offshore Wind Farm Environmental Statement.

(4) Percival SM (2001) *Opcit,*

(5) Musters, C.J.M., M.A.W. Noordervliet and W.J. ter Keurs. 1996. Bird casualties caused by a wind energy project in an estuary. Bird Study 43: 124-126.

(6) Percival SM (2001) *Ibid,*

(7) British Trust for Ornithology (2005) *Opcit.*

(8) DONG Energy (2006) *Opcit.*

(9) ERM-UK (2004). *Lochelbank Wind Farm: Environmental Statement*. Report for National Wind Power.

mortality rates per turbine [1]. In Hong Kong, no bird collision/carcass was recorded by the monthly bird monitoring conducted during the operation of the onshore wind turbine in Lamma Island from March 2006 to February 2007 [2]. This implies that the actual collision rate could be much lower than that predicted in the EIA studies. In this Study, a comprehensive site selection study has been carried out such that the by siting the wind turbine away from habitat and area with significant ecological interests, such as Country Parks, SSSI, Special Area and Restricted Areas; as well as important bird habitat (ie breeding sites of Roseate Tern, Black-naped Tern and Bridled Tern, nesting sites and frequent utilising areas of White-bellied Sea Eagle) or as important routes of migratory birds (higher density of seabirds occurred in southern waters between southeastern Lamma and Po Toi and southeastern Hong Kong waters [3]) (see *Figure 8.2* and *Section 3)*.

It has also been suggested that lighting of turbines for safety/navigation purpose has the potential to attract nocturnal migrant birds at night and subsequently increase the collision risk, especially in conditions of poor visibility [4]. These nocturnal migrants are usually small songbirds (Order Passeriformes) including warblers, hummingbirds and flycatchers, which are commonly found in woody areas and not over open sea. Within the Assessment Area, low number of Barn Swallow (a passerine) was observed with no individuals flying at rotor height; which suggested that the area is not an important habitat for this species. Although some shorebirds and seabirds also exhibit nocturnal migration, their relatively low abundance suggested that the study area is not an important habitat for these species. The effects of lighting on birds in terms of light colour, type, duration on and intensity remain poorly unknown [5] [6] and no conclusive recommendation has been made. It is noted that aviation warning lights of low intensity will be installed on top of the nacelle of the wind turbine, monitoring mast and offshore substation to alert vessels during periods of poor visibility. The impacts due to the light of these structures are expected to be minimal as the Project Site and areas in the vicinity are not an important bird habitat and have relatively low utilisation.

Overall, in view of the limited number of birds flying within the risk height within the Project Site, it is anticipated that the collision risk due to the operation of the wind turbines and wind monitoring mast is low and will not cause any unacceptable impacts to these migratory bird species.

(1) Drewitt AL, Langston RHW (2006) Assessing the impacts of wind farms on birds. *Ibis*. 148:29-42.
(2) HK Electric. (2007*). Renewable Energy by a Wind Turbine System on Lamma Island*. Monthly EM&A Reports. *http://lammawindturbine.hec.com.hk*.
(3) HKBWS (2006) *Op cit*.
(4) Kingsley A, Whittam B (2001) Potential Impacts of Wind Turbines on Birds at North Cape, Prince Edward Island. A report for the Prince Edward Island Energy Corporation.
(5) Drewitt AL, Langston RHW (2006) *Opcit*.
(6) National Wind Coordinating Committee (2004) Wind Turbine Interations with Birds and Bats: A Summary of Research Results and Remaining Questions. Fact Sheet: 2nd Edition.

8.9.3 *Cumulative Impact*

At present, there are no planned projects at Southwestern Lamma waters that could create cumulative terrestrial ecological impacts during the construction and operation of the wind farm. Therefore, no cumulative impacts will arise.

8.10 EVALUATION OF THE IMPACTS TO BIRDS

The following section discusses and evaluates the significance of the impacts to avifauna (particularly migratory birds) identified in the previous section. Based upon the information presented above, the significance of bird impacts associated with the construction and operation of the wind farm have been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* and presented in *Table 8.11*.

Table 8.11 Overall Impact Evaluation for Avifauna

Evaluation Criteria	Birds
Habitat quality	The Project Site is located in the southwest Lamma waters (approximately 2 km from the nearest shoreline) where sightings of birds (especially migratory birds) are low to moderate and higher sightings were recorded in Spring. In view of the present condition of the Project Site, as well as other areas within the Study Area, the marine water habitat within the Project Site is not an important bird habitat or important flight path of migratory birds.
Species	Bird species of conservation interest recorded within the Study Area include White-bellied Sea Eagle, Black Kite, Common Buzzard, Pacific Reef Egret and Ancient Murrelet. A total of 14 identified and one unidentified species were recorded including Aleutian Tern, Ancient Murrelet, Barn Swallow, Black Kite, Black-headed Gull, Black-naped Tern, Black-tailed Gull, Bridled Tern, Common Tern, Heuglin's Gull, Little Tern, Red-necked Phalarope, Whiskered Tern, White-winged Tern and Barn Swallow, two of which were considered bird species of conservation interest (Black Kite and Ancient Murrelet).
Size/Abundance	Relatively small scale loss of approximately 0.16 ha of open waters within the Project Site (~600 ha) comparing to the similar habitats within the Study Area (~25,800 ha). Bird species were found to be infrequently utilising the Project Site during the baseline surveys (most of them were flying). The relatively high mean density recorded within the Study Area was mainly attributable to the occurrence of the Heuglin's Gull (mostly resting) and white-winged Tern (mostly flying). Reduction of species abundance/diversity and ecological carrying capacity will not be expected.
Duration	The impact will be low and temporary during the construction phase – the construction of wind monitoring mast and wind turbine is expected to last for about 6 months and 9 months respectively.

Evaluation Criteria	Birds
	The impact will persist during the operational phase but is not predicted to cause adverse impacts to birds due to the offshore location (> 2km) and limited number of bird flying within rotor risk area of the Project Site.
Reversibility	The impacts will be permanent and irreversible with the existence of the wind farm.
Magnitude	The risks of collision of the bird species and operational noise impacts to birds are not considered to be significant, particularly considering that the wind farm will be operated in offshore waters with moderate sightings of migratory birds.
Overall Impact Conclusion	**Low to Moderate**

In view of the offshore location and low to moderate magnitude of impacts on birds, reduction of species abundance/diversity and ecological carrying capacity due to marine water habitats consumed for the development of wind farm are not expected. Overall operational impacts on birds are not expected to cause adverse impacts and are therefore considered to be low to moderate.

8.11 *MITIGATION MEASURES*

Annex 16 of the *EIAO-TM* states that the general policy for mitigation of significant ecological impacts, in order of priority, is:

Avoidance: Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives;

Minimisation: Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on intensity of works operations or timing of works operations; and

Compensation: The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

At each stage, residual impacts are to be re-assessed to determine whether there is a need to proceed to the next stage of mitigation. The following measures have been developed in accordance with this approach to mitigate the impacts.

8.11.1 *Avoidance*

The Southwest wind farm site was proposed based on the following considerations:

- Avoid habitat and area with significant ecological interests, such as Country Parks, SSSI, Special Area and Restricted Areas; and,

- Avoid adverse impacts to birds by siting the wind turbine and monitoring mast away from important bird habitat (ie breeding sites of Roseate Tern, Black-naped Tern and Bridled Tern, nesting sites and frequent utilising areas of White-bellied Sea Eagle) or important routes of migratory birds.

8.11.2 *Minimisation*

The previous discussion in *Section 8.9* has indicated that the potential ecological impacts due to the construction and operation of a wind farm at the Project Site are considered to be low. The following measures are recommended to further reduce the potential impacts and disturbance to the surrounding habitats.

- In addition to the requirement from Civil Aviation Department (CAD), extreme level of lighting should be avoided as to minimise the numbers of birds attracted to the wind turbine at night. Lighting should be of low intensity.
- The construction should adopt good construction/operation practices to minimise the impact of construction/operation on marine water habitat (such as no dumping of rubbish or chemicals, see *Section 9*).

8.12 RESIDUAL IMPACTS

There will be the permanent loss of approximately 0.16 ha of marine water habitats (in terms of open waters/ subtidal soft bottom habitats). Since the wind farm structures would not be located at important bird habitat or on travelling routes of migratory birds, the potential residual impacts due to bird collision with the operating wind turbines and monitoring mast are considered to be minor and of low magnitude and significance. No adverse residual impact due to the construction of the wind turbine is expected after the implementation of the proposed mitigation measures.

8.13 ENVIRONMENTAL MONITORING AND AUDIT

The implementation of the ecological mitigation measures stated in *Section 8.11.2* should be checked as part of the environmental monitoring and audit procedures during the construction and operation period.

Although no adverse residual impacts are envisaged based on the results of impact assessment, monitoring for bird abundance and distribution for one year of pre-construction phase, one year of the construction phase (1) and the first year of operation phase is recommended.

The purpose of the construction and operation monitoring is to investigate the temporal variation in species occurrence, abundance and distribution of birds

(1) Construction phase refers to the one year period including wind turbine construction and pre-commissiong phase, which is the fourth year of the construction programme as stated in *Section 5*.

before and after the commencement of the wind farm. Particular focus will be made on species of conservation interest (especially the Birds of Prey including White-bellied Sea Eagle and Black Kite) and migratory birds (eg White-winged Tern, Heuglin's Gull).

Traditional vessel-based survey will be applied for pre-construction, construction and operation monitoring, which will be undertaken at once per week during migratory season (March to May) and at once/twice per month for the rest of the year. Line transects survey method will be used at designated sampling locations within the Project Site. Locations of sampling transects will be finalised during the detailed design stage (after confirmation of the types and siting of the turbines).

The results will be reviewed and analysed after the operation monitoring period. Should bird abundance be significantly different (taking into account naturally occurring alterations to distribution patterns such as due to seasonal change) to the pre-construction activity (following the operation monitoring), recommendations for a further operation monitoring survey will be made. Data should then be re-assessed and the need for any further monitoring established. Significance levels will be quantitatively determined following the operation monitoring which will review up-to-date publicly available information on bird distribution to allow for typical variance levels.

If, after the first-year operation monitoring period, insignificant variation in bird abundance have been reported then the monitoring will be ceased, as it will have been confirmed that the wind turbine is not having an adverse impact on bird species.

8.14 *CONCLUSIONS*

The proposed Southwest Lamma wind farm was studied in detail through a site selection study in order to select a site that avoided to the extent practical, adverse impacts to important habitats for birds particularly migratory birds or bird species of high ecological value.

A total of 14 identified species were recorded in the Project Site including Aleutian Tern, Ancient Murrelet, Barn Swallow, Black Kite, Black-headed Gull, Black-naped Tern, Black-tailed Gull, Bridled Tern, Common Tern, Heuglin's Gull, Little Tern, Red-necked Phalarope, Whiskered Tern and White-winged Tern, two of which were considered bird species of conservation interest (Black Kite and Ancient Murrelet). In addition, in the wider Study Area a further three bird species of conservation interest were recorded, including White-bellied Sea Eagle, Common Buzzard and Pacific Reef Egret. Most of the birds that are of conservation interest are common and widespread in Hong Kong with the exception of Pacific Reef Egret (uncommon but widespread resident), White-bellied Sea Eagle (uncommon resident) and Ancient Murrelet (scarce winter visitor). The assessment revealed that the Project Site did not provide an important foraging ground for birds.

Potential construction phase impacts to birds may arise from the permanent loss of habitats due to the construction of wind turbine foundation, substation and monitoring mast; temporary disturbance and displacement of birds. The relatively small scale loss of approximately 0.16 ha of open waters within the Project Site is not expected to be significant for bird/migratory bird populations in view of similar habitats in the vicinity and the limited bird use in the area. The direct ecological impact due to the construction of the wind farm is expected to be low, and will not contribute to any potential cumulative impact. Barrier effect to bird movement and bird collisions during the operation of the wind farm were assessed. Aleutian Tern, Ancient Murrelet and Barn Swallow, Black Kite, Black-headed Gull, Black-naped Tern, Black-tailed Gull, Bridled Tern, Common Tern, Heuglin's Gull, Little Tern, Red-necked Phalarope, Whiskered Tern, White-winged Tern have utilised the Project Site and therefore are the species that may be affected by the operation of the wind farm. However, these species were recorded in relatively low numbers and most of them were flying below the rotor area. Since the wind farm is not located within important bird habitat or on the flight path of migratory birds, the potential risk of bird collision will be low. In addition, collision risk assessment using the worse case scenario also predicted low number of bird collision. Overall, no adverse residual impacts are envisaged.

A bird monitoring programme will be undertaken to confirm that the construction and operation of the wind turbines will not cause adverse impacts to birds. Monitoring for bird abundance and distribution will be undertaken for one year during the pre-construction phase, one year during the construction phase for the wind turbines and the first year of the operation of the turbines.

Annex 8

Baseline Information on Avifauna for Southwest Lamma Wind Farm

Table 1 Checklist of Seabird Species Recorded in Hong Kong (Adopted from HKBWS [(1)])

Principal Status in Hong Kong: R = Resident, W = Winter Visitor, Su = Summer Visitor; M = Migrant, A = Autumn, Sp = Spring, O = Occasional, "-" = cannot be determined

No.	Common Name	Species Name	Principal status
1	Streaked Shearwater	*Calonectris leucomelas*	SpM
2	Whiskered Tern	*Chlidonias hybridus*	M
3	White-winged Tern	*Chlidonias leucopterus*	M
4	Christmas Island Frigatebird	*Fregata andrewsi*	-
5	Lesser Frigatebird	*Fregata ariel*	O
6	Great Frigatebird	*Fregata minor*	-
7	Brown-headed Gull	*Larus brunnicephalus*	M
8	Yellow-legged Gull	*Larus cachinnans*	W,M
9	Mew Gull	*Larus canus*	M
10	Black-tailed Gull	*Larus crassirostris*	W
11	Slender-billed Gull	*Larus genei*	-
12	Glaucous-winged Gull	*Larus glaucescens*	M
13	Heuglin's Gull	Larus heuglini	W,M
14	Glaucous Gull	*Larus hyperboreus*	OW
15	Pallas's Gull	*Larus ichthyaetus*	W,M
16	Little Gull	*Larus minutus*	-
17	Relict Gull	*Larus relictus*	OW
18	Black-headed Gull	*Larus ridibundus*	W
19	Saunders's Gull	*Larus saundersi*	W,M
20	Slaty-backed Gull	*Larus schistisagus*	W,M
21	White-tailed Tropicbird	*Phaethon lepturus*	-
22	Red Phalarope	*Phalaropus fulicarius*	-
23	Red-necked Phalarope	*Phalaropus lobatus*	M
24	Wedge-tailed Shearwater	*Puffinus pacificus*	-
25	Short-tailed Shearwater	*Puffinus tenuirostris*	-
26	Black-legged Kittiwake	*Rissa tridactyla*	W
27	Long-tailed Jaeger	*Stercorarius longicaudus*	SpM
28	Parasitic Jaeger	*Stercorarius parasiticus*	-
29	Pomarine Jaeger	*Stercorarius pomarinus*	-
30	Little Tern	*Sterna albifrons*	M
31	Aleutian Tern	*Sterna aleutica*	AM
32	Bridled Tern	*Sterna anaethetus*	Su,M
33	Greater Crested Tern	*Sterna bergii*	M
34	Caspian Tern	*Sterna caspia*	M
35	Roseate Tern	*Sterna dougallii*	Su
36	Sooty Tern	*Sterna fuscata*	-
37	Common Tern	*Sterna hirundo*	M
38	Gull-billed Tern	*Sterna nilotica*	M
39	Black-naped Tern	*Sterna sumatrana*	Su

(1) Hong Kong Bird Watching Society (2009). List of Hong Kong Bird Record (March 2009). http://hkbws.org.hk/BBS/viewthread.php?tid=7730&extra=page%3D1

No.	Common Name	Species Name	Principal status
40	Masked Booby	*Sula dactylatra*	-
41	Brown Booby	*Sula leucogaster*	-
42	Red-footed Booby	*Sula sula*	-
43	Ancient Murrelet	*Synthliboramphus antiquus*	W
44	Japanese Murrelet	*Synthliboramphus wumizusume*	-

Table 2 Bird Species Recorded Within the Study Area during the Surveys

Commonness & Distribution: CW = common and widespread, UW = uncommon but widespread, UC = uncommon and localised, OV = Occasional Visitor

Status in Hong Kong followed Viney (2005) [1] and AFCD (2006) [2]: R = Resident, WV = Winter Visitor, SV = Summer Visitor; PM = Passage/Seasonal Migrant; Sp = Spring Migrant; AM = Autumn Migrant

Notes: Blank cells indicate such information is not known/assessed. Species of Conservation Interest is highlighted.

Bird Group	Family	Common Name	Species Name	Commonness	Main HK Status	China Protection Status	CITES	China Red Data Book
Birds of Prey	Accipitridae	Black Kite	*Milvus migrans*	CW	R, WV	II	II	
	Accipitridae	Common Buzzard	*Buteo buteo*	CW	WV	II	II	
	Accipitridae	White-bellied Sea Eagle	*Haliaeetus leucogaster*	UC	R	II	II	Indeterminate
Egrets & Herons	Ardeidae	Cattle Egret	*Bubulcus ibis*	CW	R, PM			
	Ardeidae	Chinese Pond Heron	*Ardeola bacchus*	CW	R			
	Ardeidae	Great Egret	*Ardea alba*	CW	R, WV			
	Ardeidae	Little Egret	*Egretta garzetta*	CW	R			
	Ardeidae	Pacific Reef Egret	*Egretta sacra*	UW	R	II		Rare
	Ardeidae	Unidentified Egrets	Family Ardeidae					
	Ardeidae	Schrenck's Bittern	*Ixobrychus eurhythmus*	Scarce	PM			
Shorebirds (excluded Egrets & Herons)	Scolopacidae	Eastern Curlew	*Numenius madagascariensis*	Scarce	PM			
	Glareolidae	Oriental Pratincole	*Glareola maldivarum*	Uncommon in spring; scarce in autumn	PM			
	Scolopacidae	Red-necked Phalarope	*Phalaropus lobatus*	C	PM			
Gulls & Terns	Laridae	Black-headed Gul	*Larus ichthyaetus*	C	WV, PM			
	Laridae	Black-legged Kittiwake	*Rissa tridactyla*	Rare	WV			
	Laridae	Black-tailed Gull	*Larus crassirostris*	UC	WV			
	Laridae	Heuglin's Gull	*Larus heuglini*	C	WV, PM			
	Sternidae	Aleutian Tern	*Sterna aleutica*	UC	PM			

(1) Viney C, Phillipps K, Lam CY. (2005). The Birds of Hong Kong and South China. Information Services Department, Hong Kong.

(2) AFCD (2006). Hong Kong Online Biodiversity Database. *http://www.afcd.gov.hk/english/conservation/hkbiodiversity/database/search.asp*

Bird Group	Family	Common Name	Species Name	Commonness	Main HK Status	China Protection Status	CITES	China Red Data Book
	Sternidae	Black-naped Tern	*Sterna sumatrana*	C	SV			
	Sternidae	Bridled Tern	*Sterna anaethetus*	UC	SV			
	Sternidae	Common Tern	*Sterna hirundo*	C	PM			
	Sternidae	Greater Crested Tern	*Sterna bergii*	Scarce	SV, PM			
	Sternidae	Little Tern	*Sterna albifrons*	UC	PM			
	Sternidae	Roseate Tern	*Sterna dougallii*	UC	SV			
	Sternidae	Whiskered Tern	*Chlidonias hybridus*	UC	PM			
	Sternidae	White-winged Tern	*Chlidonias leucopterus*	UC	PM			
	Sternidae	Unidentified Terns	*Sterna* sp.					
Seabirds (excluded Gulls & Terns)	Alcidae	Ancient Murrelet	*Synthliboramphus antiquus*	Scarce	WV			Vulnerable
	Stercorariidae	Arctic Skua	*Stercorarius parasiticus*		Vagrant			
	Fregatidae	Lesser Frigatebird	*Fregata ariel*	Scarce	SV			
Others	Columbidae	Feral Pigeon	*Columbia livia*	CW	R			
	Corvidae	Large-billed Crow	*Corvus macrorhynchus*	CW	R			
	Corvidae	Unidentified Crow	*Corvus* sp.	CW	R			
	Hirundinidae	Barn Swallow	*Hirundo rustica*	CW	PM, SV			
	Motacillidae	Unidentified Pipit	*Anthus* sp.	CW	PM, WV			
	Motacillidae	Yellow Wagtail	*Motacilla flava*	CW	PM, WV			
	Sturnidae	Crested Myna	*Acridotheres cristatellus*	CW	R			
Total number of identified species = 33								
Total number of unidentified species = 4								

Table 3 ***Total and Mean Abundance (Number of Individuals per Survey Trip) of Bird Species in Each Season Recorded within the Study Area***

*Note: The five most abundant bird species recorded are highlighted.

Bird Group	Common Name		Mean Abundance (Total Abundance)						
		Effective Survey Trips	9	9	6	3	27		
		Species Name	Spring	Summer	Autumn	Winter	Overall	%	Rank
Birds of Prey	Black Kite	*Milvus migrans*	35.7 (321)	20.2 (182)	12.2 (73)	45.3 (136)	26.4 (712)	32%	1
	Common Buzzard	*Buteo buteo*	0.1 (1)	0 (0)	0 (0)	0 (0)	0 (1)	0%	27
	White-bellied Sea Eagle	*Haliaeetus leucogaster*	0.7 (6)	0.2 (2)	0.3 (2)	0 (0)	0.4 (10)	0%	18
Egrets & Herons	Cattle Egret	*Bubulcus ibis*	2.1 (19)	0 (0)	0.3 (2)	0 (0)	0.8 (21)	1%	13
	Chinese Pond Heron	*Ardeola bacchus*	0 (0)	0 (0)	1 (6)	0 (0)	0.2 (6)	0%	22
	Great Egret	*Ardea alba*	0.1 (1)	0.3 (3)	0 (0)	0 (0)	0.1 (4)	0%	24
	Little Egret	*Egretta garzetta*	8.2 (74)	10.9 (98)	11.2 (67)	3 (9)	9.2 (248)	11%	2
	Pacific Reef Egret	*Egretta sacra*	0.6 (5)	0.6 (5)	0.5 (3)	2 (6)	0.7 (19)	1%	14
	Unidentified Egrets	Family Ardeidae	0.8 (7)	0 (0)	5 (30)	0 (0)	1.4 (37)	2%	11
	Schrenck's Bittern	*Ixobrychus eurhythmus*	1.8 (16)	0 (0)	0 (0)	0 (0)	0.6 (16)	1%	16
Shorebirds (excluded Egrets & Herons)	Eastern Curlew	*Numenius madagascariensis*	2.4 (22)	0 (0)	0 (0)	0 (0)	0.8 (22)	1%	12
	Oriental Pratincole	*Glareola maldivarum*	0.1 (1)	0 (0)	0 (0)	0 (0)	0 (1)	0%	27
	Red-necked Phalarope	*Phalaropus lobatus*	22.9 (206)	0 (0)	0.2 (1)	0 (0)	7.7 (207)	9%	3
Gulls & Terns	Aleutian Tern	*Sterna aleutica*	1.2 (11)	1 (9)	10.8 (65)	0 (0)	3.1 (85)	4%	9
	Black-headed Gull	*Larus ichthyaetus*	0 (0)	0 (0)	0 (0)	0.7 (2)	0.1 (2)	0%	26
	Black-legged Kittiwake	*Rissa tridactyla*	0 (0)	0 (0)	0 (0)	0.3 (1)	0 (1)	0%	27
	Black-naped Tern	*Sterna sumatrana*	5.6 (50)	5.7 (51)	0 (0)	0 (0)	3.7 (101)	5%	7
	Black-tailed Gull	*Larus crassirostris*	0.1 (1)	0 (0)	0 (0)	0 (0)	0 (1)	0%	27
	Bridled Tern	*Sterna anaethetus*	0.2 (2)	11 (99)	0 (0)	0 (0)	3.7 (101)	5%	7
	Common Tern	*Sterna hirundo*	2.3 (21)	4.2 (38)	8 (48)	0 (0)	4 (107)	5%	6
	Greater Crested Tern	*Sterna bergii*	0.1 (1)	0 (0)	0 (0)	0 (0)	0 (1)	0%	27
	Heuglin's Gull	*Larus heuglini*	5.2 (47)	0 (0)	0 (0)	45.3 (136)	6.8 (183)	8%	4
	Little Tern	*Sterna albifrons*	0.1 (1)	0 (0)	0 (0)	0 (0)	0 (1)	0%	27
	Roseate Tern	*Sterna dougallii*	1.1 (10)	0.9 (8)	0 (0)	0 (0)	0.7 (18)	1%	15
	Whiskered Tern	*Chlidonias hybridus*	0 (0)	0 (0)	0.7 (4)	0 (0)	0.1 (4)	0%	24

Bird Group	Common Name		Mean Abundance (Total Abundance)					%	Rank
		Effective Survey Trips	9	9	6	3	27		
		Species Name	Spring	Summer	Autumn	Winter	Overall		
	White-winged Tern	*Chlidonias leucopterus*	19.8 (178)	0 (0)	0 (0)	0 (0)	6.6 (178)	8%	5
	Unidentified Terns	*Sterna* sp.	0.6 (5)	0.3 (3)	0.2 (1)	0 (0)	0.3 (9)	0%	19
Seabirds (excluded Gulls & Terns)	Ancient Murrelet	*Synthliboramphus antiquus*	0.8 (7)	0 (0)	0 (0)	0 (0)	0.3 (7)	0%	20
	Arctic Skua	*Stercorarius parasiticus*	0.8 (7)	0 (0)	0 (0)	0 (0)	0.3 (7)	0%	20
	Lesser Frigatebird	*Fregata ariel*	0 (0)	0.1 (1)	0 (0)	0 (0)	0 (1)	0%	27
Others	Barn Swallow	*Hirundo rustica*	2.9 (26)	3.8 (34)	2.8 (17)	0.7 (2)	2.9 (79)	4%	10
	Crested Myna	*Acridotheres cristatellus*	0 (0)	0 (0)	0 (0)	4.7 (14)	0.5 (14)	1%	17
	Feral Pigeon	*Columbia livia*	0 (0)	0 (0)	0 (0)	0.3 (1)	0 (1)	0%	27
	Large-billed Crow	*Corvus macrorhynchus*	0.1 (1)	0.2 (2)	0.5 (3)	0 (0)	0.2 (6)	0%	22
	Yellow Wagtail	*Motacilla flava*	0 (0)	0 (0)	0.2 (1)	0 (0)	0 (1)	0%	27
	Unidentified Pipit	*Anthus* sp.	0 (0)	0 (0)	0.2 (1)	0 (0)	0 (1)	0%	27
	Unidentified Crow	*Corvus* sp.	0 (0)	0 (0)	0 (0)	0.3 (1)	0 (1)	0%	27
		Total	**116.3 (1,047)**	**59.4 (535)**	**54 (324)**	**102.7 (308)**	**82 (2,214)**	**100%**	

Table 4 Total Abundance of Each Species recorded under different Bird Activities and Elevation

Bird Activities: F = Flying, S = Soaring, Fo = Foraging, R = Resting, S = Swimming

			Bird Activities					Flying Elevation				
Bird Group	**Common Name**	**Species Name**	**F**	**S**	**Fo**	**R**	**S**	**Sea-level (0 m)**	**Below Rotor Height (>0 - 14 m)**	**Within Rotor Height (>14 - 136m)**	**Above Rotor Height (> 136m)**	**Overall**
Birds of Prey	Black Kite	*Milvus migrans*	338	295	56	19	4	17	130	499	66	*712*
	Common Buzzard	*Buteo buteo*	0	1	0	0	0	0	0	0	1	*1*
	White-bellied Sea Eagle	*Haliaeetus leucogaster*	6	2	0	2	0	1	2	7	0	*10*
Egrets & Herons (excluded Egrets & Herons)	Cattle Egret	*Bubulcus ibis*	21	0	0	0	0	0	15	6	0	*21*
	Chinese Pond Heron	*Ardeola bacchus*	6	0	0	0	0	0	6	0	0	*6*
	Great Egret	*Ardea alba*	2	0	0	2	0	2	1	1	0	*4*
	Little Egret	*Egretta garzetta*	123	3	8	114	0	104	110	34	0	*248*
	Pacific Reef Egret	*Egretta sacra*	8	0	2	9	0	7	12	0	0	*19*
	Unidentified Egrets	Family Ardeidae	37	0	0	0	0	0	30	7	0	*37*
	Schrenck's Bittern	*Ixobrychus eurhythmus*	16	0	0	0	0	0	0	16	0	*16*
Shorebirds	Eastern Curlew	*Numenius madagascariensis*	22	0	0	0	0	0	0	22	0	*22*
	Oriental Pratincole	*Glareola maldivarum*	1	0	0	0	0	0	1	0	0	*1*
	Red-necked Phalarope	*Phalaropus lobatus*	114	0	1	34	58	97	104	6	0	*207*
Gulls & Terns	Aleutian Tern	*Sterna aleutica*	44	0	0	41	0	41	36	8	0	*85*
	Black-headed Gull	*Larus ichthyaetus*	0	0	0	2	0	2	0	0	0	*2*
	Black-legged Kittiwake	*Rissa tridactyla*	1	0	0	0	0	0	0	1	0	*1*
	Black-naped Tern	*Sterna sumatrana*	54	0	16	31	0	15	66	20	0	*101*
	Black-tailed Gull	*Larus crassirostris*	0	0	0	0	1	1	0	0	0	*1*
	Bridled Tern	*Sterna anaethetus*	46	0	45	10	0	9	84	8	0	*101*
	Common Tern	*Sterna hirundo*	77	0	11	19	0	21	66	20	0	*107*
	Greater Crested Tern	*Sterna bergii*	0	0	0	1	0	1	0	0	0	*1*
	Heuglin's Gull	*Larus heuglini*	39	0	1	143	0	142	8	33	0	*183*
	Little Tern	*Sterna albifrons*	0	0	0	1	0	1	0	0	0	*1*
	Roseate Tern	*Sterna dougallii*	6	0	0	12	0	2	16	0	0	*18*

Bird Group	Common Name	Species Name	Bird Activities					Flying Elevation				Overall
			F	S	Fo	R	S	Sea-level (0 m)	Below Rotor Height (>0 - 14 m)	Within Rotor Height (>14 - 136m)	Above Rotor Height (> 136m)	
	Whiskered Tern	*Chlidonias hybridus*	2	0	0	2	0	2	2	0	0	*4*
	White-winged Tern	*Chlidonias leucopterus*	175	0	0	3	0	2	156	20	0	*178*
	Unidentified Terns	*Sterna* sp.	9	0	0	0	0	0	5	4	0	*9*
Seabirds (excluded Gulls & Terns)	Ancient Murrelet	*Synthliboramphus antiquus*	7	0	0	0	0	3	2	2	0	*7*
	Arctic Skua	*Stercorarius parasiticus*	3	0	0	2	2	4	3	0	0	*7*
	Lesser Frigatebird	*Fregata ariel*	1	0	0	0	0	0	0	1	0	*1*
Others	Barn Swallow	*Hirundo rustica*	79	0	0	0	0	3	73	3	0	*79*
	Crested Myna	*Acridotheres cristatellus*	0	0	0	14	0	0	0	14	0	*14*
	Feral Pigeon	*Columbia livia*	1	0	0	0	0	0	0	1	0	*1*
	Large-billed Crow	*Corvus macrorhynchus*	6	0	0	0	0	0	5	1	0	*6*
	Yellow Wagtail	*Motacilla flava*	1	0	0	0	0	0	0	1	0	*1*
	Unidentified Pipit	*Anthus* sp.	0	1	0	0	0	0	1	0	0	*1*
	Unidentified Crow	*Corvus* sp.	1	0	0	0	0	0	0	1	0	*1*
		Total	**1,246**	**302**	**140**	**461**	**65**	**477**	**934**	**736**	**67**	***2,214***

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CALCULATING BIRD COLLISION RISK

The Collision Risk Model (CRM) used in this assessment is developed by Scottish National Heritage [(1)]. The first stage is to determine the risk (probability) of a bird being hit by a turbine blade when making a transit through a rotor without any avoidance. The probability depends on the bird dimension (length and wingspan) and operational measures of the wind turbine including:

- Maximum chord width of rotor = 2m
- Pitch angle of rotor = 24 degrees
- Rotor diameter = 111 m
- Rotation period = 4.29 m/s

Collision risk was estimated for the identified species recorded within the Assessment Area (*Figure 15*). However, some bird species were not included in the assessment because all individuals recorded within the Assessment Area were below the rotor height during the surveys and thus the risk cannot be determined by the adopted calculations (*Table 5*). This included Ancient Murrelet, Artic Skua, Barn Swallow, Black-headed Gull, Black-tailed Gull, Bridled Tern, Greater Crested Tern, Little Tern and Whiskered Tern.

Table 5 Identified Bird Species observed within the Assessment Area during the Surveys

Bird Species	**Total no. of individuals recorded**				
Season	**Spring**	**Summer**	**Autumn**	**Winter**	***Total***
Aleutian Tern	0	3	17	0	*20*
Ancient Murrelet	3	0	0	0	*3*
Arctic Skua	2	0	0	0	*2*
Barn Swallow	2	1	5	0	*8*
Black Kite	18	0	0	13	*31*
Black-headed Gul	0	0	0	2	*2*
Black-legged Kittiwake	0	0	0	1	*1*
Black-naped Tern	2	6	0	0	*8*
Black-tailed Gull	1	0	0	0	*1*
Bridled Tern	0	11	0	0	*11*
Common Tern	8	14	19	0	*41*
Greater Crested Tern	1	0	0	0	*1*
Heuglin's Gull	42	0	0	131	*173*
Little Tern	1	0	0	0	*1*
Red-necked Phalarope	41	0	0	0	*41*
Whiskered Tern	0	0	2	0	*2*
White-bellied Sea Eagle	1	0	0	0	*1*
White-winged Tern	49	0	0	0	*49*
Elevation	**0m**	**>0 – 14m**	**>14 – 136m**	**> 136m**	
Aleutian Tern	11	5	4	0	

(1) Band W (2000) Windfarms and Birds: Calculating a theoretical collision risk assuming no avoiding action. Guidance Note Series. Scottish Natural Heritage.

Bird Species	Total no. of individuals recorded				
Ancient Murrelet	3	0	0	0	
Arctic Skua	2	0	0	0	
Barn Swallow	0	8	0	0	
Black Kite	0	12	19	0	
Black-headed Gul	2	0	0	0	
Black-legged Kittiwake	0	0	1	0	
Black-naped Tern	0	6	2	0	
Black-tailed Gull	1	0	0	0	
Bridled Tern	3	8	0	0	
Common Tern	3	28	10	0	
Greater Crested Tern	1	0	0	0	
Heuglin's Gull	142	3	28	0	
Little Tern	1	0	0	0	
Red-necked Phalarope	34	6	1	0	
Whiskered Tern	0	2	0	0	
White-bellied Sea Eagle	0	0	1	0	
White-winged Tern	2	27	20	0	
Total	*205*	*105*	*87*	*0*	

*Note: Bird Activities: F = Flying, S = Soaring, Fo = Foraging, R = Resting, S = Swimming

Of the five species of species of conservation interest, Black Kite and Ancient Murrelet, were the only two recorded species within the Project Site during the surveys.

The predicted collision risk from the CRM therefore generated an average collision risk of upwind flying direction and downwind flying direction for 9 species, including:

- Aleutian Tern
- Black Kite
- Black-legged Kittiwake
- Black-naped Tern
- Common Tern
- Heuglin's Gull
- Red-necked Phalarope
- White-bellied Sea Eagle
- White-winged Tern

Table 6 presents the results of the model calculations.

Table 6 Calculation of Collision Risk

1. CALCULATION OF COLLISION RISK FOR *ALEUTIAN TERN* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.34	0.02500	0.57500	2.70649	5.47632	0.69629	0.00087	4.54083	0.57735	0.00072
Wingspan (m)	0.8	0.07500	0.57500	0.90216	2.13727	0.27174	0.00204	1.20178	0.15280	0.00115
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	0.54130	1.69748	0.21583	0.00270	0.55617	0.07071	0.00088
		0.17500	0.86010	0.38664	1.64727	0.20944	0.00367	0.43207	0.05494	0.00096
Bird speed (m/sec)	5.5	0.22500	0.99435	0.30072	1.69522	0.21554	0.00485	0.60254	0.07661	0.00172
Rotor Diameter (m)	111	0.27500	0.94665	0.24604	1.53564	0.19525	0.00537	0.68451	0.08703	0.00239
Rotation Period (sec)	4.29	0.32500	0.89895	0.20819	1.41322	0.17968	0.00584	0.72932	0.09273	0.00301
		0.37500	0.85125	0.18043	1.31310	0.16695	0.00626	0.75184	0.09559	0.00358
		0.42500	0.80355	0.15921	1.22741	0.15606	0.00663	0.75993	0.09662	0.00411
		0.47500	0.75585	0.14245	1.15158	0.14642	0.00695	0.75814	0.09639	0.00458
Bird aspect ratio: b	0.425	0.52500	0.70815	0.12888	1.08281	0.13768	0.00723	0.74931	0.09527	0.00500
		0.57500	0.66045	0.11767	1.01926	0.12959	0.00745	0.73526	0.09349	0.00538
		0.62500	0.61275	0.10826	0.95966	0.12202	0.00763	0.71725	0.09120	0.00570
		0.67500	0.56505	0.10024	0.90314	0.11483	0.00775	0.69616	0.08851	0.00597
		0.72500	0.51735	0.09333	0.84907	0.10796	0.00783	0.67263	0.08552	0.00620
		0.77500	0.46965	0.08731	0.79696	0.10133	0.00785	0.64713	0.08228	0.00638
		0.82500	0.42195	0.08201	0.74647	0.09491	0.00783	0.62002	0.07883	0.00650
		0.87500	0.37425	0.07733	0.69732	0.08866	0.00776	0.59157	0.07522	0.00658
		0.92500	0.32655	0.07315	0.64928	0.08255	0.00764	0.56200	0.07146	0.00661
		0.97500	0.27885	0.06940	0.60219	0.07657	0.00747	0.53148	0.06758	0.00659
			Overall p(collision) =			Upwind	12.16%		Downwind	8.40%
							Average	**10.28%**		

2. CALCULATION OF COLLISION RISK FOR *BLACK KITE* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.69	0.02500	0.57500	4.42881	9.34975	0.72648	0.00091	8.41426	0.65379	0.00082
Wingspan (m)	1.5	0.07500	0.57500	1.47627	3.42842	0.26639	0.00200	2.49292	0.19370	0.00145
F: Flapping (0) or gliding (+1)	1	0.12500	0.70150	0.88576	2.55178	0.19827	0.00248	1.41047	0.10959	0.00137
		0.17500	0.86010	0.63269	2.29810	0.17856	0.00312	0.89876	0.06983	0.00122
Bird speed (m/sec)	9	0.22500	0.99435	0.49209	2.17280	0.16883	0.00380	0.55505	0.04313	0.00097
Rotor Diameter (m)	111	0.27500	0.94665	0.40262	2.15645	0.16756	0.00461	0.76370	0.05934	0.00163
Rotation Period (sec)	4.29	0.32500	0.89895	0.34068	1.98082	0.15391	0.00500	0.86172	0.06696	0.00218
		0.37500	0.85125	0.29525	1.84168	0.14310	0.00537	0.92326	0.07174	0.00269
		0.42500	0.80355	0.26052	1.72615	0.13412	0.00570	0.96118	0.07468	0.00317
		0.47500	0.75585	0.23310	1.62677	0.12640	0.00600	0.98296	0.07638	0.00363
Bird aspect ratio: b	0.46	0.52500	0.70815	0.21090	1.53893	0.11957	0.00628	0.99319	0.07717	0.00405
		0.57500	0.66045	0.19256	1.45962	0.11341	0.00652	0.99490	0.07730	0.00444
		0.62500	0.61275	0.17715	1.38679	0.10775	0.00673	0.99012	0.07693	0.00481
		0.67500	0.56505	0.16403	1.31900	0.10249	0.00692	0.98031	0.07617	0.00514
		0.72500	0.51735	0.15272	1.25521	0.09753	0.00707	0.96649	0.07510	0.00544
		0.77500	0.46965	0.14286	1.19464	0.09282	0.00719	0.94946	0.07377	0.00572
		0.82500	0.42195	0.13421	1.13671	0.08832	0.00729	0.92978	0.07224	0.00596
		0.87500	0.37425	0.12654	1.08097	0.08399	0.00735	0.90792	0.07055	0.00617
		0.92500	0.32655	0.11970	1.02706	0.07980	0.00738	0.88422	0.06870	0.00636
		0.97500	0.27885	0.11356	0.97469	0.07573	0.00738	0.85898	0.06674	0.00651
			Overall p(collision) =			Upwind	10.91%		Downwind	7.37%
							Average	**9.14%**		

3. CALCULATION OF COLLISION RISK FOR *BLACK-LEGGED KITTIWAKE* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.41	0.02500	0.57500	6.44638	13.49315	0.72029	0.00090	12.55766	0.67035	0.00084
Wingspan (m)	0.97	0.07500	0.57500	2.14879	4.80955	0.25674	0.00193	3.87405	0.20680	0.00155
F: Flapping (0) or gliding (+1)	1	0.12500	0.70150	1.28928	3.47372	0.18543	0.00232	2.33242	0.12451	0.00156
		0.17500	0.86010	0.92091	3.04015	0.16229	0.00284	1.64081	0.08759	0.00153
Bird speed (m/sec)	13.1	0.22500	0.99435	0.71626	2.80494	0.14973	0.00337	1.18718	0.06337	0.00143
Rotor Diameter (m)	111	0.27500	0.94665	0.58603	2.35214	0.12556	0.00345	0.81199	0.04335	0.00119
Rotation Period (sec)	4.29	0.32500	0.89895	0.49588	2.02673	0.10819	0.00352	0.56418	0.03012	0.00098
		0.37500	0.85125	0.42976	1.77774	0.09490	0.00356	0.44093	0.02354	0.00088
		0.42500	0.80355	0.37920	1.62039	0.08650	0.00368	0.50694	0.02706	0.00115
		0.47500	0.75585	0.33928	1.49342	0.07972	0.00379	0.55631	0.02970	0.00141
Bird aspect ratio: b	0.42	0.52500	0.70815	0.30697	1.38324	0.07384	0.00388	0.58889	0.03144	0.00165
		0.57500	0.66045	0.28028	1.28547	0.06862	0.00395	0.60905	0.03251	0.00187
		0.62500	0.61275	0.25786	1.19714	0.06391	0.00399	0.61977	0.03308	0.00207
		0.67500	0.56505	0.23875	1.11614	0.05958	0.00402	0.62316	0.03327	0.00225
		0.72500	0.51735	0.22229	1.04097	0.05557	0.00403	0.62073	0.03314	0.00240
		0.77500	0.46965	0.20795	0.97049	0.05181	0.00401	0.61361	0.03276	0.00254
		0.82500	0.42195	0.19534	0.90384	0.04825	0.00398	0.60265	0.03217	0.00265
		0.87500	0.37425	0.18418	0.84038	0.04486	0.00393	0.58850	0.03142	0.00275
		0.92500	0.32655	0.17423	0.77959	0.04162	0.00385	0.57169	0.03052	0.00282
		0.97500	0.27885	0.16529	0.72105	0.03849	0.00375	0.55262	0.02950	0.00288
			Overall p(collision) =			Upwind	6.87%		Downwind	3.64%
							Average	**5.26%**		

4. CALCULATION OF COLLISION RISK FOR *BLACK-NAPED TERN* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.35	0.02500	0.57500	4.72406	6.51727	0.47474	0.00059	5.58178	0.40660	0.00051
Wingspan (m)	0.23	0.07500	0.57500	1.57469	2.48426	0.18096	0.00136	1.54876	0.11282	0.00085
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	0.94481	2.13162	0.15528	0.00194	0.99032	0.07214	0.00090
		0.17500	0.86010	0.67487	2.11021	0.15372	0.00269	0.71087	0.05178	0.00091
Bird speed (m/sec)	9.6	0.22500	0.99435	0.52490	2.11249	0.15388	0.00346	0.49474	0.03604	0.00081
Rotor Diameter (m)	111	0.27500	0.94665	0.42946	1.86288	0.13570	0.00373	0.37727	0.02748	0.00076
Rotation Period (sec)	4.29	0.32500	0.89895	0.36339	1.67813	0.12224	0.00397	0.48442	0.03529	0.00115
		0.37500	0.85125	0.31494	1.53229	0.11162	0.00419	0.55264	0.04026	0.00151
		0.42500	0.80355	0.27789	1.41165	0.10283	0.00437	0.59569	0.04339	0.00184
		0.47500	0.75585	0.24863	1.30823	0.09530	0.00453	0.62150	0.04527	0.00215
Bird aspect ratio: b	1.52	0.52500	0.70815	0.22496	1.21712	0.08866	0.00465	0.63500	0.04626	0.00243
		0.57500	0.66045	0.20539	1.13511	0.08269	0.00475	0.63941	0.04658	0.00268
		0.62500	0.61275	0.18896	1.06001	0.07722	0.00483	0.63690	0.04639	0.00290
		0.67500	0.56505	0.17497	0.99029	0.07214	0.00487	0.62902	0.04582	0.00309
		0.72500	0.51735	0.16290	0.92483	0.06737	0.00488	0.61687	0.04494	0.00326
		0.77500	0.46965	0.15239	0.86281	0.06285	0.00487	0.60128	0.04380	0.00339
		0.82500	0.42195	0.14315	0.80361	0.05854	0.00483	0.58288	0.04246	0.00350
		0.87500	0.37425	0.13497	0.74674	0.05440	0.00476	0.56215	0.04095	0.00358
		0.92500	0.32655	0.12768	0.69182	0.05039	0.00466	0.53946	0.03930	0.00363
		0.97500	0.27885	0.12113	0.63855	0.04651	0.00454	0.51512	0.03752	0.00366
			Overall p(collision) =			Upwind	7.85%		Downwind	4.35%
							Average	**6.10%**		

5. CALCULATION OF COLLISION RISK FOR *COMMON TERN* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.35	0.02500	0.57500	3.83830	8.26171	0.74070	0.00093	7.32622	0.65682	0.00082
Wingspan (m)	0.98	0.07500	0.57500	1.27943	3.06574	0.27486	0.00206	2.13024	0.19098	0.00143
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	0.76766	2.30687	0.20682	0.00259	1.16557	0.10450	0.00131
		0.17500	0.86010	0.54833	2.09872	0.18816	0.00329	0.69938	0.06270	0.00110
Bird speed (m/sec)	7.8	0.22500	0.99435	0.42648	2.00164	0.17945	0.00404	0.45201	0.04052	0.00091
Rotor Diameter (m)	111	0.27500	0.94665	0.34894	1.72360	0.15453	0.00425	0.51655	0.04631	0.00127
Rotation Period (sec)	4.29	0.32500	0.89895	0.29525	1.56622	0.14042	0.00456	0.59633	0.05346	0.00174
		0.37500	0.85125	0.25589	1.44045	0.12914	0.00484	0.64449	0.05778	0.00217
		0.42500	0.80355	0.22578	1.33515	0.11970	0.00509	0.67218	0.06026	0.00256
		0.47500	0.75585	0.20202	1.24385	0.11152	0.00530	0.68588	0.06149	0.00292
Bird aspect ratio: b	0.357	0.52500	0.70815	0.18278	1.16255	0.10423	0.00547	0.68958	0.06182	0.00325
		0.57500	0.66045	0.16688	1.08864	0.09760	0.00561	0.68588	0.06149	0.00354
		0.62500	0.61275	0.15353	1.02034	0.09148	0.00572	0.67657	0.06066	0.00379
		0.67500	0.56505	0.14216	0.95642	0.08575	0.00579	0.66289	0.05943	0.00401
		0.72500	0.51735	0.13236	0.89596	0.08033	0.00582	0.64574	0.05789	0.00420
		0.77500	0.46965	0.12382	0.83829	0.07516	0.00582	0.62580	0.05611	0.00435
		0.82500	0.42195	0.11631	0.78291	0.07019	0.00579	0.60358	0.05411	0.00446
		0.87500	0.37425	0.10967	0.72943	0.06540	0.00572	0.57945	0.05195	0.00455
		0.92500	0.32655	0.10374	0.67753	0.06074	0.00562	0.55375	0.04965	0.00459
		0.97500	0.27885	0.09842	0.62698	0.05621	0.00548	0.52669	0.04722	0.00460
				Overall p(collision) =		Upwind	9.38%		Downwind	5.76%
							Average	**7.57%**		

6. CALCULATION OF COLLISION RISK FOR *HEUGLIN'S GULL* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.6	0.02500	0.57500	4.42881	11.27660	0.87619	0.00110	10.34110	0.80350	0.00100
Wingspan (m)	1.39	0.07500	0.57500	1.47627	4.07070	0.31629	0.00237	3.13520	0.24361	0.00183
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	0.88576	2.93715	0.22822	0.00285	1.79584	0.13954	0.00174
		0.17500	0.86010	0.63269	2.57336	0.19995	0.00350	1.17402	0.09122	0.00160
Bird speed (m/sec)	9	0.22500	0.99435	0.49209	2.38690	0.18546	0.00417	0.76914	0.05976	0.00134
Rotor Diameter (m)	111	0.27500	0.94665	0.40262	2.06645	0.16056	0.00442	0.67370	0.05235	0.00144
Rotation Period (sec)	4.29	0.32500	0.89895	0.34068	1.89082	0.14692	0.00477	0.77172	0.05996	0.00195
		0.37500	0.85125	0.29525	1.75168	0.13611	0.00510	0.83326	0.06474	0.00243
		0.42500	0.80355	0.26052	1.63615	0.12713	0.00540	0.87118	0.06769	0.00288
		0.47500	0.75585	0.23310	1.53677	0.11941	0.00567	0.89296	0.06938	0.00330
Bird aspect ratio: b	0.432	0.52500	0.70815	0.21090	1.44893	0.11258	0.00591	0.90319	0.07018	0.00368
		0.57500	0.66045	0.19256	1.36962	0.10642	0.00612	0.90490	0.07031	0.00404
		0.62500	0.61275	0.17715	1.29679	0.10076	0.00630	0.90012	0.06994	0.00437
		0.67500	0.56505	0.16403	1.22900	0.09549	0.00645	0.89031	0.06918	0.00467
		0.72500	0.51735	0.15272	1.16521	0.09054	0.00656	0.87649	0.06810	0.00494
		0.77500	0.46965	0.14286	1.10464	0.08583	0.00665	0.85946	0.06678	0.00518
		0.82500	0.42195	0.13421	1.04671	0.08133	0.00671	0.83978	0.06525	0.00538
		0.87500	0.37425	0.12654	0.99097	0.07700	0.00674	0.81792	0.06355	0.00556
		0.92500	0.32655	0.11970	0.93706	0.07281	0.00673	0.79422	0.06171	0.00571
		0.97500	0.27885	0.11356	0.88469	0.06874	0.00670	0.76898	0.05975	0.00583
				Overall p(collision) =		Upwind	10.42%		Downwind	6.89%
							Average	**8.65%**		

7. CALCULATION OF COLLISION RISK FOR *RED-NECKED PHALAROPE* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.19	0.02500	0.57500	2.55887	4.12840	0.55519	0.00069	3.19291	0.42939	0.00054
Wingspan (m)	0.38	0.07500	0.57500	0.85296	1.68797	0.22700	0.00170	0.75247	0.10119	0.00076
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	0.51177	1.42107	0.19111	0.00239	0.27976	0.03762	0.00047
		0.17500	0.86010	0.36555	1.46413	0.19690	0.00345	0.31521	0.04239	0.00074
Bird speed (m/sec)	5.2	0.22500	0.99435	0.28432	1.51542	0.20379	0.00459	0.48234	0.06487	0.00146
Rotor Diameter (m)	111	0.27500	0.94665	0.23262	1.36243	0.18322	0.00504	0.55772	0.07500	0.00206
Rotation Period (sec)	4.29	0.32500	0.89895	0.19684	1.24457	0.16737	0.00544	0.59798	0.08042	0.00261
		0.37500	0.85125	0.17059	1.14779	0.15436	0.00579	0.61715	0.08299	0.00311
		0.42500	0.80355	0.15052	1.06466	0.14318	0.00608	0.62268	0.08374	0.00356
		0.47500	0.75585	0.13468	0.99085	0.13325	0.00633	0.61887	0.08323	0.00395
Bird aspect ratio: b	0.50	0.52500	0.70815	0.12185	0.92372	0.12422	0.00652	0.60840	0.08182	0.00430
		0.57500	0.66045	0.11126	0.86151	0.11586	0.00666	0.59301	0.07975	0.00459
		0.62500	0.61275	0.10235	0.80305	0.10799	0.00675	0.57386	0.07717	0.00482
		0.67500	0.56505	0.09477	0.74750	0.10052	0.00679	0.55181	0.07421	0.00501
		0.72500	0.51735	0.08824	0.69426	0.09336	0.00677	0.52744	0.07093	0.00514
		0.77500	0.46965	0.08254	0.64288	0.08645	0.00670	0.50122	0.06740	0.00522
		0.82500	0.42195	0.07754	0.59302	0.07975	0.00658	0.47347	0.06367	0.00525
		0.87500	0.37425	0.07311	0.54443	0.07322	0.00641	0.44445	0.05977	0.00523
		0.92500	0.32655	0.06916	0.49690	0.06682	0.00618	0.41438	0.05573	0.00515
		0.97500	0.27885	0.06561	0.45027	0.06055	0.00590	0.38341	0.05156	0.00503
				Overall p(collision) =		Upwind	10.68%		Downwind	6.90%
							Average	**8.79%**		

8. CALCULATION OF COLLISION RISK FOR *WHITE-BELLIED SEA EAGLE* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.23	0.02500	0.57500	8.21790	27.01631	1.00000	0.00125	26.08082	1.00000	0.00125
Wingspan (m)	0.67	0.07500	0.57500	2.73930	9.31727	0.39015	0.00293	8.38177	0.35098	0.00263
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	1.64358	6.26024	0.26214	0.00328	5.11894	0.21435	0.00268
		0.17500	0.86010	1.17399	5.10385	0.21372	0.00374	3.70452	0.15512	0.00271
Bird speed (m/sec)	15.5	0.22500	0.99435	0.91310	4.45833	0.18669	0.00420	2.84057	0.11895	0.00268
Rotor Diameter (m)	111	0.27500	0.94665	0.74708	3.69088	0.15455	0.00425	2.15073	0.09006	0.00248
Rotation Period (sec)	4.29	0.32500	0.89895	0.63215	3.14763	0.13180	0.00428	1.68508	0.07056	0.00229
		0.37500	0.85125	0.54786	2.73890	0.11469	0.00430	1.35396	0.05670	0.00213
		0.42500	0.80355	0.48341	2.41721	0.10122	0.00430	1.10988	0.04648	0.00198
		0.47500	0.75585	0.43252	2.15507	0.09024	0.00429	0.96045	0.04022	0.00191
Bird aspect ratio: b	0.343	0.52500	0.70815	0.39133	1.93548	0.08105	0.00425	0.92284	0.03864	0.00203
		0.57500	0.66045	0.35730	1.81841	0.07614	0.00438	0.95610	0.04004	0.00230
		0.62500	0.61275	0.32872	1.71647	0.07188	0.00449	0.98044	0.04106	0.00257
		0.67500	0.56505	0.30437	1.62388	0.06800	0.00459	0.99543	0.04168	0.00281
		0.72500	0.51735	0.28338	1.53871	0.06443	0.00467	1.00299	0.04200	0.00304
		0.77500	0.46965	0.26509	1.45952	0.06112	0.00474	1.00457	0.04207	0.00326
		0.82500	0.42195	0.24903	1.38523	0.05801	0.00479	1.00126	0.04193	0.00346
		0.87500	0.37425	0.23480	1.31499	0.05506	0.00482	0.99389	0.04162	0.00364
		0.92500	0.32655	0.22211	1.24816	0.05227	0.00483	0.98312	0.04117	0.00381
		0.97500	0.27885	0.21072	1.18419	0.04959	0.00483	0.96948	0.04060	0.00396
				Overall p(collision) =		Upwind	8.32%		Downwind	5.36%
							Average	**6.84%**		

9. CALCULATION OF COLLISION RISK FOR *WHITE-WINGED TERN* PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
No of Blades	3				Upwind:			Downwind:		
Max Chord Width (m)	2	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	24	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length (m)	0.23	0.02500	0.57500	7.62739	13.59127	0.61319	0.00077	12.65577	0.57098	0.00071
Wingspan (m)	0.67	0.07500	0.57500	2.54246	4.84225	0.21846	0.00164	3.90676	0.17626	0.00132
F: Flapping (0) or gliding (+1)	0	0.12500	0.70150	1.52548	3.54793	0.16007	0.00200	2.40663	0.10858	0.00136
		0.17500	0.86010	1.08963	3.14205	0.14176	0.00248	1.74271	0.07862	0.00138
Bird speed (m/sec)	15.5	0.22500	0.99435	0.84749	2.91638	0.13158	0.00296	1.29863	0.05859	0.00132
Rotor Diameter (m)	111	0.27500	0.94665	0.69340	2.43397	0.10981	0.00302	0.89382	0.04033	0.00111
Rotation Period (sec)	4.29	0.32500	0.89895	0.58672	2.08805	0.09420	0.00306	0.62550	0.02822	0.00092
		0.37500	0.85125	0.50849	1.82402	0.08229	0.00309	0.43909	0.01981	0.00074
		0.42500	0.80355	0.44867	1.61299	0.07277	0.00309	0.30566	0.01379	0.00059
		0.47500	0.75585	0.40144	1.43822	0.06489	0.00308	0.32944	0.01486	0.00071
Bird aspect ratio: b	0.343	0.52500	0.70815	0.36321	1.28935	0.05817	0.00305	0.34947	0.01577	0.00083
		0.57500	0.66045	0.33163	1.16743	0.05267	0.00303	0.36708	0.01656	0.00095
		0.62500	0.61275	0.30510	1.07003	0.04828	0.00302	0.38689	0.01745	0.00109
		0.67500	0.56505	0.28250	0.98130	0.04427	0.00299	0.39800	0.01796	0.00121
		0.72500	0.51735	0.26301	0.89946	0.04058	0.00294	0.40224	0.01815	0.00132
		0.77500	0.46965	0.24604	0.82318	0.03714	0.00288	0.40092	0.01809	0.00140
		0.82500	0.42195	0.23113	0.75144	0.03390	0.00280	0.39506	0.01782	0.00147
		0.87500	0.37425	0.21793	0.68346	0.03083	0.00270	0.38543	0.01739	0.00152
		0.92500	0.32655	0.20615	0.61863	0.02791	0.00258	0.37265	0.01681	0.00156
		0.97500	0.27885	0.19557	0.55648	0.02511	0.00245	0.35720	0.01612	0.00157
			Overall p(collision) =			Upwind	5.36%		Downwind	2.31%
							Average	**3.83%**		

The second stage is to estimate the number of bird flying through rotors (ie number of bird at risk) per season. The Assessment Area consisted of area of approximately 20 km^2 which included the entire Project Site (~ 6 km^2) and the number of bird at risk will be estimated for whole area. This is to provide a more conservative approach by assuming all birds recorded in close proximity will pass through the Project Site. The flight risk window was first estimated by multiplying the width of the assessment area (ie 5 km) with the maximum height of the turbine (ie 136 m). The total rotor area as proportion to the flight risk window was then calculated by considering the total number of wind turbine (ie 35) and the radius of the rotor (ie 55.5 m). The number of birds at risk in each season was then estimated by assuming the bird utilised the area for 7 hours per day for the duration of species that persisted in each season [(1)]. This duration was calculated as the number of days between the first and the last calendar dates for which the species persisted in the area plus 6 days (as a buffer period) [(2)].

Finally, the number of bird collisions per year will be predicted by multiplying the risk (1st stage) with the number of birds at risk (2nd stage). This number, however, assumes the birds fly as if the wind turbine structures and rotors were not there and take no avoiding action (ie death). In reality most birds do take avoiding action and therefore the predicted number is usually adjusted by the avoidance factor. It is suggested that an avoidance rate of 95% is conservative enough for collision risk assessment [(3)]. For this assessment, both predictions (no avoidance and 95% avoidance rate) were estimated and assessed. Detailed calculations of the predictions were showed in *Table 6*.

(1) BMT Asia Pacific (2009). *Hong Kong Offshore Wind Farm in Southeastern Waters - Environmental Impact Assessment.* EIA Report - Section 7 Avifauna.(Ref: ESB-146/2006).

(2) BMT Asia Pacific (2009). *Ibid.*

(3) Scottish Natural Heritage (2009) Guidance & Information Specific to Bird Interests – Avoidance Factor.

Table 7 Calculation of Number of Collision Predicted Per Year in Each Grid for Each Species

1. Aleutian Tern

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km^2)	0.680
Band Collision (%)	10.28%	Total rotor area as proportion of risk window (km^2)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Summer	3	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	17	3	0.5000	5.2500	73.5000	36.6085	3.7639	0.1882
Winter	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

2. Black Kite

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km^2)	0.680
Band Collision (%)	9.14%	Total rotor area as proportion of risk window (km^2)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	18	16	1.7778	18.6667	1306.6667	650.8183	59.4983	2.9749
Summer	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	13	3	1.0000	10.5000	304.5000	151.6639	13.8652	0.6933

3. Black-legged Kittiwake

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km²)	0.680
Total survey time of Assessment Area per day (hr)	5.26%	Total rotor area as proportion of risk window (km²)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Summer	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	1	1	0.3333	3.4983	24.4878	12.1967	0.6411	0.0321

4. Black-naped Tern

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km²)	0.680
Total survey time of Assessment Area per day (hr)	5.26%	Total rotor area as proportion of risk window (km²)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	2	2	0.2222	2.3333	16.3333	8.1352	0.4276	0.0214
Summer	6	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5. Common Tern

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km²)	0.680
Total survey time of Assessment Area per day (hr)	7.57%	Total rotor area as proportion of risk window (km²)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	8	4	0.4444	4.6667	98.0000	48.8114	3.6940	0.1847
Summer	14	2	0.2222	2.3333	39.6667	19.7570	1.4952	0.0748
Autumn	19	4	0.6667	7.0000	98.0000	48.8114	3.6940	0.1847
Winter	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

6. Heuglin's Gull

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km²)	0.680
Band Collision (%)	8.68%	Total rotor area as proportion of risk window (km²)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	42	17	1.8889	19.8333	158.6667	79.0279	4.4894	0.2245
Summer	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	131	11	3.6667	38.5000	106.3333	52.9620	3.0086	0.1504

7. Red-necked Phalarope

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km^2)	0.680
Band Collision (%)	8.79%	Total rotor area as proportion of risk window (km^2)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	41	1	0.1111	1.1667	72.3333	36.0274	3.1662	0.1583
Summer	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

8. White-bellied Sea Eagle

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km^2)	0.680
Band Collision (%)	6.84%	Total rotor area as proportion of risk window (km^2)	0.498

	Spring	Summer	Autumn	Winter
Total no. of survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	1	1	0.1111	1.1667	8.1667	4.0676	0.2783	0.0139
Summer	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

9. White-winged Tern

Total survey time of Assessment Area per day (hr)	0.6667	Area of risk window (km²)	0.680
Band Collision (%)	3.83%	Total rotor area as proportion of risk window (km²)	0.498

	Spring	Summer	Autumn	Winter
Total no. of Survey day	9	9	6	3

Season	Total no. of bird sighted	Actual no. of bird sighted at risk height	No. of bird at risk per survey trip	No. of bird at risk per day	No. of bird at risk per season	No. of bird passing through rotor per season	No. of collision per season	
							No Avoidance	95% Avoidance
Spring	49	20	2.2222	23.3333	40.0000	19.9230	0.7639	0.0382
Summer	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Autumn	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Winter	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 1
(Annex 8)

Seasonal Variation of the Distribution of Chinese Pond Heron in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_Chinese Pond Heron_L.mxd
Date: 20/08/2009

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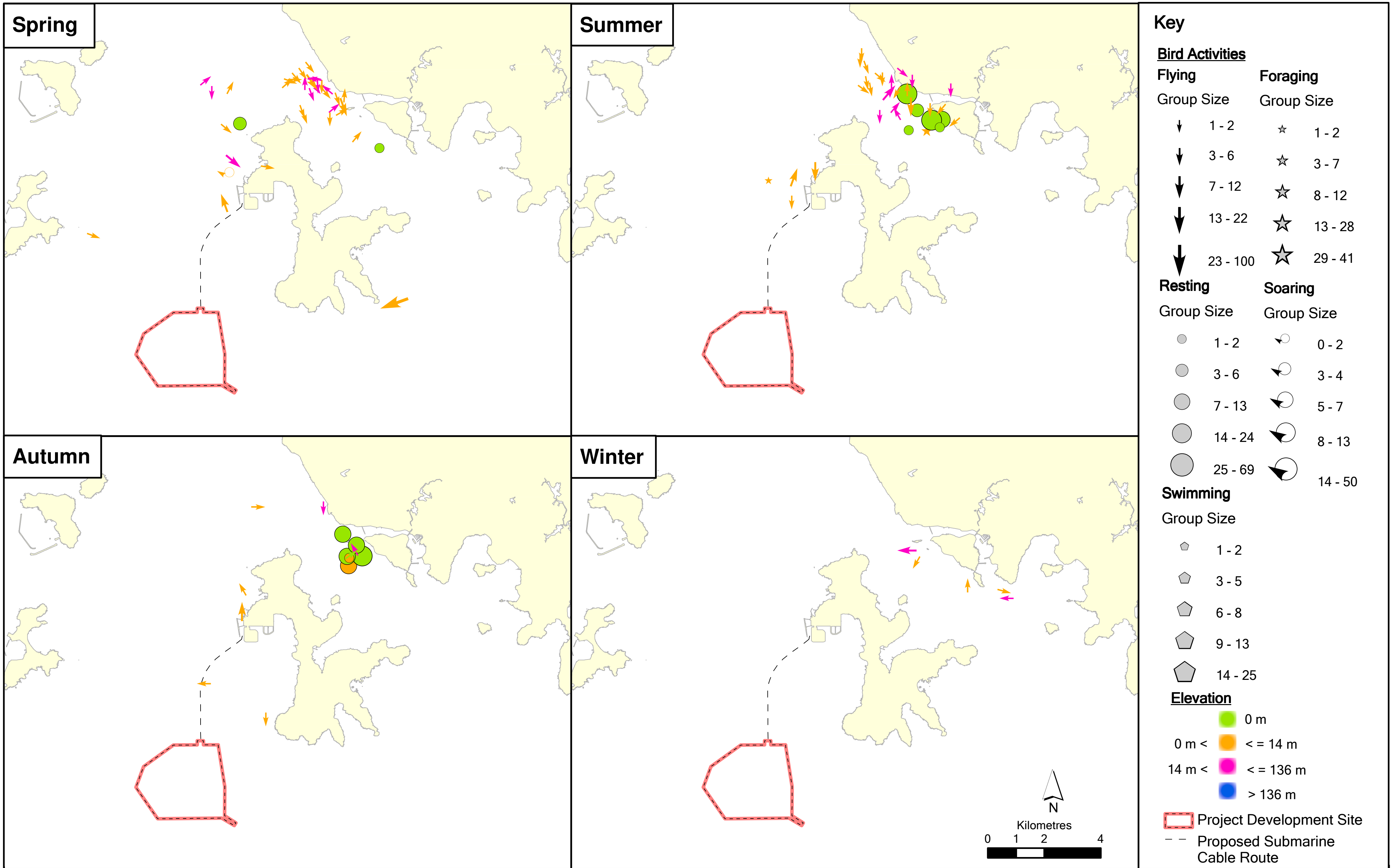

Figure 2
(Annex 8)

Seasonal Variation of the Distribution of Little Egret in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_Little Egret_L.mxd
Date: 20/08/2009

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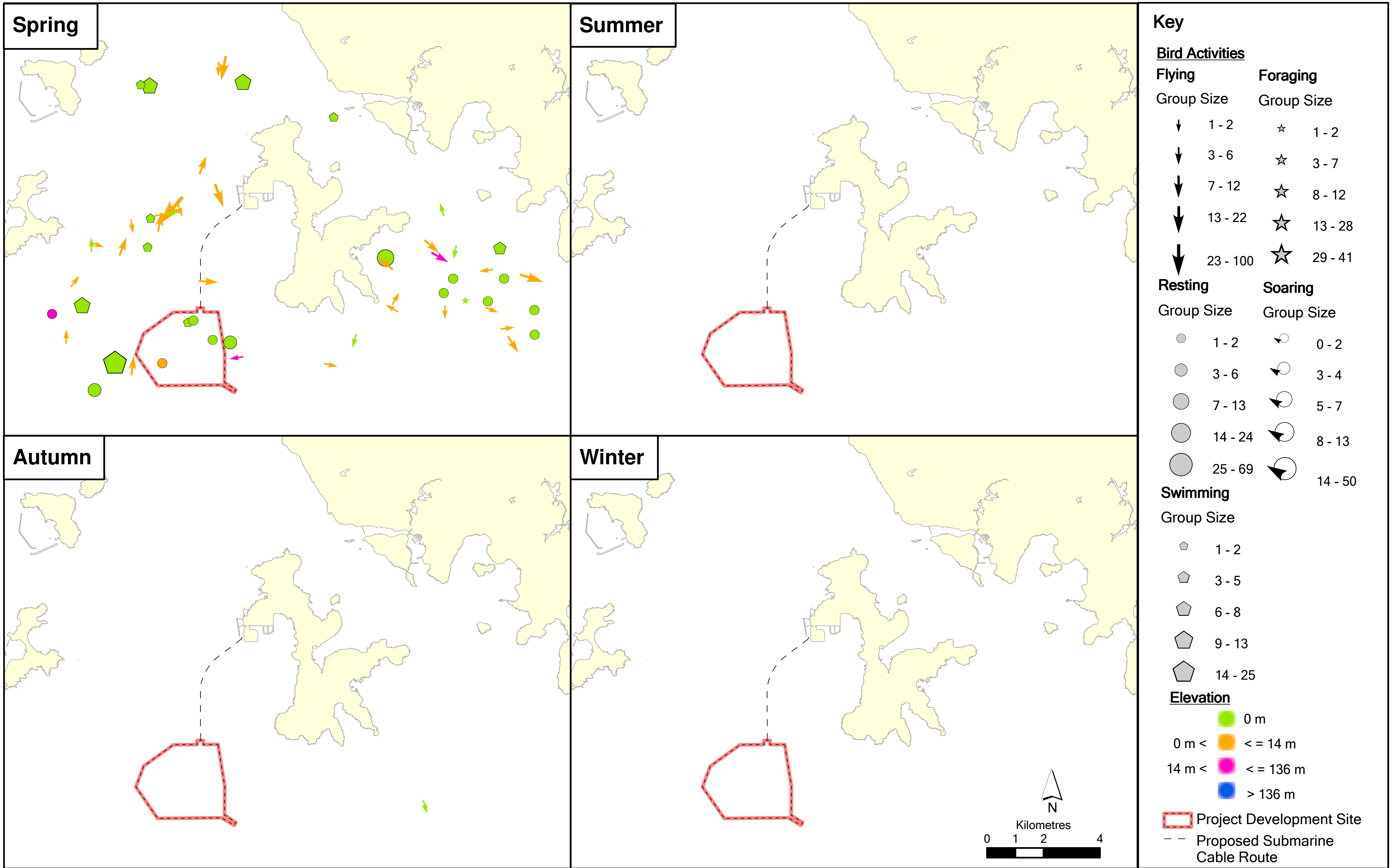

Figure 3
(Annex 8)

Seasonal Variation of the Distribution of Red-necked Phalarope in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_Red-necked Phalarope_L.mxd
Date: 20/08/2009

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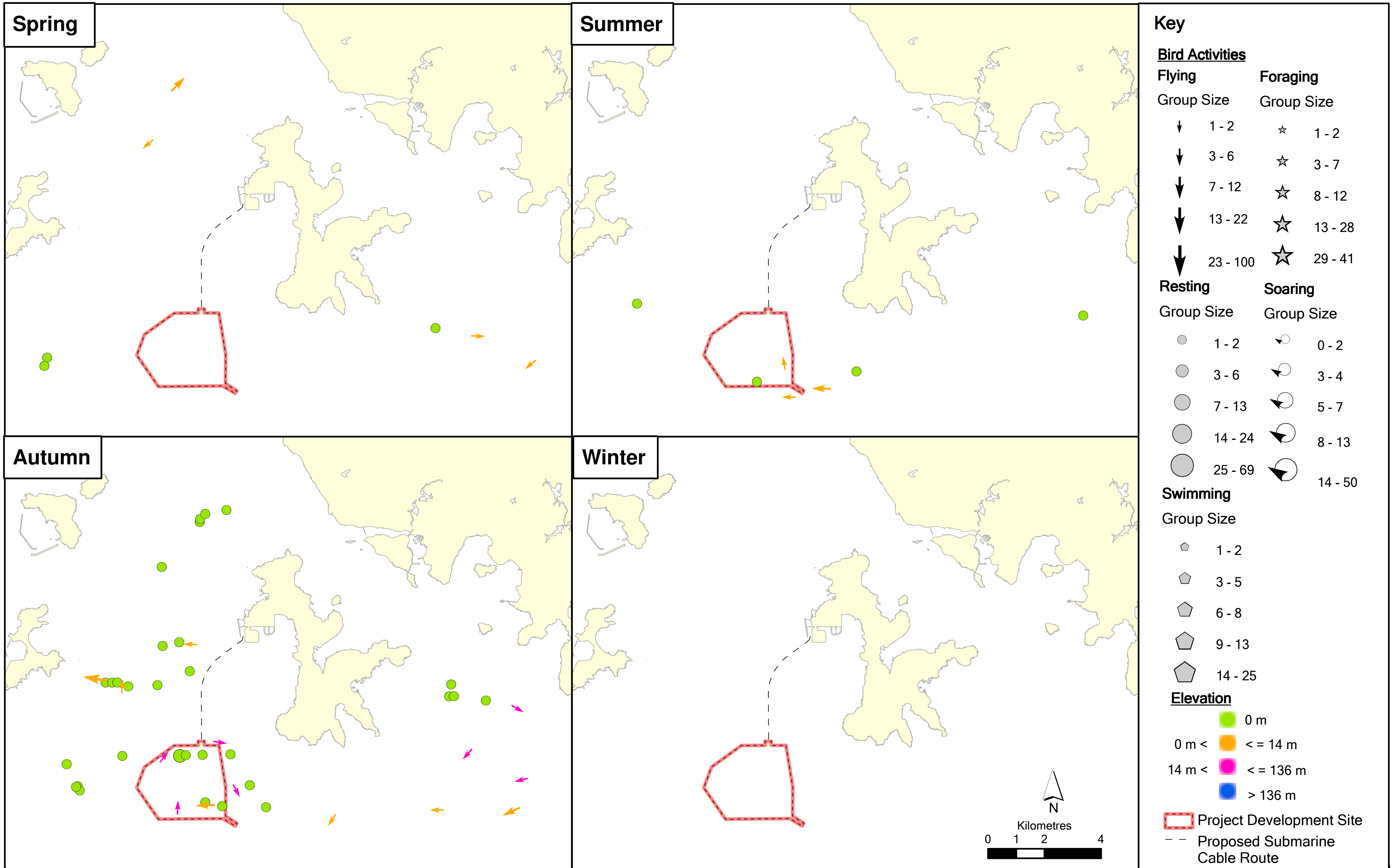

Figure 4
(Annex 8)

Seasonal Variation of the Distribution of Aleutian Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\0088440_Aleutian Tern_L.mxd
Date: 20/08/2009

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Figure 5
(Annex 8)

Seasonal Variation of the Distribution of Black-headed Gull, Black-tailed Gull and Black-legged Kittiwake
in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\by_species\
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Date: 20/08/2009

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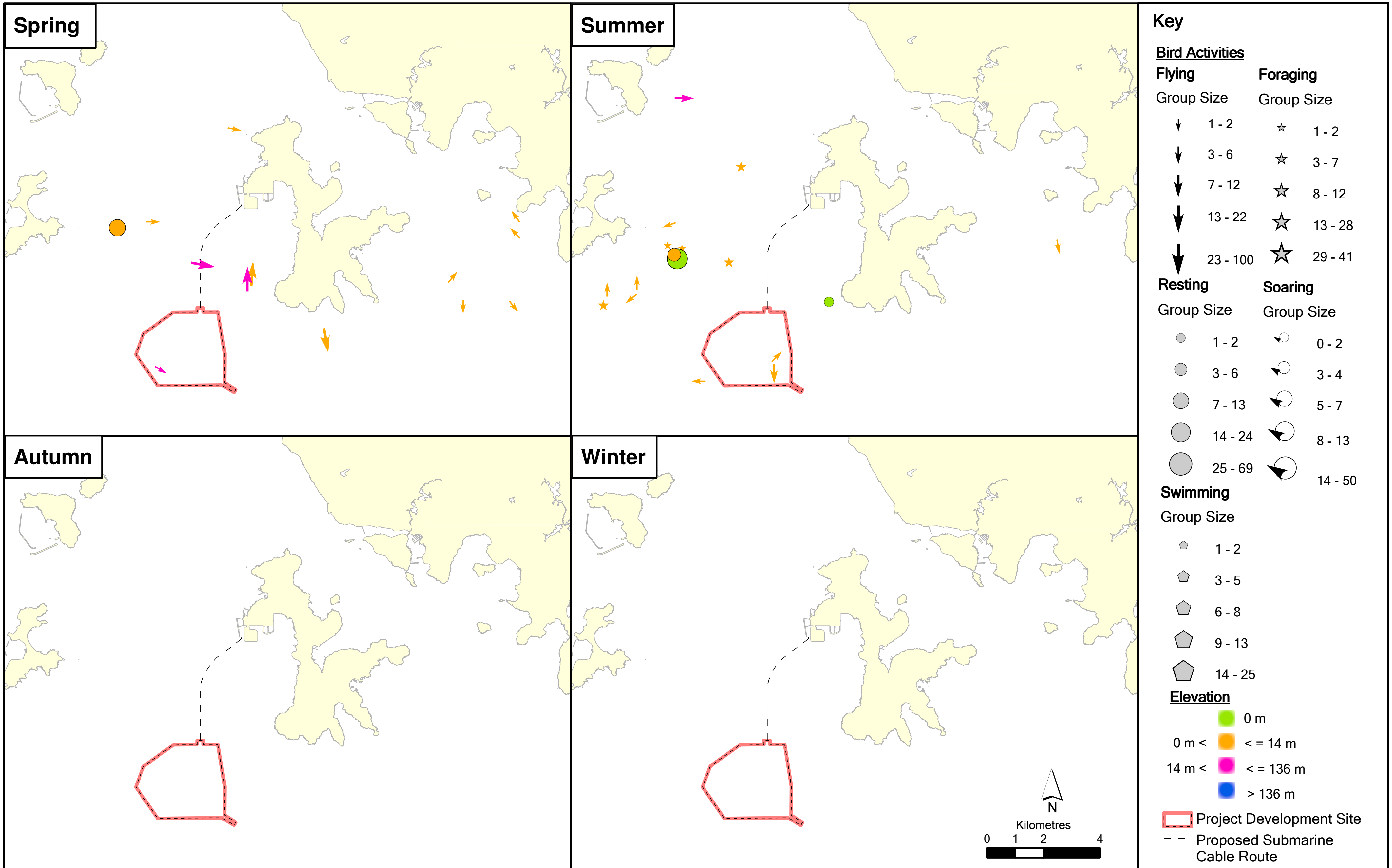

Figure 6
(Annex 8)

Seasonal Variation of the Distribution of Black-naped Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\0088440_Black-naped Tern_L.mxd
Date: 20/08/2009

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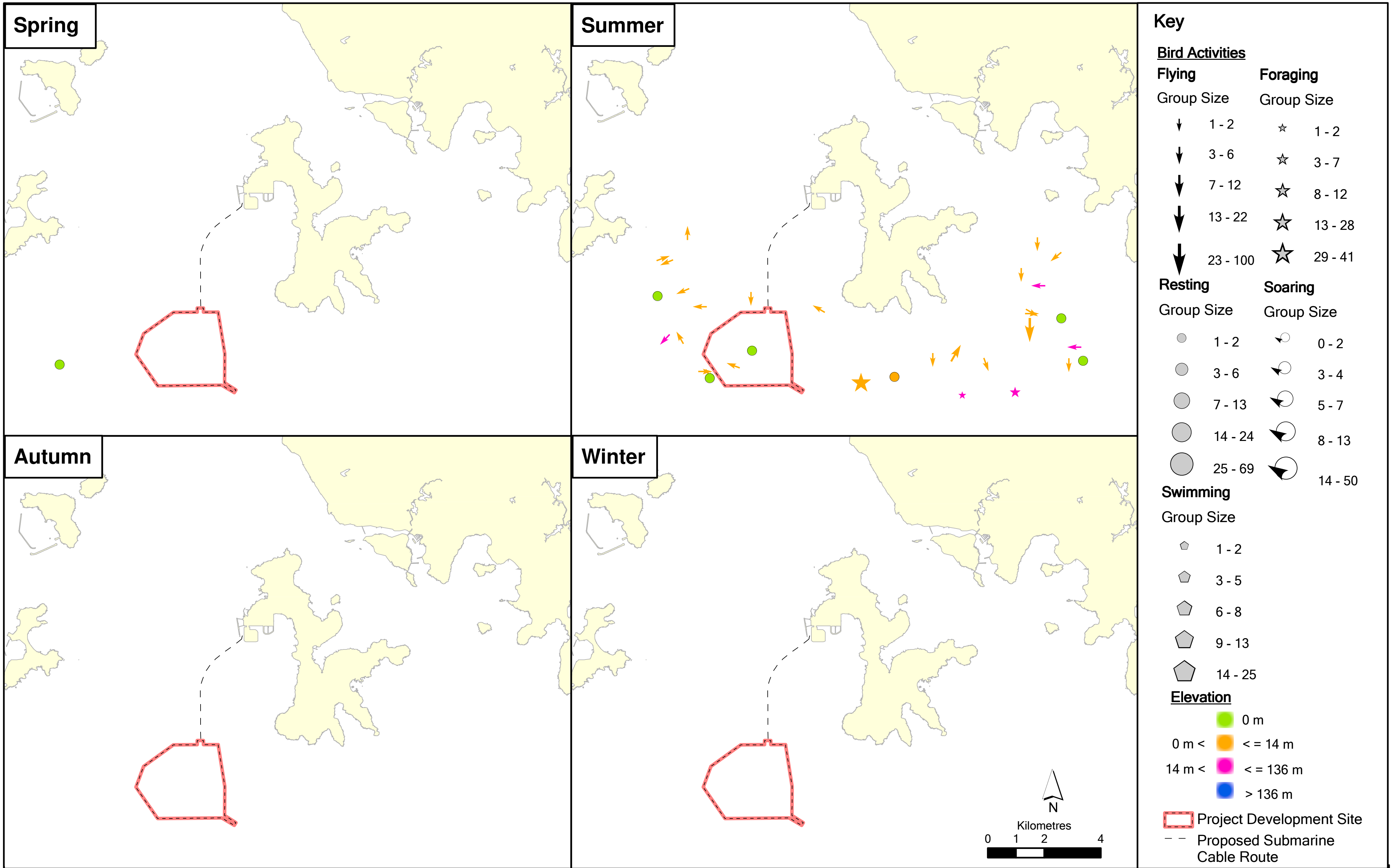

Figure 7
(Annex 8)

Seasonal Variation of the Distribution of Bridled Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_Bridled Tern_L.mxd
Date: 20/08/2009

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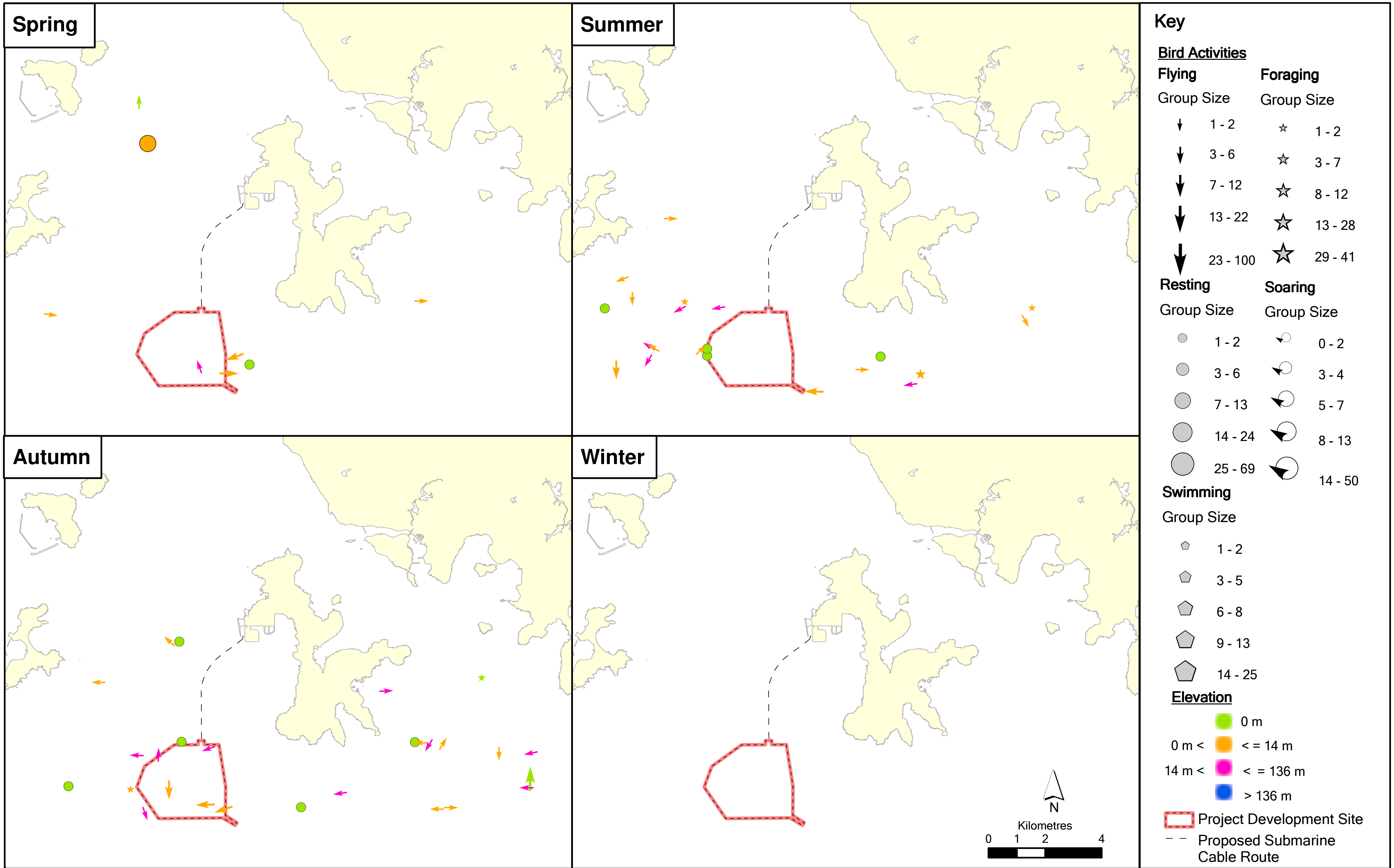

Figure 8
(Annex 8)

Seasonal Variation of the Distribution of Common Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\0088440_Common Tern_L.mxd
Date: 20/08/2009

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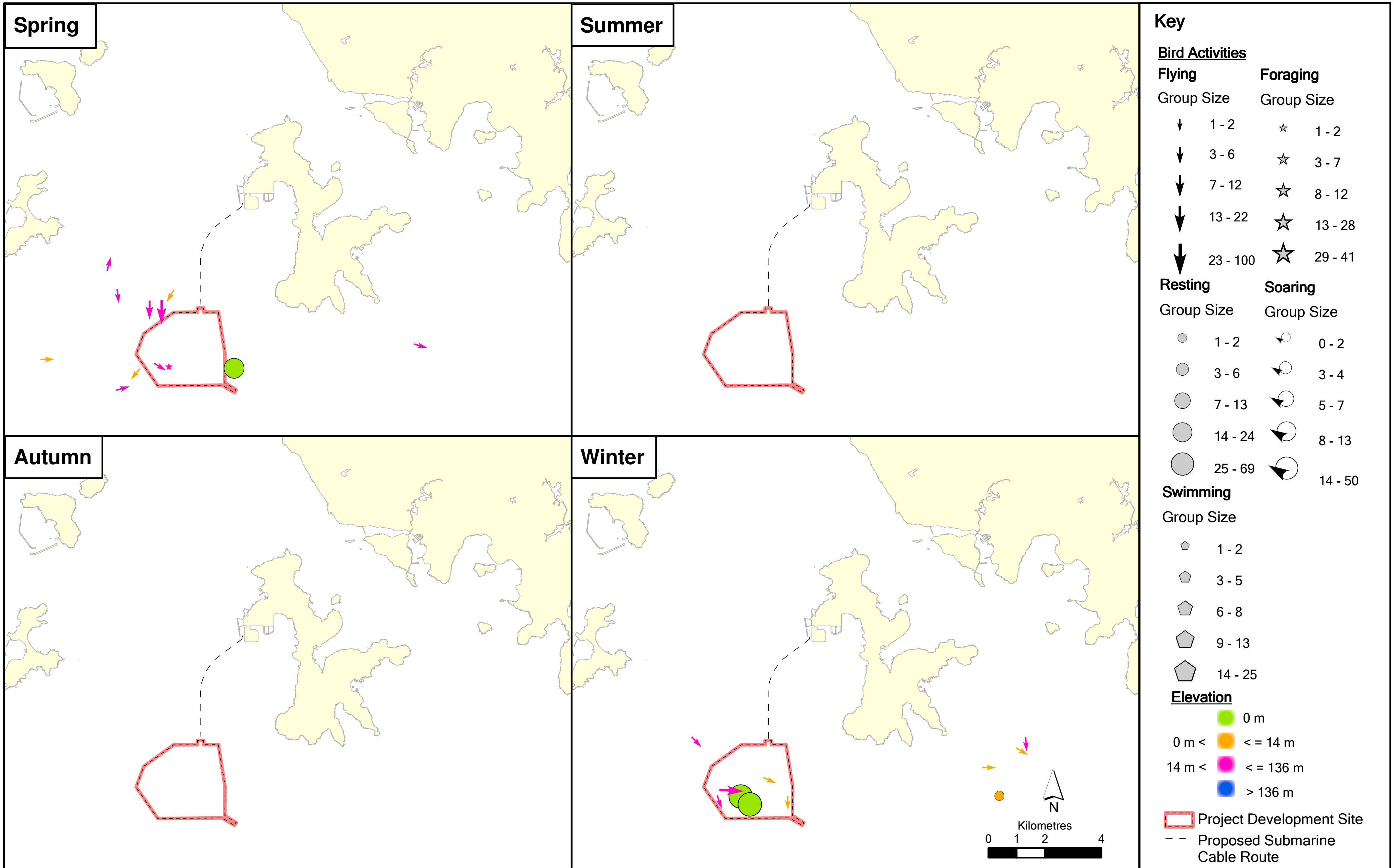

Figure 9
(Annex 8)

Seasonal Variation of the Distribution of Heuglin's Gull in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\by_species\
0088440_Heuglin's Gull_L.mxd
Date: 20/08/2009

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Figure 10
(Annex 8)

Seasonal Variation of the Distribution of Roseate Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_Roseate Tern_L.mxd
Date: 20/08/2009

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Figure 11
(Annex 8)

Seasonal Variation of the Distribution of Whiskered Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\0088440_Whiskered Tern_L.mxd
Date: 20/08/2009

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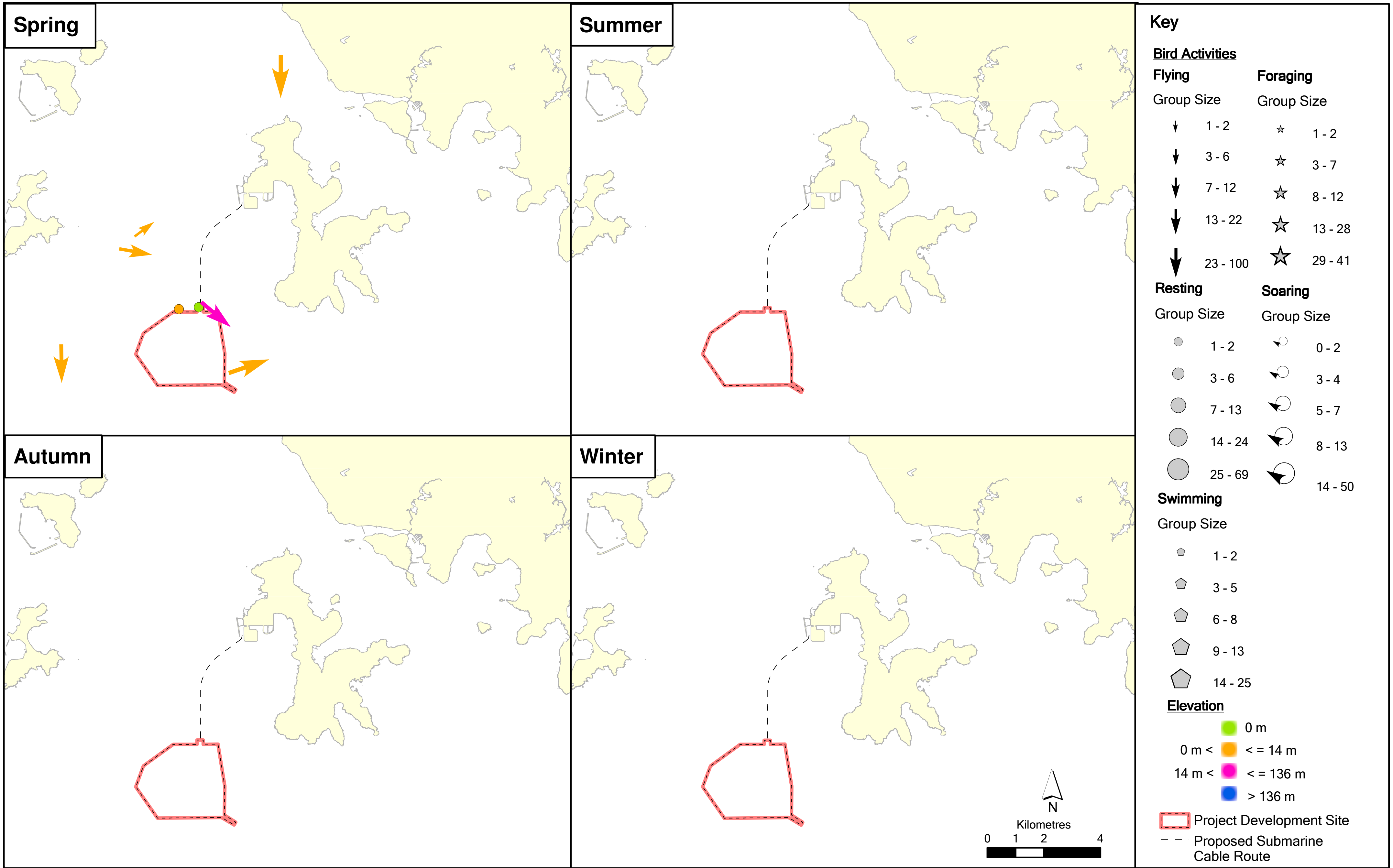

Figure 12
(Annex 8)

Seasonal Variation of the Distribution of White-winged Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\0088440_White-winged Tern_L.mxd
Date: 20/08/2009

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Figure 13
(Annex 8)

Seasonal Variation of the Distribution of Unidentified Tern in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\
0088440_Unidentified Tern_L.mxd
Date: 20/08/2009

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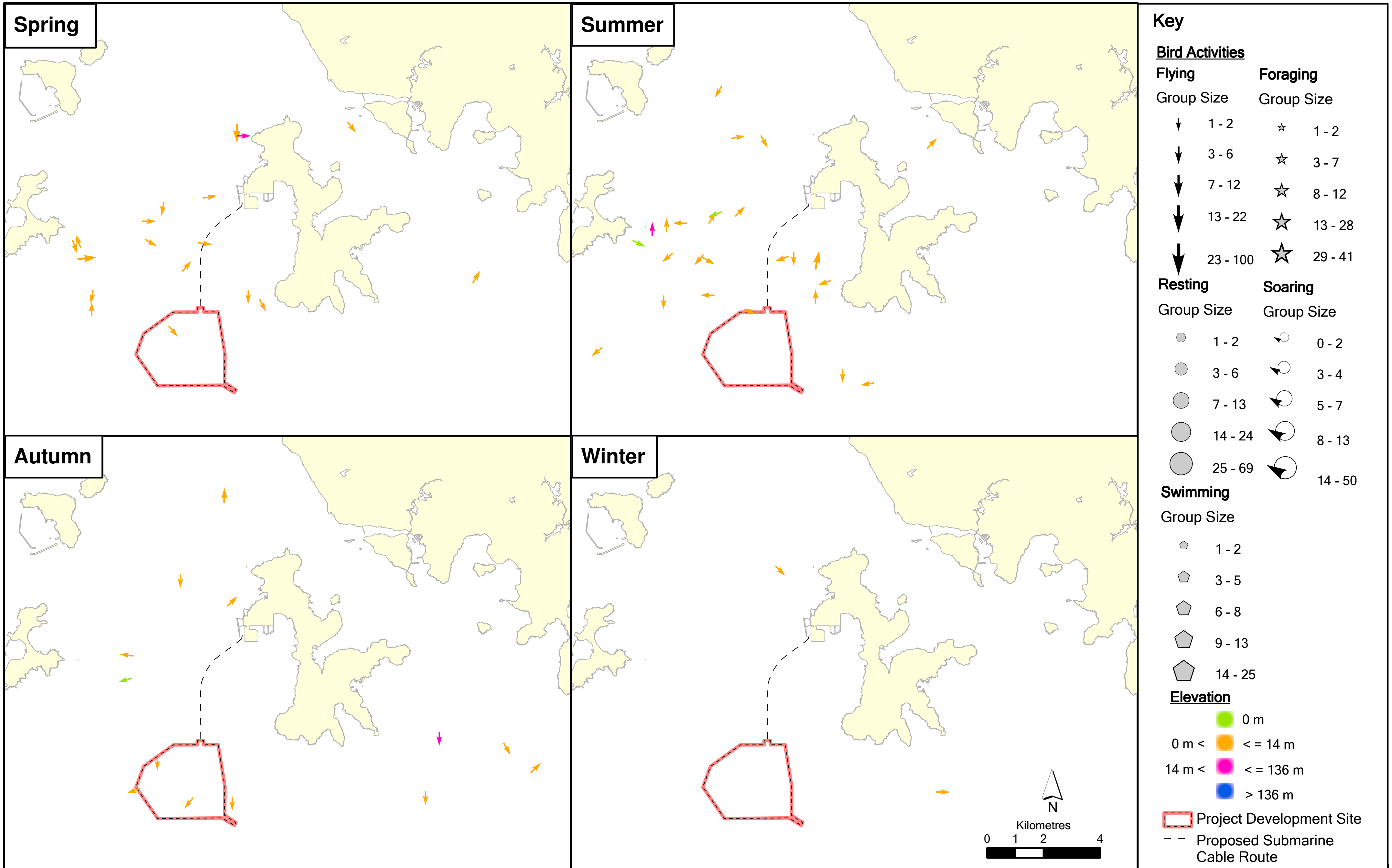

Figure 14
(Annex 8)

Seasonal Variation of the Distribution of Barn Swallow in Waters around Lamma Island during July 08 to June 09
(Total effective survey trips = 27)

File: Bird Survey\May_09\By_Species\0088440_Barn Swallow_L.mxd
Date: 20/08/2009

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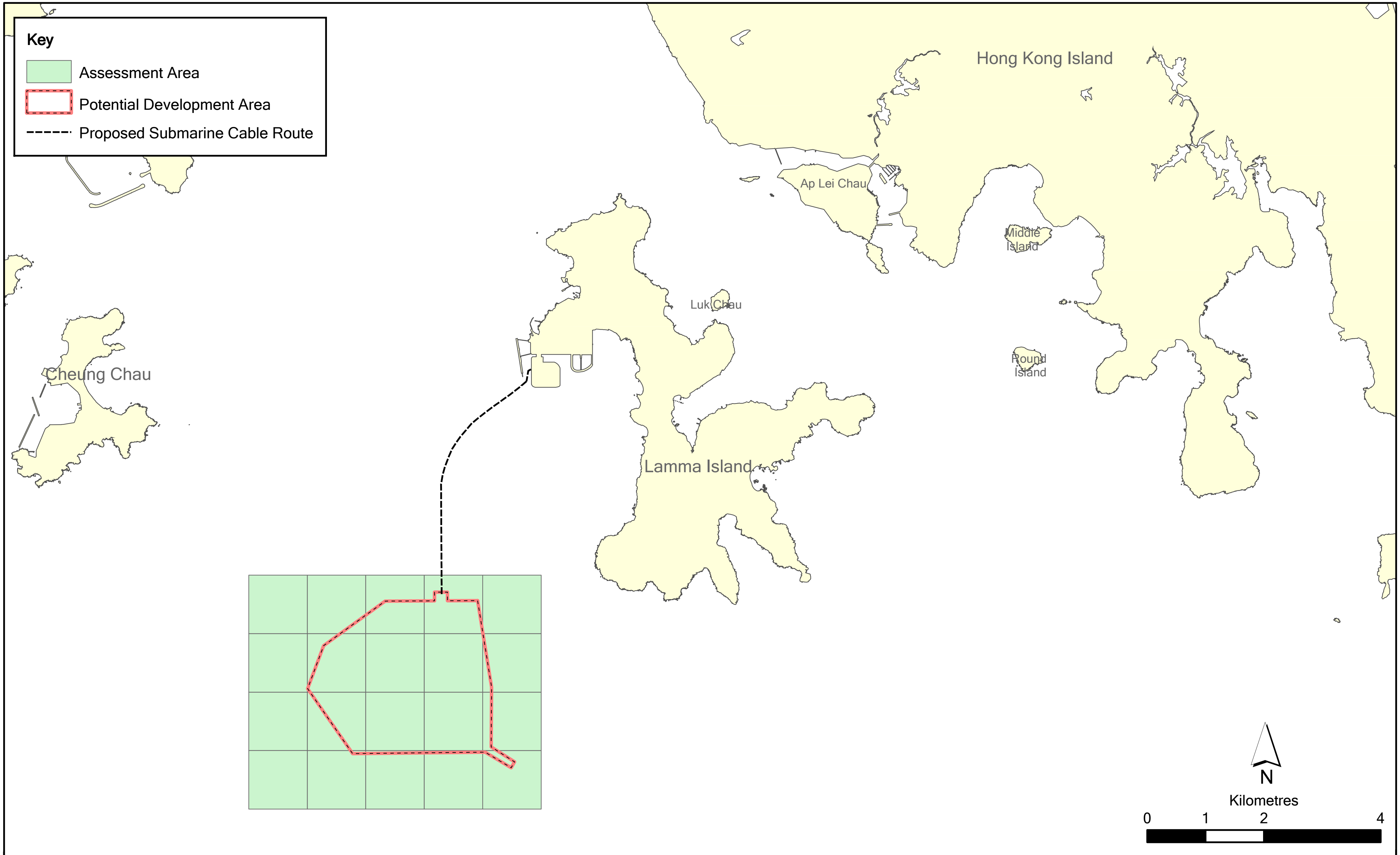

Figure 15
(Annex 8)

Assessment Area of Collision Risk
(A total of 20km^2)

File: Bird Survey\May_09\
0088440_Grid_L_bird_.mxd
Date: 10/08/2009

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Table 8 Sighting Records during the Surveys from July 2008 to June 2009

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
1	24/7/2008	0943	*Egretta garzetta*	Little Egret	831102.9	811346.7	1	50	Flying
2	24/7/2008	0943	*Egretta garzetta*	Little Egret	832253.4	812598.2	2	50	Flying
3	24/7/2008	0946	*Egretta garzetta*	Little Egret	831909.9	812905.9	1	40	Flying
4	24/7/2008	0949	*Milvus migrans*	Black Kite	830687.2	812815.5	1	30	Foraging
5	24/7/2008	0953	*Milvus migrans*	Black Kite	830822.6	812962.7	1	20	Foraging
6	24/7/2008	1000	*Milvus migrans*	Black Kite	829486.9	813943.3	1	5	Foraging
7	24/7/2008	1029	*Sterna sumatrana*	Black-naped Tern	824222.0	811987.8	3	20	Flying
8	24/7/2008	1042	*Sterna sumatrana*	Black-naped Tern	826224.8	809567.6	3	2	Foraging
9	24/7/2008	1057	*Egretta garzetta*	Little Egret	827172.5	809093.1	1	5	Foraging
10	24/7/2008	1101	*Milvus migrans*	Black Kite	828120.2	808699.4	1	10	Flying
11	24/7/2008	1127	*Sterna anaethetus*	Bridled Tern	824305.7	807213.9	1	1	Flying
12	24/7/2008	1140	*Sterna sumatrana*	Black-naped Tern	823634.5	806778.1	2	2	Foraging
13	24/7/2008	1140	*Sterna sumatrana*	Black-naped Tern	823634.5	806778.1	2	2	Foraging
14	24/7/2008	1140	*Sterna sumatrana*	Black-naped Tern	823634.5	806778.1	1	2	Foraging
15	24/7/2008	1141	*Sterna sumatrana*	Black-naped Tern	824138.6	806685.4	2	2	Foraging
16	24/7/2008	1152	*Sterna sumatrana*	Black-naped Tern	825790.9	806195.2	3	2	Foraging
17	24/7/2008	1253	*Sterna dougallii*	Roseate Tern	821557.9	804860.5	2	4	Flying
18	24/7/2008	1320	*Sterna sumatrana*	Black-naped Tern	824716.3	801975.6	1	5	Flying
19	24/7/2008	1322	*Sterna anaethetus*	Bridled Tern	825069.8	802175.7	1	10	Flying
20	24/7/2008	1348	*Sterna anaethetus*	Bridled Tern	831625.2	802133.9	1	1	Resting
21	24/7/2008	1356	*Sterna dougallii*	Roseate Tern	833739.6	802024.9	2	5	Flying
22	26/7/2008	0936	*Milvus migrans*	Black Kite	837650.8	809019.4	1	60	Soaring
23	26/7/2008	0937	*Milvus migrans*	Black Kite	837673.3	808792.9	1	20	Flying
24	26/7/2008	0949	*Milvus migrans*	Black Kite	839320.9	807087.9	1	40	Flying
25	26/7/2008	0955	*Milvus migrans*	Black Kite	838541.0	806677.2	1	10	Foraging
26	26/7/2008	1003	*Milvus migrans*	Black Kite	837363.7	806702.4	1	20	Foraging
27	26/7/2008	1011	*Milvus migrans*	Black Kite	834127.0	807182.5	1	120	Foraging
28	26/7/2008	1023	*Milvus migrans*	Black Kite	833771.8	807127.2	1	80	Flying
29	26/7/2008	1029	*Milvus migrans*	Black Kite	833030.6	805978.1	1	80	Flying
30	26/7/2008	1032	*Milvus migrans*	Black Kite	833127.9	805390.6	1	80	Soaring
31	26/7/2008	1036	*Milvus migrans*	Black Kite	833385.2	805066.9	1	40	Resting
32	26/7/2008	1050	*Sterna anaethetus*	Bridled Tern	836487.1	804399.3	2	5	Flying
33	26/7/2008	1114	*Sterna anaethetus*	Bridled Tern	836487.2	804369.3	1	5	Flying
34	26/7/2008	1114	*Sterna anaethetus*	Bridled Tern	838298.0	802702.3	1	0	Resting
35	26/7/2008	1141	*Sterna anaethetus*	Bridled Tern	833802.7	802967.7	6	3	Flying
36	26/7/2008	1201	*Milvus migrans*	Black Kite	830600.0	803644.5	1	70	Soaring
37	26/7/2008	1238	*Sterna anaethetus*	Bridled Tern	824033.0	803517.4	2	2	Flying
38	26/7/2008	1303	*Sterna anaethetus*	Bridled Tern	826550.0	804888.3	2	5	Flying
39	26/7/2008	1322	*Milvus migrans*	Black Kite	828497.8	806493.5	1	40	Flying
40	26/7/2008	1407	*Milvus migrans*	Black Kite	828906.1	810176.3	3	2	Flying
41	26/7/2008	1409	*Milvus migrans*	Black Kite	828579.9	811158.4	1	80	Flying
42	26/7/2008	1436	*Egretta garzetta*	Little Egret	830464.4	813532.4	1	10	Flying
43	26/7/2008	1437	*Ardea alba*	Great Egret	831566.1	811700.7	1	10	Flying
44	26/7/2008	1444	*Milvus migrans*	Black Kite	831721.5	811897.4	1	70	Soaring
45	26/7/2008	1446	*Milvus migrans*	Black Kite	832067.0	811687.3	4	10	Soaring
46	26/7/2008	1447	*Ardea alba*	Great Egret	832459.4	811568.5	2	0	Resting
47	26/7/2008	1447	*Egretta garzetta*	Little Egret	832424.1	811572.5	6	0	Resting

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
48	26/7/2008	1447	*Egretta sacra*	Pacific Reef Egret	832425.2	811572.5	1	0	Resting
49	26/7/2008	1447	*Milvus migrans*	Black Kite	832424.1	811572.5	1	0	Flying
50	26/7/2008	1458	*Milvus migrans*	Black Kite	834164.1	810611.5	4	100	Soaring
51	26/7/2008	1500	*Milvus migrans*	Black Kite	834392.0	810228.8	4	70	Flying
52	26/7/2008	1503	*Egretta sacra*	Pacific Reef Egret	834903.9	810011.4	1	0	Resting
53	28/7/2008	0820	*Milvus migrans*	Black Kite	834873.2	810386.1	0	80	Soaring
54	28/7/2008	0824	*Milvus migrans*	Black Kite	834357.8	810798.3	4	80	Soaring
55	28/7/2008	0826	*Egretta garzetta*	Little Egret	833743.2	811149.2	1	2	Flying
56	28/7/2008	0826	*Milvus migrans*	Black Kite	833569.9	810547.5	1	50	Flying
57	28/7/2008	0831	*Egretta garzetta*	Little Egret	833303.3	811248.0	11	0	Resting
58	28/7/2008	0831	*Egretta sacra*	Pacific Reef Egret	833303.3	811248.0	1	0	Resting
59	28/7/2008	0831	*Milvus migrans*	Black Kite	833303.3	811248.0	3	0	Resting
60	28/7/2008	0833	*Egretta garzetta*	Little Egret	833262.9	811601.1	1	1	Flying
61	28/7/2008	0836	*Egretta garzetta*	Little Egret	832887.1	811589.3	1	5	Flying
62	28/7/2008	0838	*Milvus migrans*	Black Kite	832679.1	811620.3	2	0	Resting
63	28/7/2008	0840	*Milvus migrans*	Black Kite	831926.9	811732.1	1	20	Flying
64	28/7/2008	0841	*Egretta garzetta*	Little Egret	831715.1	811453.0	2	50	Flying
65	28/7/2008	0844	*Egretta garzetta*	Little Egret	833613.8	812286.2	1	20	Flying
66	28/7/2008	0844	*Milvus migrans*	Black Kite	833681.5	812359.8	1	100	Soaring
67	28/7/2008	0844	*Milvus migrans*	Black Kite	833681.5	812359.8	1	80	Resting
68	28/7/2008	0930	*Hirundo rustica*	Barn Swallow	825403.0	812209.8	1	10	Flying
69	28/7/2008	0938	*Hirundo rustica*	Barn Swallow	827036.9	810442.3	1	10	Flying
70	28/7/2008	0944	*Hirundo rustica*	Barn Swallow	832973.0	810393.8	1	1	Flying
71	28/7/2008	1000	*Hirundo rustica*	Barn Swallow	826189.2	807988.3	1	2	Flying
72	28/7/2008	1001	*Hirundo rustica*	Barn Swallow	825194.7	807764.6	2	6	Flying
73	28/7/2008	1010	*Hirundo rustica*	Barn Swallow	824034.5	807565.5	2	6	Flying
74	28/7/2008	1011	*Hirundo rustica*	Barn Swallow	823577.7	807517.4	1	5	Flying
75	28/7/2008	1013	*Sterna sumatrana*	Black-naped Tern	823666.3	807508.5	1	5	Flying
76	28/7/2008	1015	*Hirundo rustica*	Barn Swallow	823068.1	807366.2	1	15	Flying
77	28/7/2008	1023	*Hirundo rustica*	Barn Swallow	823601.4	806341.4	1	10	Flying
78	28/7/2008	1027	*Sterna dougallii*	Roseate Tern	823969.6	806305.1	2	0	Resting
79	28/7/2008	1027	*Sterna sumatrana*	Black-naped Tern	823969.6	806305.1	14	0	Resting
80	28/7/2008	1029	*Hirundo rustica*	Barn Swallow	824711.3	806256.8	1	5	Flying
81	28/7/2008	1031	*Hirundo rustica*	Barn Swallow	825063.7	806229.6	1	10	Flying
82	28/7/2008	1044	*Hirundo rustica*	Barn Swallow	827650.3	806300.3	1	10	Flying
83	28/7/2008	1046	*Hirundo rustica*	Barn Swallow	828073.6	806304.7	1	5	Flying
84	28/7/2008	1050	*Hirundo rustica*	Barn Swallow	828907.9	806265.8	3	5	Flying
85	28/7/2008	1054	*Hirundo rustica*	Barn Swallow	829159.6	805452.9	2	10	Flying
86	28/7/2008	1059	*Sterna anaethetus*	Bridled Tern	828935.9	804538.5	1	10	Flying
87	28/7/2008	1110	*Hirundo rustica*	Barn Swallow	828847.1	804975.5	2	5	Flying
88	28/7/2008	1113	*Hirundo rustica*	Barn Swallow	825018.6	805014.5	2	10	Flying
89	28/7/2008	1133	*Sterna anaethetus*	Bridled Tern	823249.4	804991.1	1	0	Resting
90	28/7/2008	1137	*Sterna sumatrana*	Black-naped Tern	822535.6	805458.2	1	2	Flying
91	28/7/2008	1153	*Hirundo rustica*	Barn Swallow	821102.0	803004.0	2	5	Flying
92	28/7/2008	1212	*Sterna anaethetus*	Bridled Tern	824932.7	802319.8	2	10	Flying
93	28/7/2008	1218	*Sterna anaethetus*	Bridled Tern	825094.6	802094.0	2	0	Resting
94	28/7/2008	1225	*Sterna sumatrana*	Black-naped Tern	827396.1	802232.6	3	1	Flying
95	28/7/2008	1235	*Hirundo rustica*	Barn Swallow	829807.0	802151.4	2	10	Flying
96	28/7/2008	1238	*Sterna anaethetus*	Bridled Tern	830443.8	801949.6	41	3	Foraging

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
97	28/7/2008	1249	*Sterna anaethetus*	Bridled Tern	832977.3	802733.3	2	2	Flying
98	28/7/2008	1300	*Milvus migrans*	Black Kite	835474.3	803622.1	1	150	Flying
99	28/7/2008	1307	*Milvus migrans*	Black Kite	837208.1	802662.7	1	150	Soaring
100	28/7/2008	1324	*Sterna anaethetus*	Bridled Tern	837982.2	803173.9	1	20	Flying
101	28/7/2008	1330	*Sterna anaethetus*	Bridled Tern	836709.3	805364.3	1	15	Flying
102	28/7/2008	1331	*Sterna anaethetus*	Bridled Tern	836105.7	805738.2	1	10	Flying
103	28/7/2008	1355	*Sterna anaethetus*	Bridled Tern	836673.4	806822.4	2	10	Flying
104	28/7/2008	1358	*Sterna anaethetus*	Bridled Tern	837329.3	806379.4	1	5	Flying
105	28/7/2008	1402	*Milvus migrans*	Black Kite	838793.0	807395.6	1	50	Flying
106	28/7/2008	1405	*Milvus migrans*	Black Kite	838247.0	807795.0	4	50	Flying
107	28/7/2008	1408	*Milvus migrans*	Black Kite	838292.1	808346.9	1	80	Flying
108	28/7/2008	1408	*Milvus migrans*	Black Kite	838292.1	808346.9	1	60	Flying
109	28/7/2008	1409	*Milvus migrans*	Black Kite	837119.8	808515.8	1	30	Foraging
110	28/7/2008	1420	*Milvus migrans*	Black Kite	836227.1	810303.2	2	80	Flying
111	15/8/2008	0921	*Milvus migrans*	Black Kite	833754.7	810475.9	1	100	Soaring
112	15/8/2008	0927	*Egretta garzetta*	Little Egret	832938.2	811227.6	14	0	Resting
113	15/8/2008	0928	*Milvus migrans*	Black Kite	833113.6	811266.8	1	60	Soaring
114	15/8/2008	0930	*Egretta sacra*	Pacific Reef Egret	832924.6	811383.8	1	0	Resting
115	15/8/2008	0931	*Milvus migrans*	Black Kite	832478.5	811486.0	4	60	Soaring
116	15/8/2008	0934	*Egretta garzetta*	Little Egret	832202.3	811691.9	3	1	Flying
117	15/8/2008	0937	*Egretta garzetta*	Little Egret	832069.6	812324.5	1	5	Flying
118	15/8/2008	0942	*Egretta garzetta*	Little Egret	831512.0	812608.6	1	20	Flying
119	15/8/2008	0943	*Egretta garzetta*	Little Egret	831123.7	812725.8	2	10	Flying
120	15/8/2008	1055	*Milvus migrans*	Black Kite	828484.5	810201.2	6	150	Soaring
121	15/8/2008	1058	*Milvus migrans*	Black Kite	828505.6	810992.0	1	10	Flying
122	15/8/2008	1058	*Milvus migrans*	Black Kite	828341.8	808705.9	2	60	Soaring
123	15/8/2008	1124	*Hirundo rustica*	Barn Swallow	825281.9	807871.7	1	0	Flying
124	15/8/2008	1145	*Hirundo rustica*	Barn Swallow	822595.1	806837.5	1	0	Flying
125	15/8/2008	1156	*Sterna anaethetus*	Bridled Tern	823560.2	806175.1	1	10	Flying
126	15/8/2008	1255	*Sterna anaethetus*	Bridled Tern	824131.5	805160.5	1	1	Flying
127	15/8/2008	1306	*Sterna hirundo*	Common Tern	821959.4	805583.0	2	5	Flying
128	15/8/2008	1322	*Sterna hirundo*	Common Tern	821754.1	802367.4	4	3	Flying
129	15/8/2008	1345	*Sterna aleutica*	Aleutian Tern	826742.8	801988.2	1	0	Resting
130	15/8/2008	1348	*Sterna aleutica*	Aleutian Tern	827868.5	801442.3	1	10	Flying
131	15/8/2008	1354	*Sterna aleutica*	Aleutian Tern	829013.7	801738.5	3	10	Flying
132	15/8/2008	1354	*Sterna hirundo*	Common Tern	828741.5	801612.4	6	10	Flying
133	15/8/2008	1515	*Milvus migrans*	Black Kite	838160.0	806384.9	1	15	Flying
134	15/8/2008	1526	*Milvus migrans*	Black Kite	837642.2	808641.0	1	30	Flying
135	15/8/2008	1534	*Milvus migrans*	Black Kite	836811.8	809682.2	1	30	Flying
136	15/8/2008	1535	*Milvus migrans*	Black Kite	836375.6	809542.1	1	50	Flying
137	15/8/2008	1538	*Milvus migrans*	Black Kite	835247.9	809434.3	2	200	Flying
138	21/8/2008	0923	*Milvus migrans*	Black Kite	837432.1	808638.2	1	20	Resting
139	21/8/2008	1022	*Sterna hirundo*	Common Tern	836222.2	804096.7	1	10	Flying
140	21/8/2008	1023	*Sterna anaethetus*	Bridled Tern	836407.7	803792.5	9	10	Flying
141	21/8/2008	1032	*Sterna aleutica*	Aleutian Tern	838286.3	804331.8	1	0	Resting
142	21/8/2008	1047	*Sterna hirundo*	Unidentified Terns	838401.8	804013.9	2	20	Flying
143	21/8/2008	1056	*Sterna anaethetus*	Bridled Tern	835889.3	801599.1	3	20	Foraging
144	21/8/2008	1107	*Sterna anaethetus*	Bridled Tern	834029.8	801491.6	1	50	Foraging
145	21/8/2008	1121	*Sterna hirundo*	Common Tern	832148.7	801858.3	1	30	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
146	21/8/2008	1123	*Sterna hirundo*	Common Tern	831108.2	802852.5	1	0	Resting
147	21/8/2008	1124	*Sterna hirundo*	Common Tern	832513.7	802236.6	5	10	Foraging
148	21/8/2008	1134	*Sterna aleutica*	Aleutian Tern	830266.9	802357.5	1	0	Resting
149	21/8/2008	1134	*Sterna hirundo*	Common Tern	830464.5	802388.4	1	10	Flying
150	21/8/2008	1144	*Sterna sumatrana*	Black-naped Tern	827486.0	802838.6	2	3	Flying
151	21/8/2008	1148	*Sterna aleutica*	Aleutian Tern	827697.7	802641.9	1	10	Flying
152	21/8/2008	1158	*Sterna hirundo*	Common Tern	824752.5	803086.8	2	5	Flying
153	21/8/2008	1207	*Sterna hirundo*	Common Tern	822883.0	802700.9	2	20	Flying
154	21/8/2008	1219	*Sterna hirundo*	Common Tern	822327.1	804887.0	1	5	Flying
155	21/8/2008	1219	*Sterna sumatrana*	Black-naped Tern	822329.8	804897.0	1	5	Flying
156	21/8/2008	1225	*Hirundo rustica*	Barn Swallow	823472.6	804772.1	1	5	Flying
157	21/8/2008	1227	*Sterna aleutica*	Aleutian Tern	822506.2	804744.6	1	0	Resting
158	21/8/2008	1228	*Sterna hirundo*	Common Tern	824180.9	804794.3	2	10	Foraging
159	21/8/2008	1234	*Sterna hirundo*	Common Tern	823987.6	804518.4	1	50	Flying
160	21/8/2008	1239	*Sterna hirundo*	Common Tern	825349.3	804572.9	1	20	Flying
161	21/8/2008	1244	*Hirundo rustica*	Barn Swallow	826508.0	804444.1	1	5	Flying
162	21/8/2008	1259	*Milvus migrans*	Black Kite	830035.7	805636.5	2	30	Resting
163	21/8/2008	1305	*Milvus migrans*	Black Kite	828883.6	806166.1	1	1	Foraging
164	21/8/2008	1308	*Milvus migrans*	Black Kite	828517.4	806523.0	1	30	Flying
165	21/8/2008	1335	*Sterna hirundo*	Common Tern	823687.2	807734.1	2	5	Flying
166	21/8/2008	1400	*Egretta garzetta*	Little Egret	828820.7	809399.0	5	10	Flying
167	21/8/2008	1402	*Milvus migrans*	Black Kite	828841.3	809794.1	8	50	Soaring
168	21/8/2008	1441	*Egretta garzetta*	Little Egret	831202.6	812674.9	1	2	Flying
169	21/8/2008	1445	*Egretta garzetta*	Little Egret	832063.4	812157.0	16	0	Resting
170	21/8/2008	1448	*Milvus migrans*	Black Kite	832343.8	811600.0	1	30	Soaring
171	21/8/2008	1451	*Egretta garzetta*	Little Egret	833227.3	810978.4	1	0	Resting
172	21/8/2008	1454	*Milvus migrans*	Black Kite	833815.6	810757.0	3	180	Soaring
173	25/8/2008	0931	*Egretta garzetta*	Little Egret	832757.8	810858.6	7	1	Foraging
174	25/8/2008	0936	*Milvus migrans*	Black Kite	832081.2	811292.8	1	30	Flying
175	25/8/2008	0948	*Egretta garzetta*	Little Egret	830527.2	812310.7	2	10	Flying
176	25/8/2008	1020	*Hirundo rustica*	Barn Swallow	826114.4	810602.9	1	5	Flying
177	25/8/2008	1033	*Milvus migrans*	Black Kite	828230.0	810337.5	1	50	Flying
178	25/8/2008	1057	*Sterna hirundo*	Unidentified Terns	824925.8	808045.3	1	20	Flying
179	25/8/2008	1117	*Sterna sumatrana*	Black-naped Tern	823851.2	806447.3	6	1	Resting
180	25/8/2008	1200	*Milvus migrans*	Black Kite	825850.9	805269.4	1	10	Flying
181	25/8/2008	1223	*Sterna sumatrana*	Black-naped Tern	821479.4	805221.4	1	10	Flying
182	25/8/2008	1226	*Sterna sumatrana*	Black-naped Tern	821347.3	804674.8	3	5	Foraging
183	25/8/2008	1231	*Sterna hirundo*	Common Tern	821353.7	804552.6	1	0	Resting
184	25/8/2008	1239	*Sterna hirundo*	Common Tern	822903.6	803222.8	1	50	Flying
185	25/8/2008	1240	*Sterna hirundo*	Common Tern	823063.0	803164.4	1	5	Flying
186	25/8/2008	1250	*Sterna hirundo*	Common Tern	824969.7	802883.9	1	0	Resting
187	25/8/2008	1250	*Sterna hirundo*	Common Tern	824970.4	803133.9	1	0	Resting
188	25/8/2008	1300	*Sterna anaethetus*	Bridled Tern	825913.9	802534.3	2	5	Flying
189	25/8/2008	1317	*Hirundo rustica*	Barn Swallow	830675.0	801871.1	1	5	Flying
190	25/8/2008	1410	*Sterna hirundo*	Common Tern	836453.4	804581.5	1	5	Foraging
191	25/8/2008	1426	*Milvus migrans*	Black Kite	834588.1	806954.8	9	100	Soaring
192	25/8/2008	1444	*Milvus migrans*	Black Kite	837962.8	807629.8	1	200	Flying
193	25/8/2008	1450	*Milvus migrans*	Black Kite	837530.8	808474.7	3	80	Soaring
194	25/8/2008	1503	*Milvus migrans*	Black Kite	835800.1	809878.2	1	50	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
195	4/9/2008	0948	*Egretta sacra*	Pacific Reef Egret	837355.2	808845.7	1	1	Foraging
196	4/9/2008	0951	*Egretta sacra*	Pacific Reef Egret	838421.0	807787.2	2	0	Resting
197	4/9/2008	1011	*Sterna hirundo*	Common Tern	837054.3	806810.0	2	0	Foraging
198	4/9/2008	1026	*Milvus migrans*	Black Kite	834851.6	807106.6	1	20	Flying
199	4/9/2008	1038	*Sterna hirundo*	Common Tern	834699.6	804514.0	1	0	Resting
200	4/9/2008	1039	*Sterna hirundo*	Common Tern	834899.6	804494.3	1	5	Flying
201	4/9/2008	1042	*Sterna hirundo*	Common Tern	833680.5	806326.2	1	30	Flying
202	4/9/2008	1043	*Sterna hirundo*	Common Tern	835690.5	804472.4	1	5	Flying
203	4/9/2008	1052	*Sterna aleutica*	Aleutian Tern	836549.4	804121.1	2	20	Flying
204	4/9/2008	1052	*Sterna hirundo*	Common Tern	837670.7	804114.3	1	5	Flying
205	4/9/2008	1053	*Hirundo rustica*	Barn Swallow	837994.1	804272.6	1	5	Flying
206	4/9/2008	1101	*Hirundo rustica*	Barn Swallow	839013.2	803604.5	1	5	Flying
207	4/9/2008	1101	*Sterna hirundo*	Common Tern	838768.4	803226.0	7	0	Flying
208	4/9/2008	1102	*Sterna hirundo*	Common Tern	838641.7	802900.7	1	15	Flying
209	4/9/2008	1105	*Sterna hirundo*	Common Tern	838782.8	804127.0	1	30	Flying
210	4/9/2008	1107	*Family Ardeidae*	Unidentified Egrets	838616.0	803008.4	30	1	Flying
211	4/9/2008	1115	*Sterna hirundo*	Common Tern	835978.1	802193.7	1	5	Flying
212	4/9/2008	1126	*Hirundo rustica*	Barn Swallow	835104.6	802530.4	2	2	Flying
213	4/9/2008	1142	*Sterna hirundo*	Common Tern	832047.9	802689.8	1	30	Flying
214	4/9/2008	1157	*Sterna aleutica*	Aleutian Tern	828858.2	803020.2	1	0	Resting
215	4/9/2008	1200	*Sterna aleutica*	Aleutian Tern	828387.1	802820.5	1	30	Flying
216	4/9/2008	1205	*Sterna aleutica*	Aleutian Tern	827288.6	802414.5	1	0	Resting
217	4/9/2008	1219	*Hirundo rustica*	Barn Swallow	824760.2	802783.7	1	2	Flying
218	4/9/2008	1220	*Sterna hirundo*	Common Tern	824639.5	802859.0	1	5	Foraging
219	4/9/2008	1225	*Chlidonias hybridus*	Whiskered Tern	823415.8	802877.4	1	0	Resting
220	4/9/2008	1226	*Chlidonias hybridus*	Whiskered Tern	823269.4	802870.9	1	0	Resting
221	4/9/2008	1228	*Sterna aleutica*	Aleutian Tern	822773.4	802985.4	1	0	Resting
222	4/9/2008	1228	*Sterna aleutica*	Aleutian Tern	822844.6	802828.4	1	0	Resting
223	4/9/2008	1229	*Sterna aleutica*	Aleutian Tern	822716.2	802959.5	1	0	Resting
224	4/9/2008	1231	*Sterna hirundo*	Common Tern	822453.9	802957.1	1	0	Resting
225	4/9/2008	1235	*Sterna aleutica*	Aleutian Tern	822386.7	803763.4	1	0	Resting
226	4/9/2008	1244	*Sterna aleutica*	Aleutian Tern	824354.7	804051.1	1	0	Resting
227	4/9/2008	1246	*Sterna hirundo*	Common Tern	824857.4	804057.6	1	20	Flying
228	4/9/2008	1248	*Sterna hirundo*	Common Tern	825623.1	804067.2	1	30	Flying
229	4/9/2008	1249	*Sterna aleutica*	Aleutian Tern	826598.0	804085.2	1	0	Resting
230	4/9/2008	1251	*Sterna aleutica*	Aleutian Tern	825826.9	804026.3	1	30	Flying
231	4/9/2008	1253	*Sterna aleutica*	Aleutian Tern	826377.8	804055.5	4	0	Resting
232	4/9/2008	1256	*Sterna aleutica*	Aleutian Tern	827191.4	804096.9	1	0	Resting
233	4/9/2008	1257	*Sterna aleutica*	Aleutian Tern	828181.1	804110.6	1	0	Resting
234	4/9/2008	1303	*Milvus migrans*	Black Kite	829022.9	805581.1	1	10	Flying
235	4/9/2008	1322	*Sterna aleutica*	Aleutian Tern	826735.6	807055.3	1	0	Resting
236	4/9/2008	1341	*Sterna aleutica*	Aleutian Tern	825781.4	807948.6	1	0	Resting
237	4/9/2008	1344	*Sterna aleutica*	Aleutian Tern	826750.8	808010.0	1	5	Flying
238	4/9/2008	1345	*Sterna aleutica*	Aleutian Tern	826367.1	808073.9	2	0	Resting
239	4/9/2008	1345	*Sterna hirundo*	Common Tern	826367.1	808073.9	2	0	Resting
240	4/9/2008	1400	*Milvus migrans*	Black Kite	828598.0	811109.9	1	50	Flying
241	4/9/2008	1410	*Sterna aleutica*	Aleutian Tern	827287.2	812622.3	1	0	Resting
242	4/9/2008	1414	*Sterna aleutica*	Aleutian Tern	827086.4	812323.6	1	0	Resting
243	4/9/2008	1414	*Sterna aleutica*	Aleutian Tern	827104.0	812430.3	1	0	Resting

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
244	4/9/2008	1418	*Egretta garzetta*	Little Egret	829185.6	812850.2	1	5	Flying
245	4/9/2008	1420	*Sterna aleutica*	Aleutian Tern	828033.5	812751.4	1	0	Resting
246	4/9/2008	1421	*Milvus migrans*	Black Kite	829948.9	812911.3	1	10	Flying
247	4/9/2008	1423	*Milvus migrans*	Black Kite	830458.1	812487.3	1	30	Soaring
248	4/9/2008	1432	*Egretta garzetta*	Little Egret	832172.2	811877.0	8	0	Resting
249	4/9/2008	1440	*Egretta garzetta*	Little Egret	832381.0	810766.9	10	10	Resting
250	4/9/2008	1440	*Milvus migrans*	Black Kite	832381.0	810766.9	2	2	Resting
251	4/9/2008	1447	*Corvus macrorhynchus*	Large-billed Crow	835375.1	809684.0	1	100	Flying
252	11/9/2008	0927	*Milvus migrans*	Black Kite	834172.0	810363.9	5	50	Flying
253	11/9/2008	0932	*Egretta garzetta*	Little Egret	832863.7	811110.4	18	0	Resting
254	11/9/2008	0932	*Milvus migrans*	Black Kite	832863.7	811110.4	1	0	Resting
255	11/9/2008	0934	*Egretta garzetta*	Little Egret	832584.3	811356.6	1	20	Flying
256	11/9/2008	0937	*Milvus migrans*	Black Kite	831876.1	811363.4	1	50	Flying
257	11/9/2008	1001	*Hirundo rustica*	Barn Swallow	827989.1	813255.6	1	2	Flying
258	11/9/2008	1001	*Hirundo rustica*	Barn Swallow	827979.2	813225.5	1	5	Flying
259	11/9/2008	1034	*Hirundo rustica*	Barn Swallow	826435.3	810215.9	1	5	Flying
260	11/9/2008	1035	*Sterna aleutica*	Aleutian Tern	825751.3	810739.0	1	0	Resting
261	11/9/2008	1045	*Hirundo rustica*	Barn Swallow	828274.0	809498.6	1	2	Flying
262	11/9/2008	1103	*Sterna hirundo*	Common Tern	826007.0	808097.3	2	10	Flying
263	11/9/2008	1111	*Hirundo rustica*	Barn Swallow	824523.5	807590.6	2	5	Flying
264	11/9/2008	1121	*Sterna hirundo*	Common Tern	823499.0	806633.7	2	5	Flying
265	11/9/2008	1124	*Sterna aleutica*	Aleutian Tern	824179.0	806657.1	1	0	Resting
266	11/9/2008	1126	*Sterna aleutica*	Aleutian Tern	823371.5	806790.4	10	10	Flying
267	11/9/2008	1128	*Sterna aleutica*	Aleutian Tern	823761.1	806647.0	1	0	Resting
268	11/9/2008	1129	*Sterna aleutica*	Aleutian Tern	823991.6	806650.1	1	0	Resting
269	11/9/2008	1130	*Sterna aleutica*	Aleutian Tern	824353.2	806505.8	1	10	Flying
270	11/9/2008	1131	*Sterna aleutica*	Aleutian Tern	824568.4	806521.4	1	0	Resting
271	11/9/2008	1135	*Sterna aleutica*	Aleutian Tern	825594.1	806552.4	1	0	Resting
272	11/9/2008	1136	*Egretta garzetta*	Little Egret	827259.9	806587.4	1	10	Flying
273	11/9/2008	1148	*Egretta garzetta*	Little Egret	829456.9	805328.6	1	1	Flying
274	11/9/2008	1203	*Sterna aleutica*	Aleutian Tern	827807.5	804531.8	1	50	Flying
275	11/9/2008	1205	*Sterna hirundo*	Unidentified Terns	827749.5	803792.2	1	30	Flying
276	11/9/2008	1206	*Sterna hirundo*	Common Tern	827391.4	804282.6	1	20	Flying
277	11/9/2008	1208	*Sterna hirundo*	Common Tern	826449.6	804527.6	1	0	Resting
278	11/9/2008	1239	*Sterna hirundo*	Common Tern	826004.6	802821.0	5	10	Flying
279	11/9/2008	1244	*Sterna hirundo*	Common Tern	825152.4	801981.8	1	30	Flying
280	11/9/2008	1245	*Sterna aleutica*	Aleutian Tern	826311.8	802225.4	1	30	Flying
281	11/9/2008	1247	*Hirundo rustica*	Barn Swallow	826719.7	802350.3	2	2	Flying
282	11/9/2008	1248	*Hirundo rustica*	Barn Swallow	828267.1	802329.3	1	1	Flying
283	11/9/2008	1249	*Sterna aleutica*	Aleutian Tern	827277.2	802306.1	3	10	Flying
284	11/9/2008	1249	*Sterna hirundo*	Common Tern	827277.2	802306.1	4	10	Flying
285	11/9/2008	1252	*Sterna aleutica*	Aleutian Tern	827888.8	802275.3	1	0	Resting
286	11/9/2008	1252	*Sterna hirundo*	Common Tern	827914.5	802127.5	4	10	Flying
287	11/9/2008	1258	*Sterna aleutica*	Aleutian Tern	829434.9	802248.1	1	0	Resting
288	11/9/2008	1258	*Sterna hirundo*	Common Tern	830676.7	802213.4	1	0	Resting
289	11/9/2008	1259	*Ardeola bacchus*	Chinese Pond Heron	829868.2	802057.9	5	1	Flying
290	11/9/2008	1259	*Bubulcus ibis*	Cattle Egret	829755.5	802076.9	2	1	Flying
291	11/9/2008	1307	*Sterna aleutica*	Aleutian Tern	831757.0	801777.1	2	1	Flying
292	11/9/2008	1316	*Sterna aleutica*	Aleutian Tern	835469.5	802140.4	1	10	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates		Group Size	Elevation	Activity
					X	Y			
293	11/9/2008	1316	*Sterna hirundo*	Common Tern	835469.5	802140.4	1	10	Flying
294	11/9/2008	1333	*Sterna aleutica*	Aleutian Tern	838101.2	802075.5	5	10	Flying
295	11/9/2008	1336	*Sterna aleutica*	Aleutian Tern	838445.8	803203.7	1	20	Flying
296	11/9/2008	1348	*Hirundo rustica*	Barn Swallow	835596.8	804628.9	1	20	Flying
297	11/9/2008	1349	*Sterna hirundo*	Common Tern	835183.8	804396.9	2	20	Flying
298	11/9/2008	1405	*Sterna aleutica*	Aleutian Tern	835981.3	806587.2	1	0	Resting
299	11/9/2008	1412	*Sterna aleutica*	Aleutian Tern	835914.2	806160.2	1	0	Resting
300	11/9/2008	1414	*Sterna aleutica*	Aleutian Tern	836076.7	806164.2	1	0	Resting
301	11/9/2008	1417	*Sterna aleutica*	Aleutian Tern	838331.2	805724.5	1	20	Flying
302	11/9/2008	1418	*Sterna aleutica*	Aleutian Tern	837211.7	806012.7	1	0	Resting
303	11/9/2008	1428	*Motacilla flava*	Yellow Wagtail	838704.1	807342.4	1	50	Flying
304	11/9/2008	1434	*Milvus migrans*	Black Kite	837781.3	808680.0	4	100	Soaring
305	11/9/2008	1442	*Milvus migrans*	Black Kite	836714.8	809063.9	1	100	Flying
306	11/9/2008	1449	*Milvus migrans*	Black Kite	835716.3	810089.9	1	100	Flying
307	26/9/2008	0956	*Milvus migrans*	Black Kite	836966.8	808658.9	1	100	Soaring
308	26/9/2008	0959	*Milvus migrans*	Black Kite	837781.7	808286.6	1	20	Foraging
309	26/9/2008	1006	*Milvus migrans*	Black Kite	839050.9	806171.8	1	100	Soaring
310	26/9/2008	1009	*Milvus migrans*	Black Kite	838704.6	806006.5	1	80	Flying
311	26/9/2008	1115	*Anthus sp.*	Unidentified Pipit	831878.7	802621.9	1	5	Soaring
312	26/9/2008	1216	*Hirundo rustica*	Barn Swallow	825617.6	803761.6	1	5	Flying
313	26/9/2008	1235	*Milvus migrans*	Black Kite	829196.4	805586.1	1	100	Soaring
314	26/9/2008	1325	*Milvus migrans*	Black Kite	828017.3	809148.1	1	50	Foraging
315	26/9/2008	1333	*Egretta garzetta*	Little Egret	828632.4	809939.3	1	10	Flying
316	26/9/2008	1404	*Milvus migrans*	Black Kite	828101.5	812864.5	1	50	Flying
317	26/9/2008	1428	*Milvus migrans*	Black Kite	832174.0	811249.2	1	30	Soaring
318	26/9/2008	1429	*Egretta garzetta*	Little Egret	832325.9	811100.0	7	0	Resting
319	26/9/2008	1437	*Milvus migrans*	Black Kite	833744.4	810004.0	1	100	Soaring
320	26/9/2008	1438	*Milvus migrans*	Black Kite	833771.2	810060.2	1	50	Soaring
321	6/10/2008	1020	*Egretta garzetta*	Little Egret	828606.1	809149.2	3	2	Flying
322	6/10/2008	1056	*Hirundo rustica*	Barn Swallow	824459.8	806701.2	1	0	Flying
323	6/10/2008	1117	*Milvus migrans*	Black Kite	829319.6	805218.9	1	70	Soaring
324	6/10/2008	1153	*Ardeola bacchus*	Chinese Pond Heron	823449.5	803989.0	1	2	Flying
325	6/10/2008	1153	*Milvus migrans*	Black Kite	823535.4	803005.1	1	15	Flying
326	6/10/2008	1222	*Chlidonias hybridus*	Whiskered Tern	827544.3	801835.1	2	10	Flying
327	6/10/2008	1300	*Phalaropus lobatus*	Red-necked Phalarope	835097.1	802218.7	1	0	Flying
328	6/10/2008	1356	*Milvus migrans*	Black Kite	837988.6	807812.7	1	60	Flying
329	6/10/2008	1401	*Milvus migrans*	Black Kite	837196.6	808678.9	3	100	Soaring
330	6/10/2008	1407	*Milvus migrans*	Black Kite	836409.3	808988.9	2	200	Flying
331	6/10/2008	920	*Corvus macrorhynchus*	Large-billed Crow	834542.9	809972.8	2	5	Flying
332	6/10/2008	922	*Milvus migrans*	Black Kite	834324.7	810442.3	10	80	Soaring
333	6/10/2008	932	*Egretta garzetta*	Little Egret	832657.4	811493.4	13	0	Resting
334	6/10/2008	940	*Milvus migrans*	Black Kite	831788.1	812426.8	2	100	Soaring
335	6/10/2008	943	*Egretta garzetta*	Little Egret	831490.4	812792.9	1	30	Flying
336	6/10/2008	948	*Milvus migrans*	Black Kite	830364.8	813261.5	1	1	Flying
337	17/10/2008	1430	*Milvus migrans*	Black Kite	828138.3	812930.4	1	50	Flying
338	17/10/2008	1440	*Milvus migrans*	Black Kite	830035.7	813362.0	1	50	Soaring
339	17/10/2008	1449	*Milvus migrans*	Black Kite	831779.2	811844.8	1	50	Soaring
340	17/10/2008	1455	*Egretta garzetta*	Little Egret	832406.9	811042.0	1	1	Resting
341	17/10/2008	934	*Milvus migrans*	Black Kite	837440.1	808845.7	1	5	Resting

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Y	Group Size	Elevation	Activity
342	17/10/2008	948	*Milvus migrans*	Black Kite	839047.9	806598.2	1	50	Soaring
343	17/10/2008	950	*Milvus migrans*	Black Kite	839158.9	806125.0	3	50	Flying
344	17/10/2008	959	*Milvus migrans*	Black Kite	836684.1	806639.6	1	100	Flying
345	20/10/2008	1045	*Milvus migrans*	Black Kite	824725.3	807515.6	1	100	Flying
346	20/10/2008	1053	*Milvus migrans*	Black Kite	822569.1	807446.2	1	150	Soaring
347	20/10/2008	1331	*Milvus migrans*	Black Kite	833714.0	806036.4	1	50	Flying
348	20/10/2008	1340	*Milvus migrans*	Black Kite	835373.6	806586.9	1	30	Flying
349	20/10/2008	1400	*Milvus migrans*	Black Kite	839257.7	806867.1	1	150	Flying
350	20/10/2008	1413	*Milvus migrans*	Black Kite	837907.7	809088.3	1	120	Soaring
351	20/10/2008	1422	*Milvus migrans*	Black Kite	835800.6	810233.2	1	200	Soaring
352	20/10/2008	941	*Milvus migrans*	Black Kite	833413.9	810788.2	1	80	Soaring
353	20/10/2008	945	*Egretta garzetta*	Little Egret	832466.1	811146.7	1	0	Flying
354	20/10/2008	945	*Haliaeetus leucogaster*	White-bellied Sea Eagle	832184.7	811513.3	2	100	Soaring
355	20/10/2008	947	*Milvus migrans*	Black Kite	832464.3	811833.0	1	100	Soaring
356	20/10/2008	949	*Milvus migrans*	Black Kite	831875.7	811732.2	1	20	Flying
357	20/10/2008	950	*Milvus migrans*	Black Kite	831636.2	811952.3	2	30	Flying
358	20/10/2008	954	*Milvus migrans*	Black Kite	830140.2	813046.1	1	50	Flying
359	2/2/2009	0915	*Milvus migrans*	Black Kite	836504.1	809376.1	1	20	Flying
360	2/2/2009	0915	*Milvus migrans*	Black Kite	836494.8	809426.8	6	20	Soaring
361	2/2/2009	0929	*Milvus migrans*	Black Kite	838059.2	808268.3	1	50	Flying
362	2/2/2009	0951	*Milvus migrans*	Black Kite	835316.9	806662.7	1	10	Flying
363	2/2/2009	1004	*Milvus migrans*	Black Kite	833899.4	805352.0	2	50	Flying
364	2/2/2009	1014	*Larus heuglini*	Heuglin's Gull	834938.3	803615.2	1	10	Flying
365	2/2/2009	1018	*Larus heuglini*	Heuglin's Gull	836111.6	804186.2	1	5	Flying
366	2/2/2009	1021	*Larus heuglini*	Heuglin's Gull	836249.6	804445.7	2	50	Flying
367	2/2/2009	1022	*Milvus migrans*	Black Kite	836245.4	804688.1	2	10	Flying
368	2/2/2009	1123	*Larus heuglini*	Heuglin's Gull	827185.6	803164.2	1	10	Flying
369	2/2/2009	1124	*Larus heuglini*	Heuglin's Gull	827826.4	802362.1	1	10	Flying
370	2/2/2009	1130	*Larus heuglini*	Heuglin's Gull	826173.1	802594.6	69	0	Resting
371	2/2/2009	1208	*Larus heuglini*	Heuglin's Gull	824601.5	804521.6	2	30	Flying
372	2/2/2009	1214	*Rissa tridactyla*	Black-legged Kittiwake	825492.0	804421.1	1	30	Flying
373	2/2/2009	1223	*Milvus migrans*	Black Kite	826944.2	804512.6	1	50	Soaring
374	2/2/2009	1225	*Milvus migrans*	Black Kite	827539.8	804119.2	10	10	Foraging
375	2/2/2009	1229	*Milvus migrans*	Black Kite	828261.7	804524.3	1	50	Soaring
376	2/2/2009	1240	*Milvus migrans*	Black Kite	829326.9	806478.9	1	10	Flying
377	2/2/2009	1335	*Milvus migrans*	Black Kite	826909.7	807279.9	1	20	Flying
378	2/2/2009	1428	*Milvus migrans*	Black Kite	829034.8	810062.3	1	30	Flying
379	2/2/2009	1439	*Milvus migrans*	Black Kite	830887.7	811770.7	1	50	Flying
380	2/2/2009	1440	*Milvus migrans*	Black Kite	831302.0	812009.6	1	50	Flying
381	2/2/2009	1445	*Milvus migrans*	Black Kite	831991.0	810799.5	1	20	Soaring
382	2/2/2009	1448	*Milvus migrans*	Black Kite	832816.3	810696.2	1	50	Flying
383	2/2/2009	1454	*Milvus migrans*	Black Kite	833642.2	809706.9	1	10	Flying
384	13/2/2009	1018	*Milvus migrans*	Black Kite	831807.6	811969.8	1	10	Flying
385	13/2/2009	1022	*Milvus migrans*	Black Kite	831201.1	812324.4	1	20	Flying
386	13/2/2009	1026	*Milvus migrans*	Black Kite	830735.5	812886.9	2	50	Flying
387	13/2/2009	1127	*Milvus migrans*	Black Kite	826736.8	808105.7	1	20	Flying
388	13/2/2009	1405	*Milvus migrans*	Black Kite	835107.5	804954.9	1	20	Flying
389	13/2/2009	1408	*Milvus migrans*	Black Kite	834651.9	803721.3	1	30	Flying
390	13/2/2009	1416	*Milvus migrans*	Black Kite	833538.4	806131.4	2	50	Soaring

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Y	Group Size	Elevation	Activity
391	13/2/2009	1419	*Egretta sacra*	Pacific Reef Egret	833541.5	806897.8	2	1	Flying
392	13/2/2009	1420	*Milvus migrans*	Black Kite	833810.8	806614.8	1	50	Flying
393	13/2/2009	1425	*Milvus migrans*	Black Kite	834687.6	806264.5	1	10	Flying
394	13/2/2009	1437	*Milvus migrans*	Black Kite	837619.1	806611.2	1	20	Flying
395	13/2/2009	1441	*Milvus migrans*	Black Kite	839007.2	806748.2	1	10	Flying
396	13/2/2009	1442	*Milvus migrans*	Black Kite	838413.5	807386.1	1	30	Soaring
397	13/2/2009	1452	*Milvus migrans*	Black Kite	837613.9	808871.1	1	30	Flying
398	13/2/2009	1455	*Milvus migrans*	Black Kite	837299.0	809086.5	1	10	Flying
399	13/2/2009	1500	*Milvus migrans*	Black Kite	835663.1	809641.9	10	50	Soaring
400	13/2/2009	1502	*Egretta garzetta*	Little Egret	835498.8	809862.7	2	1	Flying
401	24/2/2009	0921	*Egretta sacra*	Pacific Reef Egret	838011.4	808577.5	2	10	Resting
402	24/2/2009	1001	*Acridotheres cristatellu*	Crested Myna	833229.0	806641.9	14	30	Resting
403	24/2/2009	1002	*Milvus migrans*	Black Kite	833249.7	806499.9	3	30	Soaring
404	24/2/2009	1004	*Columbia livia*	Feral Pigeon	833129.7	805776.5	1	60	Flying
405	24/2/2009	1004	*Milvus migrans*	Black Kite	833129.7	805776.5	4	80	Soaring
406	24/2/2009	1009	*Milvus migrans*	Black Kite	833529.6	804748.2	1	60	Flying
407	24/2/2009	1041	*Milvus migrans*	Black Kite	838321.8	805623.2	1	1	Flying
408	24/2/2009	1103	*Larus heuglini*	Heuglin's Gull	835312.9	802622.7	1	1	Resting
409	24/2/2009	1113	*Hirundo rustica*	Barn Swallow	833370.3	802746.3	1	1	Flying
410	24/2/2009	1114	*Milvus migrans*	Black Kite	832938.2	802597.0	1	5	Flying
411	24/2/2009	1140	*Larus heuglini*	Heuglin's Gull	825843.1	802794.0	8	30	Flying
412	24/2/2009	1144	*Larus heuglini*	Heuglin's Gull	826496.6	802322.5	49	0	Resting
413	24/2/2009	1144	*Larus ichthyaetus*	Black-headed Gul	826496.6	802322.5	2	0	Resting
414	24/2/2009	1148	*Larus heuglini*	Heuglin's Gull	825419.2	802395.6	1	30	Flying
415	24/2/2009	1149	*Milvus migrans*	Black Kite	825199.4	802109.1	1	50	Flying
416	24/2/2009	1256	*Milvus migrans*	Black Kite	828885.6	806644.7	2	10	Flying
417	24/2/2009	1348	*Milvus migrans*	Black Kite	827615.6	808419.1	9	80	Soaring
418	24/2/2009	1358	*Milvus migrans*	Black Kite	829389.1	809631.1	34	150	Soaring
419	24/2/2009	1358	*Milvus migrans*	Black Kite	828306.5	810080.1	1	20	Flying
420	24/2/2009	1401	*Milvus migrans*	Black Kite	828520.1	810523.8	2	50	Soaring
421	24/2/2009	1405	*Hirundo rustica*	Barn Swallow	827604.0	810568.8	1	5	Flying
422	24/2/2009	1419	*Milvus migrans*	Black Kite	824672.0	811244.7	1	10	Flying
423	24/2/2009	1420	*Milvus migrans*	Black Kite	824732.2	811392.6	1	10	Flying
424	24/2/2009	1442	*Milvus migrans*	Black Kite	828439.1	812329.9	1	50	Flying
425	24/2/2009	1457	*Egretta garzetta*	Little Egret	832054.9	811312.2	4	20	Flying
426	24/2/2009	1500	*Milvus migrans*	Black Kite	832521.5	810863.0	1	50	Flying
427	24/2/2009	1501	*Egretta garzetta*	Little Egret	832394.0	810878.9	1	5	Flying
428	24/2/2009	1502	*Egretta sacra*	Pacific Reef Egret	832695.1	810938.1	1	1	Flying
429	24/2/2009	1504	*Milvus migrans*	Black Kite	833436.5	810674.7	1	150	Flying
430	24/2/2009	1509	*Egretta garzetta*	Little Egret	834212.7	810064.0	1	1	Flying
431	24/2/2009	917	*Egretta sacra*	Pacific Reef Egret	835010.6	810252.4	1	0	Flying
432	24/2/2009	917	*Milvus migrans*	Black Kite	835178.3	810132.5	5	20	Soaring
433	24/2/2009	919	*Egretta garzetta*	Little Egret	835587.3	809619.5	1	30	Flying
434	24/2/2009	920	*Milvus migrans*	Black Kite	835903.9	809735.9	1	10	Flying
435	24/2/2009	922	*Milvus migrans*	Black Kite	836464.7	809560.9	1	10	Flying
436	24/2/2009	927	*Corvus sp.*	Unidentified Crow	836831.7	809200.5	1	30	Flying
437	24/2/2009	929	*Milvus migrans*	Black Kite	837718.4	808780.6	1	40	Flying
438	24/2/2009	934	*Milvus migrans*	Black Kite	838270.2	807984.7	2	5	Flying
439	24/2/2009	935	*Milvus migrans*	Black Kite	839337.3	807501.0	1	100	Soaring

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Y	Group Size	Elevation	Activity
440	24/2/2009	937	*Milvus migrans*	Black Kite	838860.2	806559.5	1	2	Flying
441	24/2/2009	956	*Milvus migrans*	Black Kite	834331.1	806716.5	1	20	Flying
442	12/3/2009	0931	*Milvus migrans*	Black Kite	833896.9	809741.5	3	50	Soaring
443	12/3/2009	0932	*Milvus migrans*	Black Kite	833658.1	809763.1	1	50	Soaring
444	12/3/2009	0935	*Milvus migrans*	Black Kite	833118.9	809791.9	1	30	Flying
445	12/3/2009	0940	*Hirundo rustica*	Barn Swallow	832502.6	810948.0	1	2	Flying
446	12/3/2009	0943	*Milvus migrans*	Black Kite	831766.5	811145.4	1	30	Soaring
447	12/3/2009	0944	*Milvus migrans*	Black Kite	832073.2	811706.4	2	50	Soaring
448	12/3/2009	0948	*Egretta garzetta*	Little Egret	831432.3	812415.0	1	10	Flying
449	12/3/2009	0948	*Egretta garzetta*	Little Egret	831247.2	812344.3	1	20	Flying
450	12/3/2009	0949	*Egretta garzetta*	Little Egret	831094.0	812553.4	3	1	Flying
451	12/3/2009	0951	*Egretta garzetta*	Little Egret	830757.5	812864.6	1	10	Flying
452	12/3/2009	0953	*Milvus migrans*	Black Kite	830529.6	812975.2	1	10	Flying
453	12/3/2009	0955	*Milvus migrans*	Black Kite	829991.3	812938.2	1	50	Flying
454	12/3/2009	1016	*Milvus migrans*	Black Kite	826742.2	813276.9	1	50	Flying
455	12/3/2009	1032	*Egretta garzetta*	Little Egret	828537.2	811107.5	6	0	Resting
456	12/3/2009	1034	*Hirundo rustica*	Barn Swallow	828429.2	810743.8	5	1	Flying
457	12/3/2009	1037	*Milvus migrans*	Black Kite	828091.7	809577.0	1	20	Flying
458	12/3/2009	1040	*Milvus migrans*	Black Kite	827965.2	808439.2	1	20	Flying
459	12/3/2009	1053	*Milvus migrans*	Black Kite	826314.6	808190.6	1	50	Soaring
460	12/3/2009	1055	*Milvus migrans*	Black Kite	826501.1	807302.1	1	30	Flying
461	12/3/2009	1056	*Milvus migrans*	Black Kite	826001.8	807681.1	1	10	Flying
462	12/3/2009	1107	*Synthliboramphus antiquu*	Ancient Murrelet	823847.7	807114.1	2	1	Flying
463	12/3/2009	1113	*Hirundo rustica*	Barn Swallow	822699.6	806720.6	1	1	Flying
464	12/3/2009	1125	*Hirundo rustica*	Barn Swallow	823136.4	806320.4	4	1	Flying
465	12/3/2009	1129	*Larus heuglini*	Heuglin's Gull	823901.2	806127.4	1	50	Flying
466	12/3/2009	1154	*Milvus migrans*	Black Kite	828198.1	805749.1	1	50	Flying
467	12/3/2009	1159	*Milvus migrans*	Black Kite	829461.5	805152.2	1	80	Soaring
468	12/3/2009	1201	*Hirundo rustica*	Barn Swallow	828831.2	804954.0	1	5	Flying
469	12/3/2009	1213	*Larus heuglini*	Heuglin's Gull	826069.9	804992.3	1	10	Flying
470	12/3/2009	1215	*Larus heuglini*	Heuglin's Gull	825763.2	804420.3	11	20	Flying
471	12/3/2009	1216	*Larus heuglini*	Heuglin's Gull	825333.6	804494.4	3	30	Flying
472	12/3/2009	1222	*Larus heuglini*	Heuglin's Gull	824217.1	804988.3	1	50	Flying
473	12/3/2009	1227	*Hirundo rustica*	Barn Swallow	823299.3	804954.2	1	2	Flying
474	12/3/2009	1229	*Hirundo rustica*	Barn Swallow	823292.4	804522.3	1	1	Flying
475	12/3/2009	1244	*Larus heuglini*	Heuglin's Gull	824394.6	801729.5	1	50	Flying
476	12/3/2009	1426	*Milvus migrans*	Black Kite	834189.9	806461.1	1	10	Flying
477	12/3/2009	1427	*Buteo buteo*	Common Buzzard	834147.0	805876.5	1	150	Soaring
478	12/3/2009	1430	*Milvus migrans*	Black Kite	834075.2	805700.0	1	10	Flying
479	12/3/2009	1437	*Milvus migrans*	Black Kite	833417.8	805701.1	1	20	Flying
480	12/3/2009	1442	*Milvus migrans*	Black Kite	833723.4	806717.6	1	0	Foraging
481	12/3/2009	1446	*Milvus migrans*	Black Kite	834584.2	807092.8	1	50	Flying
482	12/3/2009	1517	*Milvus migrans*	Black Kite	837479.5	808543.0	2	80	Soaring
483	13/3/2009	0923	*Milvus migrans*	Black Kite	829440.6	812389.7	1	200	Flying
484	13/3/2009	0926	*Milvus migrans*	Black Kite	828729.3	812266.4	2	200	Soaring
485	13/3/2009	0946	*Ardea alba*	Great Egret	824891.7	812346.6	1	50	Flying
486	13/3/2009	1020	*Milvus migrans*	Black Kite	827043.9	807964.6	1	200	Flying
487	13/3/2009	1057	*Hirundo rustica*	Barn Swallow	825393.9	806869.5	1	2	Flying
488	13/3/2009	1110	*Milvus migrans*	Black Kite	828708.9	806893.9	1	0	Foraging

No.	Date	Time	Species Name	Common Name	Bird Coordinates		Group Size	Elevation	Activity
					X	Y			
489	13/3/2009	1116	*Milvus migrans*	Black Kite	829377.5	805948.0	1	0	Foraging
490	13/3/2009	1138	*Haliaeetus leucogaster*	White-bellied Sea Eagle	825361.1	804643.7	1	15	Flying
491	13/3/2009	1153	*Phalaropus lobatus*	Red-necked Phalarope	821896.5	804349.8	2	50	Resting
492	13/3/2009	1157	*Synthliboramphus antiquu*	Ancient Murrelet	821668.8	804217.5	2	50	Flying
493	13/3/2009	1203	*Larus heuglini*	Heuglin's Gull	821725.9	802746.5	1	2	Flying
494	13/3/2009	1211	*Phalaropus lobatus*	Red-necked Phalarope	823399.3	801655.9	4	0	Resting
495	13/3/2009	1213	*Phalaropus lobatus*	Red-necked Phalarope	824121.5	802651.5	25	0	Swimming
496	13/3/2009	1217	*Larus heuglini*	Heuglin's Gull	824823.5	802227.8	1	5	Flying
497	13/3/2009	1218	*Larus heuglini*	Heuglin's Gull	825709.7	802490.1	1	20	Flying
498	13/3/2009	1220	*Larus crassirostris*	Black-tailed Gull	826024.8	802492.9	1	0	Swimming
499	13/3/2009	1220	*Larus heuglini*	Heuglin's Gull	826024.8	802492.9	1	20	Foraging
500	13/3/2009	1229	*Larus heuglini*	Heuglin's Gull	828321.0	802436.3	24	0	Resting
501	13/3/2009	1300	*Milvus migrans*	Black Kite	833412.1	803078.9	1	40	Flying
502	13/3/2009	1330	*Milvus migrans*	Black Kite	838416.7	804532.7	1	50	Flying
503	13/3/2009	1359	*Milvus migrans*	Black Kite	833455.8	805095.3	2	100	Resting
504	13/3/2009	1408	*Milvus migrans*	Black Kite	833582.7	806970.3	1	150	Soaring
505	13/3/2009	1429	*Milvus migrans*	Black Kite	838409.8	806628.5	1	200	Soaring
506	13/3/2009	1442	*Milvus migrans*	Black Kite	837790.2	808504.5	1	100	Flying
507	13/3/2009	1444	*Haliaeetus leucogaster*	White-bellied Sea Eagle	837665.7	807263.1	1	100	Resting
508	13/3/2009	1454	*Milvus migrans*	Black Kite	835844.8	809774.2	7	100	Soaring
509	13/3/2009	918	*Egretta garzetta*	Little Egret	830835.0	812547.0	1	30	Flying
510	13/3/2009	921	*Milvus migrans*	Black Kite	830406.7	812777.8	1	100	Flying
511	13/3/2009	931	*Egretta garzetta*	Little Egret	827546.1	812196.8	1	50	Flying
512	19/3/2009	0916	*Milvus migrans*	Black Kite	835930.3	809683.9	1	20	Flying
513	19/3/2009	0954	*Milvus migrans*	Black Kite	834412.4	806765.9	1	50	Flying
514	19/3/2009	1001	*Milvus migrans*	Black Kite	833304.4	806507.6	1	20	Soaring
515	19/3/2009	1003	*Milvus migrans*	Black Kite	834069.5	805819.5	2	100	Soaring
516	19/3/2009	1119	*Milvus migrans*	Black Kite	829830.6	802078.9	2	50	Flying
517	19/3/2009	1248	*Milvus migrans*	Black Kite	828293.6	804622.4	1	50	Flying
518	19/3/2009	1322	*Milvus migrans*	Black Kite	827147.8	806475.6	1	50	Flying
519	19/3/2009	1349	*Milvus migrans*	Black Kite	822172.1	807229.8	2	100	Soaring
520	19/3/2009	1412	*Milvus migrans*	Black Kite	827018.7	808997.6	1	30	Flying
521	19/3/2009	1415	*Egretta garzetta*	Little Egret	827989.1	808298.4	3	5	Flying
522	19/3/2009	1415	*Milvus migrans*	Black Kite	828024.6	808005.9	3	80	Soaring
523	19/3/2009	1418	*Egretta garzetta*	Little Egret	828170.0	809387.1	3	10	Soaring
524	19/3/2009	1502	*Milvus migrans*	Black Kite	828317.7	812549.6	1	2	Flying
525	19/3/2009	1516	*Milvus migrans*	Black Kite	831365.2	812085.0	1	20	Flying
526	19/3/2009	1519	*Milvus migrans*	Black Kite	831789.4	811612.2	1	30	Flying
527	19/3/2009	1520	*Egretta garzetta*	Little Egret	833479.1	810241.9	1	0	Resting
528	19/3/2009	1520	*Milvus migrans*	Black Kite	832188.3	811611.4	1	0	Resting
529	19/3/2009	919	*Milvus migrans*	Black Kite	836864.4	809429.3	1	20	Flying
530	19/3/2009	926	*Milvus migrans*	Black Kite	838166.4	808607.3	1	120	Soaring
531	19/3/2009	935	*Milvus migrans*	Black Kite	838823.3	806542.3	1	30	Flying
532	19/3/2009	939	*Phalaropus lobatus*	Red-necked Phalarope	837744.4	806688.3	4	0	Swimming
533	19/3/2009	944	*Milvus migrans*	Black Kite	836439.2	806542.2	1	60	Flying
534	19/3/2009	952	*Milvus migrans*	Black Kite	834542.2	807025.2	1	50	Flying
535	6/4/2009	1000	*Phalaropus lobatus*	Red-necked Phalarope	833680.1	806152.2	4	1	Flying
536	6/4/2009	1000	*Phalaropus lobatus*	Red-necked Phalarope	833699.1	806336.3	10	0	Resting
537	6/4/2009	1007	*Egretta garzetta*	Little Egret	833992.2	804729.3	16	5	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
538	6/4/2009	1013	*Milvus migrans*	Black Kite	835486.3	804776.6	25	5	Flying
539	6/4/2009	1013	*Phalaropus lobatus*	Red-necked Phalarope	836092.0	805607.3	1	0	Resting
540	6/4/2009	1017	*Sterna sumatrana*	Black-naped Tern	836074.9	805666.5	1	5	Flying
541	6/4/2009	1019	*Hirundo rustica*	Barn Swallow	836911.3	805663.5	1	1	Flying
542	6/4/2009	1024	*Phalaropus lobatus*	Red-necked Phalarope	837268.8	805906.2	2	10	Flying
543	6/4/2009	1025	*Phalaropus lobatus*	Red-necked Phalarope	837893.8	805607.8	2	0	Resting
544	6/4/2009	1028	*Phalaropus lobatus*	Red-necked Phalarope	838876.8	805614.4	7	1	Flying
545	6/4/2009	1033	*Phalaropus lobatus*	Red-necked Phalarope	838973.6	804490.8	2	0	Resting
546	6/4/2009	1035	*Phalaropus lobatus*	Red-necked Phalarope	838982.5	803624.0	1	0	Resting
547	6/4/2009	1044	*Stercorarius parasiticus*	Arctic Skua	838192.3	803421.1	1	5	Flying
548	6/4/2009	1045	*Stercorarius parasiticus*	Arctic Skua	837594.6	803949.9	2	5	Flying
549	6/4/2009	1046	*Phalaropus lobatus*	Red-necked Phalarope	838218.4	803268.2	4	1	Flying
550	6/4/2009	1059	*Larus heuglini*	Heuglin's Gull	834915.1	803220.0	1	50	Flying
551	6/4/2009	1100	*Milvus migrans*	Black Kite	832839.6	801728.2	1	50	Flying
552	6/4/2009	1106	*Milvus migrans*	Black Kite	832202.7	803461.3	1	100	Soaring
553	6/4/2009	1107	*Phalaropus lobatus*	Red-necked Phalarope	832590.0	803385.5	2	0	Flying
554	6/4/2009	1123	*Phalaropus lobatus*	Red-necked Phalarope	828200.8	803344.9	4	0	Resting
555	6/4/2009	1125	*Phalaropus lobatus*	Red-necked Phalarope	827582.8	803441.2	2	0	Resting
556	6/4/2009	1128	*Synthliboramphus antiquu*	Ancient Murrelet	826659.9	802532.2	3	0	Flying
557	6/4/2009	1131	*Phalaropus lobatus*	Red-necked Phalarope	825798.0	802609.7	2	1	Resting
558	6/4/2009	1136	*Phalaropus lobatus*	Red-necked Phalarope	824748.3	802527.7	4	1	Flying
559	6/4/2009	1139	*Egretta sacra*	Pacific Reef Egret	823168.2	802755.4	1	1	Flying
560	6/4/2009	1151	*Phalaropus lobatus*	Red-necked Phalarope	822390.1	803555.0	2	1	Flying
561	6/4/2009	1157	*Phalaropus lobatus*	Red-necked Phalarope	822707.5	805504.9	1	1	Flying
562	6/4/2009	1158	*Phalaropus lobatus*	Red-necked Phalarope	822959.7	804675.7	7	0	Swimming
563	6/4/2009	1201	*Milvus migrans*	Black Kite	823522.3	805356.0	1	30	Soaring
564	6/4/2009	1218	*Milvus migrans*	Black Kite	827213.7	804815.3	1	50	Flying
565	6/4/2009	1220	*Milvus migrans*	Black Kite	828030.2	804622.5	1	1	Foraging
566	6/4/2009	1222	*Milvus migrans*	Black Kite	828277.0	804749.1	1	1	Flying
567	6/4/2009	1229	*Milvus migrans*	Black Kite	830029.8	805968.5	1	5	Soaring
568	6/4/2009	1234	*Milvus migrans*	Black Kite	829205.5	806315.6	1	5	Flying
569	6/4/2009	1237	*Milvus migrans*	Black Kite	828856.6	806774.1	1	10	Flying
570	6/4/2009	1239	*Milvus migrans*	Black Kite	828275.1	806768.3	1	10	Flying
571	6/4/2009	1241	*Milvus migrans*	Black Kite	827563.2	806479.0	1	20	Flying
572	6/4/2009	1251	*Phalaropus lobatus*	Red-necked Phalarope	825278.7	806722.0	2	0	Swimming
573	6/4/2009	1251	*Phalaropus lobatus*	Red-necked Phalarope	826161.2	807929.8	1	0	Flying
574	6/4/2009	1254	*Phalaropus lobatus*	Red-necked Phalarope	824408.6	806747.1	3	1	Flying
575	6/4/2009	1257	*Milvus migrans*	Black Kite	823809.7	806738.2	1	30	Flying
576	6/4/2009	1259	*Phalaropus lobatus*	Red-necked Phalarope	823503.1	806800.7	2	1	Flying
577	6/4/2009	1308	*Milvus migrans*	Black Kite	822878.3	806864.7	1	30	Flying
578	6/4/2009	1316	*Phalaropus lobatus*	Red-necked Phalarope	824715.0	807452.3	2	1	Flying
579	6/4/2009	1319	*Phalaropus lobatus*	Red-necked Phalarope	825382.9	807747.7	1	0	Swimming
580	6/4/2009	1321	*Phalaropus lobatus*	Red-necked Phalarope	825781.0	807851.3	1	1	Flying
581	6/4/2009	1322	*Phalaropus lobatus*	Red-necked Phalarope	826105.2	808020.5	25	5	Flying
582	6/4/2009	1323	*Phalaropus lobatus*	Red-necked Phalarope	826419.1	808023.1	1	2	Flying
583	6/4/2009	1329	*Hirundo rustica*	Barn Swallow	827483.4	808490.9	1	3	Flying
584	6/4/2009	1329	*Milvus migrans*	Black Kite	827604.8	808383.0	1	50	Flying
585	6/4/2009	1336	*Egretta garzetta*	Little Egret	828307.3	809761.5	4	20	Flying
586	6/4/2009	1336	*Milvus migrans*	Black Kite	828307.3	809761.5	1	50	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
587	6/4/2009	1338	*Milvus migrans*	Black Kite	828261.3	810019.3	1	5	Flying
588	6/4/2009	1343	*Bubulcus ibis*	Cattle Egret	827677.4	810237.5	5	5	Flying
589	6/4/2009	1357	*Milvus migrans*	Black Kite	824915.6	811664.5	1	30	Flying
590	6/4/2009	1414	*Milvus migrans*	Black Kite	827953.3	812855.0	1	20	Flying
591	6/4/2009	1414	*Phalaropus lobatus*	Red-necked Phalarope	827952.5	813055.0	11	2	Flying
592	6/4/2009	1417	*Phalaropus lobatus*	Red-necked Phalarope	828647.6	812579.9	6	0	Swimming
593	6/4/2009	1419	*Milvus migrans*	Black Kite	829027.2	812807.6	1	40	Flying
594	6/4/2009	1423	*Milvus migrans*	Black Kite	830387.6	812564.5	1	50	Soaring
595	6/4/2009	1425	*Egretta garzetta*	Little Egret	830536.2	812696.8	1	5	Flying
596	6/4/2009	1427	*Milvus migrans*	Black Kite	830982.6	812060.4	1	50	Flying
597	6/4/2009	1430	*Egretta garzetta*	Little Egret	831873.1	811653.1	1	40	Flying
598	6/4/2009	1432	*Bubulcus ibis*	Cattle Egret	831908.7	811573.4	6	30	Flying
599	6/4/2009	1433	*Phalaropus lobatus*	Red-necked Phalarope	831864.4	811331.2	1	0	Swimming
600	6/4/2009	1438	*Egretta garzetta*	Little Egret	832679.4	810632.2	1	1	Flying
601	6/4/2009	1443	*Milvus migrans*	Black Kite	833755.3	809860.8	2	30	Flying
602	6/4/2009	1445	*Milvus migrans*	Black Kite	834027.3	809679.3	2	30	Flying
603	6/4/2009	913	*Milvus migrans*	Black Kite	835016.7	809861.7	1	10	Flying
604	6/4/2009	925	*Milvus migrans*	Black Kite	837801.5	808708.2	1	20	Flying
605	6/4/2009	927	*Milvus migrans*	Black Kite	838127.6	808232.5	1	50	Flying
606	6/4/2009	929	*Milvus migrans*	Black Kite	838353.3	807993.9	1	50	Soaring
607	6/4/2009	931	*Milvus migrans*	Black Kite	839018.6	807015.4	2	50	Soaring
608	6/4/2009	950	*Phalaropus lobatus*	Red-necked Phalarope	835332.9	806741.6	5	1	Flying
609	6/4/2009	951	*Haliaeetus leucogaster*	White-bellied Sea Eagle	835089.4	806775.5	1	1	Flying
610	6/4/2009	953	*Milvus migrans*	Black Kite	834716.1	806555.7	1	100	Soaring
611	6/4/2009	959	*Egretta sacra*	Pacific Reef Egret	833851.5	806425.1	1	1	Flying
612	15/4/2009	1000	*Milvus migrans*	Black Kite	838099.3	807662.3	1	20	Flying
613	15/4/2009	1005	*Milvus migrans*	Black Kite	836386.9	806047.0	1	60	Flying
614	15/4/2009	1008	*Phalaropus lobatus*	Red-necked Phalarope	835616.4	806347.1	3	20	Flying
615	15/4/2009	1014	*Milvus migrans*	Black Kite	833982.9	807034.0	1	80	Flying
616	15/4/2009	1015	*Milvus migrans*	Black Kite	833847.7	806413.5	1	20	Flying
617	15/4/2009	1015	*Milvus migrans*	Black Kite	834110.4	806895.3	1	30	Flying
618	15/4/2009	1018	*Egretta sacra*	Pacific Reef Egret	833827.3	805870.2	1	2	Flying
619	15/4/2009	1018	*Milvus migrans*	Black Kite	834004.3	806463.6	4	100	Soaring
620	15/4/2009	1021	*Haliaeetus leucogaster*	White-bellied Sea Eagle	834038.0	805660.0	1	75	Flying
621	15/4/2009	1023	*Phalaropus lobatus*	Red-necked Phalarope	834062.1	804904.4	2	1	Flying
622	15/4/2009	1024	*Milvus migrans*	Black Kite	834367.5	804780.0	1	30	Soaring
623	15/4/2009	1029	*Milvus migrans*	Black Kite	835124.2	805063.0	1	50	Flying
624	15/4/2009	1032	*Phalaropus lobatus*	Red-necked Phalarope	835756.9	805092.0	2	0	Resting
625	15/4/2009	1033	*Phalaropus lobatus*	Red-necked Phalarope	835802.0	804415.1	1	1	Flying
626	15/4/2009	1035	*Phalaropus lobatus*	Red-necked Phalarope	836533.4	804838.4	1	0	Foraging
627	15/4/2009	1037	*Phalaropus lobatus*	Red-necked Phalarope	837325.7	804798.3	1	0	Resting
628	15/4/2009	1041	*Phalaropus lobatus*	Red-necked Phalarope	837451.9	804497.3	2	1	Flying
629	15/4/2009	1044	*Phalaropus lobatus*	Red-necked Phalarope	838015.2	803852.0	1	1	Flying
630	15/4/2009	1050	*Glareola maldivarum*	Oriental Pratincole	837133.6	803487.7	1	1	Flying
631	15/4/2009	1053	*Sterna aleutica*	Aleutian Tern	836924.7	803591.2	1	10	Flying
632	15/4/2009	1054	*Milvus migrans*	Black Kite	836196.9	803132.6	1	10	Soaring
633	15/4/2009	1119	*Milvus migrans*	Black Kite	830211.0	802810.2	1	50	Flying
634	15/4/2009	112	*Hirundo rustica*	Barn Swallow	826179.1	803729.0	2	2	Flying
635	15/4/2009	1130	*Phalaropus lobatus*	Red-necked Phalarope	826705.2	804063.2	2	0	Swimming

No.	Date	Time	Species Name	Common Name	Bird Coordinates		Group Size	Elevation	Activity
					X	Y			
636	15/4/2009	1133	*Phalaropus lobatus*	Red-necked Phalarope	826897.0	804122.9	1	0	Resting
637	15/4/2009	1138	*Phalaropus lobatus*	Red-necked Phalarope	827426.7	805493.0	3	1	Flying
638	15/4/2009	1139	*Milvus migrans*	Black Kite	827570.2	805388.2	1	100	Flying
639	15/4/2009	1153	*Milvus migrans*	Black Kite	829036.1	805453.8	2	10	Flying
640	15/4/2009	1156	*Milvus migrans*	Black Kite	828874.4	806772.4	1	10	Flying
641	15/4/2009	1206	*Hirundo rustica*	Barn Swallow	826660.4	806046.4	1	1	Flying
642	15/4/2009	1231	*Hirundo rustica*	Barn Swallow	825798.8	808063.9	1	5	Flying
643	15/4/2009	1246	*Milvus migrans*	Black Kite	829092.4	809511.4	2	50	Soaring
644	15/4/2009	1250	*Egretta garzetta*	Little Egret	829523.0	809558.3	1	5	Flying
645	15/4/2009	1250	*Milvus migrans*	Black Kite	827900.2	809485.5	1	20	Flying
646	15/4/2009	1255	*Milvus migrans*	Black Kite	828385.1	810850.9	4	100	Soaring
647	15/4/2009	1257	*Egretta garzetta*	Little Egret	828057.7	810918.6	1	3	Flying
648	15/4/2009	1310	*Milvus migrans*	Black Kite	827481.0	813129.0	1	20	Flying
649	15/4/2009	1313	*Milvus migrans*	Black Kite	828263.9	812965.0	1	5	Flying
650	15/4/2009	1314	*Milvus migrans*	Black Kite	828621.9	813205.6	1	5	Flying
651	15/4/2009	1316	*Milvus migrans*	Black Kite	828892.6	813186.8	5	10	Soaring
652	15/4/2009	1327	*Milvus migrans*	Black Kite	831309.7	812241.9	1	30	Flying
653	15/4/2009	1328	*Egretta garzetta*	Little Egret	831627.4	812303.9	1	20	Flying
654	15/4/2009	1329	*Milvus migrans*	Black Kite	827777.5	812695.5	1	10	Flying
655	15/4/2009	1330	*Egretta garzetta*	Little Egret	830218.2	812530.3	2	10	Flying
656	15/4/2009	1330	*Milvus migrans*	Black Kite	831805.7	812080.2	9	120	Soaring
657	15/4/2009	1332	*Egretta garzetta*	Little Egret	832155.9	811514.8	1	10	Flying
658	15/4/2009	1332	*Egretta garzetta*	Little Egret	832237.5	812106.6	1	10	Flying
659	15/4/2009	1334	*Milvus migrans*	Black Kite	832503.4	811878.6	1	5	Flying
660	15/4/2009	1336	*Milvus migrans*	Black Kite	832872.8	811047.2	1	30	Flying
661	15/4/2009	1339	*Milvus migrans*	Black Kite	833364.2	810698.3	1	5	Flying
662	15/4/2009	1346	*Milvus migrans*	Black Kite	834636.3	809922.1	5	100	Flying
663	15/4/2009	932	*Milvus migrans*	Black Kite	835847.7	809773.8	1	10	Flying
664	15/4/2009	933	*Milvus migrans*	Black Kite	836222.0	809778.2	1	20	Flying
665	15/4/2009	934	*Milvus migrans*	Black Kite	836483.2	809644.0	1	40	Flying
666	15/4/2009	936	*Milvus migrans*	Black Kite	836794.6	809385.3	2	100	Soaring
667	15/4/2009	937	*Milvus migrans*	Black Kite	837035.0	809044.3	1	30	Flying
668	15/4/2009	947	*Milvus migrans*	Black Kite	838516.6	807772.5	1	100	Flying
669	15/4/2009	952	*Milvus migrans*	Black Kite	839114.6	806881.1	2	40	Flying
670	21/4/2009	1050	*Numenius madagascariens**	Eastern Curlew	825871.8	807955.5	22	100	Flying
671	21/4/2009	1100	*Milvus migrans*	Black Kite	824610.2	807821.1	1	50	Soaring
672	21/4/2009	1100	*Milvus migrans*	Black Kite	823050.3	807758.5	1	50	Flying
673	21/4/2009	1118	*Hirundo rustica*	Barn Swallow	822811.9	806925.7	1	10	Flying
674	21/4/2009	1138	*Hirundo rustica*	Barn Swallow	827311.3	806828.0	1	2	Flying
675	21/4/2009	1149	*Milvus migrans*	Black Kite	829605.9	806083.3	1	80	Soaring
676	21/4/2009	1151	*Milvus migrans*	Black Kite	829537.2	805519.7	1	30	Soaring
677	21/4/2009	1155	*Milvus migrans*	Black Kite	829342.5	804473.8	1	30	Flying
678	21/4/2009	1157	*Hirundo rustica*	Barn Swallow	829347.5	804646.1	1	10	Flying
679	21/4/2009	1200	*Milvus migrans*	Black Kite	828214.5	804436.3	2	50	Flying
680	21/4/2009	1205	*Milvus migrans*	Black Kite	826624.5	804409.7	1	30	Flying
681	21/4/2009	1207	*Milvus migrans*	Black Kite	826443.4	804610.7	3	40	Flying
682	21/4/2009	1226	*Milvus migrans*	Black Kite	821905.7	804571.0	1	20	Flying
683	21/4/2009	1252	*Milvus migrans*	Black Kite	825876.5	802846.7	2	30	Flying
684	21/4/2009	1349	*Sterna hirundo*	Unidentified Terns	838103.8	802274.0	5	5	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Bird Coordinates Y	Group Size	Elevation	Activity
685	21/4/2009	1412	*Milvus migrans*	Black Kite	835876.4	803730.9	1	50	Soaring
686	21/4/2009	1436	*Milvus migrans*	Black Kite	835859.9	806523.9	1	40	Flying
687	21/4/2009	1445	*Milvus migrans*	Black Kite	837804.1	806450.4	2	30	Flying
688	21/4/2009	1448	*Milvus migrans*	Black Kite	838490.7	806642.5	1	40	Flying
689	21/4/2009	1454	*Milvus migrans*	Black Kite	838691.5	807801.1	1	100	Flying
690	21/4/2009	1457	*Haliaeetus leucogaster*	White-bellied Sea Eagle	837813.8	808301.8	1	40	Flying
691	21/4/2009	1457	*Milvus migrans*	Black Kite	837813.8	808301.8	1	40	Flying
692	21/4/2009	1502	*Milvus migrans*	Black Kite	837156.5	808850.7	1	50	Flying
693	21/4/2009	1507	*Milvus migrans*	Black Kite	835970.8	809844.1	1	30	Flying
694	21/4/2009	951	*Egretta garzetta*	Little Egret	831283.2	812406.0	2	20	Flying
695	21/4/2009	951	*Egretta garzetta*	Little Egret	831010.9	813077.6	1	10	Flying
696	8/5/2009	1018	*Milvus migrans*	Black Kite	838157.4	805340.4	2	20	Foraging
697	8/5/2009	1032	*Milvus migrans*	Black Kite	837186.9	805003.9	1	80	Flying
698	8/5/2009	1100	*Sterna sumatrana*	Black-naped Tern	831578.1	803410.7	7	5	Flying
699	8/5/2009	1112	*Milvus migrans*	Black Kite	829089.3	803712.5	1	1	Flying
700	8/5/2009	1117	*Phalaropus lobatus*	Red-necked Phalarope	828407.6	802800.3	1	20	Flying
701	8/5/2009	1118	*Sterna hirundo*	Common Tern	828125.9	802245.8	4	10	Flying
702	8/5/2009	1121	*Sterna hirundo*	Common Tern	827072.7	802486.6	1	20	Flying
703	8/5/2009	1127	*Milvus migrans*	Black Kite	827199.6	803852.1	1	50	Flying
704	8/5/2009	1139	*Sterna sumatrana*	Black-naped Tern	828974.8	805779.0	7	10	Flying
705	8/5/2009	1139	*Sterna sumatrana*	Black-naped Tern	828801.0	805594.0	7	20	Flying
706	8/5/2009	1141	*Milvus migrans*	Black Kite	828555.2	806014.6	1	20	Soaring
707	8/5/2009	1146	*Sterna sumatrana*	Black-naped Tern	827233.7	806085.4	8	20	Flying
708	8/5/2009	1158	*Chlidonias leucopterus*	White-winged Tern	824849.9	806542.6	10	10	Flying
709	8/5/2009	1204	*Sterna dougallii*	Roseate Tern	824204.2	807403.2	10	1	Resting
710	8/5/2009	1204	*Sterna sumatrana*	Black-naped Tern	824204.2	807403.2	10	1	Resting
711	8/5/2009	1215	*Chlidonias leucopterus*	White-winged Tern	825166.5	807339.4	3	5	Flying
712	8/5/2009	1216	*Sterna sumatrana*	Black-naped Tern	825465.3	807609.6	1	5	Flying
713	8/5/2009	1225	*Milvus migrans*	Black Kite	826676.7	807928.3	1	30	Flying
714	8/5/2009	1232	*Phalaropus lobatus*	Red-necked Phalarope	827804.5	808540.0	7	1	Flying
715	8/5/2009	1234	*Milvus migrans*	Black Kite	828393.9	808932.5	2	80	Soaring
716	8/5/2009	1239	*Milvus migrans*	Black Kite	828794.9	809506.6	1	80	Flying
717	8/5/2009	1241	*Milvus migrans*	Black Kite	828679.8	810217.5	2	100	Flying
718	8/5/2009	1244	*Sterna sumatrana*	Black-naped Tern	828353.7	810889.5	1	5	Flying
719	8/5/2009	1245	*Milvus migrans*	Black Kite	828345.3	810752.1	1	10	Flying
720	8/5/2009	1258	*Milvus migrans*	Black Kite	827215.0	812446.1	1	100	Flying
721	8/5/2009	1304	*Phalaropus lobatus*	Red-necked Phalarope	827784.3	813029.0	1	8	Flying
722	8/5/2009	1308	*Milvus migrans*	Black Kite	828651.7	812822.5	1	40	Flying
723	8/5/2009	1314	*Chlidonias leucopterus*	White-winged Tern	829986.8	812761.5	100	10	Flying
724	8/5/2009	1324	*Egretta garzetta*	Little Egret	831983.9	811963.0	2	10	Flying
725	8/5/2009	1326	*Egretta garzetta*	Little Egret	832194.4	811672.6	4	10	Flying
726	8/5/2009	1332	*Milvus migrans*	Black Kite	833026.4	810673.3	1	20	Flying
727	8/5/2009	1335	*Milvus migrans*	Black Kite	833551.0	810540.5	2	10	Flying
728	8/5/2009	1340	*Family Ardeidae*	Unidentified Egrets	834109.1	809755.7	7	50	Flying
729	8/5/2009	1342	*Egretta sacra*	Pacific Reef Egret	834849.2	809778.6	1	1	Foraging
730	8/5/2009	926	*Milvus migrans*	Black Kite	836059.6	809635.1	1	1	Flying
731	8/5/2009	929	*Milvus migrans*	Black Kite	836776.1	809099.2	1	100	Flying
732	8/5/2009	931	*Milvus migrans*	Black Kite	836886.0	809180.3	6	150	Soaring
733	8/5/2009	935	*Corvus macrorhynchus*	Large-billed Crow	837328.7	808687.6	1	10	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates		Group Size	Elevation	Activity
					X	Y			
734	8/5/2009	936	*Milvus migrans*	Black Kite	838080.3	809862.4	2	50	Flying
735	8/5/2009	938	*Milvus migrans*	Black Kite	837993.6	809221.0	2	100	Flying
736	8/5/2009	942	*Milvus migrans*	Black Kite	838878.2	808277.5	4	50	Flying
737	8/5/2009	944	*Milvus migrans*	Black Kite	838386.5	807621.4	1	20	Flying
738	8/5/2009	947	*Sterna sumatrana*	Black-naped Tern	838280.0	807226.0	1	10	Flying
739	8/5/2009	949	*Milvus migrans*	Black Kite	837213.7	806974.3	1	40	Flying
740	8/5/2009	956	*Milvus migrans*	Black Kite	835774.0	807371.6	1	30	Flying
741	8/5/2009	958	*Phalaropus lobatus*	Red-necked Phalarope	835693.1	808050.2	1	0	Flying
742	11/5/2009	1007	*Phalaropus lobatus*	Red-necked Phalarope	827232.1	809632.0	4	1	Flying
743	11/5/2009	1010	*Milvus migrans*	Black Kite	828091.7	809456.0	2	60	Soaring
744	11/5/2009	1014	*Milvus migrans*	Black Kite	827671.3	808896.8	2	80	Soaring
745	11/5/2009	1027	*Milvus migrans*	Black Kite	825766.1	807329.7	1	20	Flying
746	11/5/2009	1027	*Phalaropus lobatus*	Red-necked Phalarope	825714.2	807619.2	4	1	Flying
747	11/5/2009	1029	*Hirundo rustica*	Barn Swallow	825338.2	807635.8	1	1	Flying
748	11/5/2009	1049	*Milvus migrans*	Black Kite	822510.7	806829.8	1	30	Flying
749	11/5/2009	1052	*Egretta garzetta*	Little Egret	823369.8	807131.4	1	1	Flying
750	11/5/2009	1057	*Phalaropus lobatus*	Red-necked Phalarope	823287.5	806810.5	1	0	Flying
751	11/5/2009	1105	*Milvus migrans*	Black Kite	825980.2	806829.1	1	30	Flying
752	11/5/2009	1132	*Milvus migrans*	Black Kite	827244.0	804026.5	1	50	Flying
753	11/5/2009	1137	*Chlidonias leucopterus*	White-winged Tern	827093.2	804587.5	2	0	Resting
754	11/5/2009	1139	*Chlidonias leucopterus*	White-winged Tern	826386.2	804519.0	1	5	Resting
755	11/5/2009	1139	*Stercorarius parasiticus*	Arctic Skua	826487.9	804557.1	2	0	Resting
756	11/5/2009	1200	*Ixobrychus eurhythmus*	Schrenck's Bittern	822393.0	804525.7	16	50	Flying
757	11/5/2009	1205	*Sterna hirundo*	Common Tern	821831.7	804327.0	1	10	Flying
758	11/5/2009	1211	*Sterna aleutica*	Aleutian Tern	821691.2	802841.5	1	0	Resting
759	11/5/2009	1212	*Sterna aleutica*	Aleutian Tern	821597.9	802543.9	1	0	Resting
760	11/5/2009	1214	*Chlidonias leucopterus*	White-winged Tern	822216.9	802574.0	16	10	Flying
761	11/5/2009	1215	*Sterna anaethetus*	Bridled Tern	822170.3	802571.8	2	0	Resting
762	11/5/2009	1234	*Sterna albifrons*	Little Tern	826469.9	802595.5	1	0	Resting
763	11/5/2009	1241	*Sterna bergii*	Greater Crested Tern	828390.2	802582.5	1	0	Resting
764	11/5/2009	1244	*Chlidonias leucopterus*	White-winged Tern	828851.0	802488.2	26	10	Flying
765	11/5/2009	1245	*Sterna hirundo*	Common Tern	828852.9	802568.7	1	0	Resting
766	11/5/2009	1256	*Phalaropus lobatus*	Red-necked Phalarope	831762.3	802544.9	2	1	Flying
767	11/5/2009	1320	*Sterna aleutica*	Aleutian Tern	835424.7	803882.6	1	0	Resting
768	11/5/2009	1326	*Milvus migrans*	Black Kite	833981.1	803757.2	1	10	Flying
769	11/5/2009	1328	*Phalaropus lobatus*	Red-necked Phalarope	833911.6	804560.1	1	1	Flying
770	11/5/2009	1335	*Milvus migrans*	Black Kite	833080.5	805844.4	1	100	Flying
771	11/5/2009	1338	*Milvus migrans*	Black Kite	835032.1	805996.0	1	80	Flying
772	11/5/2009	1352	*Phalaropus lobatus*	Red-necked Phalarope	836141.5	806541.6	2	0	Flying
773	11/5/2009	1402	*Milvus migrans*	Black Kite	838656.6	806260.2	1	100	Soaring
774	11/5/2009	1404	*Milvus migrans*	Black Kite	838594.2	806862.7	1	5	Flying
775	11/5/2009	1407	*Milvus migrans*	Black Kite	837921.7	807447.0	4	0	Swimming
776	11/5/2009	1409	*Egretta sacra*	Pacific Reef Egret	837906.7	807605.8	1	5	Resting
777	11/5/2009	1409	*Sterna sumatrana*	Black-naped Tern	838299.4	807805.6	2	5	Flying
778	11/5/2009	1421	*Milvus migrans*	Black Kite	835722.3	809562.6	9	100	Soaring
779	11/5/2009	1426	*Milvus migrans*	Black Kite	834951.5	809647.0	5	80	Soaring
780	11/5/2009	915	*Egretta garzetta*	Little Egret	831723.5	811257.0	2	5	Flying
781	11/5/2009	917	*Egretta garzetta*	Little Egret	830828.9	811325.8	2	5	Flying
782	11/5/2009	917	*Milvus migrans*	Black Kite	830836.6	811223.5	1	30	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates		Group Size	Elevation	Activity
					X	Y			
783	11/5/2009	919	*Egretta garzetta*	Little Egret	830741.2	811520.5	1	5	Flying
784	11/5/2009	921	*Milvus migrans*	Black Kite	830171.4	812092.1	1	10	Flying
785	11/5/2009	925	*Egretta garzetta*	Little Egret	827327.5	812623.0	1	15	Flying
786	11/5/2009	934	*Egretta garzetta*	Little Egret	828202.7	812374.7	1	10	Flying
787	11/5/2009	940	*Stercorarius parasiticus*	Arctic Skua	825934.2	812478.9	2	0	Swimming
788	11/5/2009	940	*Sterna aleutica*	Aleutian Tern	826322.9	812513.3	4	10	Flying
789	11/5/2009	943	*Phalaropus lobatus*	Red-necked Phalarope	825337.6	812458.6	8	0	Swimming
790	11/5/2009	945	*Phalaropus lobatus*	Red-necked Phalarope	825035.2	812475.7	2	0	Swimming
791	11/5/2009	950	*Sterna hirundo*	Common Tern	824942.0	811869.1	1	0	Flying
792	11/5/2009	957	*Sterna hirundo*	Common Tern	825252.3	810397.5	8	10	Resting
793	11/5/2009	958	*Sterna aleutica*	Aleutian Tern	825252.3	810397.5	2	10	Flying
794	22/5/2009	1009	*Milvus migrans*	Black Kite	824224.5	807700.7	1	10	Flying
795	22/5/2009	1016	*Milvus migrans*	Black Kite	822373.1	807165.1	1	50	Soaring
796	22/5/2009	1046	*Milvus migrans*	Black Kite	828045.2	806539.9	1	10	Soaring
797	22/5/2009	1059	*Milvus migrans*	Black Kite	829585.7	805052.1	1	20	Flying
798	22/5/2009	1108	*Chlidonias leucopterus*	White-winged Tern	827696.0	804316.2	20	20	Flying
799	22/5/2009	1117	*Milvus migrans*	Black Kite	825204.3	804310.6	1	20	Flying
800	22/5/2009	1154	*Milvus migrans*	Black Kite	824959.0	802599.9	2	60	Flying
801	22/5/2009	1159	*Sterna sumatrana*	Black-naped Tern	825751.1	802375.0	2	15	Flying
802	22/5/2009	1207	*Milvus migrans*	Black Kite	827638.6	802145.4	1	20	Flying
803	22/5/2009	1210	*Sterna hirundo*	Common Tern	828307.9	802841.9	3	15	Flying
804	22/5/2009	1258	*Sterna aleutica*	Aleutian Tern	838775.2	802587.0	1	10	Flying
805	22/5/2009	1309	*Sterna sumatrana*	Black-naped Tern	838230.5	804620.1	2	7	Flying
806	22/5/2009	1317	*Sterna sumatrana*	Black-naped Tern	836451.8	804607.4	1	8	Flying
807	22/5/2009	1323	*Sterna hirundo*	Common Tern	834928.4	804817.0	2	5	Flying
808	22/5/2009	1329	*Milvus migrans*	Black Kite	833707.1	805140.0	2	30	Soaring
809	22/5/2009	1335	*Milvus migrans*	Black Kite	833465.3	806668.1	1	10	Flying
810	22/5/2009	1342	*Milvus migrans*	Black Kite	835165.6	806801.6	2	5	Flying
811	22/5/2009	1349	*Milvus migrans*	Black Kite	836647.6	806819.3	1	5	Flying
812	22/5/2009	1403	*Milvus migrans*	Black Kite	838552.1	807771.4	1	100	Flying
813	22/5/2009	1404	*Milvus migrans*	Black Kite	838408.6	807803.8	2	100	Soaring
814	22/5/2009	1408	*Milvus migrans*	Black Kite	837868.1	808629.2	1	50	Soaring
815	22/5/2009	1414	*Haliaeetus leucogaster*	White-bellied Sea Eagle	837147.4	809060.4	1	60	Flying
816	22/5/2009	1419	*Milvus migrans*	Black Kite	835814.1	809606.7	5	80	Soaring
817	22/5/2009	849	*Egretta garzetta*	Little Egret	831577.7	812165.7	1	5	Flying
818	22/5/2009	850	*Egretta garzetta*	Little Egret	831072.5	812120.2	1	20	Flying
819	22/5/2009	850	*Milvus migrans*	Black Kite	831187.3	811960.5	1	20	Flying
820	22/5/2009	851	*Egretta garzetta*	Little Egret	831180.6	812678.5	1	30	Flying
821	22/5/2009	851	*Egretta garzetta*	Little Egret	831180.6	812678.5	1	25	Flying
822	22/5/2009	853	*Milvus migrans*	Black Kite	830580.6	812514.1	1	20	Soaring
823	22/5/2009	853	*Milvus migrans*	Black Kite	830939.3	812679.6	4	30	Flying
824	22/5/2009	854	*Egretta garzetta*	Little Egret	830487.8	812659.1	1	1	Flying
825	22/5/2009	856	*Egretta garzetta*	Little Egret	830327.9	812598.6	1	1	Flying
826	22/5/2009	856	*Milvus migrans*	Black Kite	830035.1	812502.6	1	20	Soaring
827	22/5/2009	902	*Milvus migrans*	Black Kite	829256.7	811954.4	1	30	Soaring
828	22/5/2009	905	*Milvus migrans*	Black Kite	828559.5	812388.7	1	20	Soaring
829	22/5/2009	906	*Milvus migrans*	Black Kite	828268.4	812461.9	1	10	Flying
830	22/5/2009	907	*Milvus migrans*	Black Kite	827832.1	812170.7	1	20	Flying
831	22/5/2009	911	*Milvus migrans*	Black Kite	826979.9	812808.3	2	20	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Y	Group Size	Elevation	Activity
832	22/5/2009	927	*Milvus migrans*	Black Kite	824915.3	810932.1	1	30	Soaring
833	22/5/2009	934	*Bubulcus ibis*	Cattle Egret	825951.9	810529.8	8	10	Flying
834	22/5/2009	943	*Milvus migrans*	Black Kite	828133.0	810491.4	1	15	Flying
835	22/5/2009	945	*Hirundo rustica*	Barn Swallow	828687.1	810649.3	1	40	Flying
836	22/5/2009	948	*Milvus migrans*	Black Kite	828548.4	810167.1	1	20	Flying
837	22/5/2009	950	*Milvus migrans*	Black Kite	828561.6	809284.6	1	50	Soaring
838	22/5/2009	953	*Milvus migrans*	Black Kite	828272.4	808331.6	1	20	Flying
839	10/6/2009	1020	*Milvus migrans*	Black Kite	828158.3	810368.0	1	25	Flying
840	10/6/2009	1022	*Milvus migrans*	Black Kite	828245.2	810440.8	2	50	Soaring
841	10/6/2009	1101	*Sterna anaethetus*	Bridled Tern	823439.7	806326.9	1	1	Flying
842	10/6/2009	1112	*Milvus migrans*	Black Kite	825959.9	806158.2	1	50	Flying
843	10/6/2009	1116	*Milvus migrans*	Black Kite	826784.4	806148.0	1	10	Flying
844	10/6/2009	1118	*Milvus migrans*	Black Kite	827467.4	806053.3	1	10	Flying
845	10/6/2009	1131	*Milvus migrans*	Black Kite	829218.6	805128.2	1	50	Flying
846	10/6/2009	1225	*Sterna anaethetus*	Bridled Tern	826586.8	803055.6	1	0	Resting
847	10/6/2009	1309	*Sterna anaethetus*	Bridled Tern	837785.9	802543.8	1	10	Flying
848	10/6/2009	1316	*Sterna anaethetus*	Bridled Tern	837522.2	804208.3	2	0	Resting
849	10/6/2009	1334	*Milvus migrans*	Black Kite	836379.3	806515.7	1	12	Flying
850	10/6/2009	1340	*Milvus migrans*	Black Kite	837546.9	807429.2	1	8	Flying
851	10/6/2009	1350	*Milvus migrans*	Black Kite	837136.0	809082.7	1	30	Soaring
852	10/6/2009	920	*Milvus migrans*	Black Kite	831879.4	812130.8	1	8	Flying
853	10/6/2009	921	*Egretta garzetta*	Little Egret	831707.6	812195.4	1	10	Flying
854	10/6/2009	922	*Egretta garzetta*	Little Egret	831434.1	812199.8	3	15	Flying
855	10/6/2009	922	*Milvus migrans*	Black Kite	831461.1	812186.5	1	10	Flying
856	10/6/2009	928	*Egretta garzetta*	Little Egret	830621.3	813091.1	1	4	Flying
857	10/6/2009	929	*Egretta garzetta*	Little Egret	830408.7	813330.2	1	10	Flying
858	10/6/2009	956	*Milvus migrans*	Black Kite	824978.4	812333.1	1	10	Flying
859	11/6/2009	1026	*Milvus migrans*	Black Kite	828347.3	810327.8	1	40	Soaring
860	11/6/2009	1033	*Egretta garzetta*	Little Egret	828077.6	809204.9	4	10	Flying
861	11/6/2009	1033	*Haliaeetus leucogaster*	White-bellied Sea Eagle	828077.6	809204.9	1	10	Flying
862	11/6/2009	1038	*Sterna dougallii*	Roseate Tern	827522.3	808461.3	2	5	Flying
863	11/6/2009	1105	*Fregata ariel*	Lesser Frigate Bird	823819.9	806634.9	1	50	Flying
864	11/6/2009	1157	*Sterna anaethetus*	Bridled Tern	824737.0	804615.5	1	2	Flying
865	11/6/2009	1212	*Sterna anaethetus*	Bridled Tern	823500.4	803457.2	2	20	Flying
866	11/6/2009	1323	*Milvus migrans*	Black Kite	838748.5	804173.5	1	10	Flying
867	11/6/2009	1359	*Milvus migrans*	Black Kite	834130.2	807446.5	2	100	Flying
868	11/6/2009	1411	*Milvus migrans*	Black Kite	836608.6	806716.4	1	10	Flying
869	11/6/2009	1413	*Sterna sumatrana*	Black-naped Tern	837436.6	806736.3	1	5	Flying
870	11/6/2009	1416	*Milvus migrans*	Black Kite	837837.7	806720.0	1	50	Flying
871	11/6/2009	1420	*Milvus migrans*	Black Kite	837075.7	806744.5	2	50	Flying
872	11/6/2009	1427	*Milvus migrans*	Black Kite	838358.1	808029.8	1	1	Foraging
873	11/6/2009	1428	*Milvus migrans*	Black Kite	838129.6	807911.0	1	50	Flying
874	11/6/2009	1430	*Corvus macrorhynchus*	Large-billed Crow	838037.4	808226.8	2	5	Flying
875	11/6/2009	1431	*Haliaeetus leucogaster*	White-bellied Sea Eagle	837868.4	808506.7	1	0	Resting
876	11/6/2009	1431	*Milvus migrans*	Black Kite	837868.4	808506.7	2	0	Resting
877	11/6/2009	1441	*Milvus migrans*	Black Kite	836633.1	809970.7	1	10	Flying
878	11/6/2009	1443	*Egretta sacra*	Pacific Reef Egret	835608.8	810082.8	1	1	Flying
879	11/6/2009	937	*Egretta garzetta*	Little Egret	830634.7	812528.5	1	10	Flying
880	17/6/2009	1004	*Milvus migrans*	Black Kite	833557.3	805229.5	1	20	Flying

No.	Date	Time	Species Name	Common Name	Bird Coordinates X	Y	Group Size	Elevation	Activity
881	17/6/2009	1016	*Sterna anaethetus*	Bridled Tern	834864.5	802561.5	2	2	Flying
882	17/6/2009	1231	*Sterna sumatrana*	Black-naped Tern	829339.0	804783.5	1	0	Resting
883	17/6/2009	1238	*Milvus migrans*	Black Kite	829616.4	806284.0	1	10	Flying
884	17/6/2009	1336	*Egretta garzetta*	Little Egret	827996.7	808305.4	1	1	Flying
885	17/6/2009	1339	*Milvus migrans*	Black Kite	828393.9	808959.8	1	40	Soaring
886	17/6/2009	1343	*Milvus migrans*	Black Kite	828715.3	810221.1	28	30	Foraging
887	17/6/2009	1435	*Egretta garzetta*	Little Egret	830773.7	812304.6	1	2	Flying
888	17/6/2009	1440	*Milvus migrans*	Black Kite	831473.2	811895.8	1	25	Flying
889	17/6/2009	1441	*Egretta garzetta*	Little Egret	831653.9	811671.8	1	20	Flying
890	17/6/2009	1445	*Egretta garzetta*	Little Egret	832128.5	810879.7	2	0	Resting
891	17/6/2009	1453	*Milvus migrans*	Black Kite	833494.3	810106.2	1	5	Foraging
892	17/6/2009	920	*Milvus migrans*	Black Kite	836697.1	809166.6	1	20	Soaring
893	17/6/2009	926	*Milvus migrans*	Black Kite	838383.4	808403.3	1	50	Flying
894	17/6/2009	935	*Milvus migrans*	Black Kite	838921.4	806727.2	1	15	Soaring
895	17/6/2009	938	*Milvus migrans*	Black Kite	837737.7	806646.0	1	20	Flying
896	17/6/2009	940	*Milvus migrans*	Black Kite	838018.1	806742.4	1	30	Flying
897	17/6/2009	951	*Milvus migrans*	Black Kite	834769.1	806399.1	1	60	Flying
898	17/6/2009	955	*Milvus migrans*	Black Kite	833554.3	806835.5	2	60	Flying
899	17/6/2009	957	*Milvus migrans*	Black Kite	833479.9	806569.4	1	20	Flying

CONTENTS

9 MARINE ECOLOGY ASSESSMENT

9.1 INTRODUCTION

This section of the EIA report presents the findings of the marine ecological impact assessment associated with the construction and operation of the proposed offshore wind farm. It summarises baseline information on the potentially affected marine ecological resources and also presents the findings of a field survey programme. Detailed information on the baseline conditions and results of the field surveys are presented in *Annex 9A*.

9.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

The criteria for evaluating marine ecological impacts are laid out in the *EIAO-TM* and Study Brief (no. *ESB-151/2006*). *Annex 16* of the *EIAO-TM* sets out the general approach and methodology for assessment of marine ecological impacts arising from a project or proposal. This assessment allows a complete and objective identification, prediction and evaluation of the potential marine ecological impacts. *Annex 8* of the *EIAO-TM* recommends the criteria that can be used for evaluating marine ecological impacts.

Legislative requirements and evaluation criteria relevant to the study for the protection of species and habitats of marine ecological importance are summarised below. The details on each are presented in *Annex 9A*.

1. *Marine Parks Ordinance (Cap 476);*
2. *Wild Animals Protection Ordinance (Cap 170);*
3. *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586);*
4. *Town Planning Ordinance (Cap 131);*
5. *Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG);*
6. *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAOTM);*
7. *United Nations Convention on Biodiversity (1992);*
8. *Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention); and,*
9. *PRC Regulations and Guidelines.*

9.3 *Summary of Baseline Conditions*

The wind farm and cable route are located in the waters between Lamma Island and Cheung Chau lying adjacent to the Southwest Lamma Channel. The closest distance of the site to land is approximately 3.5 km to Lamma Island. The water depth at the site ranges from -18 to -23mPD.

The findings of the literature review and field surveys and, an evaluation of the ecological importance of marine resources within the Study Area are summarised in the following section. The details are presented in full in *Annex 9A*. The ecological resources and importance of marine habitats have been characterised with reference to the available literature, comprehensive seasonal field surveys, comparisons with other similar habitats in Hong Kong and the criteria presented in *Annexes 8* and *16* of the *Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAOTM)*.

Detailed and comprehensive seasonal surveys were conducted examining the major habitats and species in the marine environment surrounding the wind farm site and cable route. The baseline surveys have included both the dry and wet seasons. The findings of the field surveys are presented in *Annex 9A*.

The marine ecological habitats in the immediate vicinity of the wind farm site and cable route off Southwest Lamma have undergone some degree of anthropogenic disturbance through reclamation for the Lamma Power Station Extension and marine traffic through the West Lamma Channel.

The key finding of the literature review was the recorded presence of finless porpoise *Neophocaena phocaenoides* in the waters of the Study Area and inter-nesting green turtles *Chelonia mydas* in waters south and southeast of Lamma Island. Although Indo-Pacific humpback dolphins *Sousa chinensis* have been recorded to the south of Lamma Island, these sightings are very scarce and this area is considered to represent the eastern limit of the species and hence does not constitute an important area for the species. The review highlighted that finless porpoises have been sighted regularly within the areas surrounding the proposed wind farm site and the cable route. The following assessment therefore focuses of potential impacts to the finless porpoise *Neophocaena phocaenoides*. Mitigation measures designed to protect porpoises, however, could be expected to also provide suitable protection to dolphins should they be present in the area at the time of works.

Due to the limited literature available for some components of the marine environment, field surveys were necessary to fill the information gaps identified for the baseline conditions of the habitats. The baseline surveys commenced in October 2008 and have included both the dry and wet seasons. These focussed seasonal surveys were conducted to characterise major marine assemblages and species within and surrounding the wind farm site and cable route. Details of the baseline surveys conducted for this EIA are summarised in *Annex 9A*.

Table 9.1 ***Marine Ecology Baseline Surveys***

Survey Type	Methodology	Date
Intertidal Assemblages	Quantitative (belt transects) survey, three 100 m belt transects (at high, mid and low intertidal zones), covering both wet and dry seasons.	28 October 2008 and 27 February 2009
Subtidal Benthic Assemblages	Quantitative grab sampling survey; covered both wet and dry seasons. 10 stations sampled to represent the wind farm site, cable route and reference sites, covering both wet and dry seasons.	19 October 2008 and 19 March 2009.
	Drop camera survey	19 March 2009
Nearshore dive surveys	Quantitative (Rapid Ecological Assessment (REA) technique) and qualitative (recorded within Study Area and areas in the vicinity)	4 and 5 May 2009
Marine Mammal*	Quantitative vessel based survey using line transect methods spanning Hong Kong southern waters 1 day a month for 6 months.	24 December 2008, 16 January 2009, 13 February 2009, 13 March 2009, 15 April 2009 and 11 May 2009.
	Qualitative vessel-based survey around Lamma Island*	July to October 2008, and in June 2009, in the following dates: 24, 26, 28 July 2008, 15, 21, 25 August 2008, 4, 11, 26 September 2008, 6, 17, 20 October 2008, and 10, 11, 17 June 2009

*Remarks: Due to the extensive data available through the AFCD's long-term marine mammal monitoring programme, a six month quantitative survey programme was recommended to supplement the existing dataset during the peak seasons (winter/spring) of Finless Porpoise (December to May). In addition, qualitative vessel-based survey programme was also conducted to cover the non-peak seasons (July to October). This proposed survey period covered all seasons, as per the Study Brief requirement, and was considered sufficient to characterise existing and historical marine mammal use of the waters of the Study Area.

9.3.1 Ecological Importance

The ecological importance of the habitats was determined through reference to the following:

- Literature review;
- Findings of the field surveys;
- Comparison with other areas in Hong Kong; and,
- *Annexes 8* and *16* of the *EIAO TM*.

Key findings and outcomes of the evaluation of ecological importance are summarised below.

Intertidal Hard Bottom Assemblages

Seasonal quantitative transect surveys were conducted on the artificial seawall of the Lamma Power Station Extension. Rocky shore species at all survey transects were common and widespread and no protected species or those of conservation interest were recorded. The assemblages recorded are considered to be of low diversity and low ecological importance.

Subtidal Soft Bottom Assemblages – Benthos

Seasonal systematic grab sampling was conducted within and in proximity to the footprint of the wind farm site and cable route. In both seasons, infaunal assemblages at the surveyed sites were dominated by polychaete worms, and the species recorded are common and widespread species with no particular conservation concern. The abundance, biomass and taxonomic richness of infauna at these sites are considered as very low in comparison with the Hong Kong average reported in the literature. The ecological importance of these assemblages is considered as low.

Subtidal Hard Bottom Assemblages – Coral

Qualitative and semi-quantitative REA surveys were conducted on the artificial seawall of the Lamma Power Station Extension and on hard substrate identified along the proposed cable route. Only three hard coral species were recorded on the artificial seawall, and a total of four octocoral species and one black coral species were recorded on the dumped material in vicinity of the cable route. These locally common and widerspread coral species with little conservation interest occurred as very scarce colonies with extremely low coverage. Given such low coral abundance and diversity at the surveyed sites the ecological importance of the associated assemblages is considered as low.

Sea Turtles

A small number of green turtles are known to nest on the Sham Wan beach in southern Lamma. Satellite tracking data suggested that these turtles may use the southern and southeastern waters of Lamma as inter-nesting habitats during June to October. It is noted however, that these data are initial and hence turtles may be present in other marine areas around Lamma and the nearby islands. Nevertheless the tracking data imply that turtles stay relatively close to inshore coastal areas and hence the ecological importance of waters within the wind farm footprint to sea turtles (particularly green turtles) is considered to be low.

Finless Porpoise

Quantitative grid analysis on porpoise habitat use revealed that during 2004-08, standardised porpoise sighting densities (SPSE values) were higher at the waters just south of Soko Islands, the offshore waters in Southeast Lantau, at southwest corner of Shek Kwu Chau and Cheung Chau, near Stanley Peninsula and around Po Toi Islands than in other areas of Hong Kong waters [(1)]. Vessel-based standard line transect surveys were undertaken in the Lamma Survey Area over a 6-month period from December 2008 to May 2009 (Winter / Spring). A total of five groups of porpoises (total abundance = 13 individuals) were sighted on-effort during the surveys. Additional data was also collected during Summer and Autumn months during the qualitative surveys. During this period one group of porpoises was recorded (total abundance = 2 individuals).

Quantitative survey data were combined with AFCD's long-term porpoise monitoring data from December 1999 for quantitative grid analysis, and the results showed that the porpoise densities (SPSE values) were considered as moderate to high and low to moderate for the proposed wind farm site and along cable route respectively. The ecological importance of these areas is considered as medium-high and low-medium respectively (*Table 9.2*).

Table 9.2 Ecological Importance of the Marine Habitats

Habitat	Ecological Importance Wind Farm Site	Ecological Importance Cable Route
Artificial Shoreline	N/A	Low
Subtidal Soft Bottom Habitats	Low	Low
Subtidal Hard Surface Habitat	Low	Low
Marine Waters	**Medium – High** for *Neophocaena phocaenoides* and **Low** for *Chelonia mydas*	**Low – Medium** for *Neophocaena phocaenoides* and **Low** for *Chelonia mydas*

9.3.2 Marine Ecological Sensitive Receivers

Based on the results of the marine ecological surveys and a review of the available information on existing conditions in the Study Area, the key sensitive receivers that may be affected by the proposed works associated with the Project are identified as follows:

- Finless Porpoise habitat within and around the wind farm site; and,
- The Potential Southwest Lamma Marine Park; and,
- Sea Turtles.

(1) Hung SK (2009) Monitoring of Marine Mammals in Hong Kong Waters - Data Collection: Final Report (2008-09). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 128 pp

The locations of the sensitive receivers identified are shown in *Figure 6.4* (see *Section 6*).

9.4 ASSESSMENT METHODOLOGY

A desktop literature review and supporting field surveys (summarised in *Section 9.3* and detailed in full in *Annex 9A*) were conducted in order to establish the ecological profile of the Study Area. The Study Area for the ecological assessment covers a large area of open water to provide information on the distribution on local habitats that could be affected by development proposals and also to ensure that linkages to wider habitats that could be affected by water quality impacts are considered. This relatively wide Study Area, the same as adopted for the water quality impact assessment (*Section 6*) also ensures that consideration is given to mobile species that are present in the area. The importance of potentially impacted ecological resources identified within the Study Area was assessed using the methodology defined in the *EIAO-TM*. The potential impacts due to the construction and operation of the wind farm and associated infrastructure were then assessed (following the *EIAO-TM Annex 16* guidelines) and the impacts evaluated (based on the criteria in *EIAO-TM Annex 8*).

9.5 POTENTIAL SOURCES OF IMPACT ON MARINE INTERTIDAL AND SUBTIDAL RESOURCES

9.5.1 Construction Phase

Potential impacts to marine ecological resources arising from the construction works may be divided into those due to direct disturbances to the habitat, and those due to perturbations to key water quality parameters. Potential impacts to marine mammals and sea turtles are discussed separately.

As discussed in *Section 5*, the construction of the proposed offshore wind farm will involve removal of the seawall at Lamma Power Station Extension, dredging and jetting for cable installation and the construction of foundations for the wind turbines, offshore wind monitoring mast and offshore substation. Impacts associated with the proposed wind farm are thus divided into those occurring during:

- Removal of the existing Lamma Power Station Extension sea wall;
- Dredging and jetting for cable installation and construction of foundations for wind turbines, the wind monitoring mast and the offshore substation.

Removal of the existing Lamma Power Station Extension Sea Wall

In order to connect the submarine cable to land, the existing rubble mound seawall at the west shore of the Lamma Power Station Extension will be exposed for installation of a steel cable slipway. Approximately 2,145 m^3 of existing seawall will be removed as part of the works. All removed seawall material will be reused to reinstate the sea wall back to the existing condition.

Impacts to the marine ecological resources potentially arising from sea wall removal and reinstatement are as follows and summarised in *Table 9.3*.

Table 9.3 ***Summary of Potential Construction Phase Impacts associated with Seawall Removal and Reinstatement***

Nature of Impact	Marine Habitat Affected	Potential Impact
Habitat Loss	Intertidal Artificial Shore	Temporary loss of approximately 0.004 ha of sea wall habitat
	Subtidal Hard Bottom Habitat	Temporary loss of approximately 0.03 ha of sea wall habitat
Short term Changes in Water Quality	Subtidal Hard Bottom Habitat	Potential water quality impacts on subtidal organisms
	Intertidal Artificial Shore	Potential water quality impacts on intertidal organisms

Habitat Loss

Subtidal Hard Surface Habitats *(including Corals)*

The removal of the seawall will lead to a temporary loss of low ecological value subtidal hard surface habitats. Although isolated colonies of corals have been recorded in this area, they are composed of common species with very low abundance and diversity.

The reinstatement of the seawall with existing materials once the steel cable slipway has been constructed will mean that there will be no long term change in the amount of available hard substrate habitat. It is anticipated that assemblages of subtidal organisms, including corals, will settle on and recolonise the newly constructed seawall, as environmental conditions of that area would be similar to existing conditions that have allowed the colonisation and growth of subtidal organisms.

Intertidal Artificial Shore Habitat

A length of approximately 16.5 m of low ecological value artificial rocky shore will be temporarily lost as a result of seawall removal activities for cable landing. The results from field surveys indicated that the intertidal assemblages recorded on the rocky shores are typical of semi-exposed rocky shore communities observed in Hong Kong. No rare or protected species were noted. The reinstatement of the seawall with materials that have been removed will mean that there will be no long term change in the amount of available artificial intertidal shore habitat. Organisms present on intertidal shores in Hong Kong rely on larval settlement for recruitment. Assuming that there is a regular supply of larvae brought to the area, recolonisation of new seawalls will occur.

Changes in Water Quality

The area that will be disturbed by construction works consists of boulders that form the seawall structure. Removal of the seawall is therefore unlikely to release significant quantities of fine sediments into the water column. Therefore water quality impacts associated with sea wall removal are expected to be negligible.

Dredging and Jetting for Cable Installation and the Construction of Foundations

There will be a requirement to undertake grab dredging within approximately 100 m of the Lamma Power Station Extension Seawall for cable installation and preparation for cable landing. Offshore of this area jetting will be required to install cables to offshore substation and within the turbine array (see *Section 5*).

Impacts to the marine ecological resources potentially arising from dredging and jetting activities are as follows and summarised in *Table 9.4*.

Table 9.4 Summary of Potential Construction Phase Impacts associated with Dredging and Jetting Activities

Nature of Impact	Marine Habitat Affected	Potential Impact
Habitat Loss	Subtidal Soft Bottom Habitat	Temporary loss of a maximum of 0.99 ha of seabed associated with dredging (0.12 ha) and jetting (0.87 ha) Permanent loss of a maximum of 3.6 ha of seabed (assuming the construction of scour material) or maximum of 0.16 ha of habitat (without scour protection).
	Subtidal Hard Bottom Habitat	Permanent loss of very small patches of hard substrate formed by dumped material in vicinity of the cable route.
Short term Changes in Water Quality	Subtidal Soft Bottom Habitat	Potential deposition of sediment on benthic organisms during dredging/jetting
	Subtidal Hard Bottom Habitat	Potential water quality impacts on subtidal organisms
	Intertidal Artificial Shore	Potential water quality impacts on intertidal organisms

Habitat Loss

Subtidal Soft Bottom Habitats

Primary impacts will be associated with the temporary disturbance of sediments during grab dredging and jetting, potential removal of organisms during dredging and permanent loss of habitats associated with the construction of wind farm foundations.

It is important, therefore, to determine whether the areas of disturbance contain unique or otherwise noteworthy benthic assemblages, which will be lost. Findings from the literature review, supplemented by focussed field surveys, indicate that the benthic assemblage within and in the vicinity of the working areas were dominated by polychaetes and characterised by low species diversity and biomass as found elsewhere in Hong Kong. All of the species recorded occur frequently in Hong Kong and no rare species were observed. As a result, the assemblages were regarded as being of low ecological value.

It is expected that the disturbed areas within the footprint of dredging or jetting works will naturally be reinstated through sediment infill. This will occur very rapidly for jetting activities during the works as disturbed sediments will subsequently settle over the cables. For grab dredging, the reinstatement may take longer, but it is likely that the seabed will return to its existing state in the short term due to the highly mobile nature of sediments in the area.

It is expected that the direct impacts to subtidal soft bottom habitats include the permanent loss of 0.09 ha of marine habitat due to the installation of each foundation (taking monopile foundations with scour protection as the worst case scenario). A total of 3.6 ha of habitat could therefore be lost. If scour protection is not needed, then only a total of 0.16 ha of seabed would be permanently lost. The seabed at the wind farm site and along the cable route is common to Hong Kong and the loss of this habitat is therefore considered to be of minor significance.

The soft bottom habitat will be replaced by hard rock bottom habitat, which has potential for colonisation, generation of new biomass and increased productivity in the area (see *Section 9.5.2*).

Subtidal Hard Surface Habitats *(including Corals)*

Small patches of dumped material [1] were recorded in vicinity to the cable route in the area where jetting is proposed (see *Annex 9A*). Dive surveys carried out at these points confirmed that these areas appeared to have been disturbed by trawling activity. The survey also confirmed that although hard substrate was recorded in these areas, the seabed is predominantly composed of soft muddy habitat. Abundance and species diversity of epibenthic fauna in these areas was low and largely composed of sparse records of gorgonians. All of the species recorded occur frequently in Hong Kong and no rare species were observed. Given that the jetting works for cable installation will be completed in a short period of time and the assemblages were regarded as being of low ecological value the impact is not considered to be unacceptable.

Changes in Water Quality

(1) Classified as dumped material following a geophysical survey. More details on the geophysical surveys can be found in *Section 12 Marine Ar*chaeology.

Suspended Sediments

The modelling works have analysed suspended sediment (SS) dispersion from dredging, jetting and foundation construction activities (see *Section 6*). The following presents a discussion of the effects of predicted changes in water quality on marine ecological resources.

Subtidal Soft Benthos: The subtidal soft benthos in and around the proposed wind farm and cable route is considered to be of low ecological value (see *Annex 9A*); however, these sessile organisms will be susceptible to the effects of increased sediment loads in the water column. Sediment may also be deposited on the seabed as a result of settling of sediments disturbed during dredging/jetting.

Impacts to benthic assemblages are expected to occur over a short duration. The area is expected to be small as sediment will be deposited within a short distance of the dredging, jetting and foundation construction works. With reference to the water quality modelling results, elevations in suspended sediment levels would be localised and confined to the works area. The largest impacts are expected in the immediate vicinity of the marine construction works (in the mixing zone) with impacts on the wider marine environment (in terms of con-compliance with the expected to be negligible (see *Section 6*).

As the area is often disturbed by demersal trawling, the organisms present are thus assumed to be adapted to seabed disturbances. The affected areas will be recolonised by fauna typical of the area and hence the temporary loss of these low ecological value assemblages is deemed acceptable.

Subtidal Hard Surface Habitats (including Corals): As discussed above, small patches of hard substrate associated with dumped material were recorded in vicinity to the cable route. A dive survey of these areas identified coral assemblages of low conservation value (including soft corals, gorgonians and black corals). The dive survey also noted that these areas were subject to a large amount of fine sediment deposition with hard substrate areas covered by fine sediments. In addition, trawling activity was evident in these areas. The drop camera survey indicated that the majority of the seabed in the wind farm site and along the cable route was composed of soft sediments. The modelling study determined that relatively high levels of suspended sediment will occur in the mixing zone at the seabed adjacent to the cable route will be short term and acceptable.

The dive survey carried out at the Lamma Power Station seawall identified the presence of isolated colonies of hard corals of low ecological value on the artificial rock substrate. Modelling work has determined that grab dredging and jetting works would lead to increased suspended sediments in this area. However, impacts were seen to be very localised and transient. The main species noted from the surveys was *Oulastrea crispata*. This coral species is known to have high tolerance limits to fluctuations in salinity, sea surface temperature (daily and seasonal), sedimentation loading, total suspended sediment and light attenuation levels (see *Annex 9A*) and is most often recorded in the most marginal conditions for corals, i.e., areas of high sediment loading, and represented by scattered, small colonies in shallow, subtidal areas with few other coral species [(1)].

The deposition rates during the dry and wet seasons have been determined through modelling (see *Section 6.6.1*). There will be very localised sediment deposition of up to 300 g m^{-2} day^{-1} around the Lamma Power Station Extension seawall associated with grab dredging works. Should silt curtains (which can reduce levels of suspended sediments by up to 75%) be used during dredging works, it can be expected that sediment deposition would also be significantly reduced to below the assessment criterion of 100 g m^{-2} day^{-1} (see *Section 6.6.2* & *Table 6.6*). As such, water quality and sediment deposition impacts to these coral communities would be considered to be of minor significance through the use of silt curtains during dredging works.

Intertidal Habitats: Intertidal habitats within the Study Area, which may be affected by the dredging and jetting activities, are associated with the artificial Lamma Power Station Extension seawall. With reference to the water quality modelling results (*Section 6*), elevations in SS levels are predicted to be localised and short term. Furthermore, the adoption of appropriate mitigation, such as the use of silt curtains during dredging at the seawall area, is expected to significantly reduce the amount of sediments released in the areas where intertidal habitats are present. Due to the low quality of the intertidal habitats identified within the Study Area and transient nature of any increase in suspended sediment, adverse impacts to the intertidal assemblages are not anticipated.

Dissolved Oxygen

The relationships between suspended sediment (SS) and dissolved oxygen (DO) are complex, with increased SS in the water column combining with a number of other factors to reduce DO concentrations in the water column. Elevated SS (and turbidity) reduces light penetration, lowers the rate of photosynthesis by phytoplankton (primary productivity) and thus lowers the rate of oxygen production in the water column. This has a particularly adverse effect on the eggs and larvae of fish, as at these stages of development, high levels of oxygen in the water are required for growth due to their high metabolic rate. DO depletions are most likely to affect sessile organisms as they cannot move away from areas where DO is low (unlike mobile species such as fish).

The results of the water quality assessment (see *Section 6*) has indicated that predicted changes in DO levels would comply with the WQO at all sensitive receivers for all construction scenarios (see *Section 6*). It is expected,

(1) Chan A, Choi C, McCorry D, Chan K, Lee MW, Put A Jr (2005) *Field Guide to Hard Coral of Hong Kong*. Friends of the Country Parks

therefore, that unacceptable impacts to marine ecological habitats and populations present in the vicinity of the wind farm site and cable route, including marine mammals and sea turtle habitats, as a result of changes in DO levels are unlikely to occur.

Nutrients

High levels of nutrients (total inorganic nitrogen - TIN and ammonia) in seawater can cause rapid increases in phytoplankton to the point where an algal bloom may occur. An intense bloom of algae can lead to sharp increases in DO levels in surface water. However, at night and when these algae die there is usually a sharp decrease in the levels of dissolved oxygen in the water, as dead algae fall through the water column and decompose on the bottom. Anoxic conditions may result if DO concentrations are already low or are not replenished. This may result in mortality to marine organisms due to oxygen deprivation.

The assessment of potential increases in nutrient levels resulting from construction activities is discussed in *Section 6*. The results show that increases are predicted to be very small and compliant with the WQO. The increased level of nutrients in the water column as a result of works is considered to be of negligible significance to marine ecological resources.

Contaminant Release

Another potential impact to marine ecological resources associated with disturbance of bottom sediment is the release of potential toxic contaminants. The potential for release of contaminants from dredged sediments has been assessed in *Section 6*, whereas, a comprehensive set of data on the quality of marine sediment is provided in *Section 7.* Elutriate tests that have been carried out in the area of grab dredging show that dissolved metal concentrations for all samples are below the reporting limits. The results also show that all PAHs and PCBs and chlorinated pesticides are all below the reporting limits. This indicates that the leaching of these pollutants is unlikely to occur. Impacts to marine ecological resources due to released contaminants from dredged sediments are therefore not expected to occur.

9.5.2 Operation Phase

Hydrodynamic Regime

The presence of offshore structures may lead to changes in hydrodynamic processes. If these changes are significant there could be potential for increased current velocities and direction, which may cause scour of seabed sediments or changes to existing hydrodynamics and hence local and far-field erosion and sedimentation patterns.

The change to current velocities has been determined (see *Section 6*) and has through modelling that has indicated that the new structures will have little effect on existing hydrodynamics and hence local erosion and sedimentation patterns. There is potential for scour around the base of turbines and offshore substation. However, if significant scour is expected to occur during further assessment in the Detailed Design Phase then it is likely that scour protection will be installed to prevent such affects from occurring (see *Section 5*). In addition, scour would be short term and stop once an equilibrium condition forms (see *Section 5*).

Water Quality

Section 6 has assessed the potential for water quality impacts during the operational phase. The impacts that have been considered include:

- Increase in suspended sediment levels due to scour of seabed sediments around the base of foundations of wind turbines and offshore substation;
- Potential for vessel discharges; and,
- Discharge of other materials (oils, hydraulic fluids etc) contained within the structures.

The consideration of these impacts has determined that with the adoption of appropriate operational management procedures and other mitigation measures the potential for release would be very low. The use of scour protection at the base of foundations would reduce the potential for the release of sediments into suspension. It is therefore anticipated that negligible impacts should occur to marine ecological resources associated with water quality impacts during the operational phase.

Increased Subtidal Hard Bottom Habitat

The new offshore structures and scour protection (if used) will provide hard substrate habitat in the wind farm area. These structures could be colonised by a variety of marine organisms, including corals. There is considerable knowledge in Hong Kong and elsewhere on the colonisation of marine structures with species such as seaweeds, crustaceans, soft corals, amphipods, anemones and more mobile fauna including crabs. Studies on offshore wind farm structures at Horn's Rev offshore wind farm in Denmark and offshore monitoring mast at North Hoyle offshore wind farm in the UK noted that colonisation of structures occurred within five months with bryozoans, sea anemones, sea squirts, starfish and mussels present [(1)(2)].

It is expected that rock scour would give higher surface complexity than monopiles providing nooks and crannies between individual rocks, which would increase the attractiveness to colonising organisms. Indeed, since 1996, AFCD have been implementing an artificial reef programme in Hong Kong marine waters to improve marine organism biomass and diversity in

(1) http://www.natwindpower.com/northhoyle/environment.asp

(2) http://www.hornsrev.dk/Miljoeforhold/miljoerapporter/Hard%20Bottom%20Status%20Report%202004-R2438-03-005-rev3.pdf

these areas. Artificial reefs deployed in Hong Kong waters as part of this programme haven taken various forms, including vessels, used-tyres, concrete units and redundant marine structures [(1)].

Colonisation of these structures could provide long term benefits associated with the attraction of fish and marine invertebrates (including shrimp) into the area. This could go some way towards offsetting the loss of habitat discussed above.

9.6 *EVALUATION OF THE MARINE ECOLOGICAL IMPACTS ON INTERTIDAL AND SUBTIDAL RESOURCES*

The following section discusses and evaluates the impacts to marine ecological resources as a result of the resources identified in the previous sections. Based upon the information presented above, the significance of the marine ecological impact associated with the construction and operation of the offshore wind farm has been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows.

- *Habitat Quality*: Impacts are predicted to occur only to habitats of low ecological value (inter-tidal and subtidal). The selection of the wind farm site has avoided direct impacts to habitats of high ecological value. Operational phase impacts are not expected to impact any habitats of high ecological value.

- *Species:* Based on literature and field surveys, no organisms of ecological interest were identified in proximity to wind farm site and cable route. Marine ecological sensitive receivers were situated at distant locations from the proposed works. Although some isolated coral colonies are present, no significant construction or operational phase impacts are expected to these sensitive receivers.

- *Size:* The maximum size of the temporary loss of artificial intertidal habitats at the Lamma Power Station Extension is 0.004 ha. Subtidal soft and hard bottom habitats that will be temporarily disturbed will amount to a maximum loss of 0.99 ha. There will be a permanent loss of a maximum 3.6 ha of soft bottom habitat that will be replaced by hard bottom habitat. The significance of impacts to these areas of relatively low ecological value of benthic assemblages will be offset by the expected reinstatement and / or recovery of areas that will be disturbed (see *Reversibility*).

- *Duration:* The construction works are predicted to last for 9 months. However, individual works will only require a relatively short period of time to complete and construction phase impacts are predicted to be transient in nature as the location of the works will be changing over

(1) http://www.artificial-reef.net/English/main.htm

time. The operational phase of the wind farm will be long term (25 years) and therefore discharges and hydrodynamic impacts will continue during the life of the wind farm, but are predicted to be very minor and hence are not expected to cause adverse impacts to marine ecological resources.

- *Reversibility:* Impacts to the benthic assemblages inhabiting the soft bottom habitats within the dredged/jetting areas are expected to be relatively short term and recolonisation of the disturbed sediments is expected to occur. Similarly the low ecological value assemblages present on the artificial seawall can be expected to recolonise once the seawall is reinstated.

- *Magnitude:* No unacceptable impacts to ecologically sensitive habitats have been predicted to occur. Operational phase impacts are not expected to cause adverse impacts and are considered to be of low magnitude.

The impact assessment presented above indicates that no unacceptable impacts to marine ecological resources considered in the above sections are expected to occur. Although soft bottom habitat will be temporarily lost, it has been demonstrated through long-term monitoring of previously dredged areas and existing Contaminated Mud Pits in the East of Sha Chau area that marine organisms have recolonised the areas following the completion of the works [(1)]. As such, it is anticipated that subtidal assemblages influenced by dredging and jetting will settle on and recolonise the seabed returning it to the former conditions.

Impacts to marine ecological resources during operation of the wind farm are predicted to be minor.

9.7 POTENTIAL SOURCES OF IMPACT ON MARINE MAMMALS

In this section of the report, the potential for impacts associated with various proposed marine works and activities are examined in detail to provide an assessment of the significance of the effects on the finless porpoise. The significance of a potential impact from works or activities on marine mammals can be determined by examining the consequences of the impact on the affected animals. This is related to the source, nature, magnitude and duration of the impact, the level of exposure to the impact in terms of the number (and life-stage) of affected animals and their response to an impact.

The consequences of an impact on these marine mammals have the potential to range from behavioural changes of individual animals through to

(1) Qian PY, Qiu JW, Kennish R and Reid C. 2003. Recolonization of benthic infauna subsequent to capping of contaminated dredged material in East Sha Chau, Hong Kong. Estuarine, Coastal and Shelf Science 56: 819-831.

population level effects (1) (2) (3). The potential consequences of impacts on marine mammals are as follows:

- **Behavioural changes:** Affected individual animals may change travelling speed, dive times, avoid areas, change travel direction to evade vessels, change vocalisation due to acoustic interference, reduce resting, socialising and mother-calf nursing. Provided that disturbances leading to behavioural changes are temporary, localised and outside areas of ecological importance to marine mammals, disturbances causing behavioural changes would generally not be considered significant (i.e. effects would be of short duration, normal activities will resume with no appreciable effect on fitness or vital rates).

- **Life function immediately affected:** Avoidance of affected areas may diminish individual animals' feeding activity. Loss of a marine area to reclamation will permanently eliminate a foraging area. Similarly, disturbance/loss of prey resources due to water quality impacts may diminish available feeding opportunities in the vicinity of works. Interference with echolocation through underwater sound generation could also affect feeding. Provided that disturbances are temporary, localised and outside areas of ecological importance to marine mammals, or permanent losses of habitat represent a small portion of available habitat, impacts would generally not be considered to have a significant effect on marine mammals (i.e. effect would be short term and therefore have no appreciable effect on fitness or vital rates).

- **Fitness and Vital Rates:** If works cause widespread and prolonged adverse impacts, with limited or no alternative habitat available for animals to use, fitness and vital rates will be affected including growth rates, reproduction rates and survival rates (life-stage specific). In the same way, any works or activity likely to result in injury or mortality of marine mammals would self-evidently affect survival rates. Activities causing impacts on fitness and vital rates would be considered significant (i.e. if effects are long-term or inescapable, they will diminish the health and survival of individuals).

- **Population effect:** Impacts on the fitness and survival of individuals have the potential to, for instance, affect population growth rates and population structure. Impacts resulting in population effects would be considered significant (i.e. if effects are long term and detrimental to the population as a whole).

(1) National Research Council (2005) *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*. National Academies Press. Washington DC. 126p.

(2) Wursig B, Greene CR, Jefferson TA. 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. Marine Environmental Research 49, 79-93.

(3) Greene CR, Moore SE. 1995. Man-made noise. In: Marine Mammals and Noise. (Eds. Richardson WJ, Greene CR, Malme CI and Thomson DH). Academic Press. London, pp. 101-158.

9.7.1 *Construction Phase*

The impacts associated with the proposed wind farm development that could affect marine mammals will include:

- Dredging and jetting for cable installation; and
- The construction of foundations for wind turbines and associated infrastructure (ie monitoring mast and offshore substation).

Dredging and jetting for cable installation

There will be a temporary disturbance 0.99 ha of subtidal soft bottom and hard bottom habitat associated with the dredging and jetting works. The physical loss of habitat has the potential to affect some individuals of finless porpoise. Based on the vessel-based survey findings conducted for this EIA (see *Annex 9A*) as well as AFCD monitoring records, it is known that the waters where cable installation works will take place are generally of low density porpoise sightings and have been evaluated to be of low to medium ecological importance. These areas are subject to disturbance vessel traffic and trawling activities and the seabed habitats do not provide unique habitat for finless porpoise. The impact of jetting and dredging works will also be very short term as seabed habitats are expected to recover and recolonise. However, the works will present a minor impact to an area considered to be generally of low to medium ecological importance to the finless porpoise.

It is noted that the area within the wind farm layout has been considered to be of medium to high ecological value. The installation works for the intra-array cables is also expected to cause minor and short term impacts to marine sediments.

Information from the fisheries impact assessment (see *Section 10*) indicates that the disturbance of marine habitat due to the cable installation works is not predicted to adversely impact the fisheries resources that would be available in the waters within and surrounding the wind farm site and cable route (the fisheries resources in the marine habitat serve as marine mammal's food prey). Consequently, adverse impacts associated with the loss of food resources to finless porpoise are not expected.

Water Quality Impacts

High SS levels do not appear to have a direct impact on porpoises. Porpoises are air breathing and therefore SS in the water column has no effect on their respiratory surfaces. Impacts may occur to these mammals as an indirect result of increased SS levels. The construction of the wind farm and installation of the cable route may cause perturbations to water quality, which have the potential to impact the fisheries resources. However, information from the fisheries impact assessment (*Section 10*) indicates that indirect impacts are not predicted to adversely impact fisheries resources as the SS elevation are localized to the works areas. The consequences of this are that impacts to marine mammals through loss of food supply (fisheries resources) are not predicted to occur. It is thus expected that unacceptable impacts to marine mammals arising from elevated SS levels will not occur.

Contaminant Release

Another potential impact on marine mammals associated with disturbance of bottom sediment that requires assessment is the potential for release contaminants affecting the food chain. The potential for release of contaminants from disturbed seabed sediments has been assessed in *Section 6.*

The results of EPD sediment monitoring at relevant stations has been presented in *Section 7*. The data show that the sediments in the local area of the wind farm site are relatively unpolluted. The levels of heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) are such that the sediments can be considered as uncontaminated.

A nearshore sediment survey in the area where grab dredging is proposed determined that the sediments in this area are uncontaminated (see *Section 7*). Elutriate tests that have also been carried out for sediments collected in the area of grab dredging and the data show that dissolved metal concentrations for all samples are below the reporting limits. The results also show that all PAHs and PCBs and chlorinated pesticides are all below the reporting limits.

As unacceptable water quality impacts due to the potential release of heavy metals and micro-organic pollutants from dredging, jetting and foundation construction works are not expected to occur, impacts to marine mammals are not expected to occur.

Potential Impacts from Works Vessels (all marine works)

Increased marine traffic: The construction of the wind farm and cable route will require the use of marine vessels, including a jack-up barge, tug, safety vessel and personnel transfer vessel. This will increase traffic flow in the area with the potential to result in an increase in marine traffic which may affect the finless porpoise.

In Hong Kong, there have been instances when dolphins in Hong Kong have been killed or injured by vessel collisions [(1)] [(2)], and it is thought that this risk is mainly associated with high-speed vessels such as ferries. In terms of potential impacts arising due to increased vessel traffic associated with the marine works, the risk of vessel collision is considered to be very small as work vessels would be slow moving. Slow moving vessels would not pose a significant risk to dolphins including young animals. To err on the side of

(1) Parsons, E. C. M. and T. A. Jefferson. 2000. Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. *Journal of Wildlife Diseases* 36(2):342-356.

(2) Jefferson, T. A., B. E. Curry, and R. Kinoshita. 2002. Mortality and morbidity of Hong Kong finless porpoises, with special emphasis on the role of environmental contaminants. *Raffles Bulletin of Zoology* (Supplement) 10:161- 171

caution, the risk of vessel strike will also be managed through a series of precautionary measures (see *Section 9.12.3* for details).

The effect of the physical presence of work vessels and other vessels on porpoise would be limited to temporary behavioural disturbance of a number of animals, if and when encounters with vessels occur. It would be expected that these animals may avoid the operating vessels in the vicinity of the works areas.

The animals have a relatively large range and therefore any works areas avoided would constitute a very small portion of the waters they inhabit. In addition, through specific mitigation measures, marine percussive piling works related to the turbine installation will not be undertaken during December to May during the peak season of finless porpoise based on the historical sightings data (see *Annex 9A*). As such, impacts associated with the increased marine traffic are not considered to be significant.

Underwater sound: Construction of the wind farm structures (e.g. turbines, wind monitoring mast and offshore substation) and cable installation has the potential to result in a short term increase in underwater sound from marine vessels, which may temporarily disturb the finless porpoise. Mitigation measures applied to control marine traffic would also help to reduce adverse impacts through vessel sound.

Foundation Construction - Potential Impacts from Piling Works

One of the primary potential impacts of piling construction is the effect of noise from the pile driving on marine mammals. Underwater sound may potentially affect marine mammals by causing the following hazards (1):

- Potential for injury or fatality of marine mammals from exposure to significant levels of underwater sound or any associated pressure effects;
- Disturbance, leading to behavioural changes or displacement;
- Interference with communication; and
- Interference with echolocation pulses used by certain marine mammals for the location of prey and other objects.

Little systematic information is however available about the impacts caused by underwater sound generated during offshore windfarm construction (2).

As discussed in *Section 4*, percussive piling has been selected as the preferred construction method for the installation of the proposed offshore structures

(1) Richardson WJ (1995). *Marine Mammals and Noise*. (Eds. Richardson WJ, Greene CR, Malme CI and Thomson DH). Academic Press. London, pp. 1-13.

(2). R. Nedwell and A.G. Brooker (2008). Measurement and assessment of background underwater noise and its comparison with noise from pin pile drilling operations during installation of the SeaGen tidal turbine device, Strangford Lough COWRIE SEAGEN-07-07 (i.e. wind turbines, wind monitoring mast and offshore substation). Sound produced during percussive piling propagates through the air into water, through the water column, and to a lesser degree, through the sediment and from there successively back into the water column. Underwater sound generation from percussive piling is however transient in nature and the overall timeframe for the piling of a foundation will be short term.

Recent studies undertaken by the UK Government's body on Wind Farm Research (COWRIE - Collaborative Offshore Wind Research Into The Environment) collected measurements of sound levels created during percussive piling for wind turbines on five wind farms throughout the North Sea (1). Source levels during the measured pile driving operations varied between 243 and 257 dB re 1 Pa at 1 metre, having an average value of 250 dB re 1 Pa at 1 metre. The study reported that measurements of > 130dB level (from which marine mammals may suffer physical injury or permanent damage to hearing (2)) were found not to exceed a few hundred metres and hence stated that a static harbour porpoise at a typical range of 250 metres could be exposed to the sound during the entire pile driving operation without harm. In addition, impacts to marine mammals from percussive piling operations associated with wind turbine installations in offshore waters can be significantly reduced by avoidance of marine percussive piling works for turbine installation during peak season of finless porpoise, adopting soft-starts procedures and strictly controlled marine mammal exclusion zones (3). As such, impacts on the behavioural disturbance and habitat displacement of marine mammals are not considered to be significant.

Other mitigation measures such as ensuring that porpoise activity is monitored during works so to avoid works when animals are present, will mean that piling works are only likely to lead to behavioural changes close the working area and that animals will move to areas less affected during the short term piling activity. The adoption of mitigation to ensure that marine mammals are outside of the area of works will ensure that impacts on behavioural changes will not be unacceptable (see *Section 9.11*).

Provided effective mitigation measures, no unacceptable residual impacts regarding underwater sound on marine mammals would therefore be expected if percussive piling is undertaken for the construction of foundations for the proposed marine structures (i.e. wind turbines, wind monitoring mast and offshore substation).

(1) R Nedwell J R , Parvin S J, Edwards B, Workman R , Brooker A G and Kynoch J E (2008) Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters. Subacoustech Report No. 544R0738 to COWRIE Ltd. ISBN: 978-0-9554279-5-4..

(2) Richardson WJ (1995). *Ibid*

(3) Nedwell J R , Parvin S J, Edwards B, Workman R , Brooker A G and Kynoch J E (2008) *Op cit*..

9.7.2 *Operation Phase*

Vessel Traffic

Similarly to the discussion of underwater sound impacts associated with increased vessel traffic during the construction phase, no unacceptable impacts are expected during the operational phase. Indeed, impacts should be much smaller and more transient during the operational phase.

Habitat Loss

There will be a permanent loss of a maximum of 3.6 ha of soft bottom habitat within the footprint of foundations for the new marine structures. In addition, the new structures will lead to a loss of habitat through the water column of an area of approximately 0.16 ha. Similarly to the discussion of construction impacts associated with jetting and dredging, the amount of habitat loss is relatively small and not considered to be significant in the context of available habitat elsewhere in the Study Area. Potential impacts on habitat fragmentation due to the establishment of wind turbines are therefore not expected to be unacceptable. No effects on ecological carrying capacity of the finless porpoise populations and their habitat usage are expected since it is considered unlikely that population size of porpoise would be affected as the area affected is not considered to be most critical for porpoise (see *Annex 9A*).

Increased Food Resource

Information from the fisheries impact assessment (see *Section 10*) indicates that the permanent loss of marine habitat is not predicted to adversely impact the fisheries resources that would be available in the waters within and surrounding the wind farm site and cable route. *Section 10* also discussed potential impacts associated with the creation of hard substrate as a result of the construction of support structures and scour protection (if used) (see *Section 5*). It is anticipated that these structures could be colonised by a variety of marine organisms supported by similar effects in Hong Kong and monitoring of offshore wind farms developed elsewhere. Colonisation of these structures could provide long term benefits associated with the attraction of fish into the area. This could offset the loss of habitat discussed above. Indeed, this 'artificial reef' effect could potentially lead to enhanced fishery resource in this area due to the aggregation of reef fish and attraction of other species into the area. It is also possible that production may increase in the area rather than just an aggregation of existing biomass. The increased number of fish attracted into the area could provide an increased food resource for porpoise. In addition, the reduction in fishing pressure within the turbine array (see *Sections 5* and *10*) may have a positive impact for porpoise by reducing the loss of juvenile species and potentially through the attraction of larger fish into the area.

Underwater Sound

The operation of the wind farm will have the potential to generate low levels of underwater sound. As the wind farm development is located in an area with existing marine traffic and near to areas with high marine traffic, it is likely that most porpoise are habituated to these sound levels and the low levels of marine traffic associated with the operation of the wind farm would be negligible in comparison [(1)]. Consequently, no unacceptable impacts associated with underwater sound generation during the operation of the wind farm are therefore expected.

9.8 EVALUATION OF THE IMPACTS TO MARINE MAMMALS

The following section discusses and evaluates the impacts to marine mammals identified in the previous section. Based upon the information presented above, the significance of the marine ecological impact associated with the construction and operation of the offshore wind farm has been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows.

- *Habitat Quality*: The development of the proposed offshore structures including wind turbines, wind monitoring mast and offshore substation will lead to a maximum loss of approximately 3.6 ha of subtidal soft bottom habitat and 0.16 ha of water column habitat. Analysis of sighting data would indicate that these areas are of medium to high ecological importance for finless porpoise. However, this area represents a small portion of the range of porpoise and the site is not located in areas that are of greatest importance for theses animals. These waters are also disturbed by existing vessel traffic.

- *Species:* Organisms of ecological interest reported from the literature and field surveys include the finless porpoise. This area is not considered to be important for Indo-pacific Humpback dolphins with very few sightings recorded (see *Annex 9A*). Significant impacts are not predicted to occur associated with water quality perturbations as these are predicted to be transient and compliant with the water quality objectives. Only indirect, temporary disturbance to marine mammals are expected during marine piling works, as construction methodologies have been designed to reduce underwater sound transmission. Operational phase marine vessel movements or underwater sound generation are not expected to impact marine mammals present in the area.

- *Size:* Jetting and dredging works will lead to the disturbance of approximately 0.99 ha of seabed habitat. In addition, the construction of marine structures could lead to a loss of 3.6 ha of similar seabed habitat and loss of 0.16 ha of water column habitat. The loss of habitat is small in the context of available habitat for porpoise. The creation of 'artificial

(1). R. Nedwell and A.G. Brooker (2008). *Ibid.*

reefs' and prevention of fishing within the turbine array and within 500 m of any structure (see *Section 5*) potentially provides an area of approximately 700 ha for improved benthic and fish productivity and increased biomass, which could lead to increased food resource for marine mammals.

- *Duration:* The marine construction works will occur over a period of 9 months. However, individual activities will be much shorter in duration with piling of each foundation being undertaken in the order of hours/days and the cable installation occurring over a few weeks. Increases in SS levels in the vicinity of sensitive receivers are expected to be low and temporary, and within environmentally acceptable limits. Operational impacts are considered minor and will occur over the lifetime of the wind farm (estimated to be 25 years).

- *Reversibility:* The only permanent impacts to porpoise are likely to be from loss of seabed (maximum of 3.6 ha) and water column habitat (0.16 ha) associated with the development of offshore structures. However, the creation of an 'artificial reef' habitat combined with reduced fishing pressure may be beneficial for marine mammals.

- *Magnitude:* As changes in water quality are localised and transient, no unacceptable impacts to porpoises have been predicted to occur during the construction or operational phase.

The impact assessment presented above indicates that with the adoption of appropriate mitigation measures, no biologically significant impacts to individual marine mammals whose home ranges overlap with the proposed project area are expected to occur. Impacts to marine mammals during operation of the offshore wind farm are predicted to be negligible.

9.9 POTENTIAL SOURCES OF IMPACT TO THE POTENTIAL SOUTHWEST LAMMA MARINE PARK

In this section of the report, the potential for impacts associated with various marine works and activities involved in the proposed project are examined in detail to provide an assessment of the significance of the potential impacts to the potential Southwest Lamma Marine Park which is at least 1 km from the wind farm site and cable route.

9.9.1 Habitat Disturbance and Alternation

Since the proposed marine park is at least 1 km away the wind farm development site, there will be no direct habitat loss from the construction and operation of wind turbines, monitoring mast, offshore substation and transmission cable.

9.9.2 *Secondary Impacts*

Secondary impacts to the associated species may arise from the potential of increased noise impact, water quality impact, marine traffic, human activities and disturbance. *Section 6* has considered the potential impacts of the construction works on water quality within the Potential Marine Park. The results show that impacts are localised and transient and there will be no unacceptable elevations of SS within the Potential Marine Park, hence impacts associated with the change in water quality are not expected. Impacts are not expected to be unacceptable due to the temporary nature and implementation of mitigation measures. For species of conservation interest including sea turtles and marine mammals, *Section 9.7* and *Section 9.10* further evaluated the specific impacts to these species and no unacceptable impacts will be caused during construction and operation phases.

9.10 POTENTIAL SOURCES OF IMPACT TO SEA TURTLES

In this section of the report, the potential for impacts associated with various marine works and activities involved in the proposed project are examined in detail to provide an assessment of the significance of the potential impacts to sea turtles that nest at Sham Wan beach approximately 5 km east of the wind farm site.

9.10.1 *Construction Phase*

Habitat Disturbance and Alteration

As discussed in *Annex 9A* the area where works are proposed does not provide suitable feeding habitat for sea turtles (particularly green turtles) although the adjacent algal-covered rocky reefs surrounding Lamma Island may. In addition, green turtles generally do not feed during the nesting season when they are most often recorded in Hong Kong waters [(1)], although some supplemental foraging may occur in inter-nesting areas with available resources [(2)(3)].

The wind farm site encompassing the wind turbines, wind monitoring mast and offshore substation is located some distance from the green turtle nesting site at Sham Wan and no direct impacts in terms of habitat loss to this nesting site will occur. Recent satellite tracking data has determined that the inter-nesting movements of a green turtle in 2008 are over a large area with areas to south and southeast of Lamma Island being mostly used (see *Annex 9A*).

(1) Bjorndal, K.A., 1985. Nutritional ecology of sea turtles. Copeia 1985, 736-751.

(2) Balazs, G.H., 1980. Synopsis of biological data on the green turtle in the Hawaiian Islands. NOAA Tech. Memo. NMFS. NOAA-TM-NMFS-SWFC-7.

(3) Tucker, A.D., Read, M.A., 2001. Frequency of foraging by gravid green turtles (Chelonia mydas) at Raine Island, Great Barrier Reef. Journal of Herpetology 35, 500-503.

Satellite tracking data and international studies indicate some plasticity in the areas used by green turtles during the inter-nesting season, which would suggest that alternative locations could be used if disruption to a specific area within the inter-nesting habitat were to occur (1)(2)(3)(4)(5). Furthermore, sea turtles are agile swimmers (6) and able to carry out long distance offshore migration by the use of visual, wave, and magnetic cues (7). Satellite tracking studies (8) (9) indicated that green turtles often utilise coastal areas during migration between nesting and foraging grounds. Given that the wind farm site is located away from the shore and Sham Wan beach, sea turtles are therefore unlikely to be affected.

The disturbance of habitats during the construction phase is therefore anticipated to be of negligible significance to sea turtles.

Water Quality Impacts

Suspended sediment associated with construction activities may also temporarily reduce the visibility for sea turtles. *Section 6* has considered the potential impacts of the construction works on water quality. The results show that impacts are localised and transient and elevations of SS would not reach the Sham Wan area where turtle nesting occurs. Impacts on sea turtles associated with the change in water quality are therefore not expected.

Potential Impacts from Works Vessels (all marine works)

Increased marine traffic: As discussed for marine mammals, the construction of the wind farm and cable route will require the use of marine vessels. This will increase traffic flow in the area with the potential to result in an increase in marine traffic which may affect sea turtles.

In terms of potential impacts arising due to increased vessel traffic, the risk of vessel collision is considered to be very small as work vessels would be slow moving and sea turtles are agile swimmers. It would be expected that sea turtles may not be affected whilst works vessels are in operation. In addition, there are relatively high of marine traffic moving in the areas where

(1) Bjorndal, K.A., 1985. *Ibid.*

(2) Bjorndal, K.A., 1997. Ibid.

(3) Balazs, G.H., 1980. *Ibid.*

(4) Tucker, A.D., Read, M.A., 2001. *Ibid.*

(5) van de Merwe, J.P., Ibrahim, K., Lee, S.Y., Whittier, J.M., in press. Habitat use of green turtles (*Chelonia mydas*) nesting in Peninsular Malaysia: Local and regional conservation implications. Wildlife Research

(6) Wyneken J (1997) Sea turtle locomotion, mechanisms, behavior, and energetics. In The Biology of Sea Turtles, Lutz PL, Musick JA (eds), pp 165-198. Boca Raton: CRC Press.

(7) Bartol SM, Musick JA (2003) Orientation, Navigation, and Natal Beach Homeing in Sea Turtle. In *The Biology of Sea Turtles* (Vol. 2), Lutz PL, Musick JA, Wyneken J (eds). Boca Raton: CRC Press.

(8) Song X, Wang H, Wang W, Gu H, Chan SKF, Jiang H (2002) Satellite tracking of post-nesting movements of green turtles, *Chelonia mydas*, from Gangkou Sea Turtle National Nature Reserve, China, 2001. *Marine Turtle Newsletter* 97: 8-9

(9) Cheng IJ (2000) Post-nesting migrations of green turtles (*Chelonia mydas*) at Wan-An Island, Penghu Archipelago, Taiwan. *Marine Biology* 137: 747-754

sea turtles inhabit (see *Section 10*) and it is highly likely that they are habituated to these movements. The increase in vessel traffic in comparison to baseline movements is also very low. Negligible impacts to sea turtles associated with the presence of the construction related vessels are predicted.

Underwater sound: The construction of the wind farm structures including wind turbines, wind monitoring mast and offshore substation, and cable installation has the potential to result in a minor and short term increase in underwater sound from marine vessels and dredging, which may affect the sea turtle to navigate during inter-nesting or migration periods. Sea turtles are noted in areas where there are existing levels of marine traffic and it is likely that individuals are habituated to these sound levels passing overhead or nearby. It is noted that during both construction and operation only a limited number of vessels will be used with appropriate measures applied to control movements (see *Section 9.12.4*). A small increase in vessel activity compared to those vessels that currently pass through these waters and thus a slight increase in underwater sound generation from dredging activities are expected to have negligible impacts on any sea turtles passing through the area.

Foundation Construction - Potential Impacts from Piling Works

As with the discussion of impacts on marine mammals, piling activities have the potential to have impacts on sea turtles navigation through underwater sound generation.

There has been limited study on the effects of underwater noise on sea turtles through piling operations, however, studies related to offshore oil and gas seismic exploration using airguns found that sea turtles exhibit some indication of avoidance from source levels above 175 dB re 1 µPa [1]. As noted in *Section 9.7.1* source levels of > 130 dB re 1 µPa levels during percussive piling for wind farm turbines were found not to exceed a few hundred metres, as measured during marine mammal monitoring works for those studies.

There does not appear to be evidence from the literature that construction of offshore wind farms are resulting in adverse behavioural impacts to sea turtles. As discussed above, the wind farm site is located some distance from the shore and recorded nesting site at Sham Wan, and the sea turtles are expected to stay relatively close to inshore coastal areas during migration. The wind farm site is therefore not a preferred habitat for sea turtles during migration. The underwater sound generated during percussive piling for wind farm turbines therefore is not expected to cause unacceptable impacts to migrating sea turtles or green turtle nesting site at Sham Wan.

Overall, there will be no adverse and unacceptable impacts to sea turtle during the construction of wind farm, mitigation measures specifically

(1) Minerals Management Service, US Department of the Interior (2004) *Op cit*

designed to minimise the potential impact are not considered necessary. However, it is considered that the soft-start/ramp-up procedures and enforcement of an exclusion zone recommended to mitigate against impacts to marine mammals would also allow sea turtles sufficient time to avoid close proximity to construction works. With the adoption of these mitigation measures, it is concluded that impacts on sea turtles from underwater sound through piling works are only expected to be of negligible significance.

9.10.2 *Operation Phase*

Vessel Traffic

Similarly to the discussion of underwater sound impacts associated with increased vessel traffic during the construction phase, no unacceptable impacts are expected during the operational phase. Indeed, impacts should be much smaller and more transient during the operational phase.

Habitat Loss

There will be a permanent loss of a maximum of 3.6 ha of soft bottom habitat within the footprint of foundations for the new marine structures. In addition, the new structures will lead to a loss of habitat through the water column of an area of approximately 0.16 ha. Similarly to the discussion of construction impacts associated with marine mammals, the loss of habitat is not considered to be significant amount of habitat loss in the context of available habitat elsewhere in the Study Area and the areas that are considered to be most important for sea turtles (see *Annex 9A*).

Underwater Sound

Similar to the consideration of underwater sound generation from piling activities for marine mammals, the operation of the wind farm has potential to disturb sea turtles. The sound levels are also expected to be less than that generated by marine vessels at a similar distance. No unacceptable impacts associated with underwater sound generation during the operation of the wind farm are therefore expected.

Light Pollution

As discussed in *Section 5*, lighting of offshore structures is proposed for aviation and navigation safety. Lighting will include steady low intensity red lights (aviation) and flashing yellow lights (navigation) the navigational lights at corner of the wind farm will be visible for 5 nautical miles (9.3 km) and the intermediate (mid-way) lights will flash at 2.5 seconds and will be visible for 2 nautical miles (3.7 km).

There is evidence that artificial lighting on nesting beaches can disturb the nesting process of sea turtles [(1)]. However, as the sites for the proposed

(1) Witherington BE (1992). Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48: 31-39

project are 5km away from the nesting area with no direct line of sight to the wind farm site it is not expected to affect sea turtle nesting at Sham Wan.

Lights on the turbines also have the potential to disturb the offshore dispersal of hatchlings at night. Upon emergence, sea turtle hatchlings use a number of visual cues to orient themselves to the ocean. In particular, they use light cues to orient themselves towards the brightest direction, usually the reflective surface of the ocean (1) (2). Lighting adjacent to nesting beaches can therefore disorient hatchlings and compromise their dispersal. However, disturbance from light is dependent on the intensity and wavelength of the emitting source. Long wavelength light (eg. red light) has minimal effect on hatchlings and hatchlings are most attracted to short wavelength light (1) (3) (4). The lowest intensity light reported to attract sea turtle hatchlings was 0.12 x 10^{14} quanta/sec/cm^2 (at a wavelength of 375 nm). The low intensity continuous red aviation lights on the proposed project are not expected to affect hatchling dispersal due to the minimal effect of this wavelength on hatchlings and the long distance from the nesting beach of the proposed sites. Furthermore, the intermediate yellow flashing navigation lights will not affect hatchling dispersal as their range is only 2 nautical miles, which is shorter than the distance between the proposed sites and the Sham Wan nesting beach. Only the corner navigation lights (visible for 5 nautical miles) would potentially be visible from the Sham Wan nesting area. There is also a small hill (200m elevation) directly between the nesting beach and the western proposed wind farm site. It is therefore highly unlikely that any of the lights associated with the operation of the proposed project would affect hatchling dispersal from the Sham Wan nesting beach.

9.11 *EVALUATION OF THE IMPACTS TO THE POTENTIAL SOUTHWEST LAMMA MARINE PARK AND SEA TURTLES*

The following section discusses and evaluates the impacts to the Southwest Lamma Marine Park, specifically sea turtles as identified in the previous section. Based upon the information presented above, the significance of the marine ecological impact associated with the construction and operation of the wind farm has been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows.

- *Habitat Quality*: The development of the proposed offshore structures including wind turbines, wind monitoring mast and offshore substation will lead to a maximum loss of approximately 3.6 ha of subtidal soft bottom habitat and 0.16 ha of water column habitat. The wind farm site

(1) Mrosovsky N (1972) The water-finding ability of sea turtles. Brain Behaviour and Evolution 5: 202-

(2) Mrosovsky N (1979) Seaward orientation of hatchling turtles: turning systems in the optic tectum. Brain Behaviour and Evolution 16: 203-

(3) Witherington BE, Bjorndal KA (1991) Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles Caretta caretta. Biological Conservation 55: 139-149.

(4) Witherington BE, Bjorndal KA (1991b) Influences of wavelength and intensity on hatchling sea turtle phototaxis: Implications for sea-finding behaviour. Copeia 1991

is at least 1km away from the potential Southwest Lamma Marine Park. Analysis of sighting data would indicate that these areas are of not of high importance as inter-nesting habitat. These waters are also disturbed by high volumes of vessel traffic.

- *Species:* Significant impacts on sea turtles are not predicted to occur associated with water quality perturbations as these are predicted to be transient and compliant with the WQO. There will be no unacceptable elevations of SS within the Potential Marine Park, hence secondary impacts associated with the change in water quality are not expected. Only indirect, temporary disturbance to sea turtles are expected during marine piling works. However, construction methodologies have been designed to reduce underwater sound transmission. Operational phase marine vessel movements or underwater sound generation are not expected to impact any sea turtles passing through the area.

- *Size:* Jetting and dredging works will lead to the disturbance of approximately 0.99 ha of seabed habitat. In addition, the construction of marine structures could lead to a loss of 3.6 ha of similar seabed habitat and loss of 0.16 ha of water column habitat. In addition, the loss of habitat is small in the context of available habitat for sea turtles. There will be no direct habitat loss in the potential Marine Park.

- *Duration:* The marine construction works will occur over a period of 9 months. However, individual activities will be much shorter in duration with piling of each foundation being undertaken in the order of hours and the cable installation occurring over a few days. Increases in SS levels in the vicinity of sensitive receivers are expected to be low and temporary, and within environmentally acceptable limits. Operational impacts will be negligible occurring over the lifetime of the wind farm (estimated to be 25 years).

- *Reversibility:* The only permanent impacts to turtles are likely to be from loss of seabed (maximum of 3.6 ha) and water column habitat (0.16 ha) associated with the development of offshore structures in an area where turtles are rarely sighted and if so usually passing through. There will be no permanent impacts to the potential Marine Park due to its remoteness from the wind farm site.

- *Magnitude:* No unacceptable impacts to affected individual sea turtles have been predicted to occur during the construction or operational phase – particularly with the adoption of appropriated mitigation for percussive piling if this approach will be taken forward for foundation construction. Secondary impacts to the potential Marine Park associated with the change in water quality are not expected to be significant as the change is considered to be localised and transient.

The impact assessment presented above indicates that with appropriate mitigation and precautionary measures, no biologically significant impacts to individual sea turtles whose home ranges overlap with the proposed project area are expected to occur. Impacts to sea turtles during operation of the terminal are predicted to be negligible.

9.12 *MITIGATION MEASURES*

9.12.1 *General*

In accordance with the guidelines in the *EIAO-TM* on marine ecology impact assessment, the general policy for mitigating impacts to marine ecological resources, in order of priority, are:

- **Avoidance:** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives;

- **Minimisation:** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on the intensity of works operations (eg dredging rates) or timing of works operations; and

- **Compensation:** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

To summarise, this initial assessment of impacts demonstrates that impacts have largely been *avoided* during the construction and operation of the offshore wind farm and cable route, particularly to the key ecological sensitive receivers (marine mammals and sea turtles), through the following measures:

- **Avoid Direct Impacts to Ecologically Sensitive Habitats:** The wind farm site has been selected based on a review of alternative locations (*Section 3*) and avoided the key habitats for porpoise being, which includes the waters just south of Soko Islands, the offshore waters in Southeast Lantau, at southwest corner of Shek Kwu Chau and Cheung Chau, near Stanley Peninsula and around Po Toi Islands (2004 – 2008 sightings data – see *Annex 9A*). The nearshore area immediately to the southwest of Lamma Island also supports relatively high numbers of sightings and this area has also been avoided.

- **Avoid Indirect Impacts to Ecologically Sensitive Habitats:** The wind farm site has been selected so dispersion of sediment from dredging and sand filling does not affect the receivers at levels of concern.

- **Adoption of Acceptable Working Rates**: The modelling work has demonstrated that the selected working rates for the dredging will not cause unacceptable impacts to the receiving water quality. Consequently, unacceptable indirect impacts to marine ecological resources have been avoided.

9.12.2 *General Measures for Marine Ecological Resources*

The following measures to mitigate the impact of the construction and operation on marine ecological resources are recommended:

- The vessel operators will be required to control and manage all effluent from vessels;
- A policy of no dumping of rubbish, food, oil, or chemicals will be strictly enforced. This will also be covered in the contractor briefings; and
- The effects of construction of the Project on the water quality of the area will be reduced as described in the *Water Quality* section (*Section 6*).

9.12.3 *Specific Measures for Corals*

As a total of four octocoral species and one black coral species were recorded during the baseline surveys on the dumped material in the vicinity of the cable route, prior to the commencement of jetting works for the cable route, a pre-construction survey will be undertaken at these sites to confirm the coral existence. Should these corals be found present, mitigation will be applied to be agreed with the AFCD at that time. Potential mitigation may include relocation of these corals to a location away from the proposed area of works.

9.12.4 *Specific Measures for Marine Mammals*

Measures to mitigate the impact of the construction and operation of the terminal have been developed in consultation with internationally recognised marine mammal experts. The following recommendations may be considered to reduce potential construction and operation impacts on marine mammals.

- All vessel operators working on the Project construction or operation will be given a briefing, alerting them to the possible presence of marine mammals in the area, and the guidelines for safe vessel operation in the presence of cetaceans. If high speed vessels are used, they will be required to slow to 10 knots when passing through a high density porpoise area (southwest of Lamma Island and around the edges of the wind farm site). With implementation of this measure, the chance of boat strike resulting in physical injury or mortality of marine mammals will be extremely unlikely. Similarly, by observing the guidelines, vessels will be operated in an appropriate manner so that marine mammals will not be subjected to undue disturbance or harassed;
- The vessel operators will be required to use predefined and regular routes, as these will become known to porpoise using these waters. This measure will further serve to minimise disturbance to marine mammals due to vessel movements; and,

During **piling** works, the following additional measures will be adopted:

- Using good engineering practice, including the use of appropriately sized piles (smaller piles generate lower levels of underwater sound) and piling equipment. This includes:
  - Quieter hydraulic hammers should be used instead of the noisier diesel hammers; and,
  - Acoustic decoupling of noisy equipment on work barges should be undertaken.

- Using ramp-up piling procedures. This comprises of low energy driving for a period of time prior to commencement of full piling. This will promote avoidance of the area by fish when sounds levels are not injurious. Blow frequency during this ramping up period should replicate the intensity that would be undertaken during full piling (e.g. one blow every two seconds) to provide cues for marine mammals to localize the sound source. Pile blow energy should be ramped up gradually over the 'soft start' period. Activities will be continuous without short-breaks and avoiding sudden random loud sound emissions.

- An exclusion zone of 500 m radius will be scanned around the work area for at least 30 minutes prior to the start of piling from the barge or an elevated observation point on land. If a marine mammal is observed in the exclusion zone, piling will be delayed until they have left the area. This measure will ensure the area in the vicinity of the piling is clear of marine mammals prior to the commencement of works and will serve to reduce any disturbance to marine mammals;

- When a marine mammal is spotted by qualified personnel within the exclusion zone, construction works will cease and will not resume until the observer confirms that the zone has been continuously clear of the marine mammal for a period of 30 minutes. This measure will ensure the area in the vicinity of the piling is clear of the marine mammal during works and will serve to reduce any disturbance to marine mammals;

- Consistent with standard Hong Kong practice, the percussive pile driving will be conducted during the day time for a maximum of 12 hours, avoiding generation of underwater sounds at night time; and

- Piling works for the wind turbines shall not be carried out from December to May to avoid the peak season of finless porpoise.

During **dredging** works, the following additional measure will be adopted:

- A marine mammal exclusion zone within a radius of 250 m from dredgers will be implemented during the construction phase. Qualified observer(s) will scan an exclusion zone of 250 m radius around the work area for at least 30 minutes prior to the start of dredging. If a marine mammal is observed in the exclusion zone, dredging will be delayed until they have left the area. This measure will ensure the area in the vicinity of the dredging work is clear of marine mammals prior to the commencement of works and will serve to reduce any disturbance to marine mammals. As per previous practice in Hong Kong, should a marine mammal move into the dredging area during dredging, it is considered that cetaceans will have acclimatised themselves to the works therefore cessation of dredging is not required [(1)].

Periodic re-assessment of mitigation measures for marine mammals and their effectiveness will be undertaken through pre-, during and post-installation monitoring programmes during construction phase (see *Section 9.15.1*).

9.12.5 *Precautionary Measures for Sea Turtles*

As discussed in *Section 9.10*, mitigation measures specifically designed to minimise potential impacts to sea turtles are not considered necessary as there will be no significant adverse impacts to sea turtles during the construction and operation of wind farm. However, it is noted that a marine mammal exclusion zone will be implemented during piling works for the wind turbines and dredging works for the cable. It is considered prudent to conservatively also apply this exclusion zone to sea turtles. As such the same measures used during the enforcement of the exclusion zone should be applied to observations of sea turtles as with marine mammals.

9.13 RESIDUAL ENVIRONMENTAL IMPACTS

Taking into consideration the ecological value of the habitats discussed in the previous sections and the resultant mitigation and precautionary measures, residual impacts occurring as a result of the proposed offshore wind farm have been determined and are as follows:

- The maximum loss of approximately 3.6 ha of subtidal soft bottom habitats, which is of low ecological value. The residual impact is considered to be acceptable, as the loss of these habitats will be compensated by the provision of hard substrate habitat that could potentially act as an 'artificial reef'.

- The loss of approximately 0.16 ha of water column. Although the habitat loss would be an inevitable and adverse consequence of the project, the residual impact is assessed to be acceptable after taking into consideration a number of factors. The loss of habitat is small in the context of the size of habitat available to porpoise and sea turtles. Taking account of the sizable ranges and mobility of affected animals, it is expected that the loss would not give rise to biologically significant adverse impacts on individual dolphins or the porpoise population as a

(1) This measure is consistent with conditions for grab dredging works inside the Sha Chau and Lung Kwu Chau Marine Park included in the issued Environmental Permit for the Permanent Aviation Fuel Facility for Hong Kong International Airport project.

whole or effect the migration or inter-nesting of sea turtles. In addition, the habitat which would be lost would not be considered highly important habitat for marine mammal or sea turtles. The area is also subject to due to considerable disturbance by heavy marine traffic and trawling by fishing vessels.

- Long term beneficial impacts associated with the creation of an 'artificial reef' system within the wind farm site, supported by reduced fishing in the area, which could be of importance in terms of improving the abundance and diversity of marine fauna in the area and providing improved food resource for marine mammals.

9.14 CUMULATIVE IMPACTS

9.14.1 *Project Specific Cumulative Impacts*

The cumulative impacts of the various project specific construction activities have been demonstrated in *Section 6 – Water Quality* as not causing unacceptable impacts to water quality. Consequently, unacceptable cumulative impacts to marine ecological resources are not predicted to occur. The only operation cumulative impacts are associated with marine traffic movements during the construction phase. However, the impacts associated with the development of the offshore wind farm are not considered to be significant with respect to the low numbers of vessels involved and heavy levels of marine traffic already in the area.

9.14.2 *Cumulative Impacts with Other Development*

As for the cumulative impacts with other developments in southern and southeastern Hong Kong waters, information from publicly available sources suggested that the construction/ implementation programmes of the following major projects would coincide with the construction of this Project:

- Open Sea Disposal of Mud at South Cheung Chau, which is at least 3 km from the wind farm site;

- Marine Burrow Area at West Po Toi, which is at least 10 km from the wind farm site;

- Exhausted Sand Burrow Pit for Disposal of Uncontaminated Mud at East Tung Lung Chau (currently not in use), which are at least 20 km from the wind farm site;

- Open Sea Disposal of Mud at Ninepin Islands and, which is at least 25 km from the wind farm site; and,

- Proposed Hong Kong Offshore Windfarm in Southeastern Water, which is at least 30 km from the wind farm site.

Results of water quality modelling undertaken as part of this EIA Study (see *Section 6* for details) showed that sediment plumes from the construction of wind farm were limited to within about 2 km of the marine works areas. Similarly, modelling carried out as part of the Lamma Power Station Navigation Channel Improvement EIA modelled the potential dispersion of sediments disposed into the South Cheung Chau disposal ground [(1)]. Results show that sediment plumes originating from disposal activities do not reach the proposed wind farm in either season.

Since the water quality mixing zone of this Project is unlikely to overlap with those of other concurrent projects in this part of Hong Kong, it can, therefore, be concluded that cumulative impacts on water quality impacts and hence on marine ecological resources are not predicted to occur.

Project-specific adverse operation phase impacts on marine ecological resources are not expected to occur (*Sections 9.5.2* and *9.7.2*), thus operation phase cumulative impacts with other developments in and around the wind farm site are not predicted.

9.15 *ENVIRONMENTAL MONITORING AND AUDIT*

The following presents a summary of the Environmental Monitoring and Audit (EM&A) measures focussed on ecology during the construction and operation phases of the offshore wind farm. Full details are presented in the separate EM&A Manual.

9.15.1 *Construction Phase*

During the construction phase, the following EM&A measures will be undertaken to verify the predictions in the EIA and ensure the environmental acceptability of the construction works:

- Water quality impacts will be monitored and checked through the implementation of a Water Quality EM&A programme (refer *Section 6* for details). The monitoring and control of water quality impacts will also serve to avoid unacceptable impacts to marine ecological resources.
- Marine piling works will be undertaken using hydraulic hammers, which typically have lower sound output than traditional diesel hammers;
- Marine piling works will take place in daylight hours, sunrise to sunset;
- Marine piling works will avoid peak seasons of marine mammals (December to May);

(1) The Hongkong Electric Co., Ltd (2003) Lamma Power Station Navigation Channel Improvement EIA. Prepared by Hyder Consulting.

- Marine piling works will employ 'soft-starts' using ramp-up piling procedures;
- Pre-, during and post-installation monitoring of marine mammal abundance, behaviour and distribution will be undertaken. Prior to the commencement of monitoring, methods may include the following to be agreed with the AFCD:
  - Vessel based surveys
  - Passive acoustic monitoring
  - Land-based theodolite tracking

  Details of the methods for the above monitoring works will be elaborated in the EM&A Manual.
- A marine mammal / sea turtle exclusion zone will also be implemented and monitored by qualified observers for the presence of marine mammals / sea turtles in waters surrounding any marine percussive piling works and dredging works during construction of the wind farm structures and cable route; and,
- As a total of four octocoral species and one black coral species were recorded during the baseline surveys on the dumped material in the vicinity of the cable route, prior to the commencement of jetting works for the cable route, a pre-construction survey will be undertaken at these sites to confirm the coral existence. Should these corals be found present, mitigation will be applied to be agreed with the AFCD at that time. Potential mitigation may include relocation of these corals to a location away from the proposed area of works.

Details of the marine mammal exclusion zone monitoring components are presented in full in the EM&A Manual.

9.15.2 *Operation Phase*

The assessment presented above as indicated that operational phase impacts are not expected to occur to marine ecological resources. No marine ecology specific operational phase monitoring is considered necessary.

9.16 CONCLUSIONS

The proposed offshore wind farm development and cable route area was studied in detail through a site selection study in order to select a preferred site that avoided to the extent practical, adverse impacts to habitats or species of high ecological value.

Potential construction phase impacts to marine ecological resources, as well as impacts to marine mammals and sea turtles, may arise from the permanent loss of habitat in the footprint of marine structures, disturbances to benthic habitats as a result of jetting and dredging and impacts on intertidal and subtidal habitats during seawall removal.

As impacts arising from the proposed dredging works are predicted to be largely confined to the specific works areas and the predicted elevations of suspended sediment due to the Project are not predicted to cause exceedances of the water quality objectives outside of the mixing zones, adverse impacts to water quality, and hence marine ecological resources or marine mammals and sea turtles, are not anticipated.

Although the loss of 0.16 ha of water column habitat would be an inevitable and adverse consequence of the project, the residual impact is assessed to be acceptable after taking into consideration a number of factors, including the sizable ranges and mobility of affected animals and the fact that the habitat that would be lost is not considered a critical habitat for marine mammal or sea turtles. The area is also subject to considerable disturbance by heavy marine traffic and trawling by fishing vessels.

The loss of 3.6 ha of soft bottom seabed habitat would also be an inevitable and adverse consequence of the project. However, this habitat is considered to be of low conservation value and is not significant in context to the amount of similar habitat available elsewhere in Hong Kong. In addition, the disturbance of approximately 0.99 ha of soft bottom habitat from dredging activities is considered to be of minor significance.

The removal of low ecological value artificial rocky shore as a result of seawall removal activities for cable landing (see *Section 5*) will not lead to unacceptable impacts for subtidal or intertidal ecology. The reinstatement of the seawall with materials that have been removed will mean that there will be no long term change in the amount of available artificial intertidal and subtidal hard bottom habitat.

Percussive piling has the potential to cause impacts to marine mammals, and to a lesser extent, sea turtles through underwater sound generation. With the adoption of mitigation that has been identified, such as marine mammal/sea turtle exclusion zones and closed periods for piling works during peak season of finless porpoise, no unacceptable impacts on these species are expected.

Operational phase adverse impacts to marine ecological resources are not expected to occur. In particular, unacceptable impacts to marine mammals and sea turtles from the generation of underwater sound levels are not predicted to be of concern. In addition, the wind farm structures, and in particular rock scour material, may have the potential to create an artificial reef, which could have beneficial impacts related to food supply for marine mammals.

No unacceptable residual impacts are predicted to marine ecological resources.

During construction phase of wind turbines, pre-, during and post-installation monitoring of marine mammal abundance, behaviour and distribution will be undertaken.

Annex 9A

Baseline Marine Ecological Resources

CONTENTS

9A BASELINE MARINE ECOLOGICAL RESOURCES

9A.1 INTRODUCTION

This *Annex* presents the findings of ecological studies for the proposed wind farm development areas off Southwest Lamma and the surrounding Study Area. Marine ecological habitats and resources have been identified and the ecological value of the Study Area evaluated. The assessment has been based on a review of the available literature, as well as detailed field surveys to provide the most up-to-date information on existing conditions. The rationale for surveys is presented, followed by the methodologies employed, results obtained and a discussion of the results and comparison with other similar studies where appropriate. The findings enclosed within this *Annex* will form the basis of establishing the ecological importance of the different marine habitats within and around the proposed wind farm development areas.

9A.1.1 *Ecological Study Area*

The Study Area for the ecological assessment covers a large area of open water of southern Hong Kong to ensure that potential marine ecological sensitivities that have been identified in the water quality impact assessment are considered. This relatively wide Study Area also ensures that consideration is given to mobile species that are present in the area (e.g. marine mammals and sea turtles). The Study Area for the marine ecology baseline has incorporated the footprint of the proposed wind farm site and the proposed alignment corridor for the submarine cable connection to the Lamma Power Station Extension. The Study Area is shown in *Figure 9A.1*.

9A.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

9A.2.1 *Introduction*

This section summarizes all legislative requirements and evaluation criteria for the protection of species and habitats of marine ecological importance in the Study Area.

9A.2.2 *Legislative Requirements and Evaluation Criteria*

Legislative requirements and evaluation criteria relevant to the study are as follows:

1. *Marine Parks Ordinance (Cap 476);*
2. *Wild Animals Protection Ordinance (Cap 170);*
3. *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586);*
4. *Town Planning Ordinance (Cap 131);*

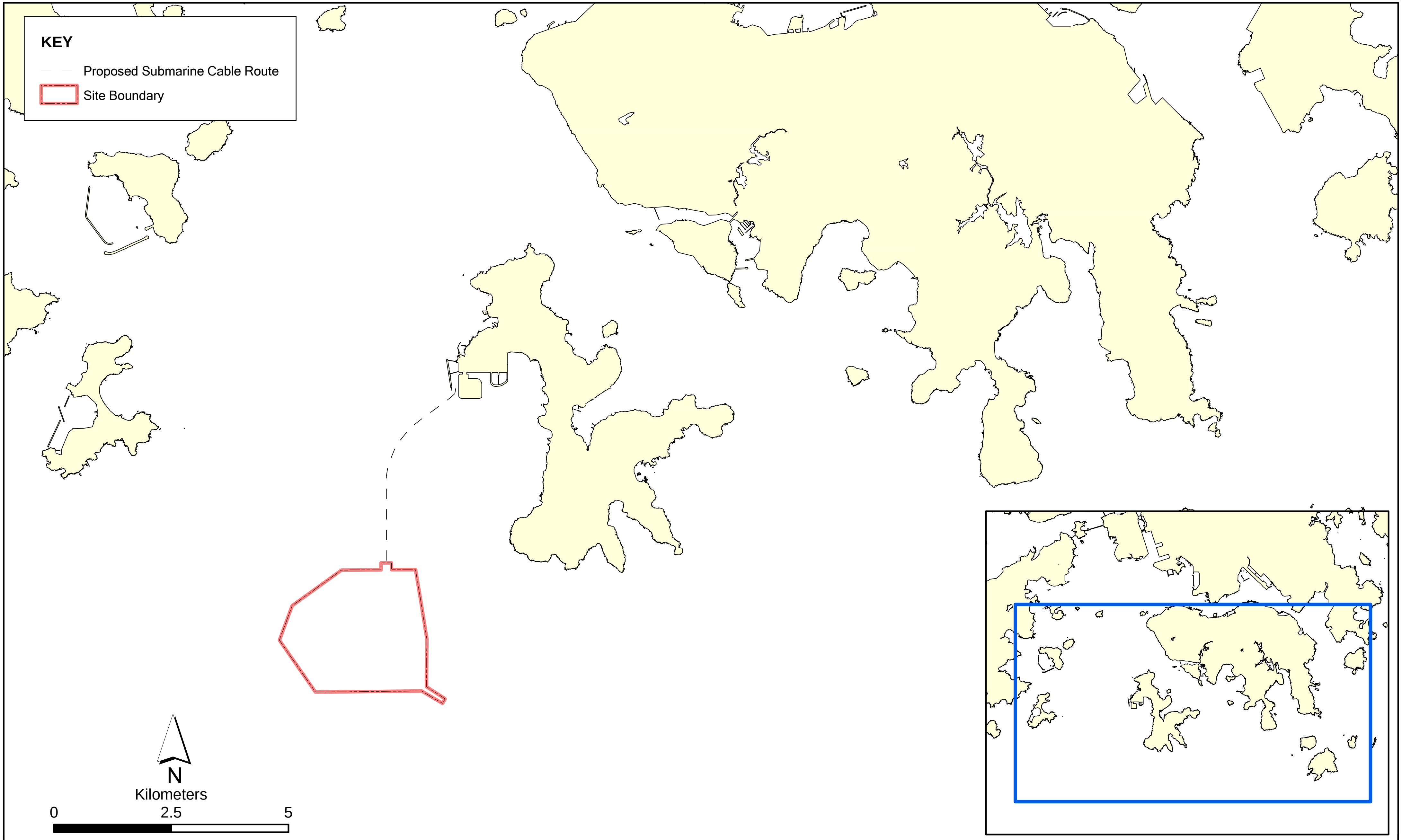

Figure 9A.1

Study Area for Baseline Marine Ecological Conditions

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Date: 14/08/2009

Environmental
Resources
Management

ERM

5. *Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG);*
6. *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAOTM);*
7. *United Nations Convention on Biodiversity (1992);*
8. *Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramseur Convention);*
9. *PRC Regulations and Guidelines; and,*
10. *City University of Hong Kong (2001). Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, AFCD, Final Report July 2001.*

9A.2.3 Marine Parks Ordinance (Cap 476)

The *Marine Parks Ordinance* provides for the designation, control and management of marine parks and marine reserves. It also stipulates the Director of Agriculture, Fisheries and Conservation as the Country and Marine Parks Authority, which is advised by the Country and Marine Parks Board. The *Marine Parks and Marine Reserves Regulation* was enacted in July 1996 to provide for the prohibition and control certain activities in marine parks or marine reserves.

9A.2.4 Wild Animals Protection Ordinance (Cap 170)

Under the *Wild Animals Protection Ordinance*, designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals including all cetaceans are protected under this Ordinance, as well as certain reptiles (including all sea turtles), amphibians and invertebrates. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1997.

9A.2.5 Protection of Endangered Species of Animals and Plants Ordinance (Cap 586)

The *Protection of Endangered Species of Animals and Plants Ordinance* was enacted to align Hong Kong's control regime with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). With effect from 1 July 2006, it replaces the *Animals and Plants (Protection of Endangered Species) Ordinance* (Cap 187). The purpose of the *Protection of Endangered Species of Animals and Plants Ordinance* is to restrict the import and export of species listed in CITES Appendices so as to protect wildlife from overexploitation or extinction. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them. Certain types of corals are CITES listed, including Blue coral (*Heliopora coerulea*), Organ pipe corals (family Tubiporidae), Black corals (order Antipatharia), Stony coral (order Scleractinia), Fire corals (family Milleporidae) and Lace corals (family Stylasteridae). The import, export and possession of listed species, no matter whether dead or living, is restricted.

9A.2.6 Town Planning Ordinance (Cap 131)

The *Town Planning Ordinance* provides for the designation of areas such as "Coastal Protection Areas", "Sites of Special Scientific Interest (SSSIs)", "Green Belt" and "Conservation Area" to promote conservation or protection or protect significant habitat.

9A.2.7 Hong Kong Planning Standards and Guidelines Chapter 10

Chapter 10 of the *HKPSG* covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation-related measures in Hong Kong, and Government departments involved in conservation.

9A.2.8 Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance

Annex 16 of the *EIAOTM* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating ecological impacts.

9A.2.9 Other Relevant Legislation

The Peoples' Republic of China (PRC) is a Contracting Party to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The Government of the Hong Kong Special Administrative Region (HKSAR) has stated that it will be "committed to meeting the environmental objectives" of the Convention [(1)].

The PRC in 1988 ratified the *Wild Animal Protection Law* of the PRC, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 96 animal taxa in Class I and 161 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

(1) Planning Environment and Lands Bureaux 1996. Environmental Policy Commitments.

9A.3 MARINE ECOLOGICAL RESOURCES – BACKGROUND

9A.3.1 *Introduction*

This section describes the baseline conditions of the marine ecological resources at the Study Area from existing information in available literature. Baseline conditions have been assessed based on a review of the findings of relevant studies and the collation of available information regarding the marine ecological resources of this part of Hong Kong.

Based on this review, an evaluation of the information collected was conducted to identify any gaps that need to be filled and to conduct an assessment of ecological importance of the marine habitats. Where information gaps were identified or where certain habitats or species were considered to warrant further attention, focussed field surveys have been conducted (see *Section 9A.4*).

9A.3.2 *Site History*

The site for the proposed wind farm is located in the waters between Lamma Island and Cheung Chau, near the southern reaches of the West Lamma Channel. The proposed submarine cable route will run from the north of the wind farm site and connect to the Lamma Power Station Extension. The water depth at the wind farm site ranges from -18 mPD to -23 mPD. The closest distance of the wind farm site to land is approximately 3.5 km to Lamma Island.

In terms of hydrography, the Study Area is located within a zone of transition in which, in the wet season, surface waters of reduced salinity, higher temperature and higher dissolved oxygen occur over the cooler, more saline oceanic waters with lower dissolved oxygen. In the dry season, with a reduced flow from the Pearl River adjacent to western Hong Kong waters, vertical stratification is usually not observed [(1)].

9A.3.3 *Literature Review*

A literature review was conducted to determine the existing marine ecological conditions within the Study Area to identify habitat resources and species of potential importance.

Based on the literature review the following habitats and/or organisms of ecological interest have been identified in the Study Area:

- Hard Bottom Habitats
  - *Intertidal Hard Bottom Habitats*
  - *Subtidal Hard Bottom Habitats*

(1) Morton B, Morton J (1983) *The Sea Shore Ecology of Hong Kong*. Hong Kong University Press

- Soft Bottom Habitats
  - *Intertidal Soft Bottom Habitats*
  - *Subtidal Soft Bottom Habitats*
    - Epifaunal Assemblages
    - Infaunal Assemblages
- Marine Mammals
- Sea Turtles

Existing conditions of each of the above marine resources based on available literature are discussed in more detail in the following sections.

9A.3.4 Hard Bottom Habitats

Intertidal Hard Bottom Habitats

Intertidal hard shores of Hong Kong display characteristic zonation patterns consisting of different algal and invertebrate species along the vertical gradient from terrestrial to marine environments.

The intertidal hard bottom habitat of southwestern Lamma Island contains mainly moderately-exposed to exposed natural rocky shores extending from Ha Mei Tsui to Sham Wan. The proposed submarine cable landing site at the Lamma Power Station Extension consists of sheltered to moderately-exposed artificial sloping seawall which was constructed in 2001.

There is little published information describing the intertidal assemblages of the artificial seawall at the Lamma Power Station Extension. A wet season intertidal survey was, however, conducted on the west coast of the Lamma Island adjacent to the power station as part of the environmental impact assessment for the navigation channel and jetty modification works at the Lamma Power Station (1). Results of this survey indicated that the survey areas were regarded as of low ecological value and comprised low abundances of common grazing molluscs and filter feeders with no particular conservation value.

In contrast, focussed quantitative surveys have been conducted on the natural rocky shores along the west of Lamma Island during the wet season of 1998 for the Lamma Power Station Extension EIA (2). A total of 18 to 29 species of intertidal fauna, including grazing molluscs, common dogwhelks and barnacles (the most abundant species being the limpet *Patelloida saccharina*, the chiton *Acanthopleura japonica* and the barnacle *Balanus amphitrite*), and some 4

(1) AXIS Environmental Consultants Ltd (1994) *Navigation Channel and Jetty Modification Works at Lamma Power Station – Environmental Impact Assessment: Intertidal Ecology Survey Final Report*. For the Hongkong Electric Co Ltd

(2) ERM (1999) *Environmental Impact Assessment of a 1,800MW Gas-Fired Power Station at Lamma Extension*. For Hongkong Electric Co Ltd

to 8 species macroalgae, were recorded in the survey transects. The assemblages recorded were considered to represent common and widespread species typical of natural rocky shores in Hong Kong.

For this EIA Study, it was considered appropriate to conduct intertidal surveys at the artificial seawall of the Lamma Power Station Extension in order to fill data gaps and provide up-to-date data on the ecological value of this habitat. No surveys were considered necessary on the intertidal habitats in vicinity of the proposed submarine cable alignment as habitats are relatively distant.

Subtidal Hard Bottom Habitats

Coral communities are commonly regarded as the most ecologically important and valuable subtidal hard bottom assemblages. The Agriculture, Fisheries and Conservation Department (AFCD) reported that there are over 80 species of hard corals recorded in Hong Kong waters [(1)]. The general trend for coral communities in Hong Kong is one of increasing abundance and diversity from west to east with the greatest diversity and abundance generally found in the northeastern waters of Hong Kong due to the optimal environmental conditions for settlement, growth and survival found in these waters. It has been suggested that the distribution of hard corals is primarily controlled by hydrodynamic conditions, in particular salinity level, turbidity and light penetration.

The western and southern waters of Hong Kong are influenced by the Pearl River Estuary which reduces salinities, increases turbidity and therefore reduces light penetration. Due to the requirements for coral growth, the cumulative effect of these conditions results in sub-optimal conditions for coral recruitment and survival in these waters. Unlike the hermatypic hard corals, ahermatypic octocorals (generally include soft and black corals) which do not require light for zooxanthellae photosynthesis, are more widely distributed in Hong Kong waters and often occur at greater depths.

Ecology of the subtidal hard bottom habitats in the vicinity of the proposed cable landing site has been reported in two key studies conducted in 1998 and 2000 respectively. In 1998, Remotely Operated Vehicle (ROV) surveys were conducted at the footprint of the extension reclamation site and the seawall of the Ash Lagoon as part of the EIA for the Lamma Power Station Extension [(2)]. Findings of the surveys showed that there was an abundant assemblage of soft corals and gorgonians, particularly the sea whip *Euplexaura robusta* and the soft corals *Dendronephthya* spp., localised within a 1 km length at a distance of approximately 50 – 100 m to the south and the west of the seawall of the Ash Lagoon. The densities of the soft coral assemblages at the site surveyed (<

(1) Chan A, Choi C, McCorry D, Chan K, Lee MW, Put A Jr (2005) *Field Guide to Hard Coral of Hong Kong*. Friends of the Country Parks

(2) ERM (1999) *Op cit*

$0.815\ m^{-2}$) were, however, considered as low in comparison with those found at other sites in Hong Kong.

A baseline marine ecological monitoring, which included quantitative Rapid Ecological Assessment (REA) dive surveys, was conducted in 2000 prior to the commencement of the reclamation works for the Lamma Power Station Extension to establish the status of the subtidal coral assemblages of the project site (1). Results of the monitoring showed that a total of 11 to 12 species of corals, predominantly gorgonians and soft corals, were found at the Ash Lagoon seawall and the seabed about 10 – 20 m from the seawall. As with the 1998 survey, the subtidal assemblages of these sites consisted mainly of gorgonians and soft corals, with *Euplexaura* sp. being particularly abundant. The octocoral abundance at these sites ranged from 4.6 to 10.1 colonies m^{-2}. Isolated colonies of the non-reef building hard coral species *Tubastrea* sp. were also present at the Ash Lagoon Seawall.

A number of studies have been conducted for the subtidal hard bottom habitats along the natural shores in the vicinity of the proposed cable alignment. In the 1998 study, ROV and quantitative SCUBA dive surveys were conducted along the west coast of Lamma Island from Shek Kok Tsui to Hai Mei Tsui South (2). Findings from the ROV survey at a depth range of 5-10 m indicated that while the seabed characteristics varied from flat sand to a steep rocky seabed comprised largely of boulders, the subtidal assemblages of the sites surveyed were dominated by gorgonians and soft corals (from the genus *Dendronephthya*) with only one hard coral species (*Tubastrea* sp.) recorded. Results of subsequent quantitative SCUBA survey at shallower coastal region of the same sites revealed that these sites were generally covered by rocks and sand with shell debris and coral cover was very low (mean cover < 1.4 % of the transect). Coral diversity was also very low, comprising hard corals from the family Faviidae and *Psammocora superficialis*, and the soft corals *Dendronephthya* spp. The subtidal assemblages were dominated by sessile organisms such as mussels *Septifer virgatus* and *Perna viridis* and barnacle *Balanus* spp., and mobile fauna including gastropods, crabs, sea cucumber and urchins. Overall, the ROV and SCUBA surveys concluded that the relative abundance and diversity of corals recorded at the sites surveyed was low in comparison with other areas in Hong Kong, and the subtidal assemblages were of low ecological value.

Another dive survey was conducted in 2001 which revisited half of the sites surveyed in the 1998 survey (3). Similar findings were reported on the seabed conditions and low abundance of hard corals and octocorals, with two additional hard coral genera *Cyphastrea* and *Goniastrea* recorded.

(1) Oceanway Corporation Limited (2000) *Baseline Marine Ecological Monitoring for Lamma Power Station Extension (Contract No. 00/9446)*. For the Hongkong Electric Co Ltd

(2) ERM (1999) *Op cit*

(3) Hyder Consulting Ltd (2003) Environmental Impact Assessment of Lamma Power Station Navigation Channel Improvement for Hong Kong Electric

As part of a study of the marine habitats of South Lamma, dive surveys were conducted along shoreline from Hung Shing Ye to Ha Mei Tsui [1], in areas over 1 km from the Project site. The surveys found sparsely scattered coral colonies of encrusting faviids, interspersed with a few soft corals of the genus *Dendronephthya*. Most colonies were small with sizes varying little amongst most colonies. In comparison to other sites around Lamma Island, western Lamma supported fewer faviid corals than the eastern coast such as at Tung O Wan. In comparison to other sites in Hong Kong, the coral communities were considered to be of low ecological value.

Dive surveys conducted around Yung Shue Wan, which is about 1 km away from the proposed cable landing point, concluded that the identified coral community was not of great significance in comparison to other areas in Lamma [2].

For this EIA Study, it was considered appropriate to conduct subtidal dive surveys at the artificial seawall of the Lamma Power Station Extension and at hard substrate(s) along the cable alignment in order to fill data gaps and provide up-to-date data on the ecological value of this habitat type.

9A.3.5 Soft Bottom Habitats

Intertidal Soft Bottom Habitats

Sandy shores along the west coast of Lamma Island that faces the wind farm site include the sandy shore adjacent to the Lamma Power Station, Kat Tsai Wan, Tit Sha Long and two gazetted beaches at Hung Shing Yeh and Lo So Shing, which are at least 1.5 km from the cable landing point at the Lamma Power Station Extension. Sandy shores generally appear almost devoid of marine life [3] and are hence of low ecological value. Sham Wan, which is an intertidal sandy shore of ecological value to nesting Green Turtles, is located at least 4 km from the cable landing point and is discussed further in *Section 9A.3.6*.

There are no intertidal soft habitats within 500 m of the cable landing point, and as such, they are not considered further here and in the Impact Assessment.

Subtidal Soft Bottom Habitats

<u>Epifauna</u>

Subtidal soft bottom habitats, as well as supporting infaunal species, commonly support macro-benthic epifauna. These organisms are generally >

(1) The Hong Kong Institute of Education (1999) Study on the Suitability of South Lamma to be Established as Marine Park or Marine Reserve. Report submitted to Marine Parks Division, AFCD

(2) Mouchel Asia Ltd (2001) Environmental Impact Assessment of Yung Shue Wan Reclamation Stage 2 for CED.

(3) Morton B, Williams GA, Lee SY (1996) The benthic marine ecology of Hong Kong, A dwindling heritage. In: *Coastal Infrastructure Development in Hong Kong: A Review*, pp 233-267. For Civil Engineering Department

1 mm in size and live either on or within the surface sediments. Due to the nature of the Hong Kong's fishery and the typical subtidal substratum in Hong Kong being soft bottom (sandy or silty) habitat, data on subtidal epifaunal assemblages in Hong Kong are primarily available from studies on benthic fisheries resources, collected by demersal trawling surveys.

Information on the epifaunal assemblages of the Study Area have been taken from the AFCD-commissioned study on Fisheries Resources and Fishing Operations in Hong Kong [(1)]. Trawl surveys undertaken as part of AFCD's study indicated that that the highest biomasses recorded in the waters were contributed by Squillidae (mantis shrimp) for both south (waters outside Shek Kok Tsui) and north (waters outside Yuen Kok) Lamma Island, which is over 2 km away from the Project Site. Other families such as Synodontidae (lizard fish) and Dasyatidae (stingrays) have been recorded in south Lamma and north Lamma, respectively.

Two species of horseshoe crab, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*, have previously been recorded in AFCD surveys around Hong Kong waters (AFCD 2006) [(2)], including the mudflat of Shui Hau as the key nursery grounds for *T. tridentatus* [(3)]. The horseshoe crab nursery ground at Shui Hau is located far away from the proposed Wind Farm Site and cable route (at least 10 km), and is considered to be too remote to be affected by the Project works.

No surveys were considered necessary for epifaunal assemblages as a review of the available literature provided sufficient evidence of a low ecological value habitat in the waters surrounding the proposed wind farm and along the submarine cable route off Southwest Lamma.

<u>Infauna</u>

Subtidal infauna are organisms (> 0.5 mm in size) living either on or within the surface sediments of the seabed. In order to provide an indication of the potential ecological value of the infaunal assemblages at the wind farm site and cable route in the context of seabed of Hong Kong waters, it is considered useful to review studies that have investigated infaunal assemblages in Hong Kong on a wide scale. Where considered useful, studies of infaunal assemblages at specific locations have also been included in the review.

A number of studies have been carried out in the vicinity of the wind farm site and cable route, dating back to 1982 and mostly in the 1990s [(4)] [(1)] [(2)] [(3)] [(4)] [(5)]. In

(1) ERM (1997) *Fisheries Resources and Fishing Operations in Hong Kong Waters*. Draft Final Report prepared for AFCD, Hong Kong SAR Government

(2) A third species of horseshoe crab *Tachypleus gigas* was not recorded in Hong Kong since March 1995 and its local status is uncertain (Chiu & Morton 1999) and likely to be locally extinct.

(3) Li HY (2008) *The Conservation of Horseshoe Crabs in Hong Kong*. MPhil Thesis. The City University of Hong Kong

(4) Shin PKS, Thompson GB (1982) Spatial Distribution of the Infaunal Benthos of Hong Kong. *Marine Ecology Progress Series* 10: 37-47

summary, these studies suggest that infaunal assemblages are polychaete-dominated, with mean abundance and mean biomass generally lower than the overall mean values (101.4 individuals $m^{-2}$and 35.2 g m^{-2} respectively) for Hong Kong. Average biomass of infauna from the studies listed above are summarised in *Table 9A.1*.

Table 9A.1 ***Biomass of Infaunal Assemblages from the Lamma Island Area & Elsewhere in Hong Kong*** [(6)]

Study	**Area/ Date**	**Biomass (g m^{-2})**
Shin & Thompson 1992	West Lamma Channel	20.20
	Hong Kong Mean	35.20
APH Consultants 1994	APH-13 December 1993	14.68
	APH-13 June 1994	3.93
	APH-15 December 1993	13.13
	APH-15 June 1994	7.53
AXIS Consultants 1994	Navigation Channel September 1994	22.20
Mouchel 1998	S15 (West Lamma) – Mean	24.14
ERM 1996 – 1997 Seabed Ecology Studies	East Sha Chau (August)	7.50
	Basalt Island (August)	6.10
	East of Ninepins (August)	12.80
	Soko Islands (November)	35.70
	South Cheung Chau (November)	47.20
	Eastern Waters (April)	32.90
	Tathong Channel (April)	35.70
	South Lamma (April)	30.60
ERM 1998	Power Station Reclamation Site (September)	6.00

Territory-wide surveys of Hong Kong subtidal infauna assemblages were conducted at proposed wind farm location and in the vicinity of the proposed cable corridor in 2001[(7)]. Nine sampling stations (Station Nos. 35 – 39, 55 – 57) are close to the proposed area of works and data extracted from them are considered to provide representative, up-to-date information of the assemblages within the Study Area. Findings of the surveys indicated that the substratum of the nine sampling stations is covered by very fine sand

(1) APH consultants (1992) *Lantau Port & Western Harbour Development, Marine Baseline Studies, October 1992*. Final Report submitted to CED

(2) AXIS Environmental Consultants Ltd (1994) *Navigation Channel and Jetty Modification Works at Lamma Power Station – Marine Benthic Ecology Survey*. Draft Final Report Submitted to Hongkong Electric Co Ltd

(3) Mouchel Asia Ltd (1998) *Strategic Sewage Disposal Scheme Stage 1. Baseline Monitoring and Performance Verification*, Draft Final Report to EPD

(4) ERM (1997) Seabed *Ecology Studies – South Lamma Final Report*. For Civil Engineering Department

(5) ERM (1999) *Op cit*

(6) Reproduced from ERM (1999) *Op cit*

(7) CityU Professional Services Limited (2002) *Consultancy Study on Marine Benthic Communities in Hong Kong (Agreement No. CE 69/2000)*. Final Report submitted to AFCD

(average median diameter of 5.83 phi unit). Benthic assemblages found were typical of Hong Kong waters. In summer, the average number of species was high (40 species 0.5 m^{-2}), while the average abundance (331 individuals per m^{-2}) and average biomass (32.33 g m^{-2}) were low when compared with average values of Hong Kong (33 species 0.5 m^{-2}, 540 individuals m^{-2} and 71.2 g m^{-2}; *Table 9A.2*). In winter, the average number of species (42 species 0.5 m^{-2}) and average biomass (35.17 g m^{-2}) were high, while the average abundance (344 individuals m^{-2}) was medium in comparison with average values of benthic assemblages in Hong Kong (34 species 0.5 m^{-2}, 450 individuals m^{-2} and 28 g m^{-2}). Concerning the species diversity, the sediments showed medium (H' = 2 to 3) to high diversity (H' >3), in comparison to other survey areas. In both seasons, no species of conservation concern were found in all stations within the Study Area.

Table 9A.2 Summary Information from Grab Survey in 2001 *(1)*

Proposed Project Area	Station No.	Summer (Wet Season)			Winter (Dry Season)		
		No. of Sp.	Abundance	Biomass	No. of Sp.	Abundance	Biomass
Cable route	38	43	322	18.84	56	692	19.12
	39	39	284	54.70	34	142	81.20
Mean		*41*	*303*	*36.77*	*45*	*417*	*50.16*
Wind farm	35	34	330	8.70	39	264	6.82
	36	43	416	61.76	34	262	42.58
	37	42	330	13.20	41	288	11.14
Mean		*40*	*359*	*27.89*	*38*	*271*	*20.18*
Overall mean		40	331	32.33	42	344	35.17
Overall in HK		33	540	71.20	34	450	28.00

Based on the above, the infaunal assemblages in the proposed Study Area are not considered to have great abundance, diversity and biomass in comparison to other areas of Hong Kong. However, it was considered appropriate to conduct benthic surveys to provide up-to-date data on such assemblages in the vicinity of the works areas of this Project.

9A.3.6 Potential Marine Park at South Lamma

The general marine and coastal waters off south Lamma Island have been proposed for designation as Marine Parks as a result of the AFCD-commissioned feasibility study (2). The proposed park is approximately 1 km away the wind farm development site. The proposed designation primarily aims to protect one of the core habitats for finless porpoise and the nesting site in Sham Wan for green turtles. A variety of studies have investigated the

(1) CityU Professional Services Limited (2002) *Op cit*

(2) HKIEd (1999) *Study on the Suitability of Southwest Lantau to be established as Marine Park or Marine Reserve*' and '*Study on the Suitability of South Lamma to be established as Marine Park or Marine Reserve*. Report submitted to AFCD.

marine ecology of these two species in this area and the results are summarised in the following sections.

9A.3.7 Other Protected Areas

The Cape D'Aguilar Marine Reserve, the potential Marine Park at Soko Islands and the potential Marine Park at Fau Lau, which are about 10 km, 10 km and 20 km away from the proposed Project Site respectively, are considered to be too remote to be affected by the Project works.

9A.3.8 Marine Mammals

A total of 16 (and possibly up to 18) species of marine mammals (mostly cetaceans) have been recorded in Hong Kong waters, two of which are considered residents: the Indo-Pacific humpback dolphin (*Sousa chinensis*, locally called Chinese white dolphins) and the finless porpoise (*Neophocaena phocaenoides*) [1]. Whilst the distribution of Indo-Pacific humpback dolphins is limited to the western waters of Hong Kong, which are influenced by freshwater input from the Pearl River [2] [3], finless porpoises are common in the waters of southern and eastern Hong Kong and do not occur in Hong Kong's northwestern waters (apart from very occasional strandings) [4]. Given the distinctive local distribution patterns of these two species, *Neophocaena phocaenoides* is considered as the key sensitive receptor of this Project and is discussed further below. *Sousa chinensis* is, however, also discussed below to establish its status within the Study Area.

A long-term monitoring programme on humpback dolphins and finless porpoise in Hong Kong and adjacent waters has been undertaken since 1995 to provide broad knowledge on the distribution, abundance, habitat use, and life history of these species [5] [6] [7] [8] [9] [1]. Systematic databases established from this programme have been evaluated to form the basis of this review.

(1) Jefferson TA, Hung SK (2007) An updated, annotated checklist of the marine mammals of Hong Kong. *Mammalia* 71: 105-114

(2) Parsons ECM (1998) The behaviour of Hong Kong's resident cetaceans: the Indo-Pacific humpback dolphin and the finless porpoise. *Aquatic Mammals* 24: 91–110

(3) Jefferson TA (2000) Population biology of the Indo-Pacific humpback dolphin in Hong Kong waters. *Wildlife Monographs* 144: 1-65

(4) Jefferson TA, Hung SK (2007) *Op cit*

(5) Hung SK (2005) Monitoring of finless porpoise (*Neophocaena phocaenoides*) in Hong Kong waters: Final Report (2003-05). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 95 pp

(6) Hung SK (2008a) Monitoring of Marine Mammals in Hong Kong Waters - Data Collection: Final Report (2007-08). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 112 pp

(7) Hung SK (2009) Monitoring of Marine Mammals in Hong Kong Waters - Data Collection: Final Report (2008-09). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 128 pp

(8) Jefferson TA (2000) Population Biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs* 144:1-65

(9) Jefferson TA,Hung SK (2004) A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals (Special Issue)* 30: 149-158

Indo-Pacific Humpback Dolphin

The Indo-Pacific humpback dolphin *Sousa chinensis* is a tropical/ sub-tropical cetacean widely distributed in the coastal and inshore waters of the Indian and western Pacific oceans [(2)]. It is protected locally by the *Wild Animals Protection Ordinance (Cap. 170)*, and is listed as "Near Threatened" in the 2009 IUCN Red List of Threatened Species [(3)]. *Sousa chinensis* is also listed in CITES Appendix I (i.e. highest protection), and is listed as "Endangered" in the China Species Red List and a "Grade I National Key Protected Species" in China. As such *S. chinensis* is considered a species of conservation interest/ concern, both locally in Hong Kong and regionally in China and across the Asia Pacific.

It has been reported that in 2006 at least 1,200 [(4)] individual dolphins were estimated to utilise the waters of the Pearl River Estuary and Hong Kong [(5)]. A more recent estimate using 2004 to 2006 survey data indicates that the total population size of this species in these waters is considered to be about 1,300 to 1,500 individual [(6)]. Of these individual dolphins, approximately 200 are thought to include waters within Hong Kong as part of their range [(7)].

Abundance of humpback dolphins in Hong Kong waters is the highest in the north and west Lantau areas *(Figure 9A.2)*. These areas are thus considered to be the major habitats for humpback dolphins in Hong Kong waters, where individuals of humpback dolphins have been consistently sighted throughout the year [(8)]. Seasonal and spatial variation of abundance of humpback dolphins is usually observed; this is thought to be due to the increased input of freshwater from the discharge of the Pearl River Estuary and the subsequent movements of estuarine prey species into Hong Kong from PRC waters [(9)] [(10)] [(11)]. AFCD reported that in 2006 the abundance of humpback

(1) Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bulletin of Zoology, Supplement* 10: 43-55

(2) Hung SK (2008b) Habitat use of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) in Hong Kong. PhD Dissertation. The University of Hong Kong, Hong Kong, 266 p

(3) Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Sousa chinensis*. In*: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>. Downloaded on 22 June 2009

(4) This estimate did not include the individuals found in the western Estuary, southwest of Macau and Zhuhai, and therefore only represented a minimum.

(5) Jefferson TA (2005) Monitoring of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Hong Kong waters – data analysis: final report. An unpublished report prepared for the Agriculture, Fisheries and Conservation Department, 169+ pp

(6) Jefferson TA (2007) Monitoring of Chinese White Dolphins in Hong Kong Waters - Biopsy Sampling and Population Data Analysis: Executive Summary (1 November 2007). Prepared for the AFCD

(7) Jefferson TA (2005) *Op cit*

(8) Jefferson TA, Hung SK (2007) *Op cit*

(9) Jefferson TA (2000) *Op cit*

(10) Barros NB, Jefferson TA, Parsons ECM (2004) Feeding habits of Indo-Pacific humpback dolphins (*Sousa chinensis*) stranded in Hong Kong. *Aquatic Mammals* (Special Issue) 30: 179-188

(11) Jefferson TA,Hung SK (2004) *Op cit*

dolphins in Hong Kong's waters ranged from 103 in spring to 193 individuals in autumn [1].

The long-term monitoring study in the past 13+ years has shown that humpback dolphins do not regularly occur in eastern waters with higher salinity, as this species has a strong preference for waters with influence from the Pearl River freshwater input [2] [3]. Waters to the east of Lantau are rarely used by dolphins, and this area appears to comprise the eastern boundary of their range [4]. The long-term sightings database has revealed that there have only been four sightings of humpback dolphins in the eastern survey areas (i.e. including southwestern Lamma waters) since 2000 (*Figure 9A.3*). Of note, all of these were solitary animals and were sighted only in winter months (in Jan 2000, Feb 2004, and Nov and Dec 2007) [5]. Their occurrence in these waters was thus considered to be extralimital.

Quantitative grid analysis (i.e. numbers of sightings standardised with survey effort) has been established to examine dolphin abundance and their fine-scale habitat usage. Of the areas surveyed, standardised dolphin sighting densities and dolphin densities were the highest at West Lantau [6]. Such analysis was, however, not undertaken for the Lamma survey area since sightings were too low to allow a cost-effective monitoring and analysis.

On the basis of the review of long-term monitoring database and relevant literature, southwestern Lamma waters are not considered to be an important area for Indo-Pacific humpback dolphins.

Finless Porpoise

The finless porpoise *Neophocaena phocaenoides* is a tropical/ sub-tropical cetacean widely distributed in coastal marine waters, as well as some river mouths and estuaries, from the Persian Gulf eastwards around the rim of the Indian Ocean to the Taiwan Strait area in southern Japan. It is protected locally by the *Wild Animals Protection Ordinance (Cap. 170)*, and is listed as "Vulnerable" in the 2009 IUCN Red List of Threatened Species [7]. *Neophocaena phocaenoides* is also listed in CITES Appendix I (i.e. highest protection), and is listed as "Endangered" in the China Species Red List. As such *N. phocaenoides* is considered a species of conservation interest/ concern, both locally in Hong Kong and regionally in China and across the Asia Pacific.

(1) Jefferson TA (2007). *Op cit*

(2) Hung SK (2008b) *Op cit*

(3) Hung SK (2009) *Op cit*

(4) Hung SK (2008b) *Op cit*

(5) Hung SK, pers comm

(6) Hung SK (2008b) *Op cit*

(7) Reeves RR, Collins T, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Neophocaena phocaenoides*. In*: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>. Downloaded on 22 June 2009

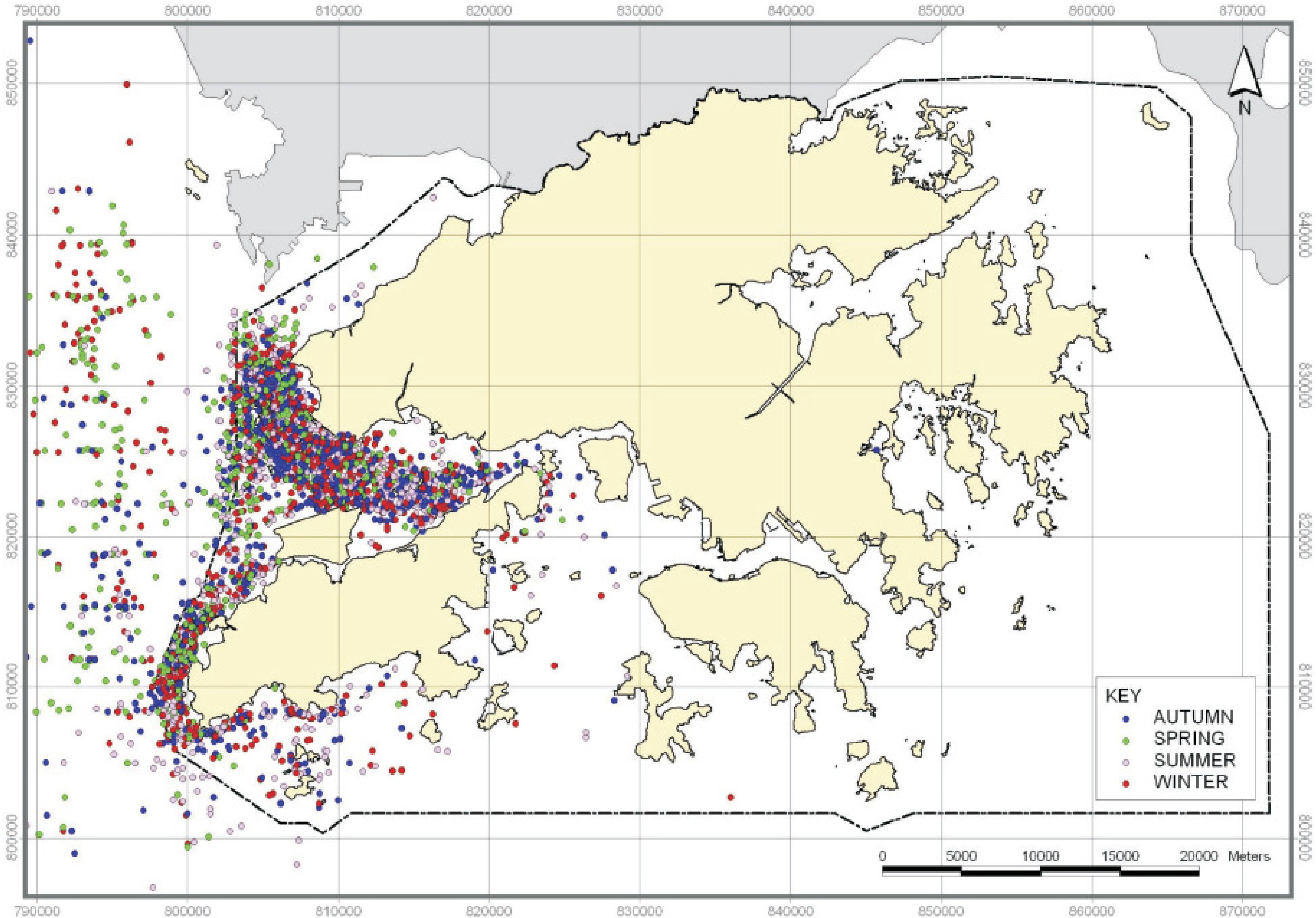

Figure 9A.2

Seasonal Distribution of the Indo-Pacific Humpback Dolphin, *Sousa chinensis*, in Hong Kong waters. Data Collected between 1995 and 2004 (AFCD 2004)

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In Hong Kong, finless porpoise occur year-round, and they can be found primarily in the southern (i.e Po Toi, Lamma, Southeast and Southwest Lantau) and eastern (i.e. Mirs Bay, Sai Kung and Ninepins) waters of the territory (1) (2) (3) (4) (5) *(Figure 9A.4)*. The AFCD reported that in 2006 at least 217 (6) individual porpoises were estimated to utilise the waters of Hong Kong and in Chinese waters just south of Hong Kong (7).

The majority of porpoise sightings have been made in southern waters, with a high concentration of sightings near the Po Toi Islands, at the southwest corner of Lamma Island, in southeast Lantau (southern waters of Cheung Chau and southwest corner of Chi Ma Wan Peninsula) and southwest Lantau (near Shek Kwu Chau and the Soko Islands) (*Figure 9A.5*). These areas are thus considered to be the main habitats for finless porpoises in Hong Kong waters. They rarely occurred in West and North Lantau, which are heavily influenced by freshwater input from the Pearl River, and are the prime habitat of the Chinese white dolphin population (8) (9). The only area where the two resident species showed substantial overlap in distribution was in South Lantau waters (10) (11).

Seasonal variation in distribution is evident for finless porpoises in Hong Kong (12) (13). They are more commonly sighted in southern waters (i.e. South Lantau and Lamma) during winter and spring, while in summer and autumn they shift to the eastern waters to a great extent (i.e. Po Toi, Ninepins and Sai Kung), potentially as a result of the influx of freshwater in those months, and hence more estuarine conditions (14) (15). Their abundance in Hong Kong waters ranges from a high of approximately 152 individuals in spring to approximately 55 in autumn (16).

(1) Hung SK (2005) *Op cit*

(2) Hung SK (2008b) *Op cit*

(3) Hung SK (2009) *Op cit*

(4) Jefferson TA, Braulik G T (1999) Preliminary report on the ecology of the finless porpoise in Hong Kong waters. *IBI Reports* 9: 41-54

(5) Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) *Op cit*

(6) This preliminary minimum population estimate included at least 147 porpoises occurring in Chinese waters just south of Hong Kong, and could be probably an underestimate because finless porpoises are very difficult to spot on surveys and some areas have not been extensively studied.

(7) Agriculture, Fisheries and Conservation Department (AFCD): Finless Porpoise website <http://www.afcd.gov.hk/english/conservation/con_mar/con_mar_fin/con_mar_fin_fin/con_mar_fin_fin_dis_howmany.html> Accessed on 23 June 2009

(8) Hung SK (2008b) *Op cit*

(9) Jefferson TA,Hung SK (2004) *Op cit*

(10) Hung SK (2008b) *Op cit*

(11) Hung SK (2009) *Op cit*

(12) Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) *Op cit*

(13) Parsons ECM (1998) *Op cit*

(14) Hung SK (2009) *Op cit*

(15) Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) *Op cit*

(16) Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) *Op cit*

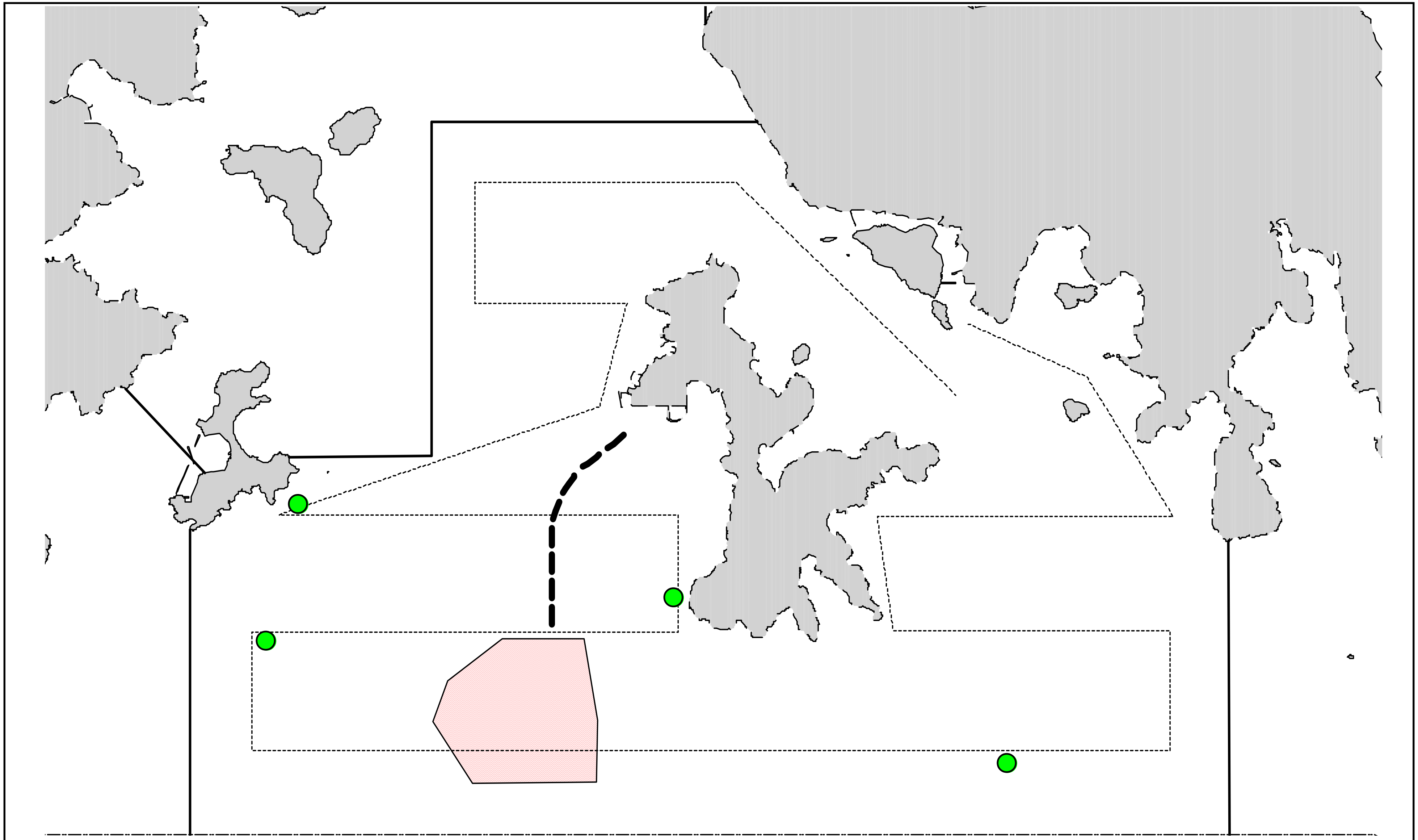

Figure 9A.3

Sightings of Indo-Pacific Humpback Dolphins in the Southwest Lamma Area since 2000

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Quantitative grid analysis on porpoise habitat use revealed that during 2004-08, standardised porpoise sighting densities (i.e Sightings Per Survey Effort (SPSE) values, representing the number of on-effort sightings per km^2, with the survey area mapped using a 1 km by 1 km grid) were higher at the waters just south of Soko Islands, the offshore waters in Southeast Lantau, at southwest corner of Shek Kwu Chau and Cheung Chau, near Stanley Peninsula and around Po Toi Islands than in other areas of Hong Kong waters [(1)].

Therefore based on the results of the information available from the long-term sighting data on marine mammals in the waters of Hong Kong, it appears that finless porpoises have been sighted regularly within the areas surrounding the proposed wind farm site and cable route. In order to provide up-to-date and detailed comprehensive baseline information to supplement information from the literature, a programme of finless porpoise surveys was undertaken for this EIA Study.

9A.3.9 Sea Turtles

Of the seven extant species of sea turtles, loggerheads (*Caretta caretta*), leatherbacks (*Dermochelys coriacea*), hawksbills (*Eretmochelys imbricata*), olive ridleys (*Lepidochelys olivacea*) and greens (*Chelonia mydas*) have been reported to occur in the waters of Hong Kong [(2)]. However, the green turtle is the only species confirmed to nest in Hong Kong [(3)].

Green turtle *Chelonia mydas* is protected locally by the *Wild Animals Protection Ordinance (Cap. 170)*, and is listed as "Endangered" in the 2009 IUCN Red List of Threatened Species [(4)]. It is also listed in CITES Appendix I (i.e. highest protection), and is listed as "Critically Endangered" on the China Species Red List and a "Grade II National Key Protected Species" in China. As such *Chelonia mydas* is considered a species of conservation interest/ concern locally, regionally and globally.

The major nesting site for green turtles in Hong Kong is at Sham Wan, southern Lamma Island, which is over 5 km from the proposed wind farm site [(5) (6) (7) (1)]. A small number of green turtles are known to nest at Sham Wan,

(1) Hung SK (2009) *Op cit*

(2) AFCD (2006) *Sea turtles recorded in Hong Kong website*. <http://www.afcd.gov.hk/english/conservation/con_fau/con_fau_sea/con_fau_sea_sea/con_fau_sea_sea.html > Accessed on 17 May 2009

(3) Nesting refers to the laying of clutches of eggs by female turtles on their natal beaches. Female turtles usually migrate (up to thousands of kilometres) from their resident foraging areas to a coastal area, ie nesting beach, for nesting. Adult females return to their natal areas for breeding and both males and females show strong fidelity to their nesting and foraging areas

(4) Seminoff JA (2004) *Chelonia mydas*. In*: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>. Downloaded on 22 June 2009

(5) AFCD (2006) *Sea turtles recorded in Hong Kong website*

(6) McGilvray F, Geermans S (1997) The status of the green turtle in Hong Kong and an action plan for its survival. Hong Kong: The Hong Kong Marine Conservation Society.

(7) Morton B (1999) On turtles, dolphins and, now, Asia's horseshoe crabs. Marine Pollution Bulletin 38: 845-846.

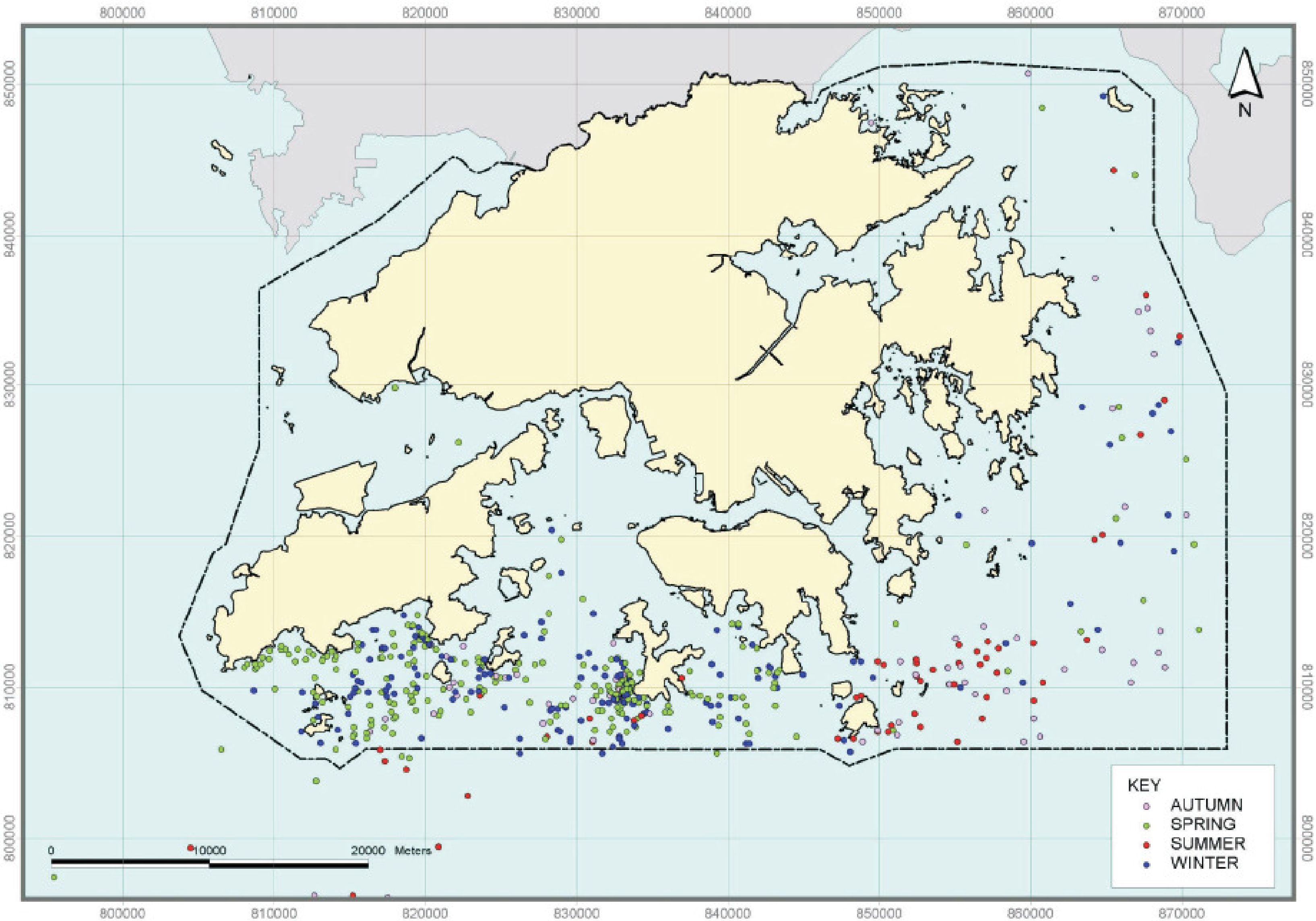

Figure 9A.4

Seasonal Distribution of the Finless Porpoise, Neophocaena phocaenoides, in Hong Kong waters. Date Collected between 1995 and 2004 (AFCD 2004)

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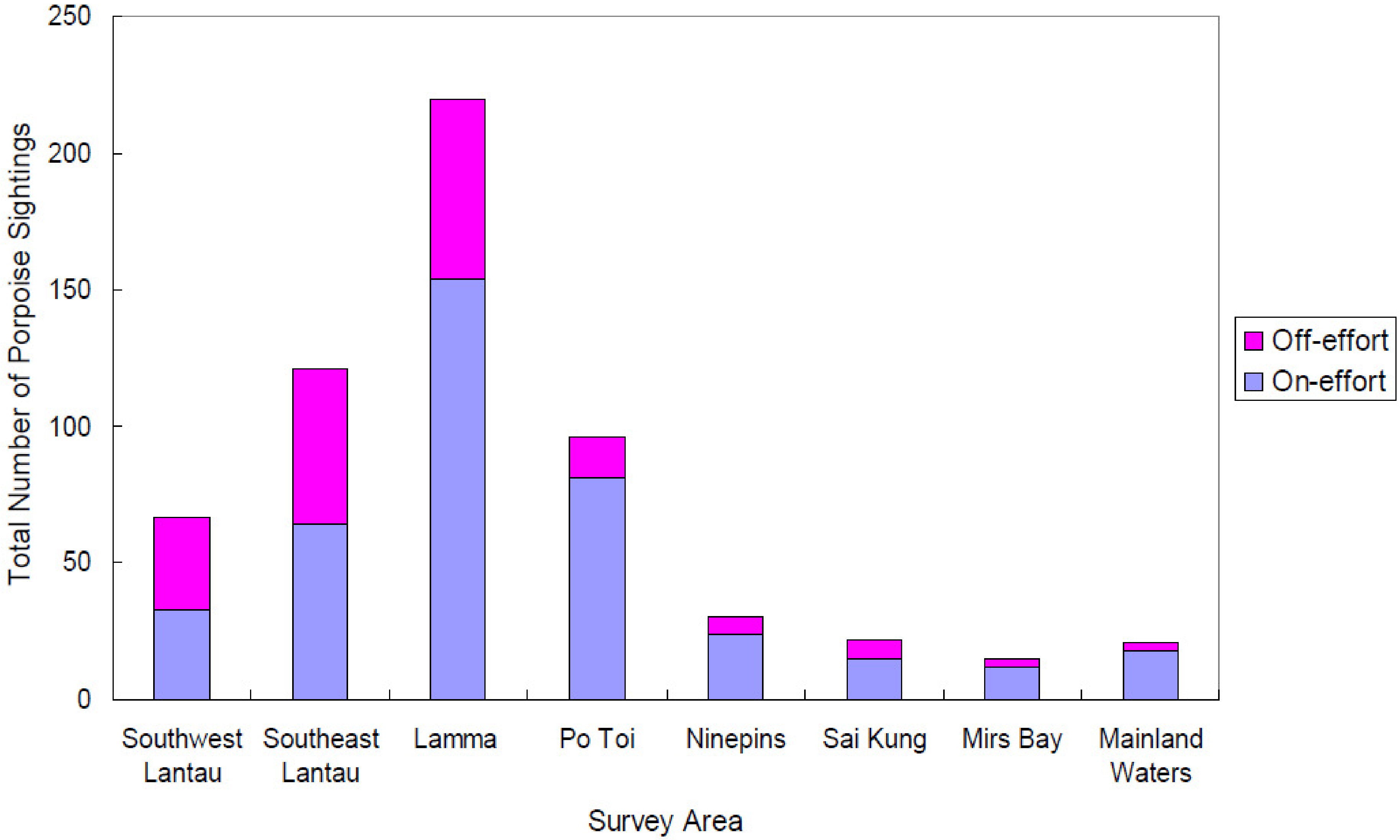

Figure 9A.5

Number of Finless Porpoise Sightings in Different Survey Areas in Hong Kong and Mainland Chinese Territorial Waters during 1996-2005 (Reproduced from Hung (2008b))

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although nesting does not occur every year [(2)]. In 1999, the 0.5 ha of sandy beach at Sham Wan was listed as a Site of Special Scientific Interest and a Restricted Area under the *Wild Animals Protection Ordinance (Cap. 170)*. Access to the beach is prohibited between 1 June and 31 October each year during the green turtle nesting season [(3)].

Satellite tracking of female green turtles nesting at Sham Wan beach has been undertaken since 2002 to examine their regional migration patterns. Results of the tracking showed that the same nesting female (named "Hong Kong 2") tracked in June 2003 and August 2008 used the waters close to Sham Wan, in the south and southeast of Lamma Island, between subsequent clutches (*Figures 9A.6* and *9A.7*). She maintained a distance of within 10 km of the beach during inter-nesting periods for just over 2 months before migrating back to foraging grounds in the coastal waters of Dao Bach Long Vi, Vietnam [(4)].

Satellite tracking of on a foraging green turtle in the Gangkou Sea Turtle National Nature Reserve populations in China revealed that they moved from its foraging grounds in Daya Bay to Wanshan Archipelago [(5)], migrating past or through Hong Kong, by Basalt Island, Tung Lung Chau and other parts of Hong Kong waters, between nesting and foraging grounds (*Figure 9A.8*). Another tracking study conducted on post-nesting green turtles populations in Taiwan also indicated that the turtles often utilise several coastal areas as temporal residential forging sites as far as to the east coast of China [(6)].

There is no documented evidence of foraging activity by sea turtles in Hong Kong waters, though sightings of sub-adults green turtles that would not undertake long-distance migration may suggest foraging behaviour (*AFCD, unpublished data*). Overseas studies have showed that green turtles may not feed during the nesting season and they normally forage on seagrass as primary food source [(7)] [(8)] but can also feed on algae [(9)]. Of note, no seagrass beds that could be foraging areas for green turtles are located in vicinity to the proposed wind farm site and cable route. In addition, the seabed at the

(1) Green turtle nesting has also been recorded in 2006 to the east of Hong Kong at Tai Long Wan, Sai Kung. However, this is the only record of nesting at this location and it is unlikely to be a major nesting site for green turtles in Hong Kong

(2) AFCD (2006) *Sea turtles recorded in Hong Kong website*

(3) AFCD (2006) *Sea turtles recorded in Hong Kong website*

(4) AFCD (2006) *Sea turtles recorded in Hong Kong website*

(5) Song X, Wang H, Wang W, Gu H, Chan SKF, Jiang H (2002) Satellite tracking of post-nesting movements of green turtles, *Chelonia mydas*, from Gangkou Sea Turtle National Nature Reserve, China, 2001. *Marine Turtle Newsletter* 97: 8-9

(6) Cheng IJ (2000) Post-nesting migrations of green turtles (*Chelonia mydas*) at Wan-An Island, Penghu Archipelago, Taiwan. *Marine Biology* 137: 747-754

(7) Bjorndal KA (1997) Foraging ecology and nutrition of sea turtles. In *The Biology of Sea Turtles*, Lutz PL, Musick JA (eds), pp 199-231. Boca Raton: CRC Press.

(8) Mortimer JA. (1982). Feeding ecology of sea turtles. In. *Biology and Conservation of Sea Turtles* (Edited by Bjorndal, KA.). Smithsonian Institute Press, Washington, D.C. pp. 103-109

(9) Bjorndal KA (1985) Nutritional ecology of sea turtles. *Copeia* 1985: 736-751.

Figure 9A.6

Inter-nesting locations (red dots) from June 25 to September 4, 2003 of the green turtle (named "Hong Kong 2") that nested on Sham Wan, Lamma Island. Map provided by AFCD

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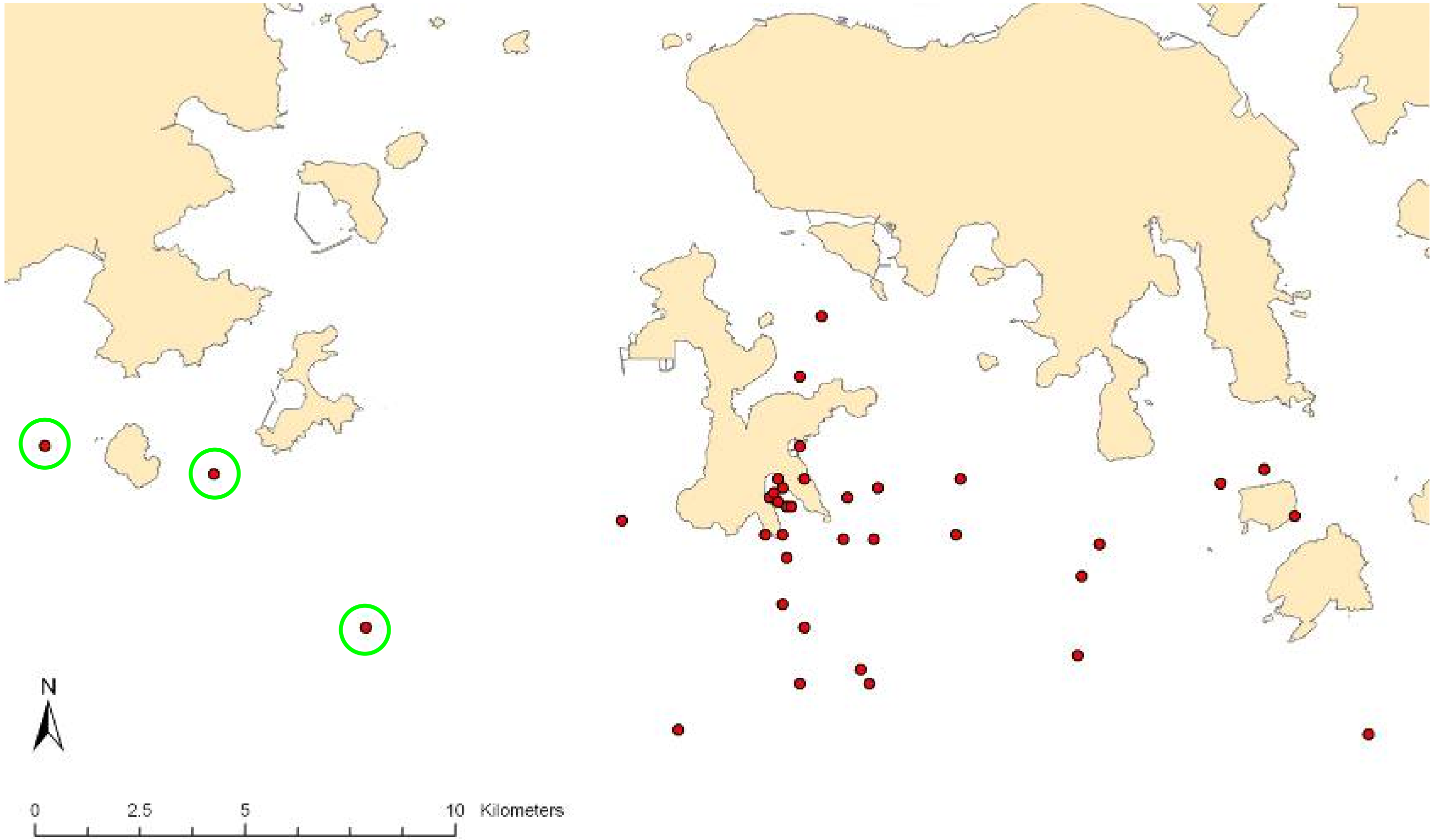

Figure 9A.7

Inter-nesting locations (red dots) from August 9 to October 12, 2008 of the green turtle (named "Hong Kong 2") that nested on Sham Wan, Lamma Island. Map provided by AFCD.

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Study Area is comprised of fine sediments which do not appear to support important foraging habitats for green turtles, either during the inter-nesting season, or as a more permanent foraging ground. The Study Area is therefore unlikely to serve as foraging habitats for this species.

Due to the very occasional occurrence of green turtle in Hong Kong waters, systematic survey for the species was considered impractical and as such, baseline surveys were not undertaken as part of this EIA.

9A.4 BASELINE MARINE ECOLOGICAL SURVEYS

The literature review of the marine ecological habitats and resources of the waters within and in close proximity to the proposed wind farm and cable route has provided an indication of the ecological importance of the Project Site. However, in order to provide up-to-date information on marine ecological baseline conditions, a number of field surveys were considered necessary and were undertaken in 2008 and 2009 (*Table 9A.3).*

Table 9A.3 Marine Ecology Baseline Surveys

Survey Type	Methodology	Season & Date
Intertidal Assemblages at Lamma Power Station Extension	Quantitative surveys of three 100 m belt transects (at high, mid and low intertidal zones) at artificial seawall, covering both wet and dry seasons	Wet Season: 28 Oct 2008 Dry Season: 27 Feb 2009
Subtidal Benthic Assemblages	Quantitative grab sampling surveys at 10 sites (three stations at each site). Sites surveyed represented the wind farm site, cable route and reference sites	Wet Season: 19 Oct 2008 Dry Season: 19 Mar 2009
Subtidal Hard Bottom Assemblages (Coral)	Semi-quantitative (Rapid Ecological Assessment (REA) technique) and qualitative (recorded within Study Area and areas in the vicinity)	4 and 5 May 2009

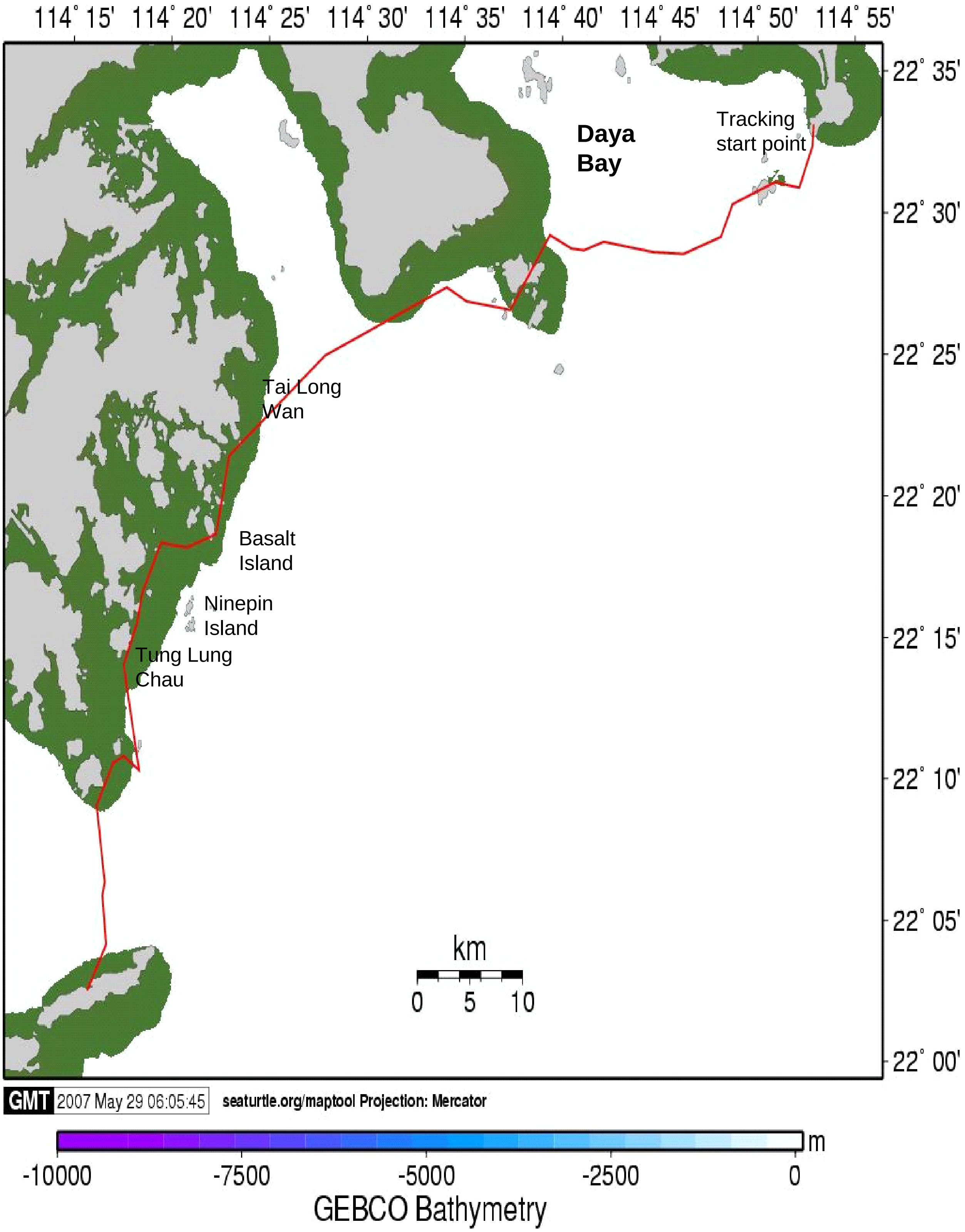

Figure 9A.8 **Migration route of a foraging green turtle in Gangkou (China) in the summer of 2007 and passed through Hong Kong waters during its migration to the Wanshan Archipelago. Map provided by AFCD**

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Survey Type	Methodology	Season & Date
Marine Mammal	Quantitative vessel-based survey using line transect methods around Lamma Island	1 day per month for 6 months, from Dec 2008 to May 2009 (inclusive) (Winter / Spring) in the following dates: 24 Dec 2008 (Winter), 16 Jan 2009 (Winter), 13 Feb 2009 (Winter), 13 Mar 2009 (Spring), 15 Apr 2009 (Spring) and 11 May 2009 (Spring
	Qualitative vessel-based survey around Lamma Island	3 days per month for 5 months, from July to October 2008 (Summer / Autumn), and in June 2009 (Summer), in the following dates: 24, 26, 28 July 2008 (Summer), 15, 21, 25 August 2008 (Summer), 4, 11, 26 September 2008 (Summer), 6, 17, 20 October 2008 (Autumn), and 10, 11, 17 June 2009 (Summer)

Survey methodologies have been selected to follow standard and accepted techniques for marine ecological surveys. In addition, each methodology has been previously conducted as part of other Environmental Impact Assessments (EIA) studies, accepted under the Hong Kong Environmental Protection Department *Environmental Impact Assessment Ordinance* (EIAO).

Survey schedules have been undertaken in accordance with the *Environmental Impact Assessment Ordinance, Cap.499 Guidance Note 7/2002 - Ecological Baseline Survey for Ecological Assessment*, specifically in terms of the following:

- Duration of Survey;
- Seasonality;
- Types of Survey Period; and
- Survey Effort.

The following sections present the methodology and results for each marine ecological survey undertaken as part of the assessment of marine ecological baseline conditions.

9A.4.1 *Intertidal Hard Bottom Assemblages*

Survey Methodology

Only one type of intertidal habitat, artificial shore, was identified in the vicinity of the proposed cable landing point The artificial shore at the Lamma Power Station Extension consists of steep seawall of large boulders, and this habitat was examined for the intertidal surveys.

The intertidal surveys consisted of quantitative transect surveys at three locations (T1, T2 and T3, *Figure 9A.9*) along the artificial sloping seawall within the 500 m study boundary of the proposed landing point. Intertidal surveys were conducted in both the wet and dry seasons. Local tide tables were used to assess tidal height at the site and times of surveys.

At each of the three survey locations, three 100 m horizontal (belt) transects along the seawall were surveyed at each of the three shore heights: 2 m (high-shore), 1.5 m (mid-shore) and 1 m (low-shore) above Chart Datum (CD). On each transect, ten quadrats (50 cm × 50 cm) were placed randomly to assess the abundance and diversity of flora and fauna. All organisms found in each quadrat were identified and recorded to the lowest possible taxonomic level to allow density per quadrat to be calculated. Sessile species, such as algae (encrusting, foliose and filamentous), barnacles and oysters, in each quadrat were also identified and estimated as percentage cover on the rock surface using a double-strung, 50 cm × 50 cm quadrat.

Survey Results

<u>Wet Season Survey Results</u>

A total of 18 faunal groups were recorded in the wet season survey. At all three transect locations, dominant (in terms of abundance) organisms recorded included the littorinid snail *Echinolittorina* spp. in the high-shore, the topshell *Monodonta labio* and the limpet *Cellana toreuma* in the mid-shore, and the limpets *C. toreuma* and *Patelloida saccharina* and the common dogwhelk *Thais clavigera* in the low-shore. Sessile species including the barnacle *Tetraclita squamosa* and the oyster *Saccostrea cucullata* are also present in the low-shore. Both the abundance/ density of mobile species and percentage cover of sessile species were considered to be low (mean ~ 38 individuals m^{-2} and ~ 13 % m^{-2} respectively). Only four species of algae and one species of cyanobacteria were recorded in the wet season survey, and the percentage cover by these species was very low (mean < 4 % m^{-2}). The surveys results are summarised below:

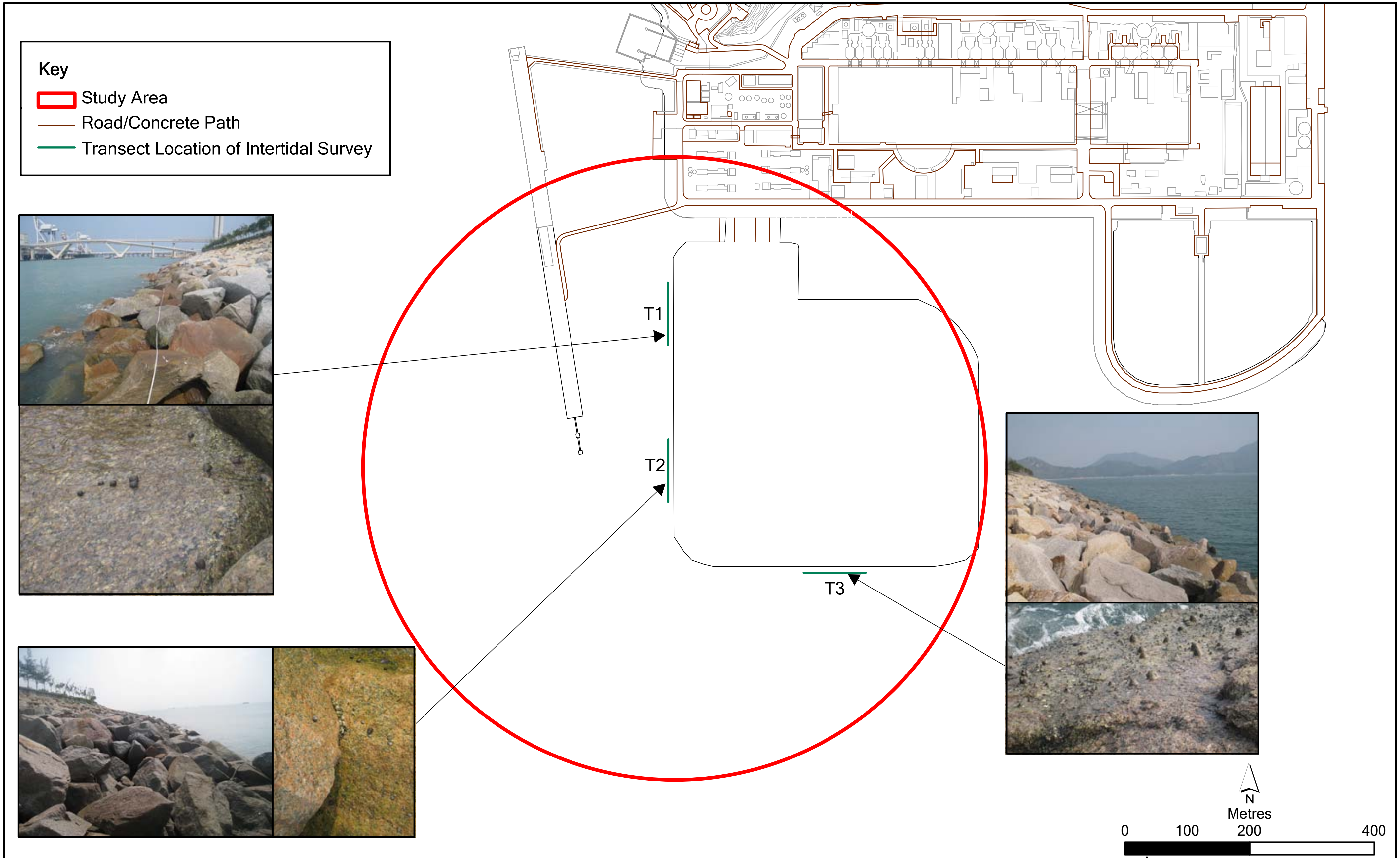

Figure 9A.9

Intertidal Survey Transect Locations at Lamma Power Station Extension

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Wet Season	**Mean Abundance per m²**		
Species	**High-shore**	**Mid-shore**	**Low-shore**
Gastropods (individuals)			
Acanthopleura japonica	0.27	0.93	3.47
Cellana toreuma	0.00	12.40	17.20
Chlorostoma argyrostoma	0.00	0.00	0.27
Echinolittorina radiata/ vidua	8.13	0.13	0.00
Echinolittorina trochoides	0.40	0.00	0.00
Monodonta labio	2.53	13.33	12.13
Nerita yoldii	0.00	1.07	4.00
Patelloida pygmaea	0.00	0.00	0.40
Patelloida saccharina	3.20	5.60	13.60
Siphonaria japonica	0.13	0.27	0.53
Thais clavigera	0.00	5.33	9.73
Grapsus albolineatus	0.00	0.00	0.40
Crustaceans			
Isopod sp. (individuals)	0.00	0.00	0.80
Ligia exotica (individuals)	1.60	0.67	1.60
Capitulum mitella (%)	0.47	1.47	0.07
Tetraclita squamosa (%)	0.87	7.83	13.87
Tubeworms			
Hydroides sp.	0.00	0.00	0.40
Bivalves			
Saccostrea cucullata (%)	0.27	1.13	12.73
Algae (%)			
Ralfsia expansa	0	0.67	0
Hildenbrandia sp.	0	2.33	3.00
Corallina sp.	0	0	3.27
Pseudulvella applanata	0	0	1.00
Cyanobacteria (%)			
Kyrtuthrix maculans	0	0.83	0

Dry Season Survey Results

The species composition of the intertidal organisms during the dry season was similar to that of the wet season, with a total of 17 faunal groups, four algal species and one species of cyanobacteria. Seasonal variation in intertidal assemblage pattern was attributed to higher abundance of grazing molluscs, particularly *Echinolittorina* spp., *Cellana toreuma*, *Monodonta labio*, *Patelloida saccharina* and *Siphonaria japonica*, lower abundance of *Thais clavigera*, lower percentage cover of *Tetraclita squamosa* and *Saccostrea cucullata*, and higher percentage cover of the encrusting algae *Hildenbrandia* sp., in the dry than the wet season. Mean abundance of mobile species, sessile species and algae recorded in the dry season survey were 64 individuals m^{-2}, 3 % m^{-2} ~ 21 % m^{-2} and respectively. The surveys results are summarised below:

Wet Season	Mean Abundance per m²		
Species	High-shore	Mid-shore	Low-shore
Gastropods (individuals)			
Acanthopleura japonica	0	3.33	2.27
Cellana toreuma	0.53	22.00	29.87
Chlorostoma argyrostoma	0	0	0.40
Echinolittorina radiata/ vidua	32.00	0	0
Echinolittorina trochoides	1.73	0	0
Monodonta labio	0	19.20	19.07
Nerita yoldii	0	0.93	1.07
Patelloida pygmaea	2.67	2.40	1.33
Patelloida saccharina	1.20	12.27	19.73
Siphonaria japonica	0.93	2.53	8.00
Siphonaria laciniosa	0.13	1.07	1.73
Thais clavigera	0.13	2.27	1.87
Crustaceans			
Ligia exotica (individuals)	0	0.13	0.13
Capitulum mitella (%)	0.17	1.07	0
Tetraclita squamosa (%)	0.03	1.63	0
Bivalves			
Saccostrea cucullata (%)	0	6.23	1.10
Septifer virgatus (%)	0	0.03	0
Algae (%)			
Ralfsia expansa	0	0.07	0
Hildenbrandia sp.	0	19.07	32.77
Green algae	0	0	0.27
Encrusting coralline algae	0	0.33	8.83
Cyanobacteria (%)			
Kyrtuthrix maculans	0.47	0.50	0

Overall, results of the seasonal intertidal surveys indicated that the artificial sloping seawall of the Study Area exhibited a low diversity of species. The species recorded during the surveys are all very common and widespread species on artificial shores of Hong Kong.

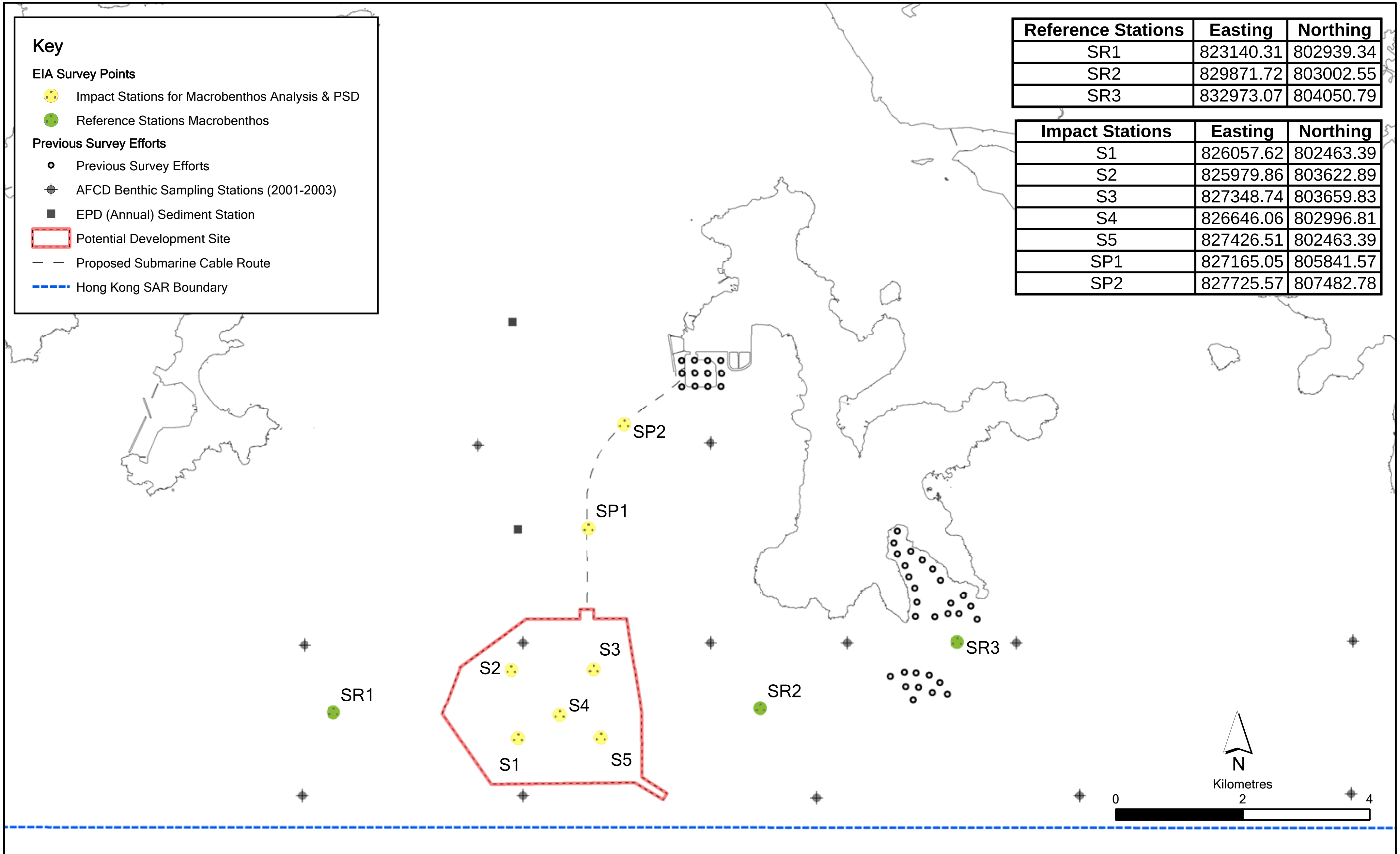
9A.4.2 *Subtidal Soft Bottom Assemblages – Benthos*

Survey Methodology

<u>Sampling Locations</u>

Benthic sediment samples were collected from 10 sites representative of the subtidal soft-bottom habitats of the potential wind farm site, cable route and the Study Area. The sampling sites were as follows:

- Proposed Wind Farm Location: S1 to S5;
- Proposed Transmission Cable Alignment: SP1 and SP2; and
- Reference Stations: SR1 to SR3.



Reference Stations	Easting	Northing
SR1	823140.31	802939.34
SR2	829871.72	803002.55
SR3	832973.07	804050.79

Impact Stations	Easting	Northing
S1	826057.62	802463.39
S2	825979.86	803622.89
S3	827348.74	803659.83
S4	826646.06	802996.81
S5	827426.51	802463.39
SP1	827165.05	805841.57
SP2	827725.57	807482.78

Figure 9A.10

Subtidal Soft Bottom Sampling Locations

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The locations of each survey site are shown in *Figure 9A.10*.

The numbers of sampling stations within the wind farm and along the cable route were considered sufficient given the relatively homogeneous nature of sediments at the sites. The reference stations have been identified in order to provide information on benthic ecology in areas that may be deemed more sensitive (eg close to Sham Wan of Lamma Island).

Field Sampling Methodology

At each of the 10 survey sites, three stations approximately 50 m apart were established and one grab sample was collected from each station. Stations were sampled using a modified Van Veen grab sampler (960 cm^2 sampling area; 11,000 cm^3 capacity) with a supporting frame attached to a swivelling hydraulic winch cable.

Sediments from the grab samples were sieved on board the survey vessel. The sediments were washed onto a sieve stack (comprising 1 mm^2 and 500 μm^2 meshes) and gently rinsed with seawater to remove all fine material. Following rinsing any material remaining on the two screens was combined and carefully rinsed using a minimal volume of seawater into pre-labelled thick triple-bagged ziplock plastic bags. A 5% solution of borax-buffered formalin containing Rose Bengal in seawater was then added to the bag to ensure tissue preservation. Samples were sealed in plastic containers for transfer to the taxonomy laboratory for sorting and identification.

Laboratory Techniques

The benthic laboratory performed sample re-screening after the samples had been held in formalin for a minimum of 24 hours to ensure adequate fixation of the organisms. Individual samples from the 500 μm^2 and 1 mm^2 mesh sieves were gently rinsed with fresh water into a 250 μm^2 sieve to remove the formalin from the sediments. Sieves were partially filled while rinsing a specific sample to maximize washing efficiency and prevent loss of material. All material retained on the sieve was placed in a labelled plastic jar, covered with 70% ethanol, and lightly agitated to ensure complete mixing of the alcohol with the sediments. Original labels were retained with the re-screened sample material.

Standard and accepted techniques were used for sorting organisms from the sediments. Small fractions of a sample were placed in a petri dish under a 10-power magnification dissecting microscope and scanned systematically with all animals and fragments removed using forceps. Each petri dish was sorted at least twice to ensure removal of all animals. Organisms representing major taxonomic groups, such as Polychaeta, Arthropoda, Mollusca, and miscellaneous taxa, were sorted into separate, labelled vials containing 70% ethanol.

Taxonomic identifications were performed by qualified and experienced specialist using stereo dissecting and high-power compound microscopes. These were generally to the species level except for unidentified taxa, which were identified to genera as far as practical. The careful sampling procedure employed minimizes fragmentation of organisms. If breakage of soft-bodied organisms occurred, only anterior portions of fragments were counted, although all fragments were retained and weighed for biomass determinations (wet weight).

Survey Results

Survey Dates and Conditions

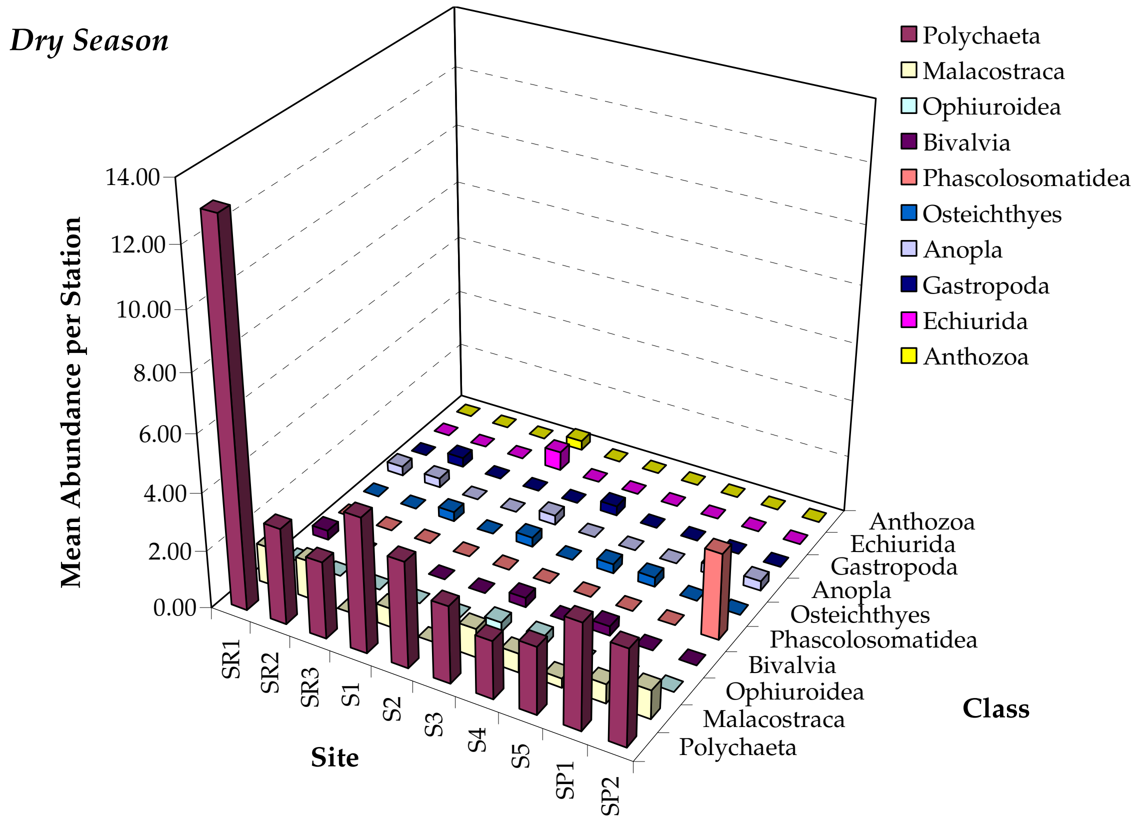
Grab samples were collected from all 10 sampling sites in both the dry (19 March 2009) and wet (28 October 2008) seasons. In general, conditions during surveys were fine with relatively calm sampling conditions throughout.

Dry Season Survey Results

A total of 173 individual organisms were collected from the 30 grab sampling stations at the 10 survey sites during the dry season survey in March 2009. The specimens belong to eight Phyla with a total of 10 classes, 41 families and 49 species identified. *Table 9A.4* provides a summary on the abundance, biomass and taxonomic richness of infauna collected at each site. A complete set of raw data is presented in *Tables 1 & 2* of *Annex 9A1.*

Results of the dry season benthic survey showed that infaunal abundance, biomass and taxonomic richness (here represented by number of families and species of infaunal organisms) were very low at all sampling sites (*Table 9A.4*). There was some variation in infaunal abundance, biomass and taxonomic richness among sampling sites. Whilst the mean infaunal abundance and mean taxonomic richness per station were significantly higher at the Reference Site SR1 than other sites, infaunal biomass was significantly higher at the wind farm site S3 than other sites (*Table 9A.4*). With the exceptions explained above, all sampling sites showed relatively similar infaunal abundance, biomass and taxonomic richness. Variation within site (ie among sampling stations) was also considered to be small, as can be seen from the low standard deviation (SD) values (*Table 9A.4*).

In terms of infaunal abundance, the majority (71.7%) of organisms recorded were from the Phylum Annelida, followed by Arthropoda (12.1%) and Sipuncula (5.2%). Each of the other recorded phyla contributed to < 3 % of the number of individuals recorded. The polychaete worm *Prionospio queenslandica*, from the family Spionidae, was the most abundant species from the dry season survey (total abundance = 25 individuals), particularly at SR1 (total abundance = 16 individuals). No rare or uncommon species were recorded in the survey. The composition of infaunal assemblage at each site



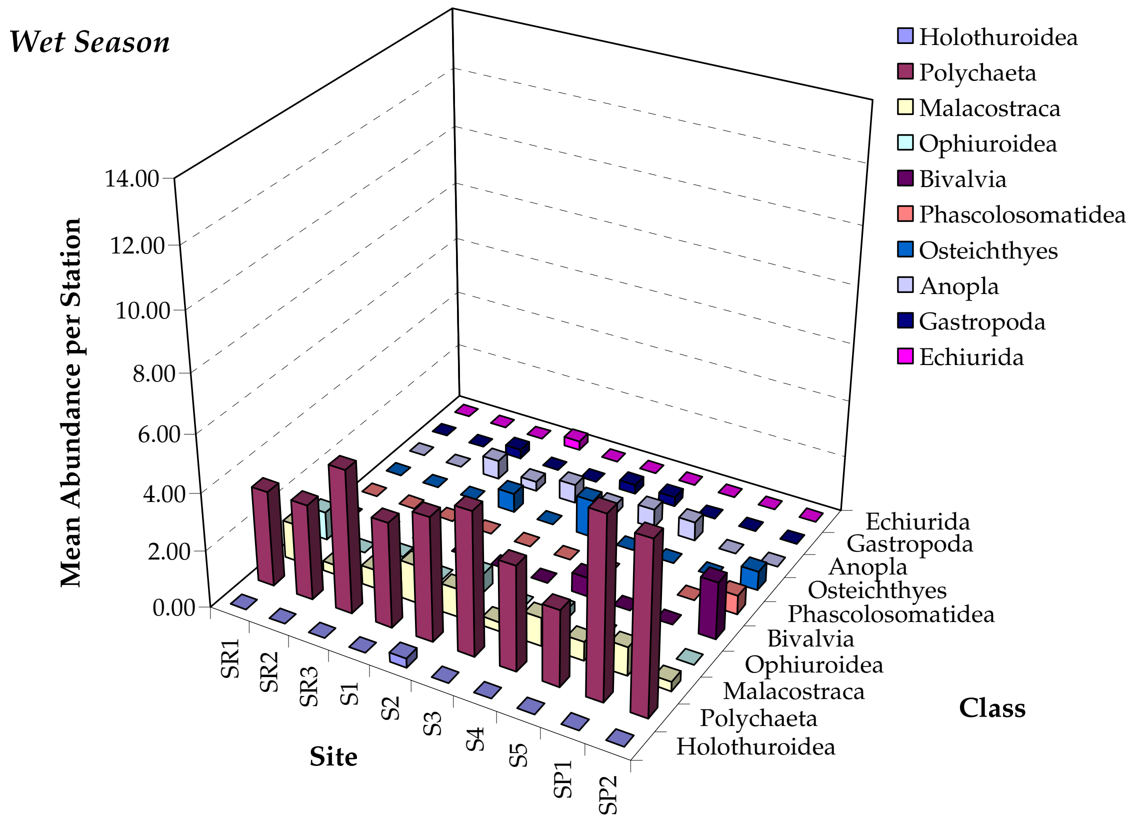


Figure 9A.11

Mean Numbers of Individuals of Infaunal Organisms (Class level) per Stations from Grab Samples collected within the Study Area during the Seasonal Benthic Surveys

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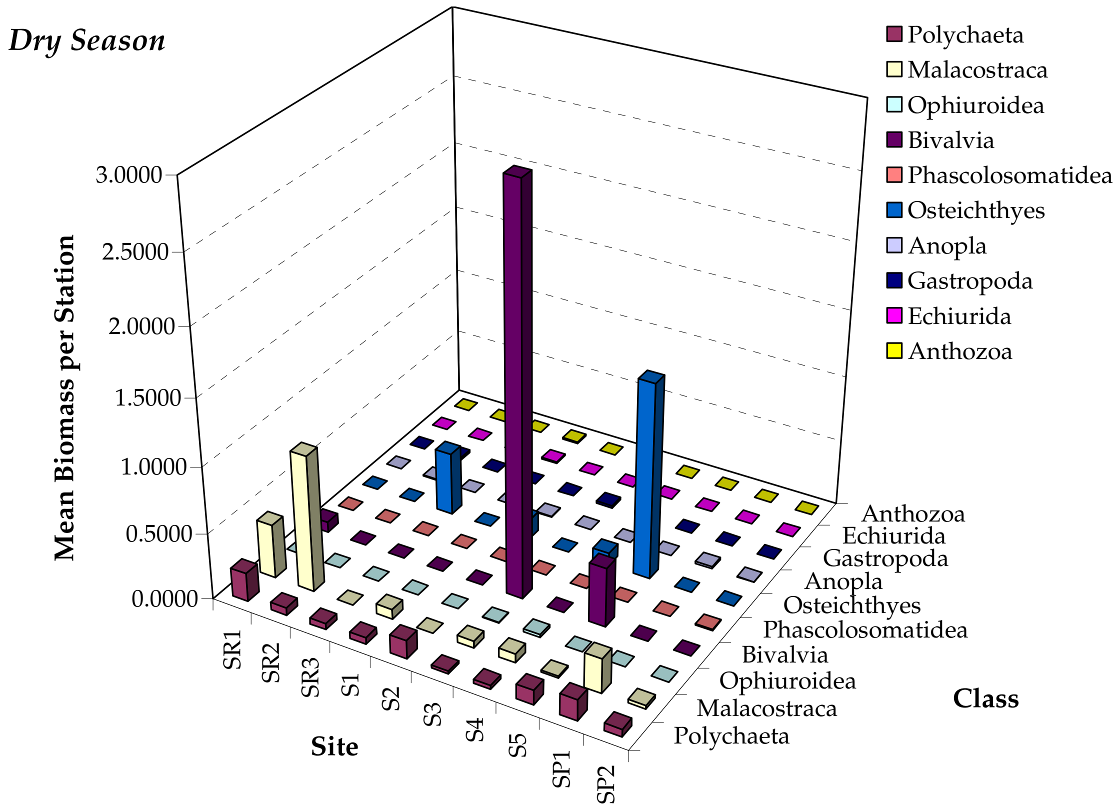

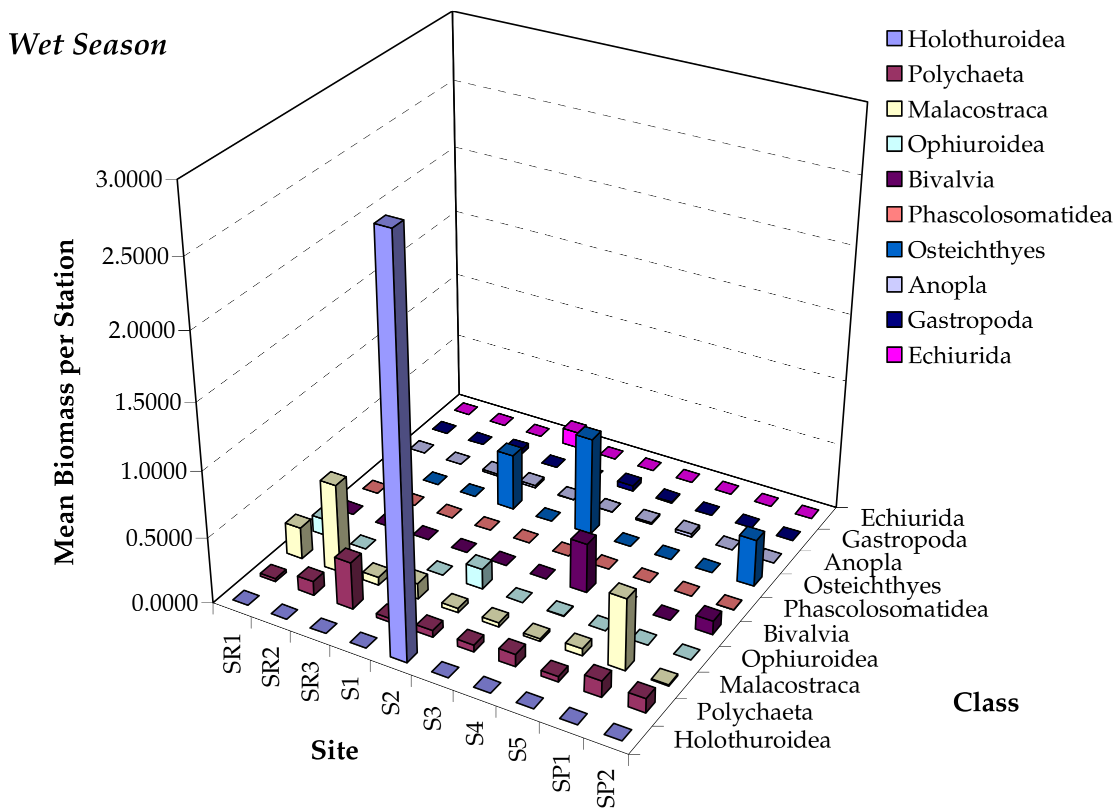

Figure 9A.12

Mean Biomass of Infaunal Organisms (Class level) per Station from Grab Samples collected within the Study Area during the Seasonal Benthic Surveys

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in terms of mean numerical abundance of organisms present (grouped by class) in the dry season survey is presented in *Figure 9A.11*.

In terms of infaunal biomass, organisms from the Phylum Mollusca contributed 41% of the total biomass recorded, while organisms from Chordata, Arthropoda and Annelida also contributed significant biomasses (25.3%, 22.4% and 10.2% respectively). Each of the other recorded phyla contributed to < 5 % of the total infaunal biomass recorded. High biomass of molluscs was contributed by a single individual of the bivalve *Scapharca* sp. at one sampling station of the S3 site. The composition of infaunal assemblage at each site in terms of mean biomass of organisms present (grouped by class) in the dry season survey is presented in *Figure 9A.12*.

Table 9A.4 Composition of Infaunal Assemblages at the Sampling Sites for the Soft Bottom Habitat Surveys at the Southwest Lamma Study Area during the Dry Season Survey in March 2009

Location	Site	Number of Stations Sampled	Total Number of Infaunal Individuals	Mean Number of Individuals per Station (± SD)	Mean Number of Individuals per m² (± SD)	Total Biomass (g wet weight)	Mean Taxonomic Richness (No. Families) per Station (± SD)	Mean Taxonomic Richness (No. Species) per Station (± SD)	Mean Biomass per Individual (g wet weight)
Reference	SR1	3	45	15.00 (± 6.00)	156.25 (± 62.50)	2.1081	8.33 (± 2.31)	8.67 (± 2.08)	0.0468
	SR2	3	16	5.33 (± 1.53)	55.56 (± 15.91)	3.3299	4.67 (± 1.53)	4.67 (± 1.53)	0.2081
	SR3	3	9	3.00 (± 1.00)	31.25 (± 10.42)	1.5615	2.00 (± 1.00)	2.00 (± 1.00)	0.1735
Wind farm	S1	3	19	6.33 (± 1.15)	65.97 (± 12.03)	0.4430	5.33 (± 0.58)	5.33 (± 0.58)	0.0233
	S2	3	13	4.33 (± 1.53)	45.14 (± 15.91)	0.8796	3.67 (± 1.15)	4.00 (± 1.73)	0.0677
	S3	3	14	4.67 (± 2.08)	48.61 (± 21.68)	9.2311	4.33 (± 2.52)	4.33 (± 2.52)	0.6594
	S4	3	10	3.33 (± 0.58)	34.72 (± 6.01)	0.6409	3.33 (± 0.58)	3.33 (± 0.58)	0.0641
	S5	3	10	3.33 (± 2.52)	34.72 (± 26.21)	6.1169	3.00 (± 2.00)	3.00 (± 2.00)	0.6117
Cable	SP1	3	14	4.67 (± 2.52)	48.61 (± 26.21)	1.3030	4.67 (± 2.52)	4.67 (±2.52)	0.0931
	SP2	3	23	7.67 (± 5.51)	79.86 (± 57.37)	0.2853	4.33 (± 2.08)	4.33 (± 2.08)	0.0124

Wet Season Survey Results

A total of 194 individual organisms were collected from the 30 grab sampling stations at the 10 survey sites during the wet season survey in October 2008. The specimens belong to eight Phyla with a total of 10 classes, 34 families and 43 species identified. *Table 9A.5* provides a summary on the abundance, biomass and taxonomic richness of infauna collected at each site. A complete set of raw data is presented in *Tables 3 & 4* of *Annex 9A1.*

Results of the wet season 2008 benthic survey showed that, as with the results of the dry season survey, infaunal abundance, biomass and taxonomic richness were very low at all sampling sites (*Table 9A.5*). Whilst the mean infaunal abundance and mean taxonomic richness per station were similar across sampling sites, with SP2 showing a slightly higher infaunal abundance, infaunal biomass was significantly higher at the wind farm site S2 than other sites (*Table 9A.5*). Variation within site (ie among sampling stations) was also considered to be small, as can be seen from the low standard deviation (SD) values (*Table 9A.5*).

Table 9A.5 Composition of Infaunal Assemblages at the Sampling Sites for the Soft Bottom Habitat Surveys at the Southwest Lamma Study Area during the Wet Season Survey in October 2008

Location	Site	Number of Stations Sampled	Total Number of Infaunal Individuals	Mean Number of Individuals per Station (± SD)	Mean Number of Individuals per m² (± SD)	Total Biomass (g wet weight)	Mean Taxonomic Richness (No. Families) per Station (± SD)	Mean Taxonomic Richness (No. Species) per Station (± SD)	Mean Biomass per Individual (g wet weight)
Reference	SR1	3	17	5.67 (± 2.52)	59.03 (± 26.21)	1.1714	4.00 (± 1.00)	4.33 (± 1.15)	0.0689
	SR2	3	11	3.67 (± 2.52)	38.19 (± 26.21)	2.3300	3.00 (± 1.73)	3.00 (± 1.73)	0.2118
	SR3	3	21	7.00 (± 2.65)	72.92 (± 27.56)	1.4495	5.67 (± 2.08)	5.67 (± 2.08)	0.0690
Wind farm	S1	3	19	6.33 (± 0.58)	65.97 (± 6.01)	2.1422	4.67 (± 1.15)	5.00 (± 1.00)	0.1127
	S2	3	21	7.00 (± 0.00)	72.92 (± 0.00)	12.2189	5.67 (± 0.58)	5.67 (± 0.58)	0.5819
	S3	3	22	7.33 (± 3.06)	76.39 (± 31.82)	2.5986	5.00 (± 1.00)	5.33 (± 1.53)	0.1181
	S4	3	20	6.67 (± 1.53)	69.44 (± 15.91)	1.5394	5.33 (± 1.53)	5.33 (± 1.53)	0.0770
	S5	3	12	4.00 (± 2.00)	41.67 (± 20.83)	0.3607	3.33 (± 1.15)	3.33 (± 1.15)	0.0301
Cable	SP1	3	22	7.33 (± 0.58)	76.39 (± 6.01)	1.9954	4.00 (± 1.00)	5.00 (± 1.00)	0.0907
	SP2	3	29	9.67 (± 6.43)	100.69 (± 66.97)	1.7443	6.00 (± 1.00)	6.33 (± 1.53)	0.0601

In terms of infaunal abundance, the majority (67.0%) of organisms recorded in the wet season were from the Phylum Annelida, followed by Arthropoda (12.4%) and Nemertinea (5.2%). Each of the other recorded phyla contributed to < 5 % of the number of individuals recorded. The polychaete worm *Aglaophamus dibranchis*, from the family Nephtyidae, was the most abundant species from the wet season survey (total abundance = 35 individuals), and it was present in most of the sampling sites. No rare or uncommon species were recorded in the wet season survey. The composition of infaunal assemblage at each site in terms of mean numerical abundance of organisms present (grouped by class) in the wet season survey is presented in *Figure 9A.11*.

In terms of infaunal biomass, organisms from the Phylum Echinodermata contributed 42% of the total biomass recorded, while organisms from Arthropoda, Chordata and Annelida also contributed significant biomasses (19.4%, 16.6% and 10.8% respectively). Each of the other recorded phyla contributed to < 6 % of the total infaunal biomass recorded. High biomass of echinoderms was contributed by a single individual of the sea cucumber *Actinopyga echinites* at one sampling station of the S2 site. The composition of infaunal assemblage at each site in terms of mean biomass of organisms present (grouped by class) in the wet season survey is presented in *Figure 9A.12*.

Overall, results from the dry and wet season surveys undertaken as part of this EIA suggested that infaunal assemblages of the surveyed sites consisted of common and widespread species typical of disturbed environment, i.e. numerical dominance of low biomass, stress-tolerant and short-lived polychaete species. Infaunal assemblage structure was largely similar between seasons, with slightly higher infaunal abundance, biomass and taxonomic richness in the wet than the dry season. The abundance, biomass and taxonomic richness of infauna at and in the vicinity of the wind farm site and cable route off Southwest Lamma are very low in comparison with the average values reported by CityU Professional Services Limited (2002) for benthic assemblages in Hong Kong (34 species per 0.5 m^2, 450 individuals per m^2 and 28 g per m^2).

9A.4.3 *Subtidal Hard Bottom Habitat – Coral*

Methodology

Subtidal dive surveys were undertaken at subtidal hard bottom habitats within and in close proximity to the footprint of the Project Area with a key focus at the proposed cable landing site and along the cable route where hard substrata were noted from the geophysical survey undertaken for this site (see *Section 12*). The dive surveys comprised the following two components:

- Qualitative spot dive survey; and

- Semi-quantitative Rapid Ecological Assessment (REA) survey.

Each of these surveys is described further in the following sections. Survey locations are presented in *Figure 9A.13* and details of the surveys are summarised in *Table 9A.6*.

Table 9A.6 ***Survey Transects and Type of Survey Undertaken***

Survey Site	Type of Survey	Total Length of Area Surveyed
T1	Semi-quantitative REA survey	100 m
T2	Semi-quantitative REA survey	100 m
T3	Semi-quantitative REA survey	100 m
T4	Semi-quantitative REA survey	100 m
T5	Semi-quantitative REA survey	100 m
T6	Semi-quantitative REA survey	100 m
T7	Semi-quantitative REA survey	100 m
T8	Semi-quantitative REA survey	100 m
Patch 4	Qualitative spot dive survey	5 m
Patch 6	Qualitative spot dive survey	5 m
Patch 7	Qualitative spot dive survey	5 m
Patch 8	Qualitative spot dive survey	5 m
Patch 9	Qualitative spot dive survey	5 m
Patch 10	Qualitative spot dive survey	5 m

<u>Qualitative Spot Dive Survey</u>

Recent geophysical surveys identified a number of small patches of hard substrate along the cable route. These patches, identified as superficial dumped materials, occurred within the 150 m wide cable corridor and within approximately 10 m depth or less. Whilst the age of the patches is unknown, it was noted that some of the materials were located on top of trawl lines, which suggested that these could be introduced on to the seabed relatively recently. The materials were also thought to be relatively mobile as displacement of the materials by trawling activity was seen on geophysical images (*Figure 9A.14*).

A series of targeted spot dive checks were carried out at selected patches of dumped materials along the proposed cable route to investigate if coral communities are present at these potential areas of hard substrate (*Figure 9A.13*). Not all identified patches of dumped material were surveyed, but the hard substrate patches surveyed are thought to be representative of all patches of dumped material noted in the Study Area. Representative ground-truthing of sessile assemblages at the selected hard substrate patches was thus used to characterise the biological nature of all patches of dumped material identified.

At each survey site, a spot dive reconnaissance check was conducted by qualified coral specialists by SCUBA to confirm the substrate type and associated sessile benthos, particularly the presence of coral communities (hard and soft corals). The immediate seabed area around the patch (5 m

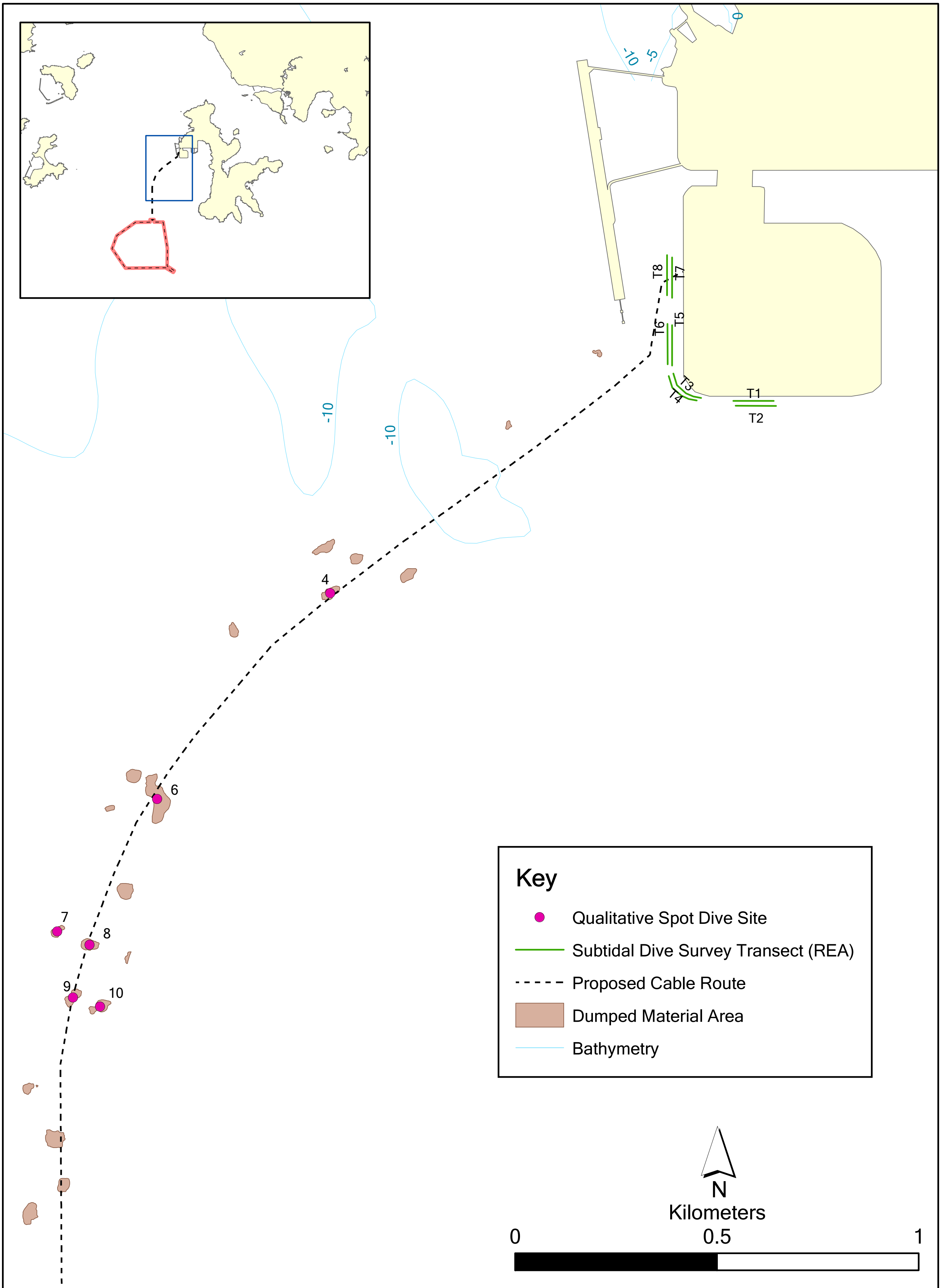

Figure 9A.13

Locations of Dive Surveys and Location of Dumped Material on the Seabed

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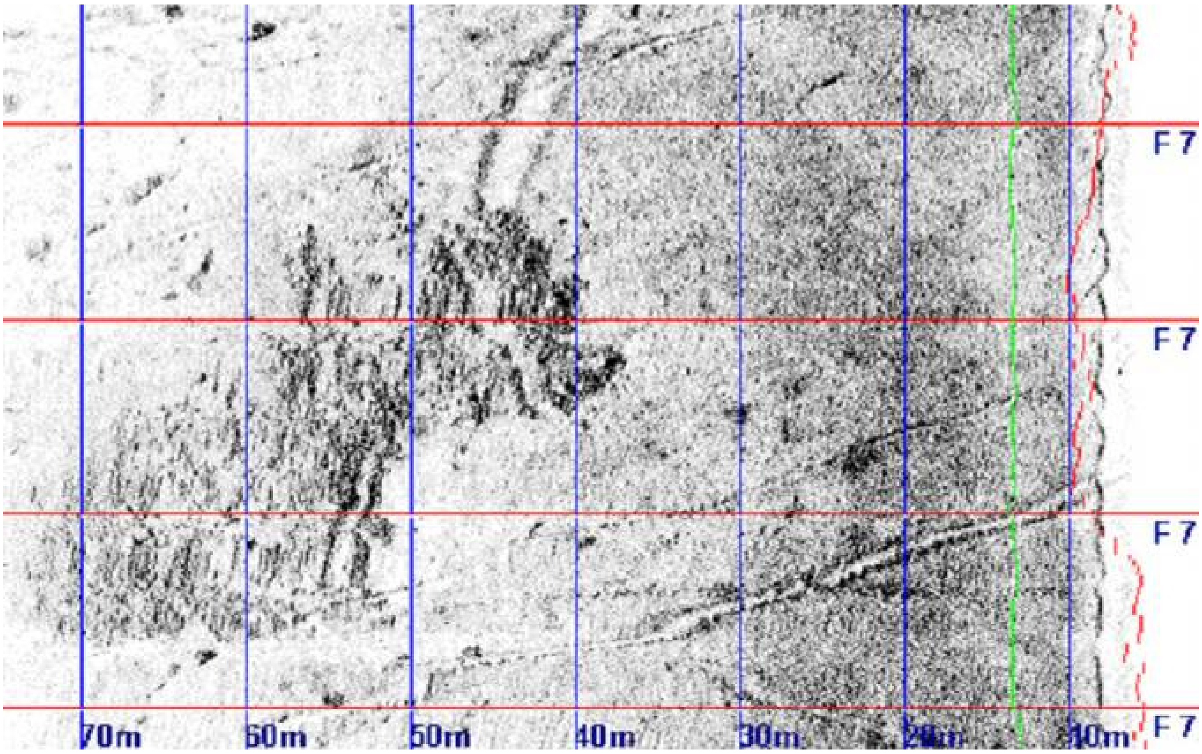
Material situated on top of a trawl line



Material displaced by trawling activity

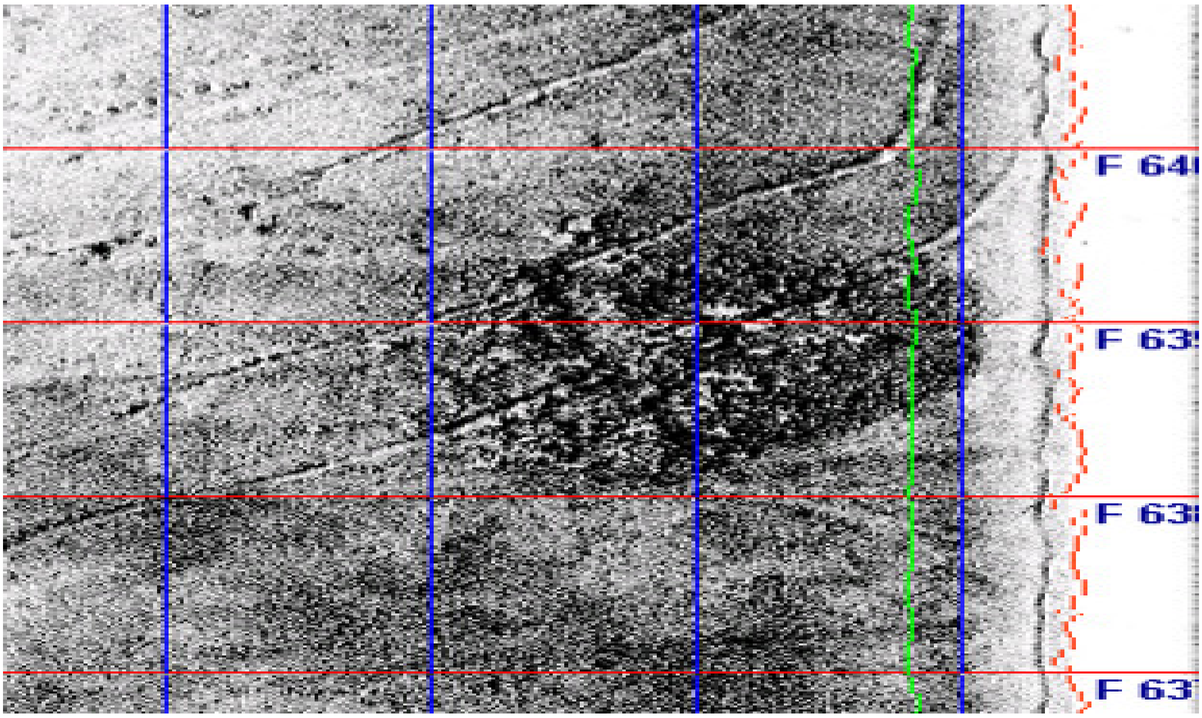


Figure 9A.14

Geophysical Image of Dumped Material on the Seabed

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radius around the centre point) was checked, and representative photographs of the seabed and associated fauna were taken. Coral species encountered during the spot dive checks were identified to the lowest possible taxonomic level.

Rapid Ecological Assessment (REA) Survey Method

The Rapid Ecological Assessment (REA) technique was employed in order to investigate the presence of any coral communities (hard and soft corals) associated with subtidal hard bottom habitats at the cable landing point area at the Lamma Power Station Extension. The REA technique allows semi-quantitative information on the ecological attributes of the subtidal habitat to be obtained in a relatively simple way without compromising scientific rigour. This technique is the standard practices for EIA marine baseline surveys in Hong Kong and has been modified from the standardised REA survey technique established for the assessment of coral communities on the Great Barrier Reef (1) for marine environment of Hong Kong (2).

A series of REA surveys were conducted by qualified coral ecologists by SCUBA at a total of eight transects along the seawall of the Lamma Power Station Extension (*Table 9A.6*; *Figure 9A.13*). The spatial coverage of the proposed REA transects included the zone of potential direct and indirect impacts, which encompassed the seawall at and in the vicinity of the proposed cable landing point. These REA transects represented a 100 m stretch of seawall at two depth zones:

- Shallow depth zone: -2 to -5 mCD (typically the depth range of coral colonies associated with seawall habitat); and
- Deep depth zone: -6 to -10 mCD.

The depths of these transects might be adjusted slightly based on the substrate habitats, the presence or absence of hard and soft corals, and field conditions.

Field data of the REA survey were recorded by coral specialists who are experienced in the underwater identification of sessile benthic taxa. REA surveys were carried out using 100 m long transects with the transect tapes laid out within a single ecological zone - habitat - depth range as bulleted above.

Following the laying of the transect line, the field surveyors swam along the transect slowly and conducted a REA of the seabed. The REA methodology encompassed an assessment of the benthic cover (Tier I) and taxon abundance (Tier II) undertaken in a swathe ~ 4 m wide, 2 m either side of each transect.

(1) DeVantier LM, De'Ath G, Done TJ, Turak E (1998) Ecological assessment of a complex natural system: A case study from the Great Barrier Reef. *Ecological Applications* 8: 480-496.

(2) Fabricius KE, McCorry D(2006) Changes in octcoral communities and benthic cover along a water quality gradient in reefs of Hong Kong. *Marine Pollution Bulletin* 52: 22-33

The belt transect width was dependent on underwater visibility and might be adjusted to a swathe ~2 m wide, 1 m either side of the each transect in case of reduced visibility. An explanation of the two assessment categories (Tiers) used in the survey is presented below.

Tier I - Categorisation of Benthic Cover

Upon the completion of each survey transect, five ecological and seven substratum attributes were assigned to one of seven standard ranked (ordinal) categories (*Tables 9A.7* and *9A.8*).

Table 9A.7 Categories used in the REA Surveys - Benthic Attributes

Ecological	Substratum
Hard coral	Hard substrate
Dead standing coral	Continuous pavement
Soft coral	Bedrock
Black coral	Rubble
Macroalgae	Sand
Turf algae	Silt
	Large boulders (>50 cm)
	Small boulders (<50 cm)
	Rocks (<26 cm)

Table 9A.8 Categories used in the REA Surveys - Ordinal Ranks of Percentage Cover

Rank	Percentage Cover (%)
0	None recorded
1	1-5
2	6-10
3	11-30
4	31-50
5	51-75
6	76-100

Tier II - Taxonomic Inventories to Define Types of Benthic Communities

An inventory of benthic taxa was compiled for each transect. Taxa were identified *in situ* to the following levels:

- Scleractinian (hard) corals to species wherever possible;
- Soft corals, anemones and conspicuous macroalgae recorded according to morphological features and to genus level where possible; and
- Other benthos (including sponges, zoanthids, ascidians and bryozoans) recorded to genus level wherever possible but more typically tophylum plus growth form.

Following the completion of each transect survey, each taxon in the inventory was ranked in terms of abundance in the community (see *Table 9A.9*). These broad categories rank taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are subjective assessments of abundance, rather than quantitative counts of each taxon.

Table 9A.9 Ordinal Ranks of Taxon Abundance

Rank	**Abundance**
0	Absent
1	Rare (a)
2	Uncommon
3	Common
4	Abundant
5	Dominant

Note:
(a) The classification of "rare" abundance refers to low abundance (small quantity) on the transect, rather than in terms of distribution in Hong Kong waters.

A set of environmental site descriptors was recorded for each REA transect as follows:

(A) The degree of exposure to prevailing wave energy was ranked from 1 - 4, where:

1 = sheltered (highly protected by topographic features from prevailing waves);

2 = semi-sheltered (moderately protected);

3 = semi-exposed (only partly protected); and

4 = exposed (experiences the full force of prevailing wave energy).

(B) Sediment deposition on the reef substratum (particle sizes ranging from very fine to moderately coarse) rated on a four point scale, from 0 – 3, where:

0 = no sediment;

1 = minor (thin layer) sediment deposition;

2 = moderate sediment deposition (thick layer), but substrate can be cleaned by fanning off the sediment; and

3 = major sediment deposition (thick, deep layer), and substrate cannot be cleaned by fanning.

A suite of representative photographs was taken for each REA transect. All field data were checked upon completion of each REA transect and a dive survey proforma sheet was completed at the end of the fieldwork day. Photographs compiled for each REA transect were then reviewed and REA data verified. Verified REA data were presented in terms of:

- Site (transect) information (Tier I and II data), depth and environmental descriptors; and
- Species abundance data for each transect.

Species lists, species richness and mean values for ecological and substratum types were compiled. The rank abundance values were converted to a mid-value percentage cover.

Survey Results

The dive surveys were conducted on 4 and 5 May 2009. The conditions during surveys were fine with calm conditions throughout. The visibility was generally < 1.0 m.

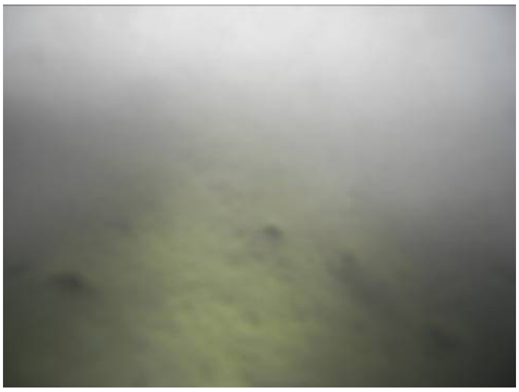
Results of Qualitative Spot Dive Checks

Results of qualitative dive surveys at Patches 4, 6, 7, 8, 9 and 10 confirmed that the seabed at these locations was composed of sandy silts with sparse rock and rubble. The hard substrate at Patches 4, 6 and 8 were sparsely colonised with the gorgonians *Echinomuricea* sp. and *Menella* sp., and substrate at Patch 8 showed sparse colonization of soft coral *Dendronephthya* sp., *Echinomuricea* sp. and black coral *Cirripathes* sp. (*Table 9A.10*). The seabed at Patches 7, 9 and 10 showed no colonization of sessile taxa. The communities identified during the survey were located on the hard substrate, but these areas only formed a small percentage of the seabed as the majority of the seabed comprised soft substrate. *Figure 9A.15* presents some images taken at the qualitative dive survey locations.

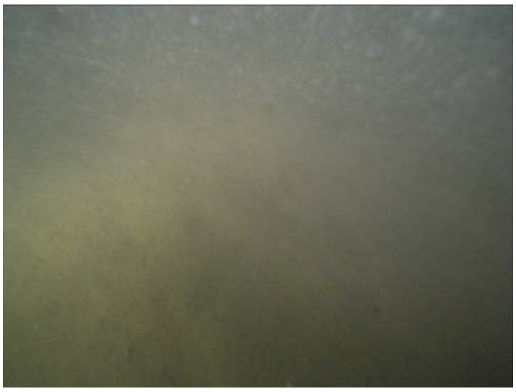
Table 9A.10 Coral Species Recorded at the Qualitative Spot-Check Patches

	Patch 4	Patch 6	Patch 7	Patch 8	Patch 9	Patch 10
Octocoral Species [(a)]						
Dendronephthya sp.	0	0	0	1	0	0
Echinomuricea sp.	1	1	0	1	0	0
Menella sp.	1	1	0	1	0	0
Black Coral Species	0	0	0	1	0	0

Note: (a). 0=absent, 1=present


Patch 4


Patch 6


Patch 7


Patch 8


Patch 8


Patch 8


Patch 9


Patch 10

Figure 9A.15

Photographs of the Seabed at Qualitative Dive Survey Locations

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Results of REA Survey

Along each transect the seabed composition was identified and conditions were noted as shown in *Table 9A.11* and *Table 9A.12*. The substrate of the REA transects was mainly large boulders. Some images taken at the REA dive survey transects are presented in *Figure 9A.16*.

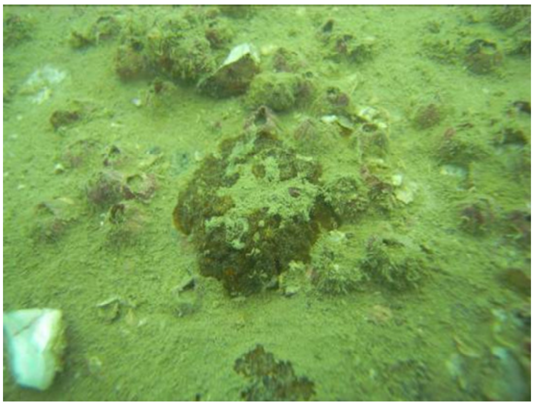
Octocoral species were not recorded in any of the REA transects at the Lamma Power Station Extension seawall. Although this was contrary to the findings of the 2000 baseline marine ecological monitoring at the Ash Lagoon Seawall, this is not unusual as localised environmental conditions (e.g. current velocity and turbidity) at the sites may potentially affect the distribution and abundance of octocorals.

Hard coral coverage at the REA transects was very low (< 5 %), and hard coral was not recorded at T2 and T8. A total of three hard coral species were recorded during the REA surveys (*Table 9A.13*). The scleractinian coral *Oulastrea crispata* and ahermatypic cup corals were recorded in the majority of the transects, and a sub-massive *Porites* sp. was recorded at T5. These results support the findings of the 2000 surveys that hard coral abundance and diversity was very low on artificial seawall of this area.

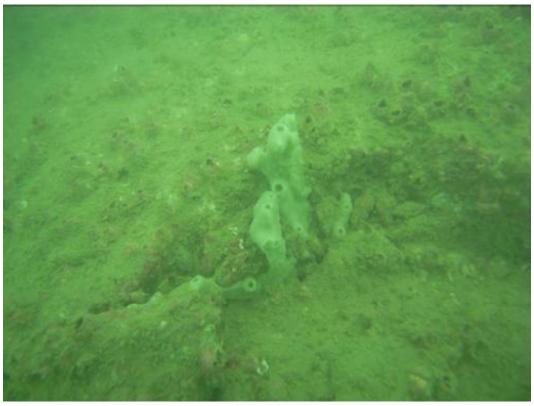
The predominant species recorded during the REA survey was *Oulastrea crispata*. This coral species belongs to the Faviidae family of which all species are known to have high tolerance limits to sub-optimal physico-chemical conditions often associated with the Hong Kong nearshore environment, e.g. fluctuations in salinity and sea surface temperature (daily and seasonal), elevated sedimentation loading and total suspended sediment, and reduced light attenuation levels. *Oulastrea crispata* is a common and ubiquitous coral species in Hong Kong, though typically not recorded in high abundance within established coral communities. It is most often recorded in the most marginal conditions for corals, i.e. areas of high sediment loading, and represented by scattered, small colonies in shallow, subtidal areas with few other coral species. This species is thus considered as a locally widespread, highly stress-tolerant species with little conversation concern.

Common subtidal species recorded at the REA transects included the barnacle *Balanus* sp., the bivalves *Tridacna* sp. and *Perna viridis*, the sea urchin *Diadema setosum* and some gastropods.

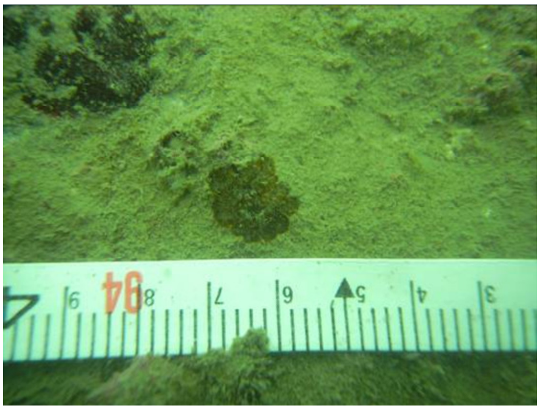
Overall, results of the dive surveys show that very sparse colonies of locally common, widespread coral species were present along the proposed cable route and the cable landing point, and their abundance and diversity were considered to be very low in the context of subtidal coral assemblages in Hong Kong.



T1

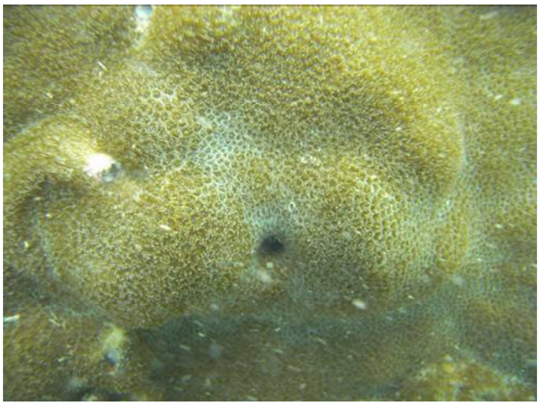


T2

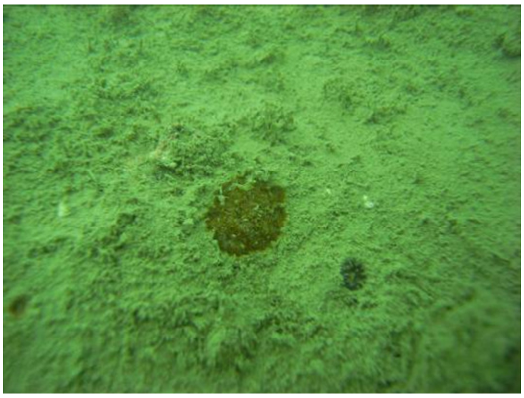


T3

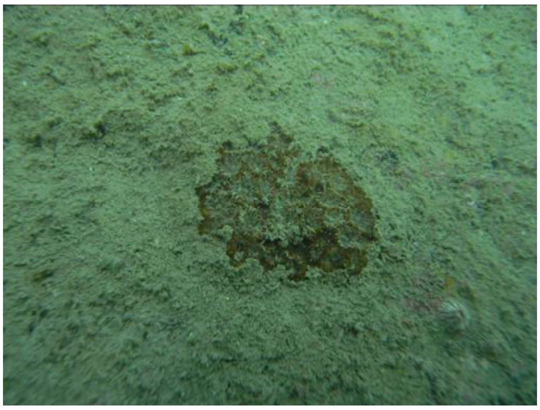
T4



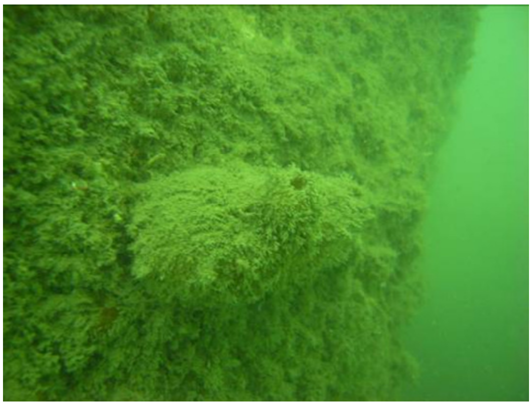
T5



T6



T7



T8

Figure 9A.16

Indicative Photographs at Semi-Qualitative Dive Survey Locations (T1 – T8)

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Table 9A.11 Description of the Seabed Recorded along Each Transect and the Qualitative Surveys

Transect (T)/ Patch (P)	Depth	Description
T1	-3 m CD	The seabed was mainly composed of large boulders with sparse small boulders and rocks. A few colonies of encrusting hard coral *Oulastrea crispata* were found along the transect.
T2	-6 m CD	The seabed was mainly composed of large boulders with sparse small boulders. No hermatypic hard coral colonies were found. Several ahermatypic cup coral colonies of the Family Dendrophyllidae were recorded.
T3	-4 m CD	The seabed was mainly composed of large boulders with sparse small boulders. Several colonies of encrusting hard coral *Oulastrea crispata* were recorded along the transect.
T4	-6 m CD	The seabed was mainly composed of large boulders with sparse small boulders. Several colonies of encrusting hard coral *Oulastrea crispata* and ahermaptypic cup coral colonies of the Family Dendrophyllidae were recorded along the transect.
T5	-4 m CD	The seabed was mainly composed of large boulders with sparse small boulders. Several colonies of encrusting hard coral *Oulastrea crispata* and sub-massive *Porites* sp. were recorded.
T6	-6 m CD	The seabed was mainly composed of large boulders. Several *Oulastrea crispata* colonies were recorded. Ahermatypic cup corals of the Family Dendrophyllidae were common along transect.
T7	-4 m CD	The seabed was mainly composed of large boulders with sparse small boulders and rocks. Colonies of encrusting hard coral *Oulastrea crispata* were found along the transect.
T8	-7 m CD	The seabed was mainly composed of large boulders with sparse large boulders and rocks. Ahermatypic cup corals of the Family Dendrophyllidae were commonly found along transect.
P4	-10 m CD	The seabed was predominately covered by sand and silt with scattered and sparse rubbles. Few colonies of the gorgonians *Echinomuricea* sp. and *Menella* sp. were recorded.
P6	-12.3 m CD	The seabed was composed of sand and silt with scattered and sparse rubbles. Few colonies of the gorgonians *Echinomuricea* sp. and *Menella* sp. were recorded.
P7	-12.9 m CD	The seabed was mainly composed of silt with sparse rocks and rubble recorded. No sessile organisms were observed.
P8	-13 m CD	The seabed was composed of sandy substrate with some sparse rocks and rubbles. A number of coral colonies, including the gorgonians *Echinomuricea* sp., *Menella* sp., *Echinogorgia* sp., soft coral *Dendronephthya* sp. and black coral *Cirripathes* sp. were recorded.
P9	-12 m CD	The seabed was composed of silt with no sessile organisms found.
P10	-13 m CD	The seabed was composed of silt with no sessile organisms found.

Table 9A.12 Seabed Attributes along the Semi-Quantitative Survey Transects

	T1	T2	T3	T4	T5	T6	T7	T8
Transect depth (a)	s	d	s	d	s	d	s	d
Seabed attributes (b)								
Bedrock	0	0	0	0	0	0	0	0
Boulders – large	4	6	5	6	6	6	6	6
Boulders – small	1	1	1	1	1	1	1	1
Rock	1	1	1	0	1	1	1	0
Rubble	1	0	0	0	1	0	1	0
Sand	1	1	0	0	0	0	0	0
Silt	0	1	1	1	1	1	1	2
Ecological attributes (b)								
Hard coral	1	0	1	1	1	1	1	0
Dead standing coral	0	0	0	0	0	0	0	0
Soft coral	0	0	0	0	0	0	0	0
Black coral	0	0	0	0	0	0	0	0
Turf algae	1	1	1	1	1	1	1	1
Macroalgae	0	0	0	0	0	0	0	0
Coralline algae	3	2	3	1	2	1	2	1

Notes: (a) T1 to T8 = transect line; s= shallow water; d=deep water

(b) 1=<5% Cover, 2= 6-10% Cover, 3 = 11-30% Cover, 4 = 31-50% Cover, 5 = 51-75% Cover, 6 = 76-100% Cover.

Table 9A.13 Species Recorded along the REA Survey Transects

Type	Taxon/ Family	Species	T1	T2	T3	T4	T5	T6	T7	T8
Hard Coral	**Hermatypic**									
	Faviidae	*Oulastrea crispata*	2	0	2	2	2	2	2	0
	Poritidae	*Porites* sp.	0	0	0	0	2	0	0	0
	Dendrophyllidae	Unidentified cup coral sp.	0	2	0	2	0	3	0	3
Others	**Crustacea**	*Balanus* sp.	3	4	3	3	3	3	3	0
		Crab (unidentified)	0	0	0	0	0	2	2	0
		Hermit crab (unidentified)	0	0	3	0	0	0	0	2
	Bryozoa	*Schizoporella errata*	0	0	0	2	0	0	0	2
		Unidentified sp.	2	0	0	0	0	0	0	0
	Bivalvia	*Tridacna* sp.	3	2	3	2	2	2	0	0
		Perna viridis	0	2	3	0	2	0	0	2
	Gastropoda	Gastropod (eg Topshell, Whelks)	2	3	3	0	2	2	3	0
		Cypraea arabica	0	0	2	0	2	0	0	0
	Echinodermata	*Diadema setosum*	3	3	4	3	3	3	0	0
		Anthocidaris crassispina	2	0	0	0	0	2	3	0
		Salmacis sphaeroides	2	0	0	0	2	0	2	0
	Cnidaria	*Haliplanella lineata*	0	0	0	0	2	0	0	0
		Sea squirt	0	0	0	0	0	0	2	2
	Porifera	Sponges	0	2	0	2	0	0	0	2
	Sabellidae	Fan worm	0	0	0	0	2	0	2	0

Note: (a). 0=absent, 1=rare, 2=uncommon, 3=common, 4=abundant, 5=dominant. Also note patches were surveyed by spot dive so that REA data were not collected for these sites. The ranks shown in the Table above indicate the relative abundance of each coral in relation to other corals in the community. In other words, these broad categories rank taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are subjective assessments of abundance, rather than quantitative counts of each taxon. For instance, if a coral is ranked as 'common', it means it was more frequent than other coral species along the transect. It should be borne in mind that coral cover along all of the transects where corals occurred was very low (<5% cover)

Drop Camera Survey

In addition to the REA and geophysical surveys (see above subsections), in order to gain additional information on the seabed conditions within the wind farm site and along the cable route a drop camera system was deployed to capture images of the seabed. The drop camera system has been developed in conjunction with the Australian Institute of Marine Science (AIMS) and field tested (by ERM staff) in Hong Kong and the offshore environment. The drop camera system is comprised of a wide-angle compact camera in an underwater housing with accompanying underwater strobe (flash) attached to a weighted camera frame (tripod). The camera is set to record still images at set intervals along transect enabling the capture of high resolution seabed photographs. Such system has been proven successful for numerous baseline surveys overseas to examine the seabed bottom and map the coral habitats [(1)(2)].

The remote drop camera system is a portable system which is deployed and retrieved by hand over the side of a survey vessel. The camera system was deployed to the seabed by a trained ERM marine scientist, with instructed assistance of vessel crew (*Box 9A.1*). On reaching the seabed, the camera system was maintained close to the seabed (<1m) for a suitable length of time, along a line of boat drift to enable a series of representative photographs of the seabed to be captured.

Box 9A.1 ***Drop camera system in action (deployment from vessel)***

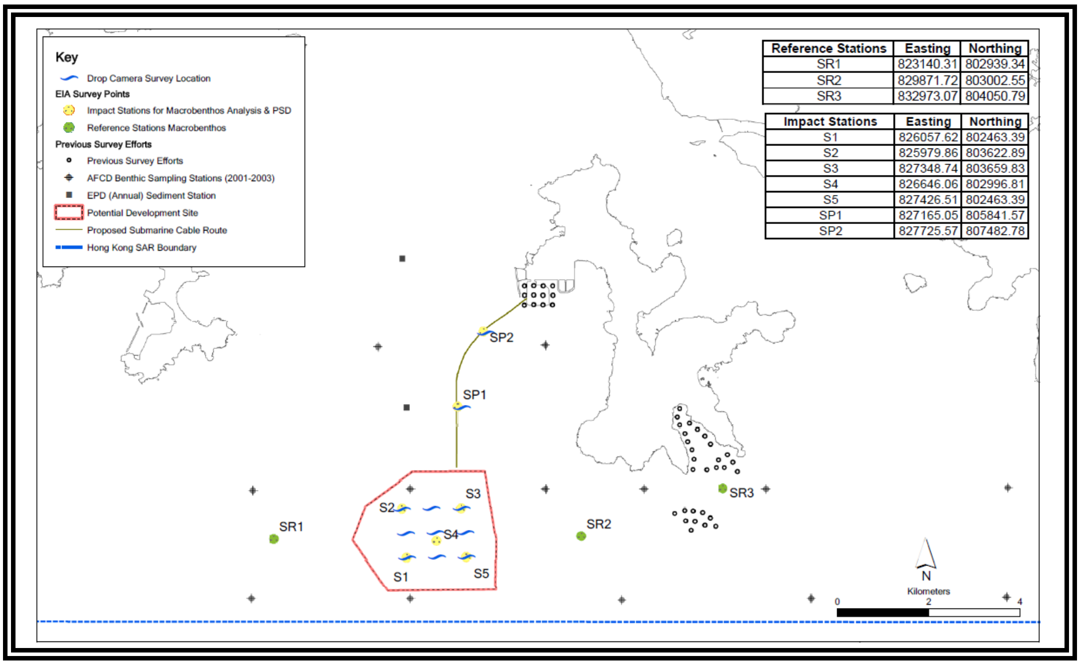
(1) ERM-Hong Kong and ERM-Malaysia (2008) Coral Habitat Verification and Assessment Study for Block A-1 and Block A-3 Gas Development, Myanmar. For Confidental Client.

(2) ERM-Hong Kong and ERM-Malaysia (2009) Marine Survey for Coral Habitats: Photo Quadrat Assessment (PQA) of Mampak, For Confidential Client.

Survey Location

The drop camera system was deployed at six points in the wind farm site, including areas in vicinity to the five benthic grab sampling points. In addition, two points were surveyed along the cable route. The location of the survey points is shown in *Box 9A.2*.

Box 9A.2 ***Drop Camera Survey Transects***



Drop Camera Survey Findings

The drop camera survey was carried out on the 19 March 2009. The conditions during the survey were fine with calm sampling conditions throughout. The drop camera survey confirmed that at all survey locations the seabed consisted of silty mud with no hard substrate recorded. *Box 9A.3* provides an indicative image of the conditions recorded during the drop camera survey.

Box 9A.3 ***Indicative Image of the Seabed Conditions at the Wind Farm Site and along the Cable Route***

9A.4.4 *Marine Mammals*

Vessel-based Survey Methodology

General Approach and Survey Area

A set of systematic standard line-transect vessel surveys (1) on the finless porpoise *Neophocaena phocaenoides* was undertaken as part of this EIA to examine the abundance, distribution, encounter rate and habitat use of this species in the Study Area. Surveys were undertaken within the Lamma Survey Area (*Figure 9A.17*). Due to the extensive data available through the AFCD's long-term marine mammal monitoring programme, a six month survey programme was undertaken from December 2008 to May 2009, hence covering winter (December-February) and spring (March-May)(2). These new data would then be collated with AFCD long term data to sufficiently characterise existing and historical marine mammal use of the waters of the Study Area.

The survey methodology of this study was consistent and compatible with that adopted in the long-term marine mammal monitoring programme conducted under the Hong Kong Cetacean Research Project (HKCRP) funded by AFCD since 1995 to allow potential comparisons and pooling of data for analysis as part of this EIA.

Survey Methods

(1) BucklandST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L (2001) *Introduction to distance sampling: estimating abundance of biological populations.* Oxford University Press, London

(2) Categorisation of seasons in Hong Kong is the same as in AFCD's long-term marine mammal monitoring study

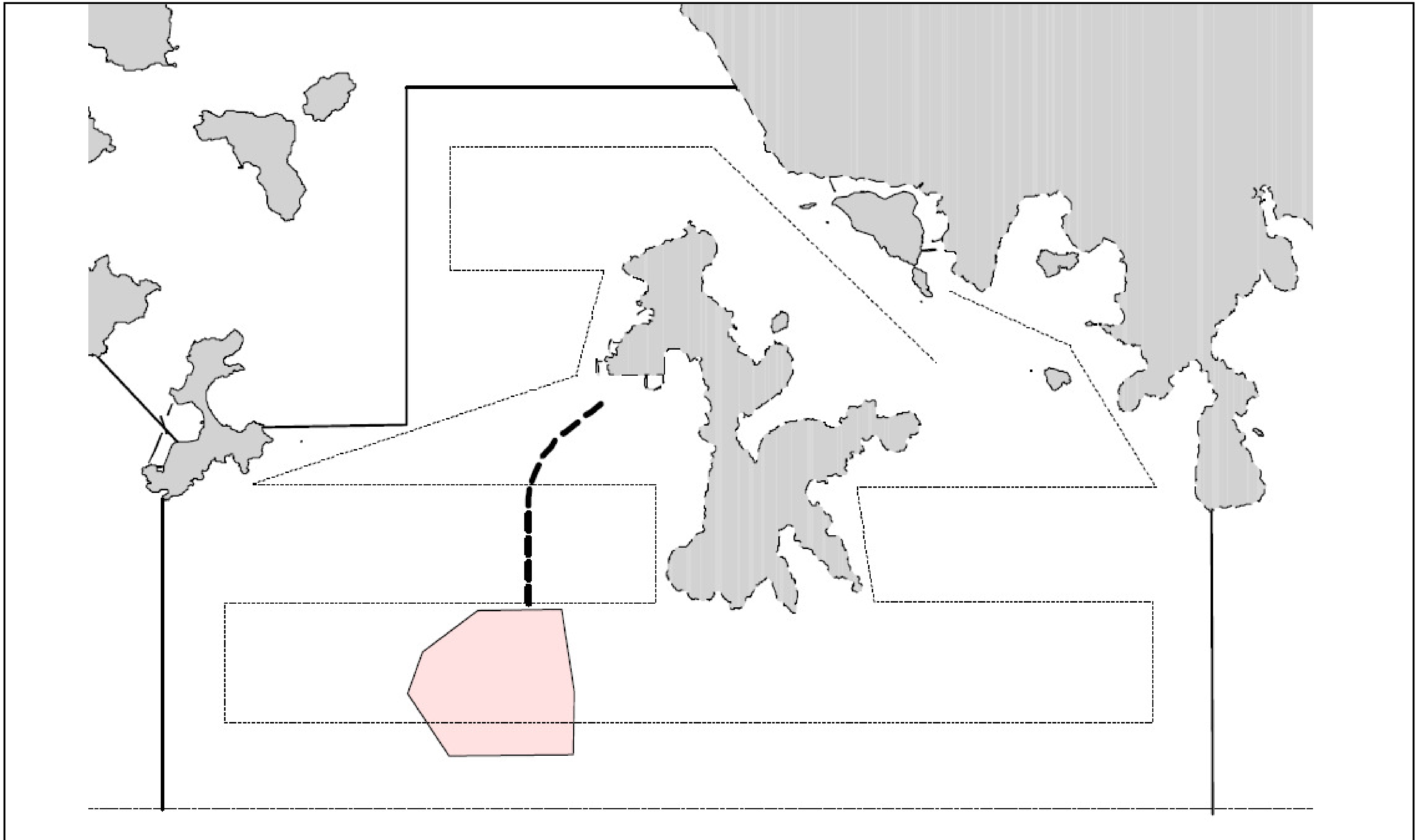


Figure 9A.17

The Transect lines for Finless Porpoise Survey

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Vessel surveys were conducted from one survey vessel (ca. 12-15 m length), weather permitting (Beaufort 0-6, no heavy rain, and visibility > 1,200 m). The vessel had an open upper deck, affording relatively unrestricted visibility. The observer team conducted searches and observations from the flying bridge area, 4-5 m eye height above the water's surface. Two experienced observers (a data recorder and a primary observer) made up the on-effort survey team (1).

As the survey vessel transited the transect lines at a constant speed of about 13-15 km/hour, the primary observer searched for porpoises continuously through 7 x 35 Brunton marine binoculars, while the data recorder searched with unaided eyes and filled out the datasheets. Both observers searched the sea ahead of the vessel, between 270° and 90° (in relation to the bow, which is defined as 0°). One to two additional experienced observers were available on the boat to work in shift (i.e. rotate every 30 minutes) in order to minimise fatigue of the survey team members.

Effort data collected during on-effort survey periods included time and position (latitude and longitude) for the start and end of search effort, weather conditions (Beaufort sea state and visibility) and distance travelled in each series (a continuous period of search effort) with the assistance of a handheld GPS (Garmin Geko 201). When porpoises were sighted, the survey team would end the survey effort and would be taken as off-effort, and immediately recorded the initial sighting distance and angle of the porpoise group from the survey vessel, as well as sighting time and position, on the sighting datasheet. The research vessel was then diverted from its course to approach the porpoise group for group size estimation, assessment of group composition and behavioural observations.

The perpendicular distance (PSD) of the porpoise group to the transect line was later calculated from the initial sighting distance and angle. The line-transect data collected during the present study were compatible with the long-term databases of HKCRP/ AFCD in a way that it can be analyzed by established computer programmes (e.g. all recent versions of DISTANCE programme including version 5.0, ArcView© GIS programme) for examination of population status including trends in abundance, distribution and habitat use.

Data Analysis Methods

Distribution Analysis: The line-transect survey data were integrated with Geographic Information System (GIS) in order to visualize and interpret seasonal and annual distribution of porpoises within the Lamma Survey Area during the survey period using sighting positions. Location data of porpoise

(1) All observers of the surveys had undergone a training program before the start of data collection. Observers were trained and calibrated in distance estimation, by asking them to make distance estimates to various objects (e.g., other boats, specific points on shore, floating debris, etc.).

groups were plotted on map layers of Hong Kong using a desktop GIS (ArcView© 3.1), and the dataset was also stratified into different subsets to examine distribution patterns of porpoise groups in different seasons and with different categories of group sizes. The data collected as part of this survey were examined in conjunction with the long-term sighting databases of HKCRP/ AFCD to examine the distribution patterns of finless porpoises in the Lamma Survey Area over the past years.

Encounter Rate Analysis: Since line-transect survey effort was uneven among different survey areas and across different years, the encounter rates of porpoises (number of on-effort sightings per 100 km of survey effort) were calculated in each survey area in relation to the amount of survey effort conducted. The encounter rate could be used as an indicator to determine area of importance to porpoises among the survey areas.

Quantitative Grid Analysis of Habitat Use: Positions of on-effort sightings were retrieved from the wind farm survey database and the long-term porpoise sighting database, and then plotted onto 1-km^2 grids among the three survey areas (i.e. Sai Kung, Ninepins and Lamma) on GIS. Sighting densities (number of on-effort sightings per km^2) and porpoise densities (total number of porpoises from on-effort sightings per km^2) were then calculated for each 1-km^2 grid with the aid of GIS. Sighting density grids and porpoise density grids were then further normalized with the amount of survey effort conducted within each grid. The total amount of survey effort spent on each grid was calculated by examining the survey coverage on each line-transect survey to determine how many times the grid was surveyed during the study period. For example, when the survey boat traversed through a specific grid 50 times, 50 units of survey effort were counted for that grid.

With the amount of survey effort calculated for each grid, the sighting density and porpoise density of each grid were then normalized by survey effort (i.e. divided by the unit of survey effort). The newly-derived unit for sighting density was termed SPSE, representing the number of on-effort **s**ightings **p**er 100 units of **s**urvey **e**ffort. In addition, the derived unit for actual porpoise density was termed DPSE, representing the number of porpoise **p**er 100 units of **s**urvey **e**ffort. Plotting the DPSE values of surveyed grid squares on maps allows areas where the most dense sightings of porpoises occur to be identified. Among the 1 km^2 grids that were partially covered by land, the percentage of sea area was calculated using GIS tools, and their SPSE and DPSE values were adjusted accordingly. The following formulae were used to estimate SPSE and DPSE in each 1 km^2 grid within the study area:

$$SPSE = ((S / E) \times 100) / SA\%$$

$$DPSE = (D / E) \times 100 / SA\%$$

Where;

S = total number of on-effort sightings

D = total number of porpoise from on-effort sightings

E = total number of units of survey effort

SA% = percentage of sea area

Both SPSE and DPSE values were useful in examining porpoise usage within a 1-km^2 area, and they were calculated using pooled data from the present study and the past decade of finless porpoise monitoring (i.e. 1999-2008).

Survey Results

Line-transect Survey Effort and Finless Porpoise Sightings

In the six-month study period (December 2008 to May 2009), a total of six days of systematic line-transect surveys had been completed in the Lamma Survey Area, covering a total of 422.1 km of survey effort.

A total of five groups of finless porpoises numbering 13 individuals were sighted during the 6-month survey, and these sightings were all made during on-effort search in the spring season (March and May 2009). A total of two porpoise individuals were sighted during off-effort search during the qualitative surveys conducted in summer and autumn (July to October 2008). Only the five on-effort sightings were used to examine porpoise encounter rates and habitat use patterns. No Indo-Pacific humpback dolphins were sighted during the surveys.

Overall Distribution

It is important to recognize that, due to differential survey effort in various survey areas, it is not possible to compare densities of porpoises by examining maps of distribution. The distribution maps are only useful for determining where animals do and do not occur, and for comparing use of the area on a small scale (within a survey area). Comparisons of density or habitat use on a larger scale should make use of numerical density estimates or the results of the grid analyses (discussed below).

Of the five on-effort sightings of finless porpoises, three were made near southwest Lamma, while two was made in the northeast portions of the Lamma Survey Area near eastern Lamma and Stanley (*Figure 9A.18*). The two off-effort porpoise sightings were made in near Stanley.

Porpoise sighting records (both on-effort and off-effort) from this survey were evaluated in conjunction with those from AFCD's monitoring survey conducted during the same period (i.e survey effort of one day per month for six months), and those from AFCD's long-term marine mammal monitoring programme from 1996 to 2008, to provide a detailed illustration of finless porpoise distribution in the Lamma Survey Area. These comparisons showed that porpoises were sighted sporadically around the southwest and

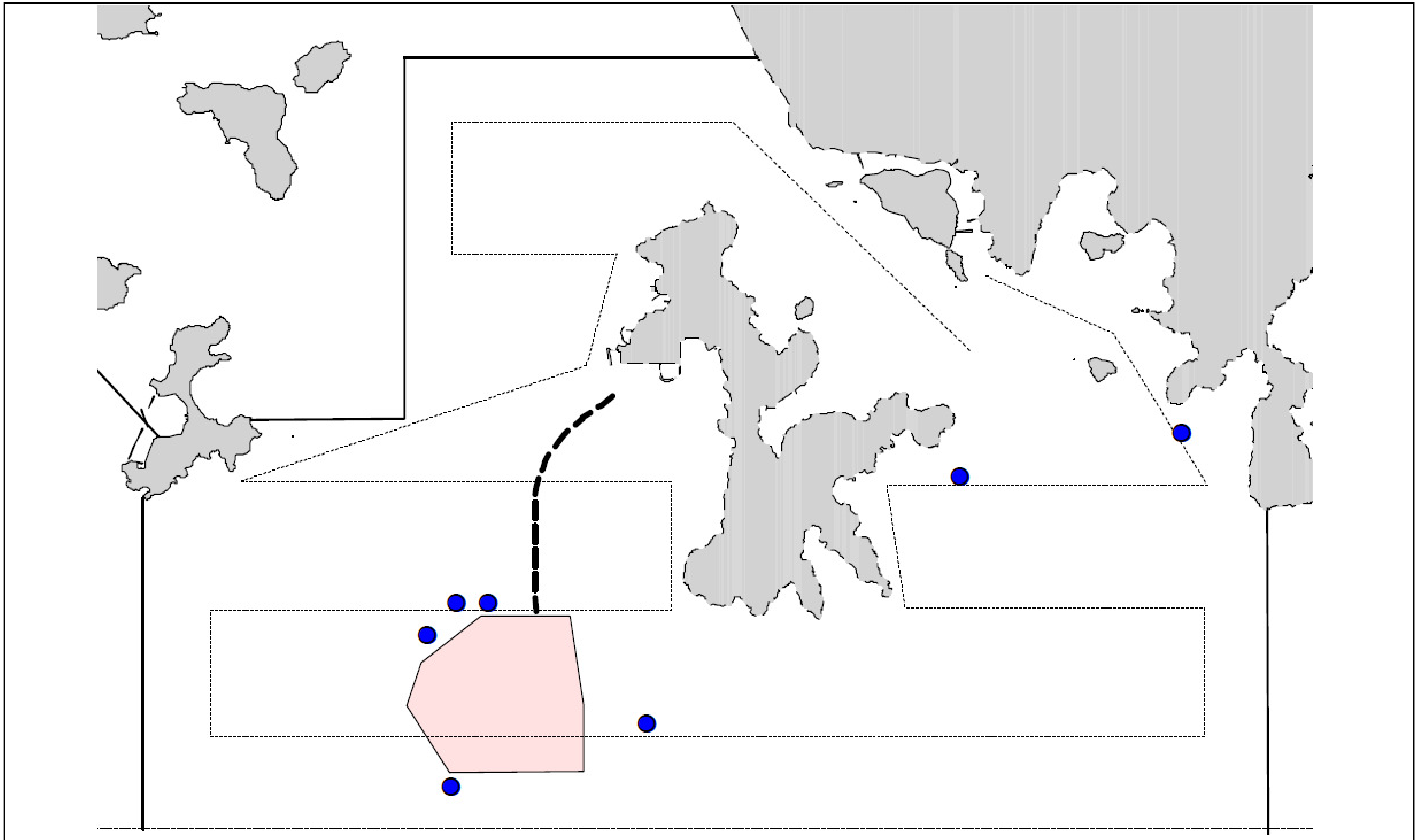

Figure 9A.18

Distribution of Finless Porpoise Sightings Recorded in Lamma Survey Area during the Wind Farm Surveys from December 2008 to May 2009

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southeast corners of Lamma Island and near Stanley Peninsula during surveys from December 2008 to May 2009, with only one porpoise sighted within the proposed wind farm site (*Figure 9A.19*). In addition, since 1996, finless porpoises have been frequently sighted at the southwest corner of Lamma Island (i.e. near Ha Mei Tsui), the nearshore, south of Cheung Chau, and near Stanley Peninsula (*Figure 9A.20*). A number of sightings were made within and in proximity to the proposed wind farm site.

Seasonal Distribution

Seasonal variations in finless porpoise occurrence within the Lamma Survey Area were examined using data collected from this study and those from AFCD's long-term monitoring programme. Overall, in Lamma waters, finless porpoise occurred more frequently during winter and spring months (i.e. December to May) than in summer and autumn months (i.e. June to November) (*Figure 9A.21)*. Whilst porpoise sightings mostly concentrated at the southwest corner of Lamma Island in the winter months, they were more evenly spread throughout the southern portion of the Lamma Survey Area in the spring months, with slightly higher sightings around the southwest and southeast corners of Lamma Island and near Cheung Chau (*Figure 9A.21*). The few porpoise sightings made in the summer months were located in the offshore waters of Lamma, while those in autumn months were scattered in the southwest portion of the survey area (*Figure 9A.21*).

As for the proposed wind farm site, porpoise sightings were the highest in spring and only very few porpoises were sighted within this area during summer and autumn (*Figure 9A.21*).

Encounter Rate

Encounter rates of finless porpoise were calculated as an indicator to determine the relative importance of the Lamma Survey Area to this species.

In the present study, porpoise encounter rates were calculated using only line-transect survey data collected in Beaufort 0-2 condition, since the porpoise encounter rate dropped markedly from 3.73 sightings per 100 km of survey effort in Beaufort 0-2 conditions to 0.24 in Beaufort 3-6 conditions during the study period, since even in relatively calm conditions finless porpoise can be more difficult to find at sea.

The porpoise encounter rate calculated for the Lamma Survey Area using the wind farm survey data and AFCD's porpoise monitoring data for the same period (December 2008 to May 2009) was 4.7 sightings per 100 km of survey effort. This was higher than the encounter rates recorded in Sai Kung and Ninepins in 2008-09 (1). The porpoise encounter rate calculated for the Lamma Survey Area using the wind farm survey data and AFCD's long-term

(1) Hung SK, pers comm

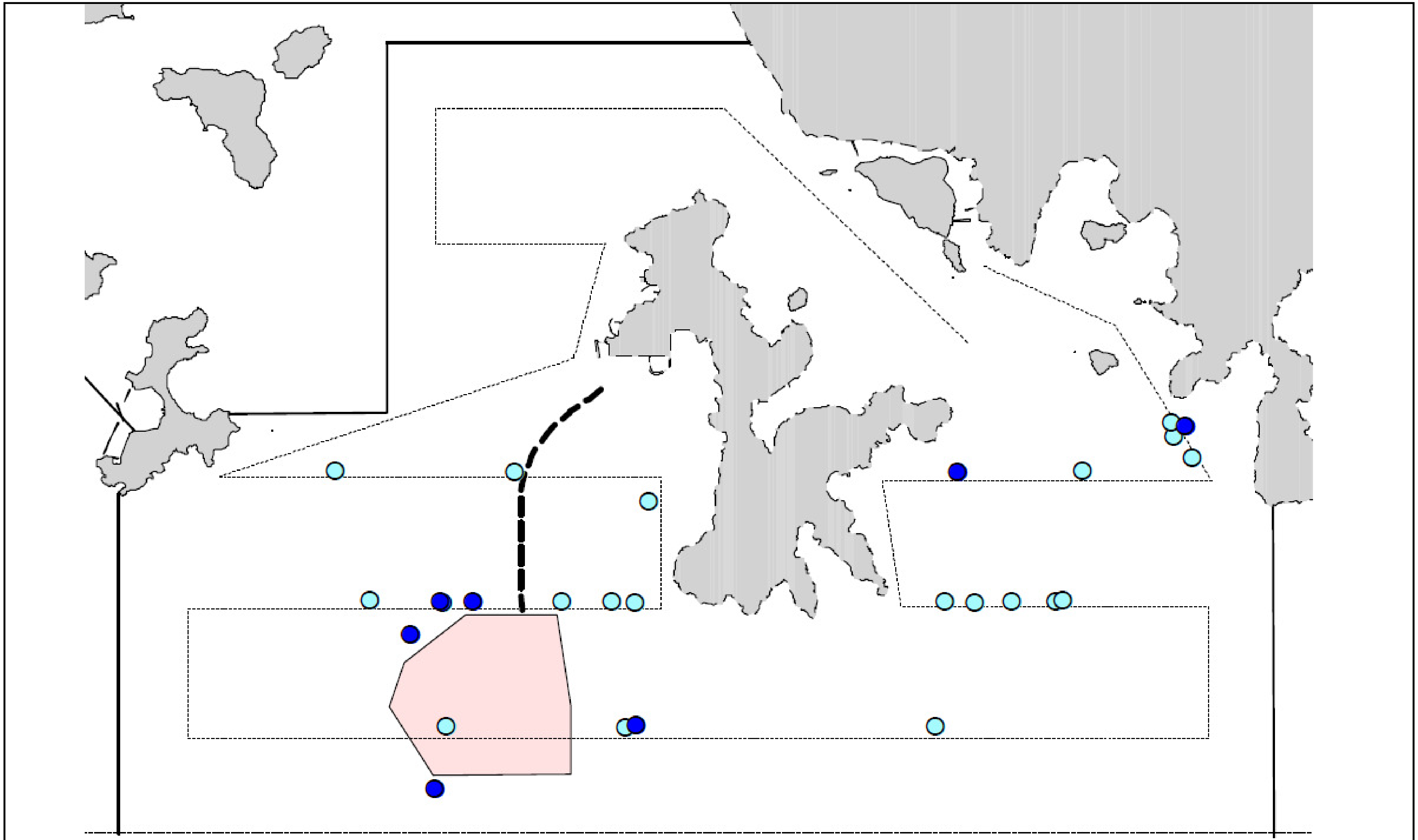

Figure 9A.19

Distribution of Finless Porpoise Sightings Recorded in Lamma Survey Area from AFCD Monitoring Surveys (light blue dots) and during the Wind Farm Surveys (dark blue dots) from December 2008 to May 2009

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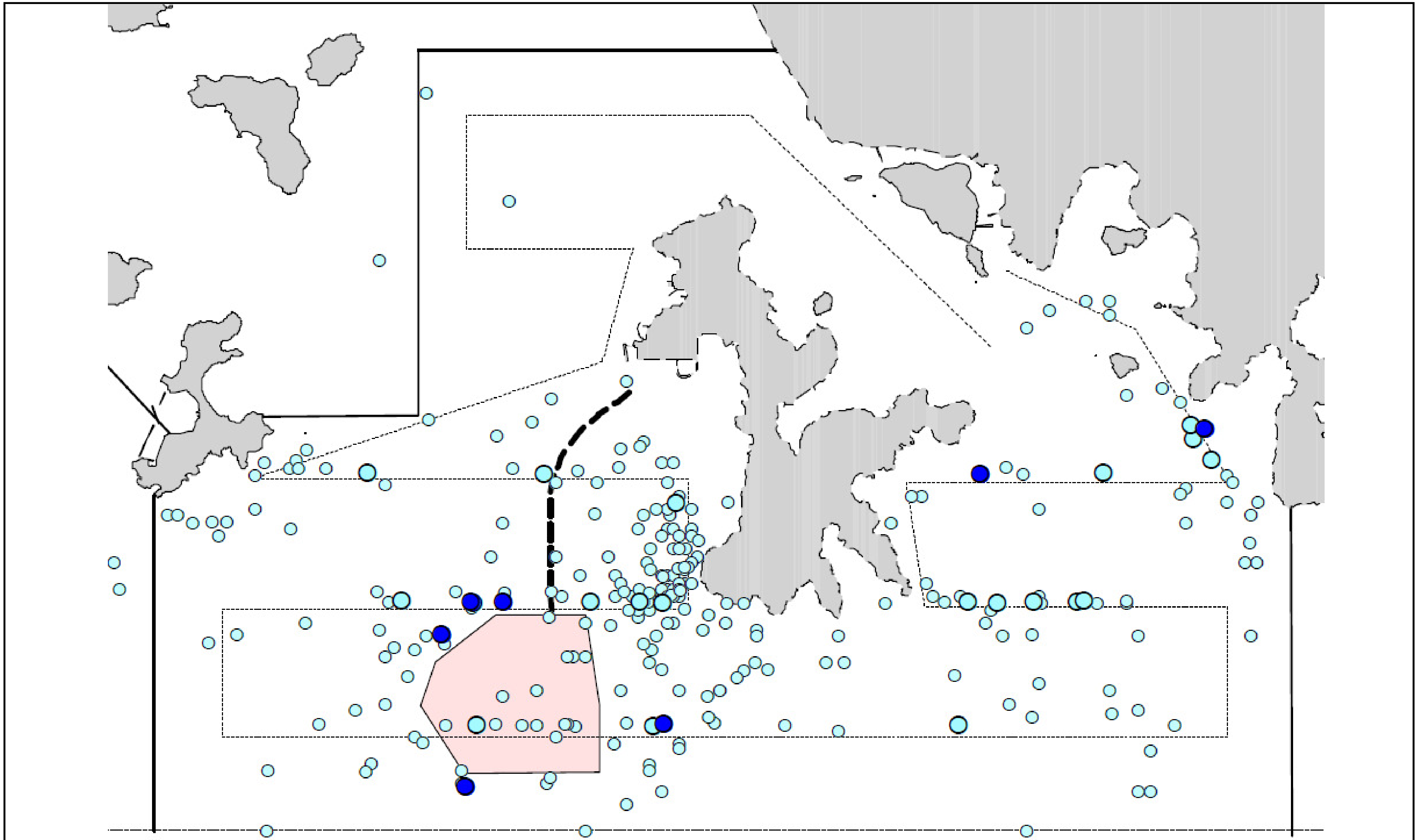

Figure 9A.20

Distribution of Finless Porpoise Sightings Recorded in Lamma Survey Area from the Long-Term Monitoring Surveys in 1996-2008 (light blue dots) and during the Wind Farm Surveys in 2008-09 (dark blue dots)

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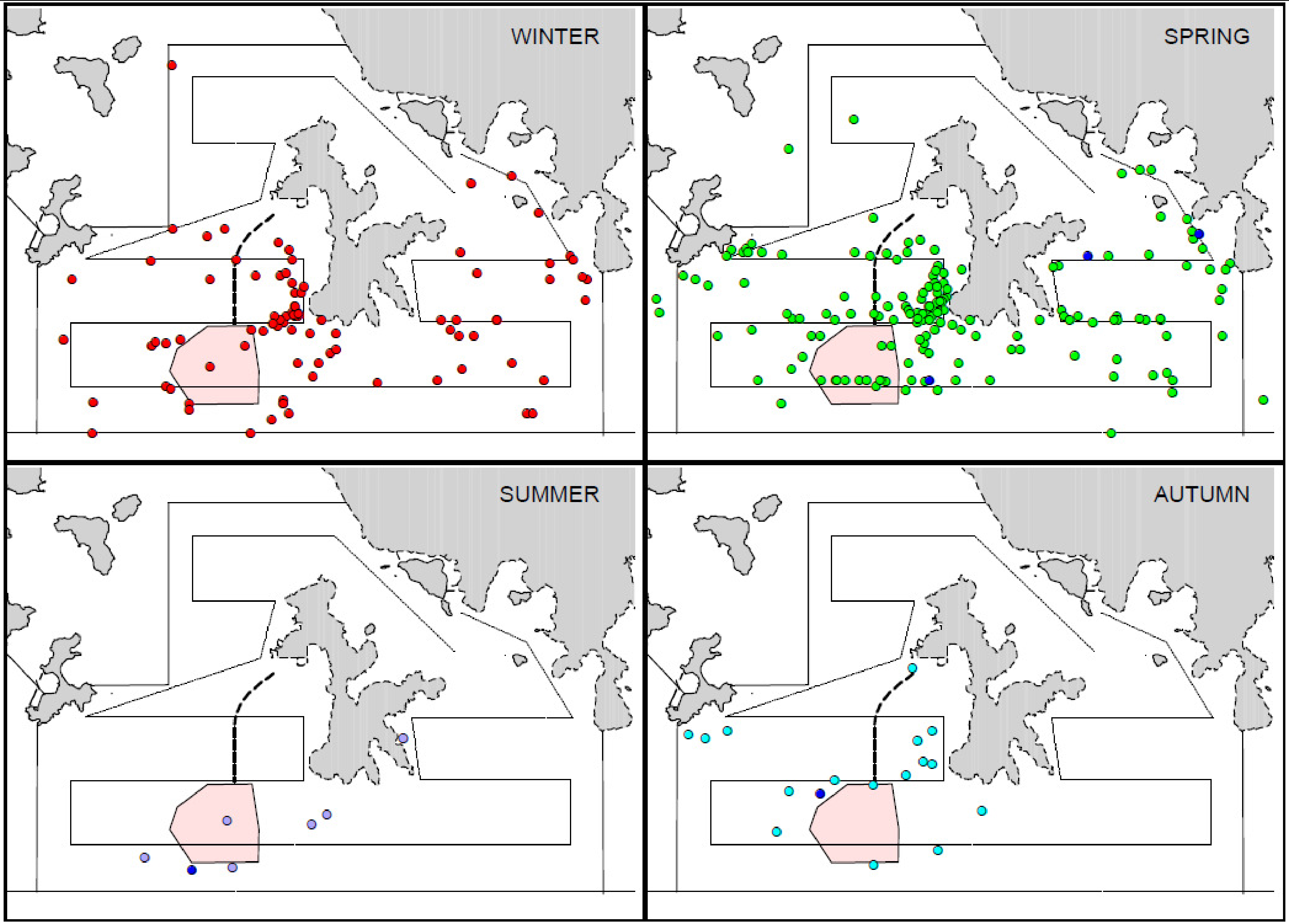

Figure 9A.21

Seasonal Distribution of Finless Porpoise Sightings Recorded in Lamma Survey Area in 1996-2009
(dark blue dots: porpoise sightings recorded during the wind farm surveys in 2008-09)

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monitoring data (from December 1999 to November 2008) was 3.2 sightings per 100 km of survey effort, which was higher than the overall encounter rate recorded in previous years of monitoring, as well as the encounter rates recorded in Ninepins and Sai Kung during the same study period [(1)]. Porpoise encounter rate within the Lamma Survey Area was the highest in spring (5.4 per 100 km of survey effort) among the four seasons.

On the basis of the above, the usage of waters of Lamma Island by finless porpoises was considered to be high in comparison to other areas of Hong Kong, especially during March to May.

Grid Analysis of Habitat Use

Grid analysis of habitat use provides the best way to compare porpoise use of specific areas, especially on a small scale. Because the data are standardized for differential survey effort, it is possible to make direct comparison of density of two grids for interpretation.

As with the analysis on encounter rate, only the survey data collected in favourable survey conditions were used for the analysis. To satisfy this condition, only the survey data from the days that had at least 50% of total survey effort collected in Beaufort 2 or below conditions were included in the grid analysis.

Data collected from surveys of this Study and those from AFCD's long-term monitoring programme (December 1999 to November 2008, December through May of each year only) were used for deriving the SPSE and DPSE values for the 169 grids in the Lamma Survey Area.

On-effort porpoise sightings in Beaufort 2 or below conditions were only made in 53 of the 169 grids since December 1999 (*Figure 9A.22*). The average DPSE value of the 169 grids for finless porpoises in the Lamma Survey Area was 13.7 (range = 0 – 133).

Habitat use of porpoises was very uneven among the 1 km^2 grids within the Lamma Survey Area, and porpoise densities were the highest near the southwest corner of Lamma Island (e.g. Grids CC30, DD31-32 and CC34) (*Figure 9A.22*). However, it should be cautioned that relatively high porpoise densities as shown in some of the grids (e.g. Grids X35, CC33 [overlap with wind farm site] and NN33) may represent artefacts of relatively low survey effort in these grids (i.e. < 10 units of survey effort, hence giving very high SPSE/DPSE values even with only one porpoise sighting).

Among the nine grids that overlapped with the proposed wind farm site, porpoises were sighted in all except one grid, and DPSE values for six of the nine grids were considered as moderate to high (*Figure 9A.22*). To correct for

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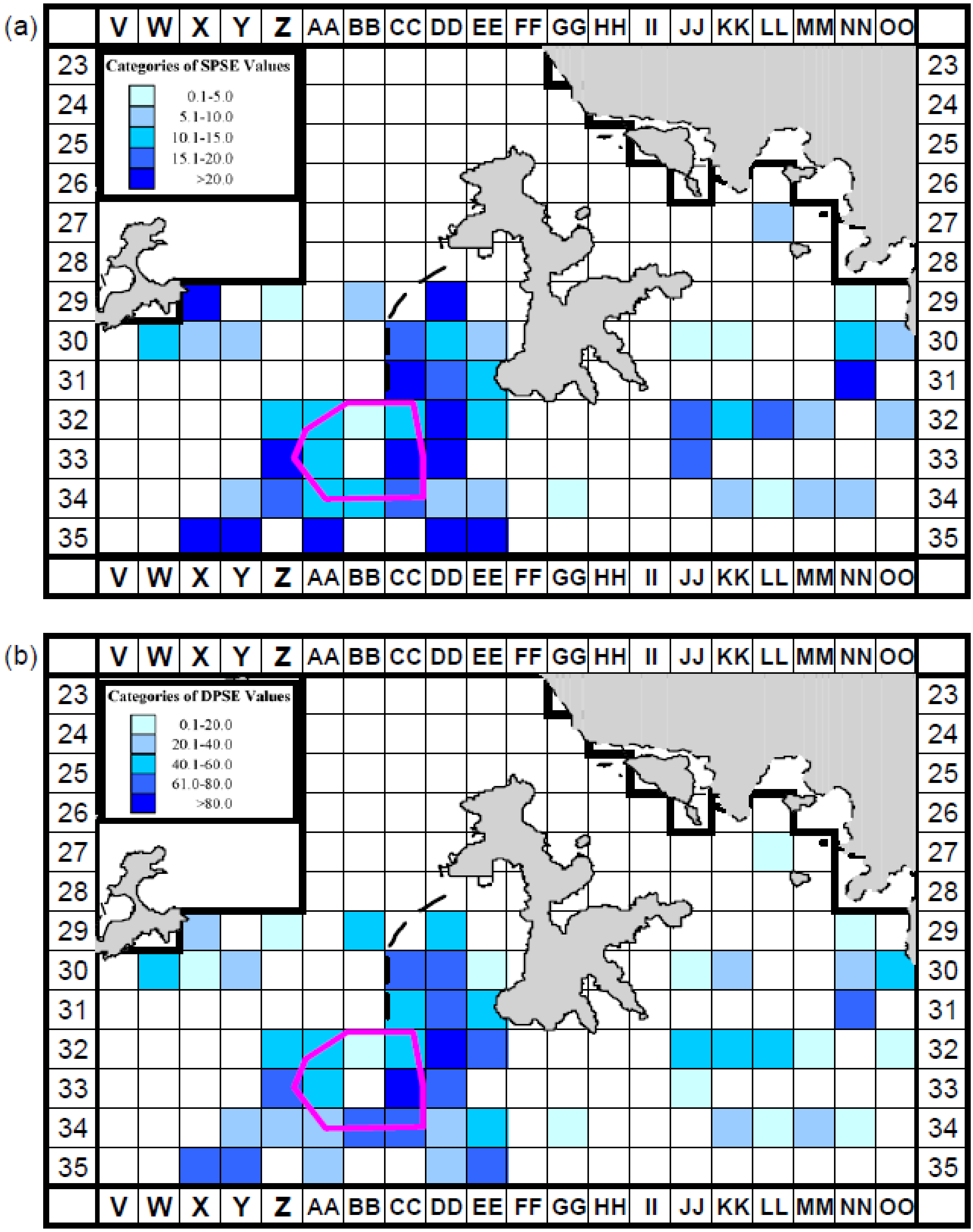

Figure 9A.22 **(a) Sighting Density of Finless Porpoises (SPSE) and (b) Density of Finless Porpoises (DPSE) with corrected survey effort per km2 in the Lamma Survey Area, using Pooled Data from Wind Farm Surveys in 2008-09 and AFCD's Long-Term Monitoring Surveys in1999-2008 (SPSE = no. of on-effort porpoise sightings per 100 units of survey effort; DPSE = no. of porpoises per 100 units of survey effort; red box: proposed wind farm site in Southwest Lamma; dotted line: connecting cable)**

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potential bias as a result of relatively low survey effort in three of these nine grids (only 6 – 9 units of survey effort), average DPSE value of these nine grids was calculated using DPSE values of only six grids and the adjusted average DPSE value was 48.2. Based on the above, the proposed site appeared to be moderately, and in some subareas highly, used by finless porpoises.

Likewise, among the four grids that overlapped with the proposed cable route, porpoises were sighted in only two grids and their DPSE values were considered as moderate and moderate to high (*Figure 9A.22*). The average DPSE value of these four grids was low to moderate (< 35).

<u>Group Size</u>

Porpoises sighted in this study tended to occur in small groups, with four of the five porpoise groups composed of 1-2 animals and one group with eight animals. Finless porpoise average group size for this study was 2.6 ± 3.05 porpoise/ group, which was slightly lower than that reported from AFCD's long-term monitoring programme (December 1999 to November 2008) for the Lamma Survey Area (3.3 porpoise/ group).

Data from this study were combined with AFCD's long-term monitoring data (collected since 1996) for analysis and the results showed that large porpoise groups were frequently sighted at the southwest corner of Lamma Island near Ha Mei Tsui (*Figure 9A.23*). A few large porpoise groups were also sighted at and near the proposed wind farm site.

9A.5 *EVALUATION OF ECOLOGICAL IMPORTANCE OF THE STUDY AREA*

The existing conditions of the marine ecological habitats and resources in the waters of the proposed wind farm and cable route have been assessed. These baseline conditions have been based on available literature and, where considered necessary, focussed field surveys to update and supplement the data. Based on this information, the ecological importance of each habitat has been determined according to the *EIAO-TM Annex 8* criteria, as follows:

- Naturalness
- Size
- Diversity
- Rarity
- Re-creatability
- Fragmentation
- Ecological Linkage

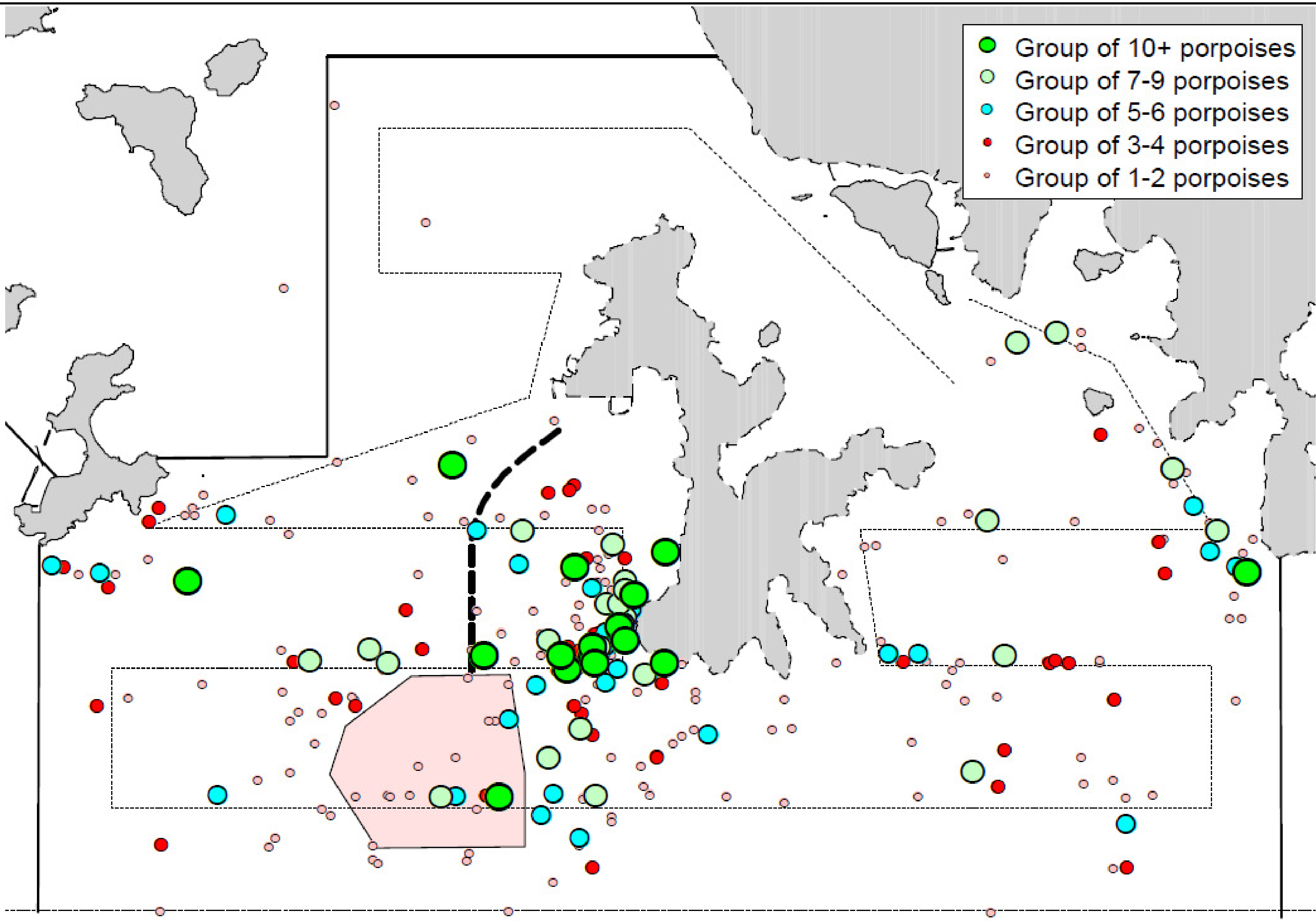

Figure 9A.23

Distribtion of Finless Porpoises with Different Group Sizes in the Lamma Survey Area from 1996 – 2009

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- Potential Value
- Nursery Ground
- Age
- Abundance

It should be pointed that that within the Study Area of this EIA, which covers quite a large areal extent, variations in the ecological characteristics of habitats across different locations (which are kilometres apart) are likely to be present. To provide information of key relevance to the marine ecological assessment, the ecological importance of habitats presented in this baseline is therefore primarily focussed on the vicinity of the works areas of the proposed project.

9A.5.1 *Intertidal Habitats*

The criteria listed below have been applied to the information gathered or reviewed on the marine ecology of the intertidal habitats at the Lamma Power Station Extension in order to determine the ecological value. The application of these criteria has led to the intertidal artificial seawall at the Lamma Power Station Extension to be classified as low ecological importance (*Table 9A.14*).

Table 9A. 14 Ecological Importance of Intertidal Habitats at the Cable Landing Point at the Lamma Power Station Extension

Criteria	Artificial Shoreline
Naturalness	Artificial, constructed habitat
Size	Large. The total length of the artificial shore in the Study Area is 745 m and is the predominant habitat type in the 500 m Study Area
Diversity	Low. The intertidal assemblages of the sloping artificial shores comprise typical biota of sheltered to moderately-exposed rocky shores in Hong Kong, but with low species diversity
Rarity	No species recorded are considered rare or of recognised conservation interest
Re-creatability	Hard bottom substrata may be re-colonised by intertidal and subtidal organisms
Fragmentation	Low. The surrounding coastlines are composed of artificial seawall
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way
Potential Value	Unlikely to become an area of conservation value
Nursery Area	No significant records identified during the literature review or field surveys.
Age	The artificial seawall has been in place since the Lamma Power Station Extension was reclaimed in the 2000s.
Abundance	Low, and generally lower abundance than natural rocky shore habitat

Criteria	Artificial Shoreline
SUMMARY	Intertidal assemblages of the artificial shores are reported to support a lower diversity and abundance of intertidal organisms as natural shores. **Ecological Importance – Low**

Note: n/a: Not Applicable

9A.5.2 *Subtidal Habitats*

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the subtidal habitats at the wind farm site and cable route in order to determine the ecological importance. The application of these criteria has led the habitats, both subtidal soft bottom and hard bottom habitats, to be classified as of low ecological importance (*Table 9A.15*).

Table 9A.15 Ecological Importance of the Subtidal Habitats of the Study Area

Criteria	Subtidal Soft Benthos	Subtidal Hard Surface Habitat along Artificial Shoreline and on Hard Substrate along Cable Route
Naturalness	Seabed habitat disturbed to some extent by fisheries vessel trawling activities	Artificial shoreline is constructed habitat Hard substrate along cable route is identified as superficial, introduced dumped material on the seabed
Size	Habitat is large in extent.	Artificial shore is large in extent (745 m) and is the predominant habitat type in the 500 m Study Area Extent of dumped material along cable route is small
Diversity	The assemblages are of lower diversity (number of benthic species recorded per unit area above the mean value of the CityU (2002) data) compared to other areas in the Hong Kong waters	Three hard coral species and no octocorals were recorded on the artificial seawall Four octocoral species and one black coral species recorded on the dumped material Both are considered very low in the context of coral assemblages in Hong Kong
Rarity	No organisms were found that are considered as rare or of recognised conservation interest.	All species of hard and soft corals recorded are commonly and widespread species of Hong Kong. No species recorded are considered rare or of recognised conservation interest
Re-creatability	Benthic organisms may recolonise disturbed seabed area	Hard bottom substrata may be recolonised by subtidal organisms including corals

Criteria	Subtidal Soft Benthos	Subtidal Hard Surface Habitat along Artificial Shoreline and on Hard Substrate along Cable Route
Fragmentation	The habitat is not fragmented	The surrounding coastlines are composed of artificial seawall Dumped material is haphazard in nature
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way	The habitat is not functionally linked to any high value habitat in a significant way
Potential Value	Unlikely to become an area of conservation interest	Very low. This habitat supported few coral species which were sparse in abundance. Conditions are not highly suited for coral growth. The area is unlikely to become an area of coral conservation
Nursery Area	No significant record identified in the literature review or field surveys	No significant record identified in the literature review or field surveys
Age	The fauna appear to be typical of those present in Hong Kong's soft benthos. The sediments in the habitat are constantly accreting and eroding and the fauna present there are typically short-lived	Coral colonies were scattered and small. No large mature coral colonies were observed
Abundance	In comparison to parts of the southern waters the assemblages are of very low abundance	Live coral coverage in the survey area was very low in the context of coral assemblages in Hong Kong
SUMMARY	The sediments support low diversity and abundance of benthic organisms that are typical of Hong Kong's benthos **Ecological Importance – Low**	Coral cover and diversity are very low in comparison to other sites in Hong Kong. **Ecological Importance - Low**

Note: n/a: Not Applicable

9A.5.3 Marine Waters off Southwest Lamma and along the Cable Route

The same assessment criteria have been applied to the marine waters off Southwest Lamma and along the Cable Route with regard to the usage of the area by marine mammals and sea turtles. This habitat has been classified as of medium importance on the use of the area by finless porpoise, but is considered as of low importance to sea turtles (*Table 9A.16*).

Table 9A.16 Ecological Importance of the Marine Waters off Southwest Lamma and along the Cable Route

Criteria	Marine Mammal Habitat	Sea Turtle Habitat
Naturalness	Close proximity to marine traffic lanes in Hong Kong.	Close proximity to marine traffic lanes in Hong Kong.

Criteria	Marine Mammal Habitat	Sea Turtle Habitat
Size	Habitat is large in extent	Habitat is large in extent
Diversity	n/a	n/a
Rarity	Finless porpoise *Neophocaena phocaenoides* has been recorded in waters within and adjacent to the wind farm site and along the cable route area. Recent sightings data (2004-2008) suggest that porpoise density is higher in the waters south of the Soko Islands, the offshore waters in Southeast Lantau, at southwest corner of Shek Kwu Chau and Cheung Chau, near Stanley Peninsula and around Po Toi Islands than in other parts of Hong Kong waters Indo-Pacific humpback dolphin *Sousa chinensis* is usually absent from these waters	Few individuals of green turtle *Chelonia mydas* are known to nest on the Sham Wan beach on southern Lamma, and the species was sighted in waters close to Sham Wan, in the south and southeast of Lamma Island, primarily from June to October during their inter-nesting period.
Re-creatability	n/a	n/a
Ecological Linkage	With the Lamma Survey Area, preferred finless porpoise habitat lies to the east of the proposed wind farm site and cable route, over coastal waters of southwest Lamma Island. The Project Area is utilised by porpoises as part of their larger habitat	Waters to the east of the proposed wind farm site and cable route serve as potential inter-nesting habitats for nesting green turtles
Potential Value	Coastal waters of South Lamma have been identified as a proposed Marine Park in 1999	Coastal waters of South Lamma have been identified as a proposed Marine Park in 1999
Nursery Area	Sheltered bays to the east of the Project Area, over coastal waters of southwest Lamma Island may potentially provide nursery areas for porpoises during calving season in spring and winter	Green turtles nest on land at the Sham Wan beach, and there is no evidence to suggest that waters off Lamma Island serve as breeding habitats for green turtles
Abundance	Porpoise densities are higher in winter and spring months than in summer and autumn. Quantitative grid analysis of porpoise density data (i.e. DPSE values) indicates these animals occur at moderate to high densities in waters within and in the immediate surrounding of the wind farm site, while porpoises occur at low to moderate densities along the cable route during these periods	A small number of green turtles are known to nest at Sham Wan, although nesting does not occur every year. Therefore very occasionally would green turtles be present in the Project Area

Criteria	Marine Mammal Habitat	Sea Turtle Habitat
SUMMARY	The Project Area is situated in waters where finless porpoises have been sighted, but porpoise densities (DPSE values) in this Area are considered to be medium to high (for wind farm site) and low to moderate (for cable route) **Ecological Importance –** **Medium-High for porpoise habitat within the wind farm site** **Medium for porpoise habitat along the cable route** **Low for porpoise habitat at the landing point**	The small number of green turtles that nest in Sham Wan may potentially use the Project Area as inter-nesting habitat, but very few historical data support this **Ecological Importance – Low**

Note: n/a: Not Applicable

9A.5.4 *Species of Conservation Interest*

In accordance with *EIAO-TM Annex 8* criteria, an evaluation of species of conservation value recorded from the Study Area is presented in *Table 9A.17.*

Table 9A.17 Species of Conservation Interest within the Study Area

Common Name	Scientific Name	Protection Status	Distribution, Rarity and other Notes
Indo-Pacific Humpback dolphin (locally known as Chinese White Dolphin)	*Sousa chinensis*	• Wild Animals Protection Ordinance • Protection of Endangered Species of Animals and Plants Ordinance (CITES Appendix I species [i.e. highest protection]) • Listed as "Endangered" in the China Species Red List • Listed as "Grade I National Key Protected Species" in China • Listed as "Near Threatened" in the 2009 IUCN Red List of Threatened Species	Range across Pearl River estuary and across Hong Kong western and Southern Waters from Deep Bay to Lamma.
Finless Porpoise	*Neophocaena phocaenoides*	• Wild Animals Protection Ordinance • Protection of Endangered Species of Animals and Plants Ordinance (CITES Appendix I species [i.e. highest protection]) • Listed as "Endangered" in the China Species Red List • Listed as "Vulnerable" in the 2009 IUCN Red List of Threatened Species	Range across southern and eastern waters and in PRC waters
Green Turtle	*Chelonia mydas*	• Wild Animals Protection Ordinance • Protection of Endangered Species of Animals and Plants Ordinance (CITES Appendix I species [i.e. highest protection]) • Listed as "Critically Endangered" in the China Species Red List • Listed as "Grade II National Key Protected Species" in China • Listed as " Endangered" in the 2009 IUCN Red List of Threatened Species	Known to nest mainly at Sham Wan, south of Lamma Island. Inter-nesting areas largely located to the south and southeast of Lamma Island.

9A.6 SUMMARY

The findings from the literature review and field surveys on marine ecological conditions are detailed above and are summarized as follows.

The marine ecological habitats in the immediate vicinity of the wind farm site and cable route off Southwest Lamma have undergone some degree of anthropogenic disturbance through reclamation for the Lamma Power Station Extension and marine traffic through the West Lamma Channel.

The key finding of the literature review was the recorded presence of finless porpoise *Neophocaena phocaenoides* in the waters of the Study Area and inter-nesting green turtles *Chelonia mydas* in waters south and southeast of Lamma Island. Although Indo-Pacific humpback dolphins *Sousa chinensis* have been recorded to the south of Lamma Island, these sightings are very scarce and this area is considered to represent the eastern limit of the species and hence does not constitute an important area for the species. The review highlighted that finless porpoises have been sighted regularly within the areas surrounding the proposed wind farm site and the cable route.

Due to the limited literature available for some components of the marine environment, field surveys were necessary to fill the information gaps identified for the baseline conditions of the habitats. The baseline surveys commenced in October 2008 and have included both the dry and wet seasons. These focussed seasonal surveys were conducted to characterise major marine assemblages and species within and surrounding the wind farm site and cable route. The details of the baseline surveys are summarized in *Table 9A.3.*

The ecological importance of the habitats was determined through reference to the following:

- Literature review;
- Findings of the field surveys;
- Comparison with other areas in Hong Kong; and,
- *Annexes 8* and *16* of the *EIAO TM*.

None of the marine ecological resources and habitats in the proposed wind farm site and cable route is considered as of high ecological value. Key findings and outcomes of the evaluation of ecological importance are summarised below.

Intertidal Hard Bottom Assemblages

Seasonal quantitative transect surveys were conducted on the artificial seawall of the Lamma Power Station Extension. Rocky shore species at all survey transects were common and widespread and no species of note were recorded. The assemblages recorded are considered to be of low diversity and low ecological importance.

Subtidal Soft Bottom Assemblages – Benthos

Seasonal systematic grab sampling was conducted within and in proximity to the footprint of the wind farm site and cable route. In both seasons, infaunal assemblages at the surveyed sites were dominated by polychaete worms, and the species recorded are common and widespread species with no particular conservation concern. The abundance, biomass and taxonomic richness of infauna at these sites are considered as very low in comparison with the Hong Kong average reported in the literature. The ecological importance of these assemblages is considered as low.

Subtidal Hard Bottom Assemblages – Coral

Qualitative and semi-quantitative REA surveys were conducted on the artificial seawall of the Lamma Power Station Extension and on hard substrate identified along the proposed cable route. Only three hard coral species were recorded on the artificial seawall, and a total of five octocoral species and one black coral species were recorded on the dumped material along cable route. These locally common and widerspread coral species with little conservation interest occurred as very scarce colonies with extremely low coverage. Given such low coral abundance and diversity at the surveyed sites the ecological importance of the associated assemblages is considered as low.

Green Turtle

A small number of green turtles are known to nest on the Sham Wan beach in southern Lamma. Satellite tracking data suggested that these turtles may use the southern and southeastern waters of Lamma as inter-nesting habitats during June to October. These data also suggested that they very rarely use waters within and surrounding the Project Area, hence the ecological importance of these waters to green turtles is considered as low.

Finless Porpoise

Vessel-based standard line transect surveys were undertaken in the Lamma Survey Area over a 6-month period from December 2008 to May 2009. A total of five groups of porpoises (total abundance = 13 individuals) were sighted on-effort during the surveys. Survey data were combined with AFCD's long-term porpoise monitoring data from December 1999 for quantitative grid analysis, and the results showed that the porpoise densities (DPSE values) were considered as moderate to high and low to moderate for the proposed wind farm site, along the cable route and at the landing point respectively. The ecological importance of these areas are considered as medium-high, medium and low respectively.

CONTENTS

10 FISHERIES IMPACT

10.1 INTRODUCTION

This Section of the EIA Report presents the findings of an impact assessment on existing fisheries resources, capture and culture fishing operations from the construction and operation of the proposed offshore wind farm development. The assessment is based on the Project Description (*Section 5*) and the findings of the Water Quality Assessment (*Section 6*). For a description of the physical and biological characteristics of the marine environment of the Study Area please refer to *Sections 6* and *9*, respectively.

10.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

10.2.1 Technical Memorandum

The criteria for evaluating fisheries impacts are laid out in the *EIAO-TM*. *Annex 17* of the *EIAO-TM* prescribes the general approach and methodology for the assessment of fisheries impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential impacts. *EIAO-TM Annex 9* recommends the criteria that are to be used for evaluating fisheries impacts.

10.2.2 Other Legislation

Other legislation which applies to fisheries includes:

- *Fisheries Protection Ordinance* (Cap 171) 1987, which provides for the conservation of fish and other aquatic life, regulates fishing practices and prevents activities detrimental to the fishing industry.

- *Marine Fish Culture Ordinance* (Cap 353) 1983, which regulates and protects marine fish culture and other related activities.

- *Environmental Impact Assessment Ordinance (cap. 499), Section 5(7) - Environmental Impact Assessment Study Brief no. ESB-126/2005 Section 3.4.6,* which outlines the key fisheries impacts to be reviewed and assessed in the EIA Report.

10.3 BASELINE CONDITIONS AND FISHERIES SENSITIVE RECEIVERS

The Study Area was the same as that for the Water Quality Impact Assessment (see *Section 6*). This area considers a range of fisheries sensitive receivers within 7 km of the wind farm site and cable route, including spawning and nursery areas and Fish Culture Zones.

10.3.1 *Overview of Hong Kong Fisheries*

In Hong Kong, marine-based commercial fishing operations are divided into culture and capture fisheries.

In 2008, the Hong Kong fishing fleet comprised of about 3,800 vessels manned by 7,900 local fishers, with crew mainly consisting family members with the assistance of hired crew. In 2008, the capture fisheries industry yielded about 158,000 tonnes of fisheries produce valued at about HK$1,780 million. The majority of the catch was caught in waters outside Hong Kong on the traditional fishing grounds over the continental shelf of the South China Seas [(1)].

Since 1999, Mainland Authorities have implemented a fishing moratorium for South China Sea fishing grounds for two months during midsummer (from 1 June to 1 August). The moratorium prohibits fishing activity by the Hong Kong fleet outside of Hong Kong waters except by gill-netting, long-lining, hand-lining and cage trapping.

The impact assessment included in this Chapter is based upon recent data that has recorded fishery activity at the proposed wind farm site (including associated infrastructure) and along the proposed cable route.

Mariculture fishery operations occur at 26 fish culture zones (FCZs), occupying about 209 ha of Hong Kong waters. They are generally located in various sheltered embayments. Typically, fish farms are relatively small scale, family-run operations consisting of one or two rafts with an average size of about 280m^2. Since 1999 there has been a steady decline in licensed operators (*Table 10.1*). In June 2002, the Marine Fish Culture Ordinance was amended to allow licenses to be transferred. In 2008, the marine fish culture industry produced about 1,370 tonnes of fish valued at HK$82 million and catering for about 10% in value of total fisheries production. Some recent figures on the local marine culture fisheries are presented in *Table 10.1*.

Table 10.1 Marine Culture Fisheries Summary Statistics 1999 - 2008 (source: AFCD)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Licensed Mariculturists	1,454	1418	1320	1237	1157	1125	1104	1081	1072	1060
Production (tonnes)*	1250	1770	2470	1210	1490	1540	1540	1490	1530	1,370
Value (HK$ million)*	66	102	136	57	76	79	76	89	99	82

* AFCD estimates

(1) AFCD (2007) http://www.afcd.gov.hk/english/fisheries/fish_cap/fish_cap_latest/fish_cap_latest.html

10.3.2 *Culture Fisheries*

No FCZs are located close to the wind farm site or the proposed cable route. The closest FCZs are located at Lo Tik Wan (> 9 km from the windfarm site, > 6 km from the cable route), Sok Kwu Wan (> 10 km from the windfarm site, > 8 km from the cable route) and Cheung Sha Wan (> 10 km from the windfarm site, > 9 km from the cable route) (see *Figure 10.1*).

10.3.3 *Capture Fisheries*

Based on the latest AFCD Port Survey data (i.e. 2006), the highest fisheries production (600 to 1,000 kg ha^{-1}) in Hong Kong occurred near the Ninepin Island Group, Po Toi and Tap Mun. The top 10 families captured in Hong Kong were scad (Carangidae), shrimp, rabbitfish (Siganidae), squid, croaker (Sciaenidae), crab, mullet (Mugilidae), sardine (Clupeidae), seabream (Sparidae) and anchovy (Engraulidae).

Fishing Vessels

The scale of fishing operations in terms of the number of vessels operating in the waters around the proposed wind farm site and cable route is presented in *Figure 10.2*.

With reference to the AFCD grid system and the findings of the Port Survey 2006, the number of vessels that operate in waters at Southwest Lamma site varies from 400 - 700 vessels to 100 – 400 vessels. Fishing operations in this area are dominated by shrimp trawlers with between 50 and 400 vessels operating in waters in proximity to the proposed wind farm site. The waters to the south of Lamma Island and the waters around the Po Toi group represent an area of the Hong Kong fishing ground where shrimp trawlers tend to concentrate operations. Of particular note, the number of vessels operating in the wind farm site is relatively high at its far eastern edge. However, the precise area where greatest activity is undertaken is unclear as the Port Survey data uses a large grid system to standardise data and the grid forms only part of the wind farm site. The area showing relatively high levels of fishing operations extends eastwards to the south of Lamma Island and the area in the wind farm site only forms a small part of this overall area (less than 10%). In other areas at the wind farm site and along the cable route the level of fishing activity is similar to that found in most nearshore zones to the south, west and east of Hong Kong waters (see *Figure 10.2*). Others areas in Hong Kong waters showing high levels of fishing vessel activity were the Ninepin Island Group, Po Toi Island Group, Tap Mun and Shelter Island. Vessels operating in the Project Area also include sampans (1 – 400 vessels), hang trawlers (10 – 50 vessels), gill netters (10 – 50 vessels), stern trawlers (1 - 50 vessels), pair trawlers (<10 vessels), long liners (1 - 50 vessels), hand lining (0 – 10 vessels) and purse seiners (1 - 50 vessels). In addition, to 2006 Port

Figure 10.1

Southwest Lamma Wind Farm Site and Cable Route in Relation to Fish Culture Zones

File: 0088440_Lamma_satellite.mxd
Date: 03/07/2009

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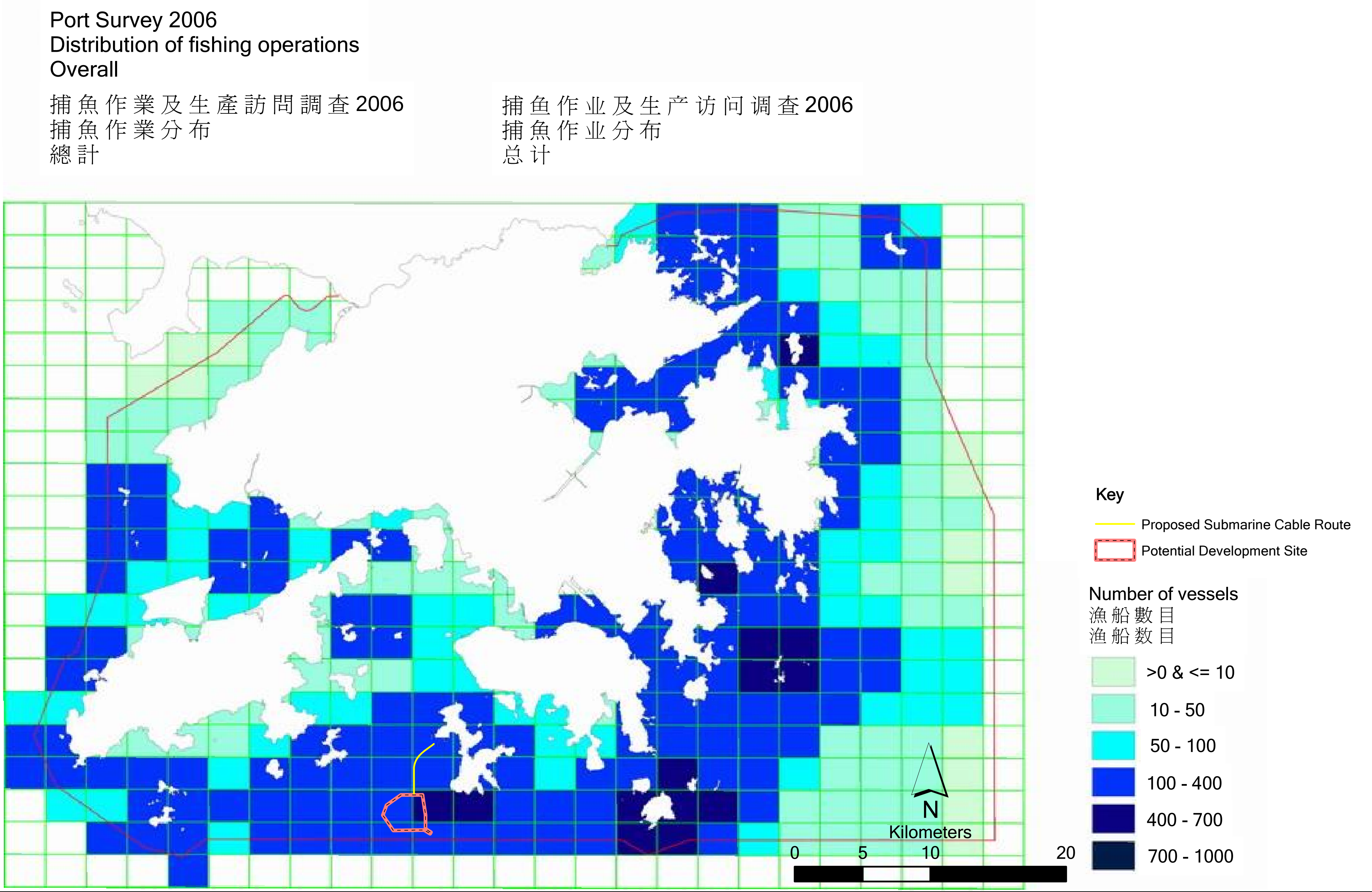

Figure 10.2

Distribution of Fishing Operations (All Vessels) in Hong Kong Waters
as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006

File: 0088440_fishing operation.mxd
Date: 05/05/2009

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Management
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Survey data, recent marine traffic information for the site has determined that greatest fishing activity occurs to the north east of the wind farm site [1].

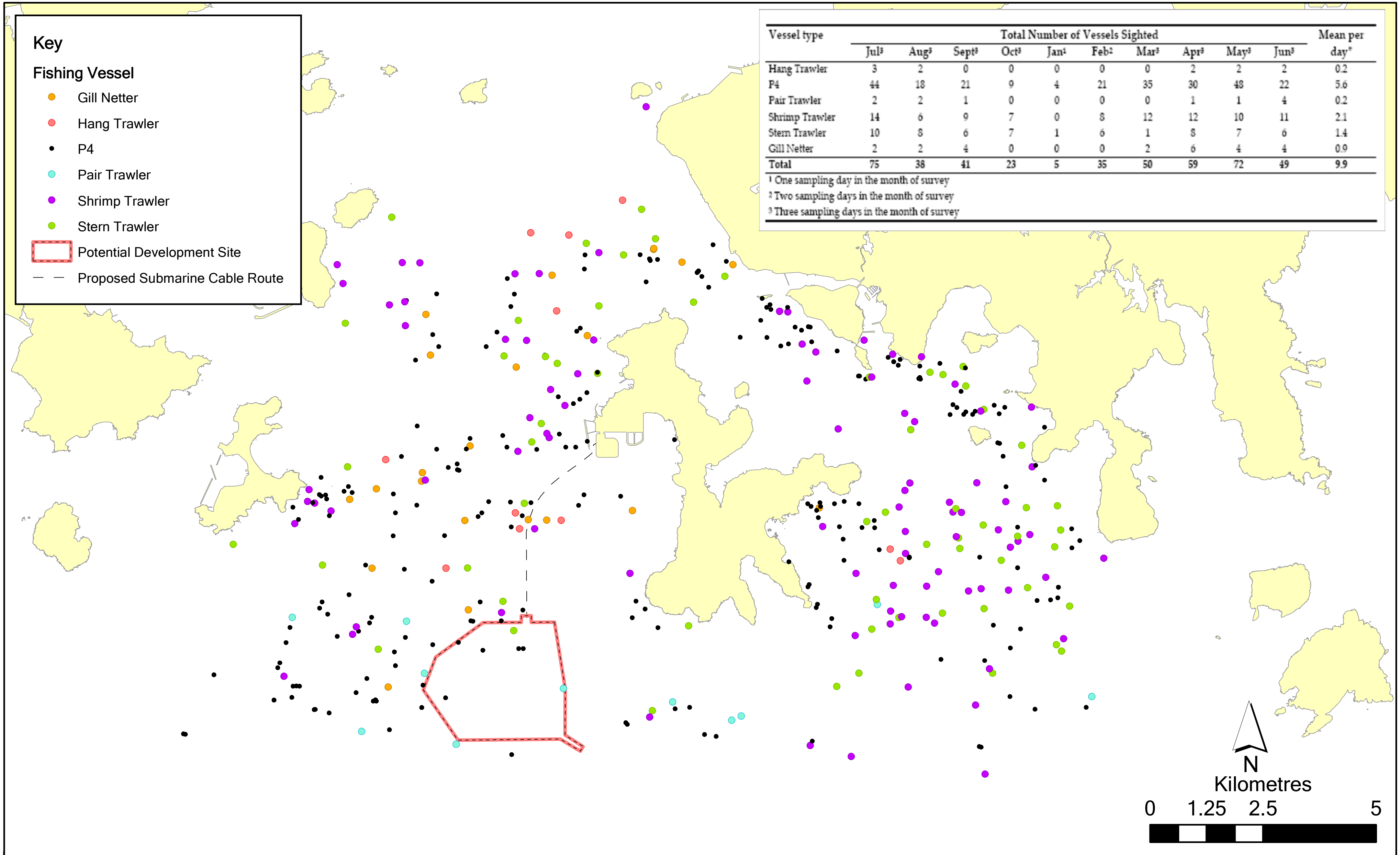
It is interesting to note that the use of these waters by trawling operations is also apparent from the results of the geophysical surveys conducted as part of the site investigation and marine archaeological surveys works (see *Section 12*). Numerous trawl scars within the study area are clearly evident from the results of these surveys and support the finding that such activities are present in these waters.

In addition, to the desk-top review, opportunistic vessel-based observations have been made of active fishing vessels in the survey area in parallel with bird and marine mammal surveys that were undertaken for this EIA (see *Sections 8* and *9*). These surveys are, however, only meant to be supplementary to more robust and quantitative surveys carried out as part of the AFCD Port Survey. The survey followed the same transects as that bird and marine mammal surveys as shown in *Figure 10.3* (see *Sections 8* and *9*). Observational records were taken from July to October 2008 and January to June 2009. Records were therefore taken over a 10 month period. A total of 6 different types of fishing vessel were recorded with a mean total number of ~10 vessels sighted in Study Area per day (*Table 10.2*). The results would therefore suggest that during the period of observation fishing activity in the wind farm area was comparatively lower than areas to the north, west and east of the wind farm (see *Figure 10.2*). The results from the vessel sighting records suggest that the predominant type of vessels moving across the wind farm site and cable route during the period of observation were small P4s [2] undertaking hand lining or gill netting activities, followed by shrimp trawling and stern trawling vessels. The data would also seem to confirm that greatest trawling activity occurs to the east of the wind farm site around the south and east of Lamma Island.

Although the results are noted as being based on opportunistic observational surveys, it is interesting to note some of the differences between these surveys and the AFCD Port Survey findings. On note are what appear to be lower levels of usage of these waters by trawling vessels and the high levels of small scale hand lining fisheries such as those observed on P4s. Overall the findings may indicate that from this newer data, the waters around the study area are less intensively fished by certain gear types than that previously recorded in other years.

(1) BMT Asia Pacific (2008) Technical Note to HKE.

(2) Defined as vessels are defined as those licensed to carry no more than four passengers



Vessel type	Total Number of Vessels Sighted										Mean per day*
	Jul[3]	Aug[3]	Sept[3]	Oct[3]	Jan[1]	Feb[2]	Mar[3]	Apr[3]	May[3]	Jun[3]	
Hang Trawler	3	2	0	0	0	0	0	2	2	2	0.2
P4	44	18	21	9	4	21	35	30	48	22	5.6
Pair Trawler	2	2	1	0	0	0	0	1	1	4	0.2
Shrimp Trawler	14	6	9	7	0	8	12	12	10	11	2.1
Stern Trawler	10	8	6	7	1	6	1	8	7	6	1.4
Gill Netter	2	2	4	0	0	0	2	6	4	4	0.9
Total	75	38	41	23	5	35	50	59	72	49	9.9

[1] One sampling day in the month of survey
[2] Two sampling days in the month of survey
[3] Three sampling days in the month of survey

Figure 10.3

Fishing Vessel Sightings (July 08 - Oct 08; Jan 09 - Jun 09)
27 Survey Days in Total

File: 0088440_Fishing Vessel_Lamma.mxd
Date: 30/06/2009

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Table 10.2 Type of fishing vessels, total number of vessel sights for each month from July 2008 to June 2009 and the mean number of vessel sightings per day

	Total Number of Vessels Sighted										Mean per day*
Vessel type	**Jul[3]**	**Aug[3]**	**Sept[3]**	**Oct[3]**	**Jan[1]**	**Feb[2]**	**Mar[3]**	**Apr[3]**	**May[3]**	**Jun[3]**	
Hang Trawler	3	2	0	0	0	0	0	2	2	2	0.2
P4	44	18	21	9	4	21	35	30	48	22	5.6
Pair Trawler	2	2	1	0	0	0	0	1	1	4	0.2
Shrimp Trawler	14	6	9	7	0	8	12	12	10	11	2.1
Stern Trawler	10	8	6	7	1	6	1	8	7	6	1.4
Gill Netter	2	2	4	0	0	0	2	6	4	4	0.9
Total	**75**	**38**	**41**	**23**	**5**	**35**	**50**	**59**	**72**	**49**	**9.9**

[1] One sampling day in the month of survey
[2] Two sampling days in the month of survey
[3] Three sampling days in the month of survey

Fisheries Production

The level of fisheries production in the waters around the site is presented in *Figure 10.4.*

Adult fish catches vary from 400 – 600 kg ha^{-1} and 200 – 400 kg ha^{-1} within and immediately adjacent to the wind farm site and cable route. In comparison to other areas of the Hong Kong fishing ground, fisheries production to the east of the proposed wind farm site is again relatively high. However, large-scale activities seem to extend around the south and west of Lamma Island with significant fishing areas of high catch value available outside of the wind farm site. Other areas of high fisheries production include areas around Cheung Chau, the Soko Islands, the Ninepin Island Group, Po Toi Island Group and Tap Mun.

Fish Fry Production

As presented in *Figure 10.5*, there is no record of fish fry catches within the proposed wind farm and cable route. Inshore areas at around Lamma Island do however record fish fry production.

Catch Value

The value of catches from the waters around the proposed wind farm is presented in *Figure 10.6.* The overall catch value of both adult fish and fish fry recorded for the waters at the site was in the range of HK$2,000 – 5,000 ha^{-1} and up to HK$ 5,000 – 10,000 ha^{-1}. The value of catches to the east of the proposed wind farm site and along the cable route is relatively high. Again, the value of catches is also high outside of the wind site around Lamma Island. Other areas of high fisheries production include areas around

Port Survey 2006
Distribution of fisheries production (adult fish)
Overall

捕魚作業及生產訪問調查2006
漁產分布(成魚)
總計

捕鱼作业及生产访问调查2006
渔产分布(成鱼)
总计

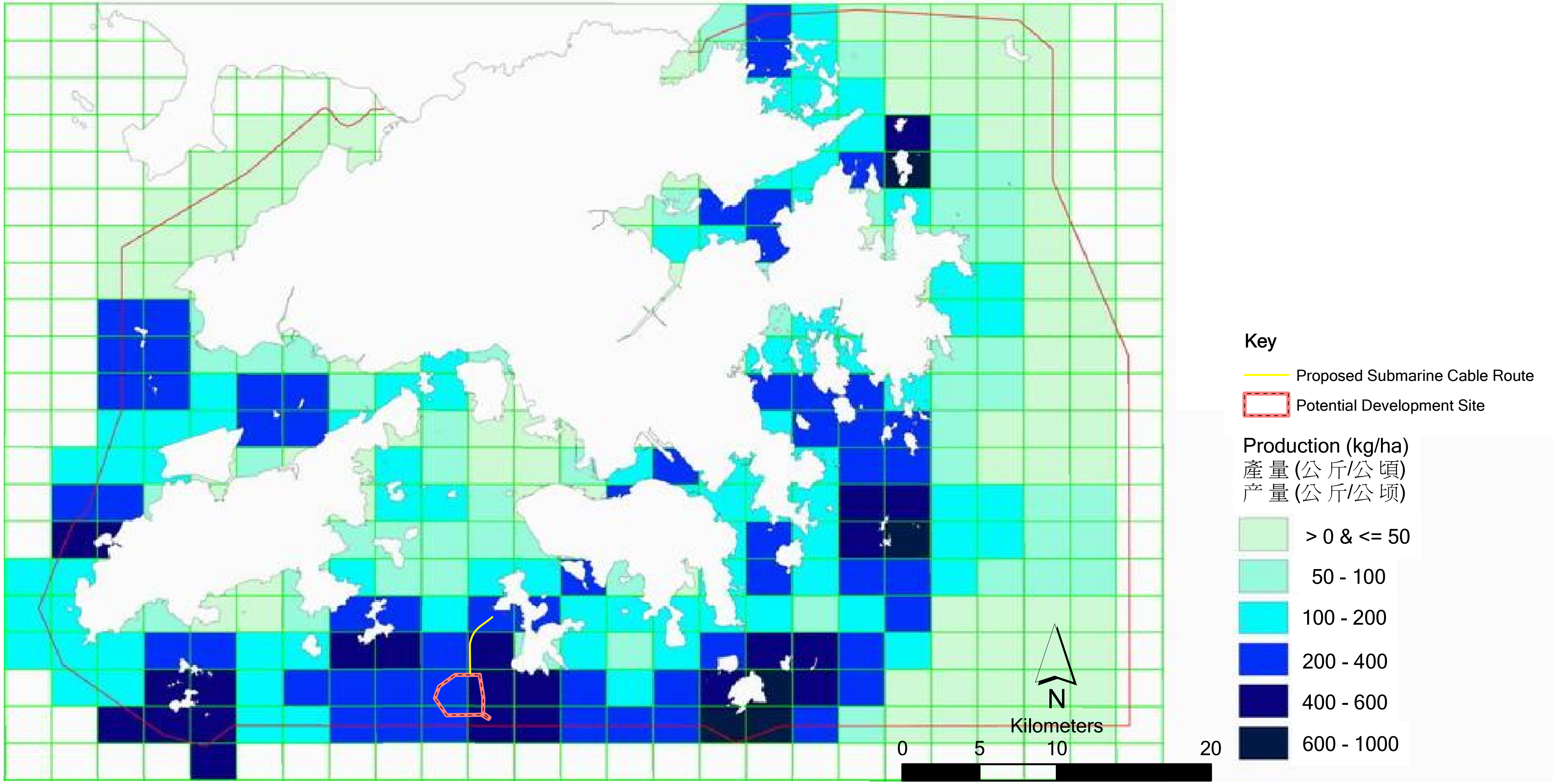

Figure 10.4

Distribution of Fish Production ('Adult' Fish) (kg ha^{-1}) in Hong Kong Waters
as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006

File: 0088440_fish production.mxd
Date: 02/11/2009

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Port Survey 2006
Distribution of fisheries production (fish fry)

捕 魚 作 業 及 生 產 訪 問 調 查 2006
漁 產 分 布 (魚 苗)

捕 鱼 作 业 及 生 产 访 问 调 查 2006
渔 产 分 布 (鱼 苗)

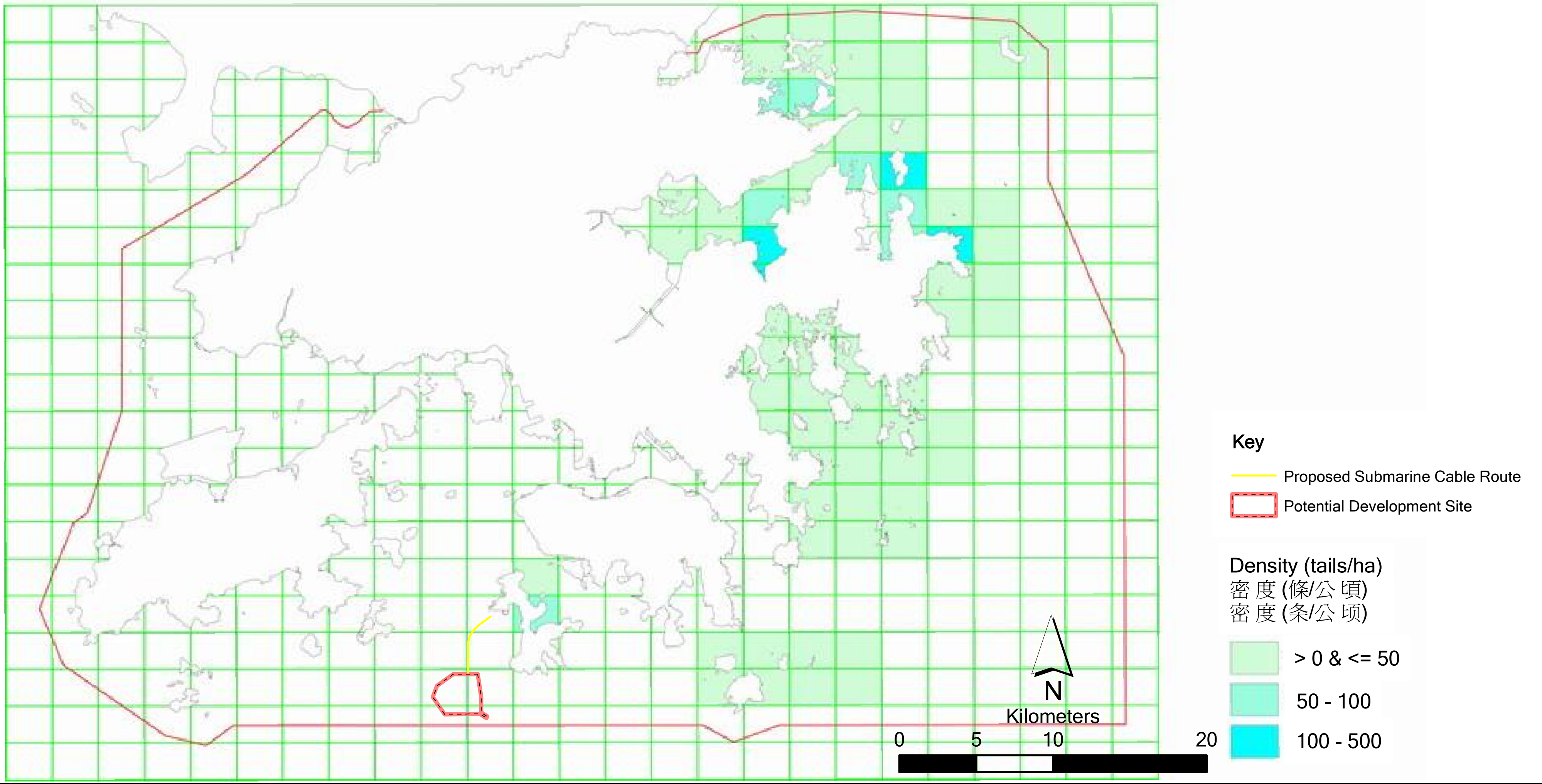

Figure 10.5

Distribution of Fish Fry Production (tails ha^{-1}) in Hong Kong Waters
as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006

File: 0088440_Fish fry production.mxd
Date: 03/05/2009

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Port Survey 2006
Distribution of fisheries production (adult fish & fish fry)
Overall

捕 魚 作 業 及 生 產 訪 問 調 查 2006
漁 產 分 布 (成 魚 及 魚 苗)
總 計

捕 鱼 作 业 及 生 产 访 问 调 查 2006
渔 产 分 布 (成 鱼 及 鱼 苗)
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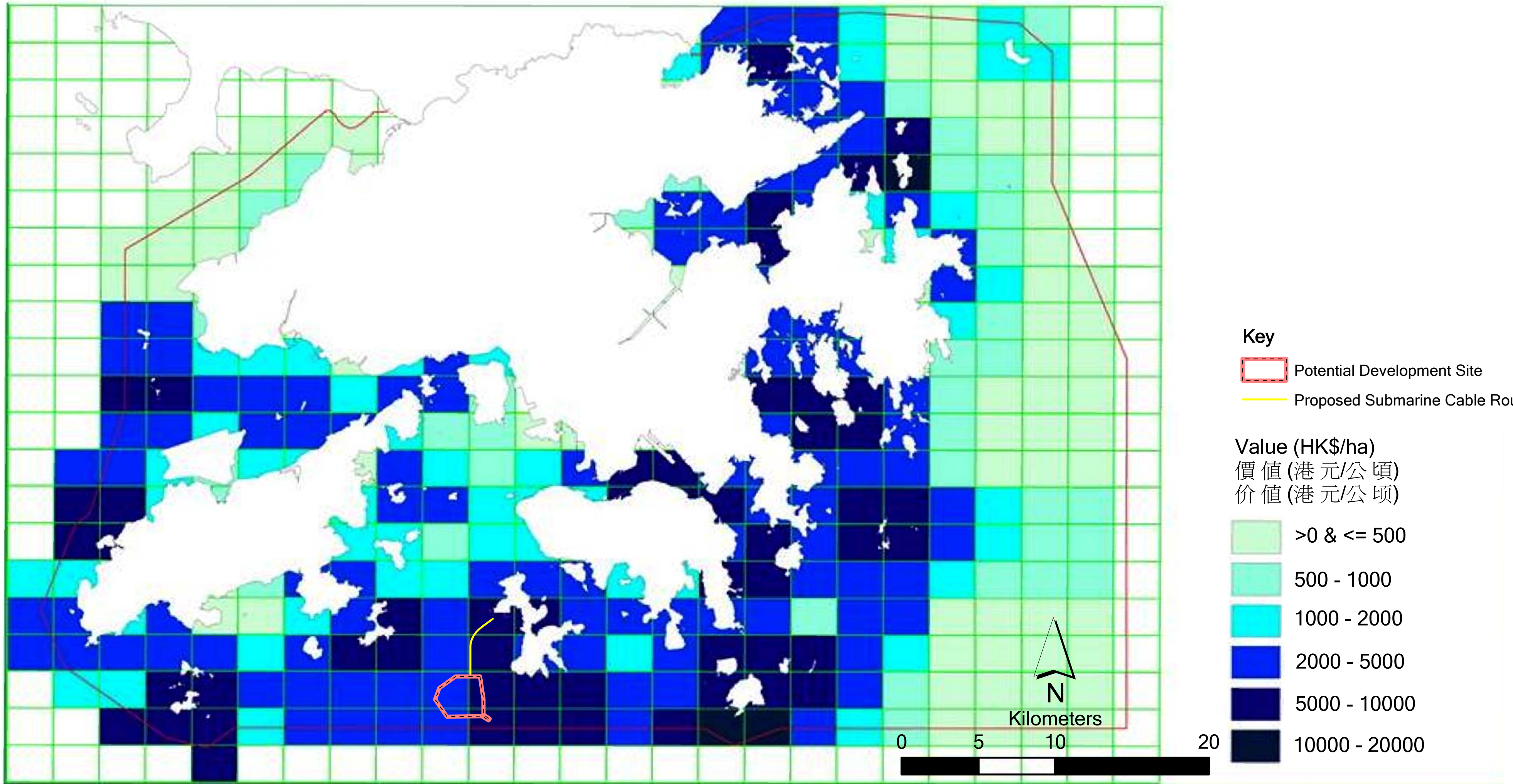

Figure 10.6

Distribution of Fisheries Production Value (Adult Fish and Fish Fry) in Hong Kong Waters
as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006

File: 0088440_fish production adult and fish fry.mxd
Date: 05/05/2009

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Cheung Chau, the Soko Islands, the Ninepin Island Group, Po Toi Island Group and Tap Mun.

Fisheries Resources – Spawning and Nursery Areas

Spawning Area: In 1998, the southern waters of Hong Kong were identified as spawning grounds for commercial fisheries resources. The key fish and crustacean species are *Johnius belengeri* (croaker), *Solenocera crassicornis* (mud shrimp) and *Metapenaeus affinis* (shrimp) (1). The majority of commercial species recorded in Hong Kong aggregate and spawn in the open waters during the period from June to September (1).

The proposed Southwest Lamma wind farm site is located within the Southern Waters fish spawning area. The proposed wind farm site encompasses a 600 ha area, which coincides with a small fraction (2.72%) of the previously identified spawning area (22,000 ha).

Nursery Area: Nursery areas in Hong Kong waters that are important habitat area for a number of commercial juvenile fish and crustacean species have been previously identified to extend across southern waters from Lantau Island to Lamma Island (1). The waters near Lamma Island were previously identified in 1998 as an important habitat area for a number of commercial juvenile fish and crustacean species including *Metapenaeopsis barbata* (prawn), *Metapenaeopsis palmensis* (prawn), *Oratosquilla* spp. (mantis shrimp), *Oxyurichthys tentacularis* (goby), Sciaenid fry and Serranid fry. Juvenile fish species have been recorded in all seasons. *Metapeneaopsis palmensis* was dominant during spring, summer and autumn, while *Thrissa kammalensis* and *Oryurthys tentacularis* commonly found in winter. High abundance of Squilla fry has also been reported in south Lamma waters during the autumn. The proposed wind farm site encompasses a 600 ha area Southern Waters nursery grounds, which coincides with a small fraction (2.72%) of the previously identified nursery grounds (22,000 ha).

Fisheries Importance

The importance of the fisheries resources within the Study Area is addressed based on the baseline information provided above. The fishing areas within and adjacent to the wind farm site are of medium-high commercial value.

The *EIAO-TM (Annex 9)* states that spawning and nursery grounds can be regarded as an important habitat type as they are critical to the regeneration and long-term survival of many organisms and their populations. However, as shown by the Port Survey data there are no recorded fish fry catches in the Project area. In addition, the area of marine waters within the wind farm site represents a small fraction of identified spawning and nursery grounds in

(1) ERM (1998). *Op. cit.*

Hong Kong, which have been reported to encompass the majority of Hong Kong southern territorial waters [1].

The impact assessment is concerned with fisheries activity in Hong Kong waters only. As discussed in *Section 10.3.1*, the majority of the fish catches by Hong Kong fishers occur in waters outside Hong Kong on the traditional fishing grounds over the continental shelf of the South China Sea and these areas will not be affected by the proposed works. Consideration on the magnitude of effects therefore needs to take account of the fact that Hong Kong waters are not of major importance for the overall capture fisheries industry in Hong Kong.

10.4 *FISHERIES IMPACT ASSESSMENT METHODOLOGY*

A desktop literature review was conducted in order to establish the fisheries importance of the area surrounding the proposed wind farm and cable route. This was supplemented by opportunistic fishing vessel observations undertaken in parallel with marine mammal and bird surveys. However, desk-top literature is seen as the primary data for determining impacts.

The importance of potentially impacted fishing resources and fisheries operations identified within the Study Area was assessed using the approach described in the *EIAO-TM*. The potential impacts due to the construction and operation of the Project and associated developments were then assessed (with reference to the *EIAO-TM Annex 17* guidelines) and the impacts evaluated (with reference to the criteria in *EIAO-TM Annex 9*).

10.5 *IDENTIFICATION OF FISHERIES IMPACTS*

10.5.1 *Construction Phase*

The construction activities associated with the proposed Project that have the potential to cause impacts to fisheries are:

- Installation of wind turbine and wind monitoring mast foundations; and
- Installation of the submarine cables.

Construction phase impacts to fisheries resources and fishing operations arising from the construction works of the proposed wind farm may be divided into those due to direct disturbances to that habitat and those due to indirect perturbations to key water quality parameters and underwater sound.

Direct Impacts

Disturbance of seabed habitats

The construction of the seabed foundations will lead to the disturbance of 0.16 ha of marine habitat. Although installation will also result in disturbance of seabed through scour protection, these areas will be reinstated as habitat for fisheries resources prior to operation hence are only considered to be a temporary loss. The seabed at the wind farm site is common to Hong Kong and the disturbance will not lead affect unique habitat that is important to fisheries.

Though a larger area of the seabed is impacted by the dredging and jetting activities for cables installation, it is expected that the temporary nature of the interference will not cause significant impacts on the fishery resources and fishing operations. In addition, fisheries resources are expected to return to the area following the cessation of cable installation activities.

Due to the small area of the marine habitat disturbed in comparison to available habitat elsewhere of similar or equal fisheries importance, impacts to local fisheries resources are considered to be of minor significance.

Access to the site

During construction, the offshore working area will need to be established and marked in accordance with *Marine Department Notice No. 23* (2009). A safety / exclusion zone of 500 m will be closed to all vessels around the area of works. The purpose of this area will be to protect the safety of construction plant and personnel and also third parties who may wish to navigate through this area. This safety zone will cover the whole wind farm area, but the extent of the safety zone will change as per the rolling construction programme. The imposition of the safety zone will mean that fishing activity will be excluded from these areas whilst construction is ongoing. These impacts will, however, be short term and be related to relatively small areas where works will be undertaken. In addition, the level of fishing activity within the majority of the areas where works will take place is not high and there is suitable habitat away from these areas for similar activities to take place. Impacts are therefore considered to be of minor significance.

Increased Vessel Traffic

The construction of the wind farm and cable route will require the use of marine vessels, including a jack-up barges, tug, safety vessel and personnel transfer vessel. This will increase traffic flow in the area with the potential for increase collisions risk. However, the development of a safety / exclusion zone 500 m from any area of works and other notifications as set out in *Section 10.7* will mean that increased risk of collision will be very low.

Indirect Impacts

Indirect impacts to fisheries resources and fishing operations during the construction phase are primarily associated with the suspension of sediments due to the marine works. Potential impacts to water quality from sediment release are listed below:

- Increased concentrations of suspended solids (SS);
- Decrease in dissolved oxygen (DO) concentrations;
- Increase in nutrient concentrations in the water column;
- Potential for contaminant release; and
- Underwater sound generated from marine construction activities.

Suspended Solids: Suspended solids (SS) fluxes occur naturally in the marine environment; consequently, fish have evolved behavioural adaptations to tolerate changes in SS load (e.g., clearing their gills by flushing water over them). However, the increase in suspended solids concentrations that would arise from the foundation installation, jetting and dredging would be uncharacteristic of the normal variable marine conditions. Beyond the active construction areas, dispersion will cause a rapid decrease in the suspended solids concentrations.

Larvae and post-juvenile fish are more susceptible to variations in SS concentrations than more mature fish since their sensory system is less developed. Adult fish are more likely to move away when they detect sufficiently elevated suspended solids concentrations and therefore are unlikely to be significantly impacted. Larvae and post-juvenile fish are more likely to be impacted as they may not be able to detect and avoid areas with elevated levels of SS.

The SS level at which fish move into clearer water is defined as the tolerance threshold and varies from species to species at different stages of the life cycle. If SS levels exceed tolerance thresholds and the fish are unable to move away from the area, the fish are likely to become stressed, injured and may ultimately die. Susceptibility to SS generally decreases with age such that eggs are the most vulnerable and adults the least sensitive to the effects of high SS concentrations. The rate, timing and duration of SS elevations will influence the type and extent of impacts upon fish and potentially crustaceans [(1)]. Literature reviews indicate that lethal responses had not been reported in

(1) The Shrimp Fishery of the Gulf of Mexico – A regional Management Plan, Gulf Coast Research Laboratory, 1977

adult fish at values below 125 mg L^{-1} (1) and that sublethal effects were only observed when levels exceeded 90 mg L^{-1} (2).

Modelling has show that temporarily elevated levels of SS are likely to occur as a result of marine construction works. However, the largest impacts are expected in the immediate vicinity of the marine construction works (in the mixing zone) with impacts on the wider marine environment are expected to be very low or nil (see *Table 6.9* in *Section 6.6.1*). Grab dredging works would only lead to increased suspended sediments directly adjacent to the Lamma Power Station Extension over two days. Indeed, no impacts from dredging are noted within an area of approximately 1km of dredging works. Although, the Lamma Power Station Extension seawall supports some isolated coral colonies, these are of low conservation value and are not expected to act as important spawning or nursery grounds. For dredging activities, elevated SS levels only occur in the localised mixing zone and do not extend far beyond this point (see *Table 6.9* in *Section 6.6.2*). Very minor impacts were noted in open water adjacent the cable route and around the nearshore zones of Lamma Island and Cheung Chau no increases in SS were recorded. Again, for foundation construction works, impacts were seen to be very localised and transient. No impacts on FCZs are predicted related to any of the construction activities.

Sediment testing has also determined that unacceptable water quality impacts due to the release of heavy metals and organic micro-pollutants associated with suspended sediments will not occur (see *Section 6.6.5*).

Negligible impacts on fisheries associated with increased SS are therefore expected.

Dissolved Oxygen: The relationship between SS levels and DO is complex. However, in general, elevated SS (and turbidity) reduces light penetration, lowers the rate of photosynthesis by phytoplankton (primary productivity) and thus lowers the rate of oxygen production in the water column. Furthermore, the potential release of sediment contaminants into the water column has the potential to consume DO in the receiving water. The resulting overall DO depletion may cause an adverse effect on the eggs and larvae of fish and crustaceans, as at these stages of development high levels of oxygen in the water are required for growth to support high metabolic growth rates.

The results of the water quality assessment (see *Section 6*) examining dispersion of sediment plumes associated with the proposed marine construction works have shown that the predicted elevated levels of SS are minor, localised to the mixing zone and transient. The calculation of

(1) References cited in BCL (1994) *Marine Ecology of the Ninepin Islands* including Peddicord R and McFarland V (1996) *Effects of suspended dredged material on the commercial crab, Cancer magister* in PA Krenkel, J Harrison and JC Burdick (Eds) Dredging and its Environmental Effects. Proc. Speciality Conference. American Society of Engineers.

(2) Alabaster JS & Lloyd R (1984) Water Quality Criteria for Freshwater Fisheries. Butterworths, London.

associated depletion in DO showed that levels would comply with the WQO at all sensitive receivers for all construction scenarios (see *Section 6*). Unacceptable impacts to fisheries from the reduction of DO concentration are not expected to occur.

Nutrients: High levels of nutrients in seawater can cause rapid increases in phytoplankton, on occasions to the point where an algal bloom occurs. An intense bloom of algae can lead to sharp decreases in the levels of dissolved oxygen. This decrease will initially occur in the surface water, and then deepen as dead algae fall through the water column and decompose on the seabed. Anoxic conditions may result if DO concentrations are already low or are not replenished. As discussed above, reduced levels of DO can impact the eggs and larvae of fish and crustaceans which require high levels of oxygen for development. Significantly low levels of DO may also result in mortality to fish.

The assessment of potential increases in nutrient levels resulting from construction activities is discussed in *Section 6*. The results show that increases are predicted to be very small with maximum increases in Total Inorganic Nitrogen (TIN) calculated as being 0.0031 mg L^{-1} and unionised nitrogen (NH_3-N) calculated as being 0.01885 mg L^{-1}. The increased levels of nutrients in the water column as a result of works are considered to be of negligible significance for fisheries.

Contaminant Release: Another potential impact on fisheries resources associated with disturbance of bottom sediment is the release of potential toxic contaminants. The potential for release of contaminants from dredged sediments has been assessed in *Section 6*, whereas, a comprehensive set of data on the quality of marine sediment is provided in *Section 7.* Elutriate tests that have been carried out in the area of grab dredging show that dissolved metal concentrations for all samples are below the reporting limits. The results also show that all PAHs and PCBs and chlorinated pesticides are all below the reporting limits. This indicates that the leaching of these pollutants is unlikely to occur. Impacts on fisheries resources due to bioaccumulation of released contaminants from dredged sediments are therefore not expected to occur.

Underwater sound: Intermittent sounds, which occur during activities such as piling, dredging, jetting and marine vessel movement, may have an impact on fish during the construction phase. The level of impact is dependent upon background noise, number of fish present, type of species affected, attenuation properties of seabed sediments etc. Percussive piling activity is likely to create the greatest amount of underwater sound of the proposed marine construction works that are being considered for this Project.

The area around the wind farm site has been identified as being subject to relatively high levels of shrimp trawling activity. In general, there is little information on the effects of underwater sound on marine invertebrates.

However, shrimp do not possess air filled spaces. They therefore can only perceive sound as a physical force through external senses. It is therefore generally considered that sound would have limited physiological or behavioural effects on marine invertebrates, except if they are located within a few metres of the sound source.

The impact of underwater sound generation from construction activities on fish is highly dependent upon the hearing capabilities of the different species present in the area, with the hearing specialists being of greatest concern. Effects of increased underwater sound could include physiological stress, avoidance and injury (at high pressure levels). The significance of these effects is dependent upon the proximity of fish to the sound source. The potential for injury can be avoided by adopting appropriate mitigation to promote movement away from the area where works are being undertaken before any injury can occur. Such mitigation, would include for example, soft-start or ramp-up approaches for piling activity (slowly increasing the energy of the emitted sound) (see *Section 10.7*).

The proposed works are a significant distance from any FCZs so effects in these areas are likely to be very small. The proposed offshore wind farm is also located in open waters and is not in area that is thought to be unique or important habitat for fish in Hong Kong. It is therefore unlikely that there will be a large aggregation of fish in the local area due to important habitat features.

Species that are most sensitive to the generation of sound are likely to instinctively avoid the area once works commence. If avoidance of the area by fish were to occur during works, it is likely that fish would be temporarily displaced to other local areas where similar habitat conditions are present. Impacts will also be very short term in nature with pulses of underwater sound followed by quick returns to be background levels.

Mitigation measures to reduce potential for impacts from underwater sound include the adoption of soft start to promote avoidance of the area in proximity to piling activities. Through these measures impacts on fish are considered to be of minor significance.

10.5.2 *Operational Phase*

The potential impacts of the Operational Phase of the Project on the fisheries of the Study Area and the sensitive receivers can be divided into six main categories:

- Permanent loss of fisheries habitat;
- Long term changes in benthic habitat;
- Changes in fishing pressure;

- Impacts associated with the presence of cables and structures; and
- Underwater sound impacts associated with operational turbines.

Loss of Fisheries Habitat

It is expected that the direct impacts to fisheries resources and fishing operations include the permanent loss of 0.16 ha of habitat. This represents 0.0001% of Hong Kong territorial waters (165,000 ha).

The seabed at the wind farm site is common to Hong Kong and the disturbance will not affect unique habitat that is important to fisheries. The seabed is largely uniform and comprises muddy seabed with little habitat diversity. The seabed does not offer any areas for shelter for fish. Although the Port Survey 2006 data would suggest that the eastern edge of the wind farm site is subject to relatively high fishing activity, the opportunistic fishing vessel sightings data collected in 2008 and 2009 revealed that activity is lower than previously recorded. In addition, it is likely that any loss to habitat would be offset by fish aggregation and increased productivity due to the 'artificial reef' effect during the operational phase (see below).

As discussed in *Section 5*, an operational safety zone of 50 m radius will be in force from the substation, turbine and monitoring mast. This will apply to non-Project vessels throughout the operational period regardless of other exclusion arrangements. However, the exclusion of fishing activities within the wind farm area (see below) means that this will lead to no additional impact for fisheries.

As is common with offshore wind farms, no fishing activity will be allowed within the wind turbine array or within 500 m of any turbine, offshore substation or offshore monitoring mast (1) (2) (3). The overall area lost for fishing activity will, therefore, be approximately 700 ha, which represents 0.42% of Hong Kong territorial waters. Although the eastern edge of the wind farm is considered to be of relatively high importance for fisheries and particularly trawling activity the magnitude of impacts is considered to be small in the context of similarly important fisheries habitat adjacent to the site and elsewhere in Hong Kong that is available for fisheries activity. The loss of fishing area is therefore considered to be of moderate significance.

(1) GE Energy (2002). Gunfleet Sands Offshore Wind Farm Environmental Statement. GE Gunfleet Ltd.

(2) Airtricity (2005). Greater Gabbard Offshore Wind Farm – Environmental Statement. Image provided by Global Scour Control Systems Ltd.

(3) Hong Kong Offshore Wind (2009). Hong Kong Offshore Wind Farm in Southeastern Waters – Environmental Impact Assessment. Reference: ESB-146/2006 Issue 3. May 2009.

Long Term Changes in Benthic Habitat

The existing seabed comprises soft muddy sediments (see *Section 7*). The wind turbine support structures and scour protection (if used) will provide hard substrate habitat in the wind farm area.

These structures could be colonised by a variety of marine organisms. There is considerable knowledge in Hong Kong and elsewhere on the colonisation of marine structures with species such as seaweeds, crustaceans, soft corals, amphipods, anemones and more mobile fauna including crabs. Studies on offshore wind farm structures at Horn's Rev offshore wind farm in Denmark and offshore monitoring mast at North Hoyle offshore wind farm in the UK noted that colonisation of structures occurred within five months with bryozoans, sea anemones, sea squirts, starfish and mussels present [(1)]. It is expected that rock scour would give higher surface complexity than monopiles providing nooks and crannies between individual rocks, which would increase the attractiveness to colonising organisms. Indeed, since 1996, AFCD have been implementing an artificial reef programme in Hong Kong marine waters to improve marine organism biomass and diversity in these areas. Artificial reefs deployed in Hong Kong waters as part of this programme haven taken various forms, including vessels, used-tyres, concrete units and redundant marine structures.

Colonisation of these structures could provide long term benefits associated with the attraction of fish and marine invertebrates (including shrimp) into the area. This could offset the loss of habitat discussed above. Indeed, this 'artificial reef' effect could lead to enhanced fishery resource in this area due to the aggregation of reef fish and attraction of other species into the area. It is also possible that production may increase in the area rather than just an aggregation of existing biomass. The increased number of fish attracted into the area could be of moderate significance for fishery activities adjacent to the wind farm site.

Changes in Fishing Pressure

The reduction in fishing pressure within the turbine array may have a positive impact for commercially exploited stocks and allow for the attraction of larger fish into the area. In particular, losses to juvenile fish will be reduced providing improved fishery resources within and adjacent to the wind farm area. This could have a beneficial impact of moderate significance for fisheries.

Presence of Cables and Structures

The wind farm structures could present increased risk of collision for fishing vessels compared to the existing situation. However, the spacing of turbines,

(1) Airtricity (2005). Greater Gabbard Offshore Wind Farm – Environmental Statement. Image provided by Global Scour Control Systems Ltd.

size of fishing vessels and inclusion of appropriate navigation lighting will mean that risks are low (*see Section 10.7).* It is concluded that the impact of the turbines structures on hydrodynamic processes is low and very localised (see *Section 6*) and these changes will not affect fisheries.

The restriction of fishing activities in the wind farm area will mean that there will be no additional concern for fishing operations associated with cables and/or the placement of scour material.

With the adoption of appropriate marking and lighting and, adoption of mitigation set out in *Section 10.7*, impacts are considered to be of negligible significance.

Underwater sound

As wind turbines rotate, vibrations travel down the wind turbine tower and are transmitted into the surrounding water and seabed. The sound generated increases with rotational spin as wind speed increases, but this is likely to be offset by increased natural sources of sound associated with waves etc. The sounds from turbines in operating wind farms tend to be of low frequency and low level. Estimates of sound levels from 3 MW wind turbine units are in the order of 110 dB and will therefore likely be absorbed by background sound. Of note, this is lower than that generated by marine vessels in the area (see above) [(1)]. Underwater sound generated from the wind monitoring mast during operation will be negligible.

It is unlikely that fish will show an avoidance reaction to operational sounds. Monitoring of offshore wind farms and areas around other marine structures with 'noisy' activities, e.g. oil and gas platforms, show the aggregation of fish during their operation. This shows that fish will habituate to a low level of underwater sound in a short space of time.

10.6 ASSESSMENT OF ENVIRONMENTAL IMPACTS

From the information presented above, the fisheries impact associated with the Project is not considered to be significant and is considered to be in compliance with *Annex 9* of the *EIAO-TM* as presented below.

- *Nature of Impact*: The nature of potential environmental impacts has been summarised above in *Section 10.5*.
- *Size of Affected Area:* The wind farm development will lead to a maximum loss of 0.16 ha of seabed habitat for the foundations installation. Other areas, e.g. those for scour protection, will be reinstated prior to operation. Approximately 700 ha of habitat will be lost to fishing activity.

(1) Airtricity (2005). Greater Gabbard Offshore Wind Farm – Environmental Statement. Image provided by Global Scour Control Systems Ltd.

- *Loss of Fisheries Resources/Production:* Fisheries resources and production rates within the Study Area range from medium to high in terms of catch weight and value, when compared to other areas in Hong Kong. However, only a small part on the eastern edge of the wind farm would be considered to be of relatively high value. However, the opportunistic fishing vessel sightings data collected in 2008 and 2009 would suggest that activity is lower than previously recorded. The scale of fisheries resource and production is not considered to be significant in terms of the amount of similar fishing habitat available elsewhere in Hong Kong, including areas immediately adjacent to the wind farm area.

- *Destruction and Disturbance of Nursery and Spawning Grounds: T*here are no recorded fish fry catches in the Project area and the area of marine waters within the wind farm site represents a small fraction of identified spawning and nursery grounds, when compared to the majority of Hong Kong southern territorial waters. The scale of destruction and disturbance to these grounds is therefore not considered to be significant.

- *Impact on Fishing Activity:* Due to the temporary nature of the construction activities and the small area of affected seabed, the adverse impacts on fishing activities arising from construction are expected to be of minor significance. During operation phase, the loss of approximately 700ha of habitat available for fishing may affect local fishermen, specifically those who habitually fish in the project area. Nevertheless, the potential for increased fish production and aggregation through the provision of new hard substratum and protected waters within in the wind farm area during the operational phase may lead to overall benefits for fisheries.

- *Impact on Aquaculture Activity:* No impact has been identified as fish culture zones are too remote to be affected by the works.

In view of the scale of impacts affected no significant impacts are expected to be associated with the construction or operation of the proposed offshore wind farm.

10.7 MITIGATION MEASURES

10.7.1 General Measures

In accordance with the guidelines in the *EIAO-TM* on fisheries impact assessment, the policy adopted in this EIA for mitigating impacts to fisheries, are:

- **Avoidance:** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives;

- **Minimisation:** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as confining works in specific area or season, restoration (and possibly enhancement) of disturbed fisheries resources and habitats;

- **Compensation:** When all possible mitigation measures have been exhausted and there are still significant residual impacts or when the impacts are permanent and irreversible, consideration shall be given to off-site compensation. It may include enhancement of fisheries resources and habitats elsewhere.

The main works have been designed to control water quality impacts to within acceptable levels and are hence are expected to control and minimise impacts to fisheries resources. Risks during the construction phase will be minimised by adopting the following measures:

- The use of competent and experienced contractors and vessels operators;
- Good planning of the installation sequence to avoid possible clashes;
- Good promulgation of information relating to construction activities;
- Thorough auditing of all vessels;
- Observing good industry construction practices by the Contractors; and,
- Surveying of the 'as-laid' cable positions and having good quality position fixing/surveying systems available;

Other best practice measures that will be adopted for the development of the offshore wind farm will include informing fishermen of possible developments in advance.

Specific measures that relate to navigation risks are discussed below for the construction and operational phases.

10.7.2 *Underwater Sound Measures*

As stated above, piling activities are of greatest concern for the generation of underwater sound. A number of mitigation measures are therefore proposed to control and reduce the amount of underwater sound generated by the works. These measures are listed below:

- Using good engineering practice, including the use of appropriately sized piles (smaller piles generate lower levels of underwater sound) and piling equipment; and
- Using ramp-up piling procedures. This comprises of low energy driving for a period of time prior to commencement of full piling. This will promote avoidance of the area by fish when sounds levels are not injurious. Blow frequency during this ramping up period should replicate the intensity that would be undertaken during full piling (e.g.

one blow every two seconds) to provide cues for fish to localize the sound source. Pile blow energy should be ramped up gradually over the 'soft start' period.

10.7.3 *Vessel Navigation Measures*

As discussed in *Section 10.5* the presence of wind turbine, offshore substation and offshore monitoring mast structures presents a navigation risk to fishing vessels, particularly as passage will be allowed for non-fishing vessels. In order to ensure that risks are acceptable, a range of key mitigation measures have been identified. Although these mitigation measures apply to the assessment of impacts on fishing vessels as required by the *Study Brief*, these measures will also mitigate impacts on other types of vessel.

Construction Phase

Position and Layout of the Offshore Wind Farm

The site selection process discussed in *Section 3* has ensured that the proposed offshore wind farm development area is located in an area of relatively low risk for navigation. This has been confirmed by the results of field survey. In addition, a geometric layout design has been adopted, which eases navigation between structures and reduces collision risk in times of low visibility.

Existing Safety Procedures

Marine traffic in Hong Kong is subject to a ranged of safety procedures that are governed by the Marine Department of the Hong Kong Government. The continued adoption of these measures by all fishing vessels using the waters in proximity to the wind farm site will ensure that appropriate navigation control procedures are adopted.

Notification, Communications, Site Protection and Marking

It is considered that the most effective measures to reduce the potential risk to fishing vessels is the adoption of appropriate notification, communications, site protection and marking.

The relevant authorities will be notified of activities in the wind farm area during construction activities, including dates of any works. In addition, the Marine Department will be notified of the final location of the wind farm structures so that these can be updated on marine charts. All vessels engaged in construction activities will be equipped with a Maritime VHF radio and an agreed frequency channel maintained.

Consideration will also be given to the use of a Guard Ship during the construction phase, particularly in periods of high activity.

A safety / exclusion zone of 500 m from any area of construction works will be established for all non-Project vessels. The working area will be marked in accordance with Marine Department Notice No. 23 (2009). All vessels involved in the construction works will show the correct lights and shapes and ensure that all movements are promulgated through the Marine Department. In addition, there will be temporary lighting of incomplete structures (see discussion of lighting and marking under operational mitigation measures below).

Operational Phase

The wind farm will be marked according to the requirements of the Marine Department. It is expected that the precise marking arrangement will be agreed during the Detailed Design Phase. However, as set out in *Section 5*, the corner turbines will have yellow flashing Morse 'U' code lights (5 second interval) visible for 5 nautical miles (9.3 km), located at least +12 mPD with radar reflectors situated beside them. The intermediate (mid-way) lights will flash at 2.5 seconds and will be visible for 2 nautical miles (3.7 km).

The above markings will need to be maintained at all times and should failure occur, the Marine Department should be notified immediately and repairs undertaken as soon as possible.

Any changes to the site will be notified to the Marine Department for alteration to marine charts and/or notices to mariners.

In addition, to the above, as stated in *Section 5*, a 50 m safety zone will be adopted around each structure for non-project vessels.

10.8 FISHERIES ENHANCEMENT PLAN

For the assessment in this EIA, it has been assumed that all fishing activities will be excluded from inside the development area of the wind farm, including a 500m and 50m buffer around each turbine during construction and operation phases, respectively. Whilst the implementation of such safety zones follow standard international practice for wind farms, it is also noted that the need for the zone should be reviewed as part of ongoing fisheries management measures to determine whether it is advisable (from an environmental and marine safety perspective) within the lifetime of the wind farm to re-introduce specific fishing practices, or otherwise develop the area further to enhance fisheries resources.

To this end, a review of Fisheries Review and Consultation Programme (FRCP) will be implemented no later than the commencement of the installation of the wind turbines. The general intention of the FRCP will be to outline, in consultation with the fishery sector, whether there is scope for fishing operations to be conducted within the development area. A secondary objective of the FCRP will be to explore the possibilities of additional measures/projects to be undertaken within the development area for the enhancement of fisheries resources.

If deemed acceptable, a Fisheries Enhancement Plan (FNP) will be developed for the wind farm area. It is envisaged the FNP may follow the Food and Agriculture Organisation of the United Nations (1) definition for responsible fisheries management, which should be an:

"… integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives."

Based on the above objective for the FNP, general goals that could be considered for the Southwest Lamma site may be as follows:

1. To set up objectives for fisheries within and in proximity to the proposed site, potentially taking into account the known biological characteristics of the resources, the nature of existing or potential fisheries and other activities related to or impacting the resources and the potential economic and social contribution of the fishery to local needs and goals within Hong Kong;

2. To determine and implement potential actions necessary to enable HK Electric, the local fishermen and other interest groups, to work towards the identified objectives. This task could be done in consultation with necessary interest groups. Actions could include those working towards a goal that the resources, the ecosystems in which they occur and their environment are maintained in a productive state no less than they were prior to works. Subsequently, where possible, considerations could also include the development of fisheries enhancement programme such as deployment of artificial reefs;

3. To have an FNP that is adaptable to changing circumstances (in the surrounding environment / fishery). In consultation with stakeholders, including the fishery sector and AFCD, review the management objectives and measures to verify that they are still appropriate and effective.

4. To report to stakeholders on the state of resources and management performance.

It is noted that the above goals and objectives are considered to be preliminary and conceptual in nature and will be reviewed further during the development of the FNP.

(1) FAO Fishery Resources Division and Fishery Policy and Planning Division. Fisheries management. FAO Technical Guidelines for Responsible Fisheries. No. 4. Rome, FAO. 1997. 82p.

It is also considered that several entities may likely be integral to achieving the goals of the FNP. It is possible that such parties may include Hongkong Electric, fisheries specialists, the fishery sector / NGOs and AFCD.

10.9 ENVIRONMENTAL MONITORING AND AUDIT (EM&A)

10.9.1 *Construction Phase*

As no unacceptable impacts have been predicted to occur during the construction of the wind farm, monitoring of fisheries resources during the construction phase is not considered necessary. There will be a need to ensure that the seabed affected by the cable installation works has restored to its original configuration to prevent impacts from occurring to fishing operations.

10.9.2 *Operation Phase*

As no unacceptable impacts have been predicted to occur during the operation of the windfarm, monitoring of fisheries resources during the operation phase may be designed as part of the FNP to be developed. Nevertheless, as part of the FCRP, it is recommended that the need for fisheries resources monitoring will be consulted with relevant stakeholders and will be confirmed.

10.10 RESIDUAL ENVIRONMENTAL IMPACTS

The identified residual impact occurring during the construction phase is the permanent loss of a maximum of 0.16 ha of seabed. In addition, 700 ha of fishing area will be lost to fisheries activity during the operation of the wind farm. The adoption of appropriate mitigation measures to manage navigational risks will also mean that the risk to fishing vessels would be low. The offshore marine structures and scour protection would provide long term benefits with respect to the creation of an 'artificial reef'. The reduced fishing pressure could also lead to a long term increased fisheries resources within and adjacent to the wind farm area. On this basis, it is considered that the construction and operation of the wind farm would not result in negative but potentially positive residual impacts to fisheries.

10.11 CUMULATIVE IMPACTS

The identified potential concurrent projects that could lead to cumulative water quality impacts are the marine dumping activities at the South Cheung Chau uncontaminated mud disposal site. The key cumulative impacts associated with mud disposal and activities being proposed for this Project would be related to construction impacts on water quality. As discussed in Section 6, it anticipated that the works proposed for this Project would not lead to potential for increasing the loading of sediments within the wider marine environment that is associated with the uncontaminated mud disposal ground. No significant cumulative impacts associated with water quality are therefore expected.

10.12 CONCLUSIONS

A review of existing information on commercial fisheries resources and fishing operations surrounding the waters adjacent to the proposed wind farm and cable route has been undertaken. Information from a study on fishing operations in Hong Kong and the AFCD Port Survey 2006 indicate that fisheries production values in the vicinity of the assessment area are medium to high. However, only a small part on the eastern edge of the wind farm would be considered to be of relatively high value. Opportunistic vessel sightings data collected in 2008 and 2009 would suggest that fishing activity is lower than previously recorded. The habitat in the wind farm area and along the cable route is not considered to be unique and significant areas of equal importance are located adjacent to the wind farm site and elsewhere in Hong Kong. Fish culture zones are too remote to be affected by the construction and operation of the wind farm.

Potential impacts to fisheries resources and fishing operations will arise from the permanent loss of a maximum of 0.16 ha muddy seabed habitat due to installation of foundations. In addition, there will be approximately 700 ha of fishing grounds lost due to the exclusion of fishing vessels from the wind farm area. This area encloses the area of seabed habitat that will be lost in the footprint of wind farm structures. No unacceptable impacts associated with the loss of fisheries habitat and fishing ground during construction and operation of the wind farm is expected to be anticipated.

Impacts arising from the proposed jetting/dredging and foundation construction works are predicted to be largely confined to the specific works areas and the predicted adverse impacts to water quality are expected to be low and transient. In addition, impacts associated with underwater sounds and vessel collision risks during construction are expected to be low.

Significant operational phase impacts to fisheries resources and fishing operations are not expected to occur. The main works have been designed to control water quality impacts to within acceptable levels and are hence are expected to control and minimise impacts to fisheries resources. Other measures that will be adopted for the development of the offshore wind farm will include informing fishermen of possible developments in advance, good engineering practices with regard to the piling activities and measures for navigation such as a geometric design of the wind farm, application of Marine Department safety procedures, notification, communication, site protection and marking, and a safety / exclusion zone during both construction and operation. The adoption of appropriate mitigation measures to manage navigational risks will also mean that the risk to fishing vessels would be low.

Measures also include the implementation of a Fisheries Review and Consultation Programme (FRCP). The general intention of the FRCP will be to outline, in consultation with the fishery sector, whether there is scope for fishing operations to be conducted within the development area. A secondary objective of the FCRP will be to explore the possibilities of additional measures/projects to be undertaken within the development area for the enhancement of fisheries resources. Depending on the outcome of the FRCP, a Fisheries Enhancement Plan (FNP) may be developed for the wind farm area.

CONTENTS

ANNEXES

Annex 11A Community Perception Studies

11 LANDSCAPE AND VISUAL IMPACT ASSESSMENT

11.1 INTRODUCTION

This *Section* presents the Landscape and Visual Impact Assessment (LVIA) for the proposed offshore wind farm.

In accordance with the *EIAO Guidance Note No. 8/2002*, the main components of the LVIA are as follows:

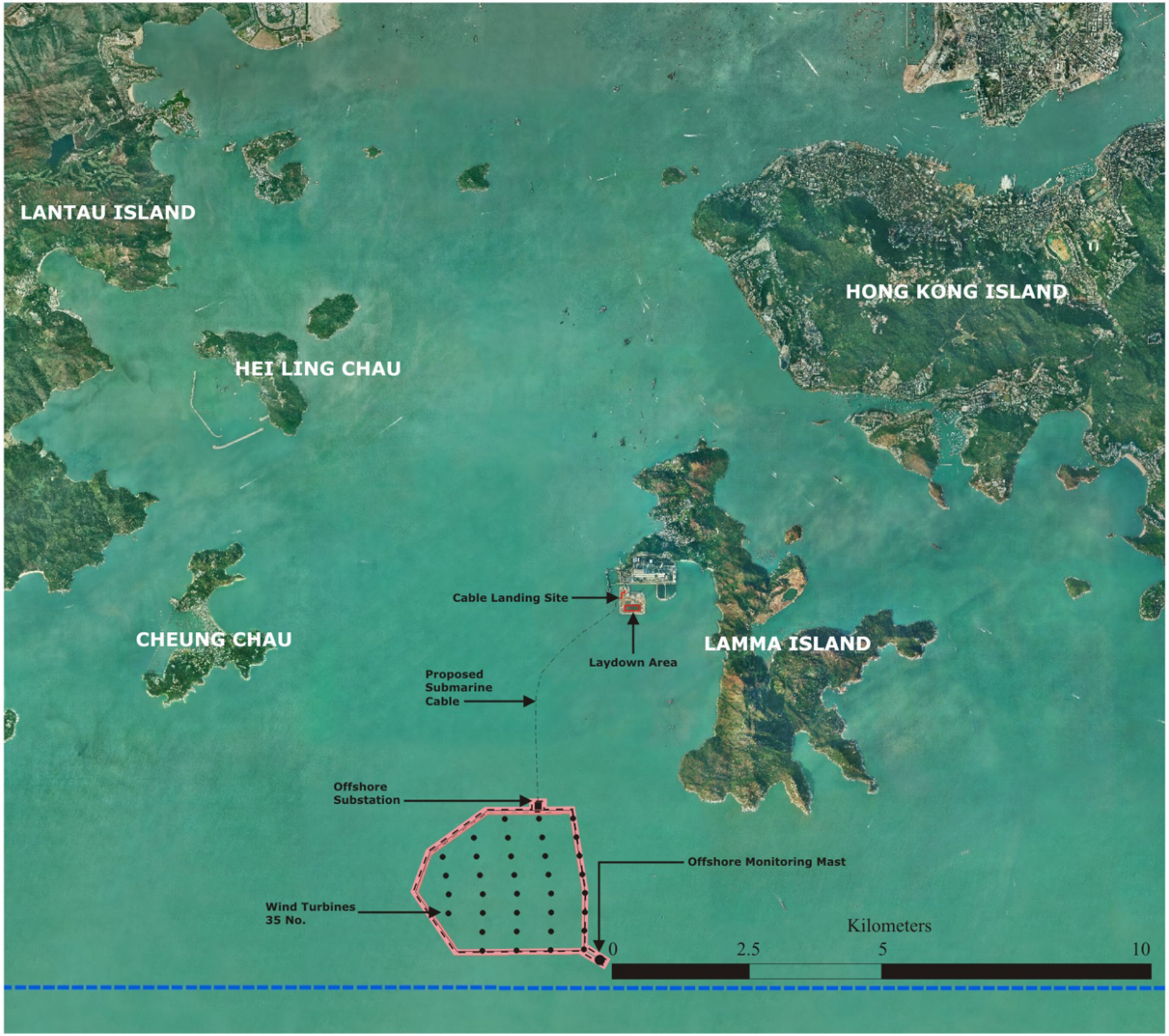
- Description of the Project;
- Review of the planning and development control framework;
- Broad Brush tree survey results;
- Baseline study of landscape character, landscape resources and also visual resources such as key views and the visual character and amenity of the Study Area;
- Landscape impact assessment during construction and operation of the Project;
- Visual impact assessment during construction and operation of the Project;
- Recommendations for landscape and visual mitigation measures for both the construction and operation phases; and
- Assessment of the residual impacts and conclusion on the acceptability of the Project.

11.2 PROJECT DESCRIPTION

The proposed wind farm will comprise the development, installation and operation of an offshore wind farm in Hong Kong waters. The wind farm site would comprise a single array of turbines and associated infrastructure, including submarine electricity cables, monitoring mast and offshore sub-station. During detailed design, the offshore substation may be required to be moved onshore to the Lamma Power Station.

The detailed description is provided in *Section 5* and the proposed location of the Project is shown in *Figure 11.1*.

For the purposes of this assessment, it is assumed that the turbines will be 125m in height. It is possible that larger turbines at a height of 136m may be adopted during the detailed design stage. The viewshed analysis is based on a



Key

- Proposed Wind Farm Location
- Hong Kong SAR Boundary

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Figure 11.1

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maximum height of 136m. While the photomontages have been prepared based on the height of 125m as this would represent the case of having the highest numbers of wind turbine installed within the site boundary and hence represent the worst scenario from visual impact point of view. Nevertheless, it should also be noted that the option of height 125m is the most likely turbine option to be selected.

11.3 LEGISLATION REQUIREMENTS AND EVALUATION CRITERIA

The LVIA was undertaken in accordance with:

- *Forests and Countryside Ordinance* (Cap. 96) and its subsidiary legislation the Forestry Regulations;
- *Town Planning Ordinance* (Cap 131);
- *Animals And Plants (Protection of Endangered Species) Ordinance* (Cap 187);
- *Country Parks Ordinance* (Cap 208);
- *Marine Parks Ordinance* (Cap 476) and associated subsidiary legislation;
- *Environmental Impact Assessment Ordinance* (Cap.499, S.16) and the Technical Memorandum on EIA Process (EIAO TM), particularly *Annexes 10, 11, 18, 20* and *21*;
- *EIAO* Guidance Note 8/2002;
- *Tseung Kwan O Outline Zoning Plan* No.S/TKO/15 (2 November 2004);
- Hong Kong Planning Standards and Guidelines;
- *Work Branch Technical Circular (WBTC*) No. 25/93 - Control of Visual Impact of Slopes;
- *SILTech Publication* (1991) – Tree Planting and Maintenance in Hong Kong (Standing Interdepartmental Landscape Technical Group) [11-23];
- *WBTC* No. 17/2000 – Improvement to the Appearance of slopes in connection with WBTC 25/93;
- *WBTC* No. 7/2002 – Tree Planting in Public Works;
- *ETWB TC (Works)* No. 34/2003 – Community Involvement in Greening Works;
- *ETWB TC (Works)* No. 2/2004 : Maintenance of Vegetation and Hard Landscape Features;

- *ETWB TC (Works)* No. 29/2004 : Registration of Old and Valuable Trees, and Guidelines for their Preservation;
- *ETWB TC (Works)* No. 11/2004 – Cyber Manual for Greening;
- *ETWB TC (Works)* No. 3/2006 - Tree Preservation;
- *Land Administration Office Instruction (LAOI)* Section D-12 – Tree Preservation;
- *Geotechnical Engineering Office (GEO)* publication (1999) – Use of Vegetation as Surface Protection on Slopes;
- *GEO* 1/2000 – Technical Guidelines on Landscape Treatment and Bio-engineering of Man-made Slopes and Retaining Walls;
- *Urban Council Publication* (1998) - Champion Trees in Urban Hong Kong (Chinese Language Edition);
- *Urban Services Department* 'Plant Selection Matrix' (1992);
- *Housing Department* 'Basic Plant List' (1988);
- *PlanD*, 'The Landscape Value Mapping of Hong Kong' 2005;
- *AFCD* 'Check List of Hong Kong Plants 2001' (2002); and
- *AFCD* 'Rare and Precious Plants of Hong Kong' (2004).

The study is also in accordance with the requirements of Study Brief No. *ESB – 151/2006.* The landscape assessment considers the potential impacts of the Project on the existing landscape and particularly on the landscape resources within 500m of the Project Site.

The visual assessment analyses the potential visual impacts of the proposed wind farm on the existing views and the visual amenity, particularly from the Visually Sensitive Receivers (VSR) within the view shed (sometimes referred to as the Zone of Visual Influence (ZVI)). This EIA will use the term "view shed". In order to illustrate the visual impacts of the development, photomontages have been prepared from selected view points, which compare the existing conditions with the view after commissioning of the proposed wind farm. The residual impacts are evaluated qualitatively, in accordance with the requirements of *Annex 10* of the *EIAO-TM*.

11.4 PLANNING

As the wind farm site is located in a marine environment, it is not covered by any Outline Zoning Plans (OZP) or related overlays relevant to the Landscape and Visual Impact Assessment.

However, the onshore lay down area and the cable landing sites are to be located at the Lamma Power Station extension, which is covered by the approved Lamma Island Outline Zoning Plan S/I-LI/9. The Power Station is zoned as 'OU – Other Specified Uses' annotated "Power Station". The Planning Intention at this site is stated as:

'This zone is intended to designate land for a power station providing electricity supply to Hong Kong Island and Lamma Island.'

As the Project components at this site will be for the supply of electricity for Hong Kong Island and Lamma Island, there are no apparent conflicts associated with the OZP.

11.5 TREE SURVEY

A broad brush tree survey of the cable landing and laydown areas was undertaken.

Methodology

The tree survey was undertaken at the Lamma Power Station Extension areas that could be affected by the works in accordance with *Section 3.4.5.4* of EIA Study Brief *No. ESB-138/2006*, the guideline from *Works Branch Technical Circular No. 3/2006, No. 55/2002, No. 2/2004, LAO Practice Note No. 6/2003 and 8/2002.*

The only trees that may be affected by the onshore cable works are a small number of juvenile *Ficus elastica* growing in planters above the sea wall. See *Figure 11.2* below. These specimens are juvenile and should be readily transplanted or compensated before the works commence.

Figure 11.2 Existing Ficus elastica at the cable landing point

The trench for the cable is approximately 1m wide and will be excavated within the road corridor. No further trees or vegetation will be affected.

Should a Tree Felling Application (TFA) be required, the exact numbers of trees to be felled or transplanted will be submitted in a separate TFA during the Detailed Design stage.

11.6 *LANDSCAPE IMPACT ASSESSMENT*

11.6.1 *Methodology*

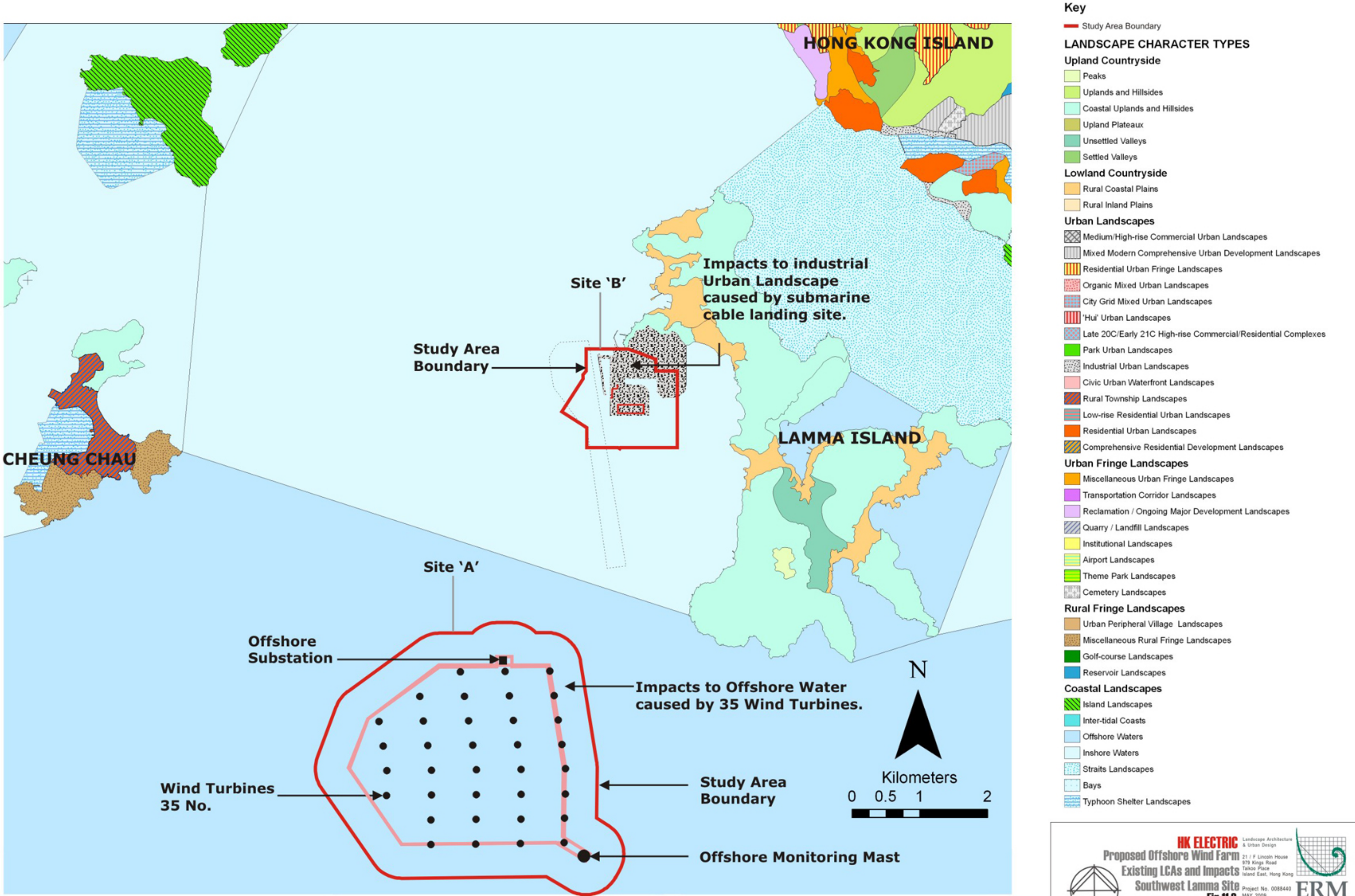
In accordance with *Annex 18* of the *EIAO-TM*, the landscape impact assessment has covered the following:

- Description of the baseline landscape within 500m of the Project Site and the works area of the enabling works along the access routes;
- Description of the Landscape Character Areas (LCAs) and Landscape Resources (LRs) including describing edges as different LRs;
- Mapping the distribution of the LCAs and LRs;
- Proposed a qualitative and quantitative assessment of significant thresholds which reflect the magnitude of change and sensitivity to change of a particular LCAs and LRs;
- Analysed the landscape impacts during construction, impact after development, and off-site landscape impacts. This section analyses the extent to which these landscape units and edges are changed, using both quantitative and qualitative assessments;
- Examined landscape mitigation measures that will contribute to reducing any landscape impacts or will enhance the landscape associated with the land based impacted areas of the wind farm. This may include planting, new landscaped areas and re-vegetation. The residual landscape impacts are also analysed, and;
- Provides conclusions on the impacts of the Project.

11.6.2 *Baseline Landscape Conditions*

As specified by the EIA Study Brief, the Landscape Impact Assessment covers the area within 500m of the proposed works (see *Figure 11.3*). The landscape baseline study examines the potential impacts on the Project Site and surrounding areas in terms of both the LCAs and the LRs.

The LCAs and LRs of the Study Area have been categorised according to the presence of common elements. These include factors such as:



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Existing LCAs and Impacts
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Fig 11.3

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- Topography;
- Vegetation type (both species and age);
- Built forms;
- Evidence on human modifications;
- Land use (past and present); and
- Edges.

11.6.3 *General Landscape Description*

The landscape where the Project is to be located comprises two contrasting sites. Site A is the seascape area where the wind turbines and associated infrastructure will be located. The seascape comprises two areas; the first being offshore where the wind turbines are to be located, the second is adjacent to the existing Lamma Power Station Extension. Both areas are typical of Hong Kong water ways.

Site B is the Lamma Power Station Extension where the submarine cable will land and connect to the grid and the onshore laydown area where the turbines will be partially assembled. This site is characterised by large heavy industrial infrastructure, roads and some soft landscape elements.

All of these landscape elements are discussed in more detail in this report.

11.6.4 *Landscape Sensitivity*

An understanding of the sensitivity to change of the LCAs and LRs is important when analysing the overall landscape impact of the Project.

Factors affecting the sensitivity of change for evaluation of landscape are:

- Quality of LCAs and LRs;
- Importance and rarity of special landscape elements;
- Ability of the landscape to accommodate change;
- Significance of the change in the local and regional context; and
- Maturity of the landscape.

The degree of sensitivity of the LCAs and LRs is classified as follows:

i) High – eg important components or landscape of particularly distinctive character susceptible to small changes;

ii) Medium – eg a landscape of moderately valued characteristics reasonably tolerant to change, and;

iii) Low – eg a relatively unimportant landscape which is able to accommodate extensive change.

The following section describes each of the LCAs and LRs within the Study Area (ie 500m from the Project boundary).

11.6.5 Landscape Character Areas

The landscape character of the overall Project Site is typical of the marine fringe environments south of Hong Kong Island, which is generally characterised by the presence of water, undulating islands with village developments and transient marine traffic.

As described in *Section 11.6.3*, there are two sites (A and B) that are different in terms of Landscape Character (refer *Figure 11.3)*. The Landscape Value Mapping of Hong Kong (1) identifies Site A as being within 'Offshore Waters Landscape' Landscape Character Type (LCT) (refer to *Figure 11.3*).

Site B is within the existing Lamma Power Station Extension and where the onshore laydown area and the submarine cable landing site will be located. The Landscape Value Mapping of Hong Kong identifies three LCT's within this area, 'Industrial Urban Landscape' and 'Coastal Uplands and Hillsides Landscape' and 'Inshore Waters Landscape'.

The above Landscape Character Types identified have been adopted as the Landscape Character Areas (LCAs) for the study.

LCAs within Site A

LCA1 – Offshore Waters Landscape

The *Appendix Descriptions on Landscape Character Types on The Planning Department of Hong Kong's* website describes Offshore Waters Landscape as:

These are coastal landscapes consisting almost exclusively of extensive areas of offshore water. They are defined by land (either mainland Hong Kong or its islands) on one side and by open sea on the other side and the result is a distinct sense of space and openness. Apart from the sea itself, the only other features in these offshore waters are occasional vessels, such as fishing vessels, ferries or cargo ships. Always possessing a sense of exposure and remoteness, they are very simple landscapes, which attain much of their character from the prevailing quality of light and weather

(1) 'The Landscape Value Mapping of Hong Kong' 2005, Planning Department, The Government of Hong Kong Special Administrative Region.

conditions. Examples of this type of landscape are the offshore waters off eastern Hong Kong and those off southern Hong Kong.

As shown in *Figure 11.4*, LCA1 is generally of a high quality, and is typical of this LCT in Hong Kong. It has a high importance as this LCA forms part of the unique identity of Hong Kong. However, due to its abundance, it is of low rarity, with a medium ability to accommodate change. This LCA therefore has a *medium* sensitivity.

Figure 11.4 Offshore Water Landscape

LCAs within Site Area B

LCA2 – Inshore Waters Landscape

The *Appendix Descriptions on Landscape Character Types on The Planning Department of Hong Kong's* website describes Inshore Waters Landscape as:

These are areas of coastal water lying close to the shore and enclosed to a certain degree by landmasses or islands, which create a limited sense of enclosure or containment. Whilst these landscapes are characterized predominantly by the horizontality and muted hues of their coastal waters, they may also include small, isolated islands or outlying rocks and marine activities of all kinds, including fish farms, anchorages, commercial shipping lanes, ferry traffic and waterborne recreational activity. The result is a largely open, tranquil and natural landscape which is punctuated by the colours and noises of human features and activities. Examples of this type of landscape are outer Victoria Harbour and Port Shelter in Sai Kung.

Figure 11.5 shows that this LCA, is generally of lower quality than the examples provided in the above description, primarily due to the presence of the Existing Power Station, which dominates the landscape character of the area. This LCA is also relatively abundant in the area and therefore its rarity is low. This LCA is also considered to have a *medium* sensitivity.

Figure 11.5 Inshore Waters Landscape

LCA3 – Industrial Urban Landscape

The *Appendix Descriptions on Landscape Character Types on The Planning Department of Hong Kong's* website describes Industrial Urban Landscape as:

Generally found on low-lying areas of reclaimed land and often along the coasts of urban areas, these are landscapes defined by their almost exclusively industrial land uses. They typically include areas of industrial buildings, often in very dense arrangements. Any occasional open areas are used for vehicle parking or open storage. Streets are mainly residual spaces, with little or no vegetation. On the peripheries, there may be areas of vacant land. These landscapes also include industrial estates: extensive areas of comprehensively developed low-rise buildings with wider roads, which are often tree lined, usually found at the edges of new towns, such as Yuen Long or Tai Po. Their unifying characteristics are their large utilitarian buildings, their limited coherence of spaces, features and materials, and absence of significant vegetation cover. Examples of this type of landscape include the container handling areas at Kwai Chung Container Terminal as well as the area of factory buildings at Wong Chuk Hang in Aberdeen.

This LCA is comprised of the existing Power Station, which is located on reclaimed land. Features here include large cranes, flue stacks and other utilitarian buildings. *Figure 11.6* demonstrates that this LCA is of low quality, importance and rarity with a high ability to accommodate change. This LCA therefore has a *low* sensitivity.

Figure 11.6 Industrial Urban Landscapes

LCA4 - Coastal Upland and Hillside Landscape

The *Appendix Descriptions on Landscape Character Types on The Planning Department of Hong Kong's* website describes Coastal Upland and Hillside Landscape as:

These are large-scale upland and hillside landscapes lying between around 40 and 300mPD which abut (wholly or in part) the sea. Consisting of hillsides, knolls, ridges and spurs, they are generally covered in low scrub or grassland with rocky outcrops or boulder fields. Woodland may be found on lower slopes or in sheltered gullies and ravines, where permanent or seasonal rocky streams tumble down these hillsides. Due to their coastal location, these landscapes usually contain few human features (other than footpaths or power lines) and often possess a distinct remote and exposed character and may offer striking views along the surrounding coast and sea. At the base of these hills, hillsides become more rocky and give way to rocky coasts (often interspersed with sandy bays) or cliffs. Examples of this type of landscape can be found around the coasts of Hong Kong, for instance on the coasts of the North East New Territories and Western Lantau.

A small portion of this LCA in the Study Area is similar to the description above. It is generally of high quality, but is low in rarity. *Figure 11.7* demonstrates that this LCA has a low to medium ability to accommodate change, mainly due to the presence of the existing Power Station. This LCA therefore has a *medium* sensitivity to change.

Figure 11.7 Coastal Upland and Hillside Landscape

11.6.6 *Landscape Resources*

Site A (the wind farm site) is located approximately 2km offshore of Lamma Island. The only LR found within this area is open sea.

Site B (the onshore laydown areas and the onshore landing site for the submarine cable), are located at the existing Lamma Power Station Extension. This is a man made reclaimed landscape element containing infrastructure associated with power generation activities, including engineering structures, hardstand areas and access roads. There are also a number of constructed soft landscape features including lawns and plantings. The potential impacts on existing LRs are shown in *Figure 11.8.*

Site A LRs

LR 1 – Seascape

Figure 11.9 shows this LR is generally of medium quality, ie the area has no significant characteristics such as colour, rock formations etc. It is also abundant, therefore is low in importance and rarity. Whilst this LR is considered to be of importance in Hong Kong, it is abundant, of high maturity and of medium quality in the Study Area. This LR is therefore considered to have a medium sensitivity.

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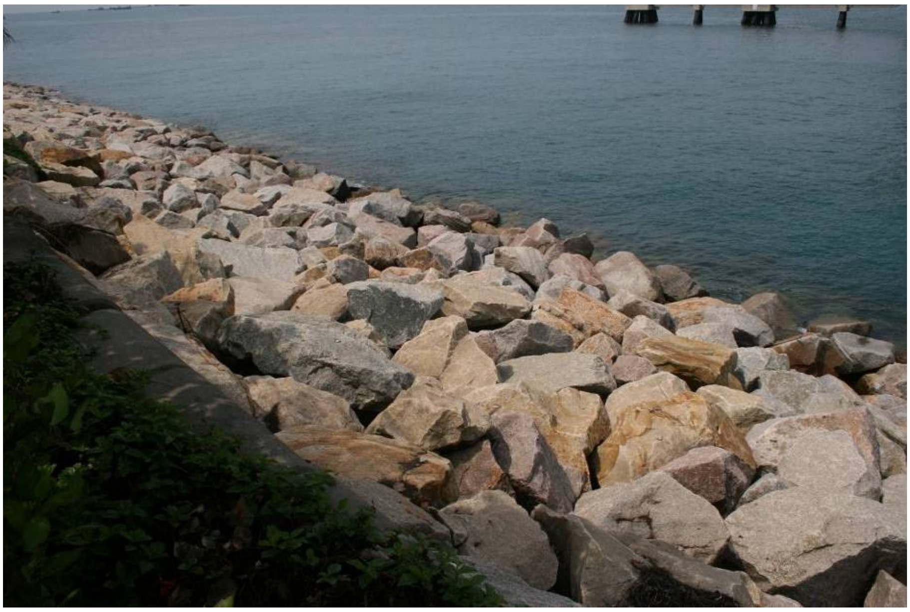
Figure 11.9 LR1 - Seascape

Site B LRs

LR 2 Man made rocky sea-wall

The man-made rocky sea wall is comprised of a revetment structure along the edge of the Lamma Power Station Extension that provides sea defence to the Power Station. *Figure 11.10* shows the revetment structure provides an artificial sea edge. This LR is of low quality, low rarity, significance and maturity. It therefore has a *low* sensitivity.

Figure 11.10 LR2 – Man made rocky sea wall



LR 3 – Industrial Area

Figure 11.11 shows this area consists of infrastructure associated with power generation including engineering structures, hardstand areas` and access roads. This LR is common in the Study Area due to the large size of the Power Station Extension and has low regional significance. It has a high ability accommodate change. The sensitivity of this LR is *low.*

Figure 11.11 ***LR3 – Industrial Area***

LR 4 – Soft Landscape areas

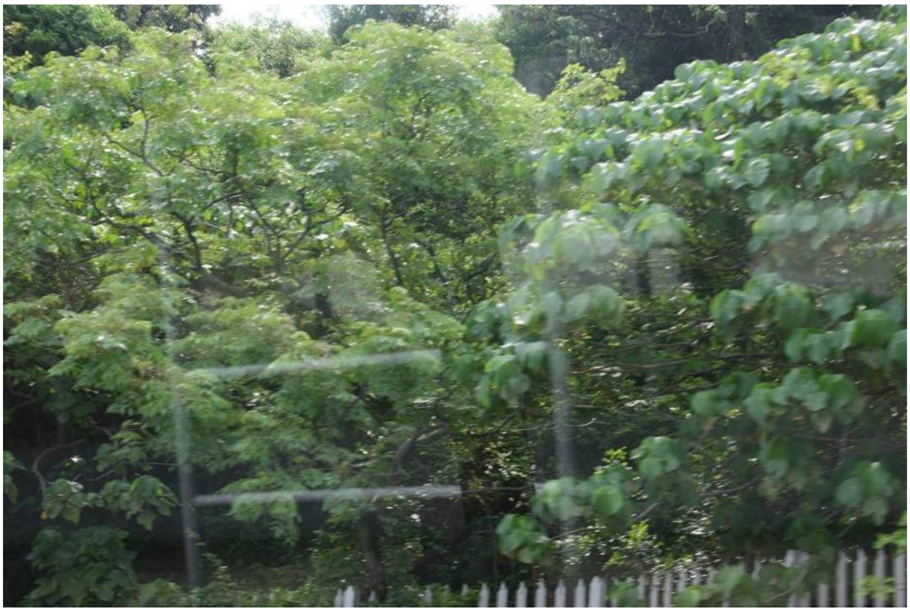
Figure 11.12 shows this LR has number of constructed soft landscape features including trees shrubs and lawn areas. This LR is of medium quality, and due to its location within the Power Station, is of medium importance and rarity. It has a low maturity and a high ability to accommodate change. The sensitivity of this LR is considered to be *low.*

Figure 11.12 LR4 – Soft Landscape Areas

LR 5 – Mixed Shrubland

Mixed Shrubland is comprised of a mix of trees and shrubs common to Hong Kong It is found in a small area at the north of the site towards the ferry pier. *Figure 11.13* shows this LR includes native species such as *Macaranga tanarius* and plantation species such as *Acacia* species., *Melia azedarach* and *Casuarina* species. The trees are generally of medium maturity and generally this LR is of fair to good quality. This LR is also relatively rare within the Study Area. The sensitivity of this LR is considered to be *medium*.

Figure 11.13 LR5 – Mixed Shrubland



LR 6 – Pond Area

The pond is located to the south of the Lamma Power Station Extension. It comprises the water body and the surrounding grassed banks. *Figure 11.14* shows the pond is generally used for industrial purposes, so it has a low landscape quality and a high ability to accommodate change. The sensitivity of this LR is considered to be *low*.

Figure 11.14 LR6 – Pond

11.6.7 Distribution of LCAs and LRs

The distribution of the existing LCAs and LRs is shown on *Table 11.1* below.

Table 11.1 Existing Landscape Character Areas (LCAs) and Landscape Resources (LRs)

ID	LCA/LR	Area (hectare) Within Study Area
LCA 1	Offshore Water Landscape	1350 ha
LCA 2	Inshore Water Landscape	113.3 ha
LCA 3	Industrial Urban Landscape	65.9 ha
LCA 4	Coastal Upland & Hillsides	3.4 ha
LR 1	Seascape	1463.3 ha
LR2	Man made rocky sea wall	7.6 ha
LR3	Industrial Area	32 ha
LR4	Soft Landscape Areas	2.6 ha
LR5	Mixed Shrubland	2.8 ha
LR6	Pond Area	12.1 ha

11.6.8 Landscape Impacts During Construction

The two key factors that affect the evaluation of LCA and LR impacts are the magnitude of change and the sensitivity of the landscape areas/resources. The sensitivity for each of the LCAs and LRs has been described above and the factors affecting the magnitude of change are outlined below.

Factors affecting the magnitude of change for assessing landscape impacts are:

- Compatibility of the proposed wind farm with the surrounding landscape, ie how well will it fit with its surroundings;
- Scale of the development, ie how big is the development relative to its surroundings; and,
- Reversibility of change, ie how easily changes to the landscape can be reversed.

The magnitude of change is classified as follows:

- Large – notable change in the landscape characteristics over an extensive area ranging to very intensive change over a more limited area;
- Intermediate – moderate changes to a local area;
- Small – small changes to specific landscape components; and
- Negligible – no changes to the baseline condition.

The landscape impact is a product of the magnitude of change the Project will have and the sensitivity of the LCA/LR. *Table 11.2* shows the significance threshold of the LCA/LR impacts.

Table 11.2 Significance Threshold of Potential Landscape Resource Impact

	Sensitivity to Change			
Magnitude of Change Caused by Project		**Low**	**Medium**	**High**
	Large	Moderate Impact	Moderate/Significant Impact	Significant Impact
	Intermediate	Slight/Moderate Impact	Moderate Impact	Moderate/ Significant Impact
	Small	Slight Impact	Slight/Moderate Impact	Moderate Impact
	Negligible	Negligible Impact	Negligible Impact	Negligible Impact

Table 11.3 provides some definitions of the significance thresholds for LCA and LR impacts.

Table 11.3 Adverse / Beneficial Impact of Landscape Impact

Level of Impacts (Negative / Beneficial/ Neither)			
Significant:	**Moderate:**	**Slight:**	**Negligible**
Adverse / beneficial impact where the Project would cause significant degradation or improvement in existing landscape baseline conditions	Adverse / beneficial impact where the Project would cause noticeable degradation or improvement in existing landscape baseline conditions	Adverse / beneficial impact where the Project would cause a barely noticeable degradation or improvement in existing landscape conditions or where the changes brought about by the Project would not be apparent in visual terms	The Project does not affect the existing landscape baseline conditions

11.6.9 Unmitigated Landscape Impacts During Construction

Table 11.4 shows the impact of the Project on each of the LRs and LCAs and the overall impact based on the preceding Landscape Impact Assessment Matrix.

Table 11.4 Unmitigated Landscape Impact Significance Threshold Matrix

ID	LR/LCA	Area (ha)	Area Affected by Proposed Development	% of Area / Length Affected	Sensitivity to Change	Magnitude of Change	Significance Threshold of Landscape Impact
LCA 1	Offshore Waters Landscape	1350 ha	700 ha	52%	Medium	Large	Moderate
LCA 2	Inshore Waters Landscape	113.3 ha	Nil	Nil	Medium	Negligible	Negligible
LCA 3	Industrial Urban Landscape	65.9 ha	2.78 ha	4.21%	Low	Small	Slight
LCA 4	Coastal Upland & Hillsides	3.4 ha	Nil	Nil	Medium	Negligible	Negligible
LR 1	Seascape	1463.3 ha	0.16 ha	0.01%	Medium	Small	Slight
LR 2	Man made rocky sea wall	7.6 ha	0.001 ha	0.01%	Low	Small	Slight
LR 3	Industrial Area	32 ha	0.02 ha	0.06%	Low	Small	Slight
LR 4	Soft Landscape areas	2.6 ha	0.001ha	0.04%	Low	Small	Slight
LR 5	Mixed Shrubland	2.8 ha	Nil	Nil	Medium	Negligible	Negligible
LR 6	Pond Area	12.1 ha	2.67ha	22.06%	Low	Intermediate	Slight

11.6.10 *Summary of un-mitigated Landscape Impacts*

Landscape Character Areas

LCA 1 Offshore Waters Landscape

This LCA is considered to have a medium sensitivity mainly due to its high importance and relative abundance. This LCA will be affected by the location of the 35 wind turbines, offshore sub-station and offshore monitoring mast. The area that will have an effect on this LCA is considered to be the entire project boundary due to the large scale of the turbines. These items will affect approximately 700ha of this LCA. The significance threshold on this LCA is considered *moderate.*

LCA 2 Inshore Waters Landscape

This LCA is also considered to have a *medium* sensitivity, mainly due to the proximity of the existing Power Station. The magnitude of change for this LCA will be negligible as the submarine cable will lie along the sea floor. The significance threshold on this LCA is *negligible.*

LCA 3 Industrial Urban Landscape

This LCA is considered to have a low sensitivity due to the heavy industrial nature of the facilities. A very small amount of area will be affected by the submarine cable landing causing a small magnitude of change. The resulting significance threshold will be *slight.*

LCA 4 Coastal Upland and Hillside Landscape

This LCA has medium sensitivity. This is due to its relatively high quality, but it has a medium ability to accommodate change due to its proximity to the Power Station. There will be no impacts on this LCA resulting in a *negligible* significance threshold.

Landscape Resources

LR1 – Seascape

This LR has a medium sensitivity as it is considered to be medium in quality and in abundance. Only a small area will be affected (0.16 ha) which is considered a small magnitude of change. As this change is only 0.01% of the LR within the study area, the significance threshold is considered to be *slight.*

LR2 - Man made rocky sea-wall

The man made rocky sea wall was considered to have a low sensitivity due to its relatively low landscape quality and its abundance in the area. Only a very small area will be affected by the submarine cable landing and the magnitude of change is considered small. This will result in a *slight* significance threshold.

LR3 – Industrial Area

The Industrial Area is considered to have a low sensitivity due to its low landscape quality and its high ability to accommodate change. A very small area will be affected by the construction of the cable trench will cause a small magnitude of change. The resulting significance threshold will be *slight.*

LR4 – Soft Landscape areas

This LR was considered to have a low sensitivity due to its low maturity and high ability to accommodate change. A very small area will be affected by the excavation of the cable trench and the magnitude of change is considered to be small. This will result in a *slight* significance threshold.

LR5 – Mixed Shrubland

This LR is considered to have a medium sensitivity due to its high quality and rarity within the Study Area. However, there will be no change to this LR and therefore a *negligible* significance threshold.

LR6 – Pond

This LR has a low sensitivity due to its low landscape quality and its high ability to accommodate change. This are will be temporarily affected during the construction stage of the project that will result in a *slight* significance threshold.

11.6.11 Landscape Mitigation Measures

Landscape mitigation measures are proposed to not only further reduce the above impacts but to generally improve the amenity of the development.

The landscape mitigation measures are shown in *Figure 11.15*.

ID No.	Landscape and Visual Mitigation Measure	Funding Agency	Implementation Agency
LMM 1	*Tree and Shrub Planting.* All plant materials affected by the works relating to the submarine cable landing are to be replaced with new plantings to match the existing situation. All planting of trees and shrubs is to be carried out in accordance with the relevant best practice guidelines. Plant densities are to be provided in future Detailed Design documents and are to be selected so as to achieve a finished landscape that matches the surrounding, undisturbed, equivalent landscape types.	Developer	Contractor
LMM 2	*Relocation.* Established trees of value to be re-located where practically feasible.	Developer	Contractor
LMM 3	*Site hoardings to be compatible with the surrounding environment.* Where possible, site hoardings should be coloured to complement the surrounding areas. *-Colours such as green and light brown are recommended.	Developer	Contractor
LMM 4	*Reinstatement.* Landscape resources affected by the onshore cable trench are to be reinstated to match existing conditions.	Developer	Contractor

Construction phase mitigation measures above will be carried out before or during the construction phase of the project.

LEGEND

- Cable
- Laydown Area
- LR 1 - Sea
- LR 2 - Man Made Rocky Sea Wall
- LR 3 - Industrial Area
- LR 4 - Soft Landscape Area
- LR 5 - Mixed Shrub land Area
- LR 6 - Pond Landscape

LANDSCAPE MITIGATION MEASURES

1 **LMM 1 – Tree and Shrub Planting.**
All plant materials affected by the works are to be replaced with new plantings to match the existing. All planting of trees and shrubs is to be carried out in accordance with the relevant best practice guidelines. Plant densities are to be provided in future detailed design documents and are to be selected so as to achieve a finished landscape that matches the surrounding, undisturbed, equivalent landscape types.

2 **LMM 2 - Relocation.**
Established trees of value to be re-located where practically feasible.

3 **LMM 3 – Site hoardings to be compatible with the surrounding environment.**
Where possible site hoardings to be coloured to complement the surrounding areas. Colours such as green and light brown are recommended.

4 **LMM 4 – Reinstatement.**
Landscape resources affected by the cable trench are to be reinstated to match existing.

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Table 11.5 Mitigated and Un-mitigated Construction Impacts

	Un-mitigated Construction impacts			**Mitigated Construction Impacts**	
	Construction Impact threshold	**Adverse/ Beneficial/Neither**	**Recommended Construction Mitigation Measures**	**Construction Impact threshold following mitigation**	**Adverse/ Beneficial/Neither**
LCA 1 Offshore Water Landscape	Moderate	Adverse	Nil	Moderate	Adverse
LCA 2 Inshore Water Landscape	Negligible	Neither	Nil	Negligible	Neither
LCA 3 Industrial Urban Landscape	Slight	Adverse	1 - 4	Negligible	Neither
LCA 4 Coastal upland & Hillsides	Negligible	Neither	Nil	Negligible	Neither
LR 1 Seascape	Slight	Adverse	Nil	Slight	Adverse
LR 2 Man made rocky sea-wall	Slight	Adverse	4	Negligible	Neither
LR 3 Industrial Area	Slight	Adverse	1 - 4	Negligible	Neither
LR 4 Soft Landscape areas	Slight	Adverse	1, 2, 4	Negligible	Neither
LR 5 Mixed Shrubland	Negligible	Neither	Nil	Negligible	Neither
LR 6 Pond	Slight	Adverse	2 ,3	Negligible	Neither

Table 11.6 Mitigated and Un-mitigated Operation Impacts

	Un-Mitigated Impacts			**Mitigated Impacts**		
	Operation	**Adverse/ Beneficial/Neither**	**Recommended Mitigation**	**Operation Day 1**	**Operation Year 10**	**Adverse/ Beneficial/Neither**
LCA 1 Offshore Water Landscape	Moderate	Adverse	Nil	Moderate	Moderate	Adverse
LCA 2 Inshore Water Landscape	Negligible	Neither	Nil	Negligible	Negligible	Neither
LCA 3 Industrial Urban Landscape	Negligible	Neither	Nil	Negligible	Negligible	Neither
LCA 4 Coastal upland & Hillsides	Negligible	Neither	Nil	Negligible	Negligible	Neither
LR 1 Seascape	Slight	Adverse	Nil	Slight	Slight	Adverse
LR 2 Man made rocky sea-wall	Negligible	Neither	Nil	Negligible	Negligible	Neither
LR 3 Industrial Area	Negligible	Neither	Nil	Negligible	Negligible	Neither
LR 4 Soft Landscape areas	Negligible	Neither	Nil	Negligible	Negligible	Neither
LR 5 Mixed Shrubland	Negligible	Neither	Nil	Negligible	Negligible	Neither
LR 6 Pond	Negligible	Neither	Nil	Negligible	Negligible	Neither

11.6.12 *Effectiveness of Landscape Character Areas and Landscape Resource Mitigation Measures*

It will not be possible to mitigate the impacts on LCA1 Offshore Waters Landscape or LR 1 Seascape. However, the mitigation measures proposed will effectively further reduce the impacts identified on the other LCAs and LRs. *Tables 11.5* and *11.6* show the effectiveness of the LMMs in reducing the significance thresholds of the impacts on the LCAs and LRs.

11.6.13 *Summary of Residual Impacts on the Landscape Character Areas During Construction*

There will be *moderate* residual construction impacts on LCA1 Offshore Waters Landscape , and *negligible* residual impacts on LCAs 2 Inshore Waters Landscape, 3 Industrial Urban Landscape and 4 Coastal Upland and Hillside Landscape.

11.6.14 *Summary of Residual Impacts on Landscape Character Areas During Operation*

There will be *negligible* residual operational impacts on LCAs 2 Inshore Waters Landscape, 3 Industrial Urban Landscape and 4 Coastal Upland and Hillside Landscape. There will be *slight* adverse residual operational impacts on LCA1 Offshore Waters Landscape.

11.6.15 *Summary of Residual Impacts on the Landscape Resources During Construction*

There will be *negligible* residual construction impacts on the following LRs:

- LR 2 Man made rocky sea-wall
- LR 3 Industrial Area
- LR 4 Soft Landscape areas
- LR 5 Mixed Shrubland
- LR 6 Pond

There will be *slight* residual construction impacts on LR1 Seascape.

11.6.16 *Summary of Residual Impacts on Landscape Resources during Operation*

There will be *slight* residual operation impacts on LR1 Seascape and negligible impacts on all other LRs.

11.7 VISUAL IMPACT ASSESSMENT

11.7.1 *Introduction*

The following tasks were undertaken for the visual impact assessment.

Define the view shed that would be potentially impacted by the Project and map the areas of visual impact - Geographical Information System (GIS) software was utilised to determine areas that could potentially see the development during construction and operation. This GIS view shed analysis was based solely on topography and did not take into account the screening potential of vegetation, which would further reduce the actual view shed. The GIS view shed analysis also mapped the visibility of the development from roads and houses.

Assess indicative view points as a means of assessing the visual impact on the broader landscape - Visually Sensitive Receiver (VSR) view points around the development, have been selected as indicative of the range of views from accessible locations within the view shed. Photomontages have been prepared to show the existing landscape and the landscape with the development at the key VSRs.

Discuss visual mitigation measures - measures (if required) that will reduce any potential visual impacts have been identified. This may include planting and recommendations for material and finishes. These measures will also help improve the overall amenity of the Project. Residual impacts are also discussed.

11.7.2 *Viewer Perception and the Acceptability of Wind Farms*

Viewer perception is an important consideration for wind farm proposals, especially in areas near tourist destinations or heritage areas. The visual impact of a wind farm ultimately depends on the opinion of the viewer. In most LVIA's undertaken in Hong Kong, the assumption for most infrastructure developments is that the change to the view will be *adverse*. However, for the development of an offshore wind farm, the degree of visual impact partly depends on how the viewer perceives renewable energy, the wind turbines and the existing baseline landscape in which the turbines are to be located.

The findings from a number of studies (both Australian and overseas) are appended to this report in *Annex 11A*.

The visible presence of wind turbines will change the existing view. However, to postulate that this will create irreversible damage to the landscape values and negatively impact the amenity of the area cannot be substantiated on the basis of perception studies (refer *Annex 11A*).

Perception studies show some people find wind turbines attractive and have shown that the majority of those surveyed find wind turbines visually appealing in the landscape. Therefore, for many people, the visual impact may be *beneficial*, not *adverse* as often assumed. Even if the wind turbines are visible at both sunset and sunrise, there is no evidence to suggest that their presence will be detrimental to the viewer's experience.

Perception studies continually show that in many Australian and overseas examples that between 60-70% of people find wind turbines an attractive element in the landscape, with up to 15% of respondents undecided and 20% disliked wind farms. Viewer perception is an important issue to consider, especially in areas near tourist destinations or other attractions.

It is important to realise that this acceptance level is unique to wind farms. Similar research to the visual impact of a power line, a major road or other large infrastructure projects would show a greater degree of dislike for the changes these types of projects make on the landscape. The greater acceptance of wind turbines in the landscape may well be a result of their clean lines and aerodynamic shape, or perhaps with their perceptual link with green energy. Irrespective of the reason, it is clear that in these studies wind turbines are generally accepted by the majority of viewers in all but the most sensitive of locations.

11.7.3 View Shed Determination and Areas of Potential Visual Impact

The visual impact assessment is informed by an understanding of the existing visual qualities within the region that can be visually affected by a development. This area is referred to as the view shed.

Defining an appropriate view shed is the starting point to understanding the visual impacts of a development as the area of the view shed will vary depending on the nature and scale of the proposed development. The larger a development the greater the view shed as it may be visually apparent for a greater distance. Once the view shed is established, locations can be identified within the view shed that are either particularly sensitive or indicative of the visual impact for a number of locations. In some circumstances, view points may be identified beyond the view shed to recognise the visual impact on locations of particularly high sensitivity.

The proposed wind turbines, substation and monitoring mast are the major visual element of the proposed development and may visually impact on the surrounding VSRs. As the viewer moves further away from these structures the visual impact decreases until it is no longer visible. However, before the point of non-visibility is reached, the wind turbines have reduced in scale such that they no longer have a significant visual impact. In most landscapes, especially those which have some degree of human intervention, the limit of the view shed is defined as that point at which the wind turbines would have an insignificant effect on the view.

It should be noted that the View Shed determination is based on the visibility of the turbines in daylight. The potential visual impacts during the night are discussed in *Section 11.7.18.*

11.7.4 *Baseline Visual Character*

The general baseline visual character of the wind farm site is characterised by the following elements:

Lamma Island – Lamma Island comprises sandy beaches, rocky shorelines as well as vegetated hill slopes with granite outcrops, particularly on the southern end of the island. Also visible within the vicinity are the low-rise village houses, however the visual envelope of Lamma is dominated by the Lamma Power Station, particularly the three stacks. The existing wind-demonstration project is also visible.

Other outlying Islands – A number of other outlying islands are also located within the visual envelope, including Cheung Chau, Hei Ling Chau and Lantau. All of these contain undulating vegetated slopes with scattered villages along the island perimeters.

Open Seascape – The visual envelope is dominated by areas of sea, ranging from the more secluded bays surrounding the outlying Islands, to more open sea areas further offshore. These areas often contain relatively high numbers of transient marine vessels, but also evoke a generally serene natural marine environment.

All of the above elements combine to create an overall visual envelope that is generally of medium to high quality due to the combination of water, islands and a mix of natural and man-made landscapes.

11.7.5 *Visually Sensitive Receivers*

In recognising that the view shed is not the limit of visibility, but rather the extent to which the wind turbine would have an insignificant visual impact on the VSRs, the extent of a view shed will differ in the context of different landscapes.

A view shed in a man-modified landscape is different to a view shed in a pristine landscape or landscapes where there are no apparent signs of human influence. This is because in landscapes that appear 'natural' or pristine, a man-made element such as a wind turbine, can visually influence the landscape for as long as a viewer can discern that newly introduced element. A man-made element in a pristine landscape irrevocably changes a pristine landscape from natural to man-modified. Therefore, view sheds in pristine areas are extended to the limit of human visibility.

However, in man-modified landscapes, in which there are many other existing built forms or modifications to the landscape, the view shed extends to that distance at which the wind turbine becomes a minor element in the landscape to all but the most sensitive of viewers. The wind turbine may still be visible beyond this view shed. However, it is considered that beyond this view shed the visual impact will be insignificant.

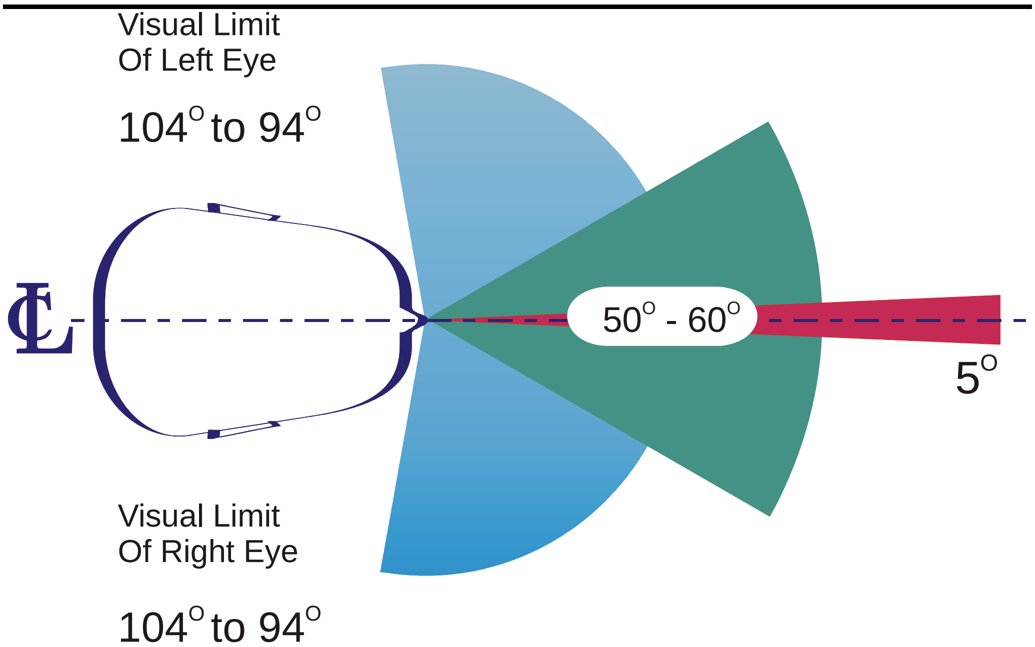
The view shed is therefore the area that is most likely to be visually impacted.

The visual impact of a development can be quantified by reference to the degree of influence on a person's field of vision. *Figure 11.16* illustrates the typical parameters of human vision based on anthropometric data.[1] This data provides a basis for assessing and interpreting the impact of a development by comparing the extent to which the development would intrude into the central field of vision (both horizontally and vertically).

11.7.6 Horizontal Field of View

The central field of vision for most people covers an angle of between 50° and 60°. Within this angle, both eyes observe an object simultaneously. This creates a central field of greater magnitude than that possible by each eye separately. This central field of vision is termed the 'binocular field' and within this field images are sharp, depth perception occurs and colour discrimination is possible. These physical parameters are illustrated in *Figure 11.16.*

Figure 11.16 ***Horizontal Field of View***



The visual impact of a development will vary according to the proportion in which a development impacts on the central field of vision. Developments, which take up less that 5% of the central binocular field, are usually insignificant in most landscapes (5% of 50° = 2.5°).

[1] (*Human Dimension & Interior Space – A Source Book of Design Reference Standards, Julius Panero and Martin Zelnik, The Architectural Press Ltd. London, 1979*).

The wind farm is comprised of a number of individual turbines of the same dimensions, with large separation distances between each individual turbine, substation and monitoring mast. It would therefore not be accurate to examine the entire width of the wind farm when reviewing the horizontal field of view. This effect can also be demonstrated by the example of a farm fence that may be many kilometres in width, yet as one moves further away it becomes less apparent, until at some distance it is not possible to separate this element from the horizontal plane of the landscape. In essence, as soon as one wind turbine becomes visually insignificant, so do all of the turbines in the entire wind farm. In assessing the visual impact of the wind turbine it is therefore assumed that the largest horizontal component is the entire rotor, which would be a maximum of 111 m wide.

As shown in *Table 11.7*, calculations suggest that the impact of a 111 m wide wind turbine rotor would reduce to insignificance at about 2.6 km, as it would form less than 5% or 2.5° of the horizontal field of view.

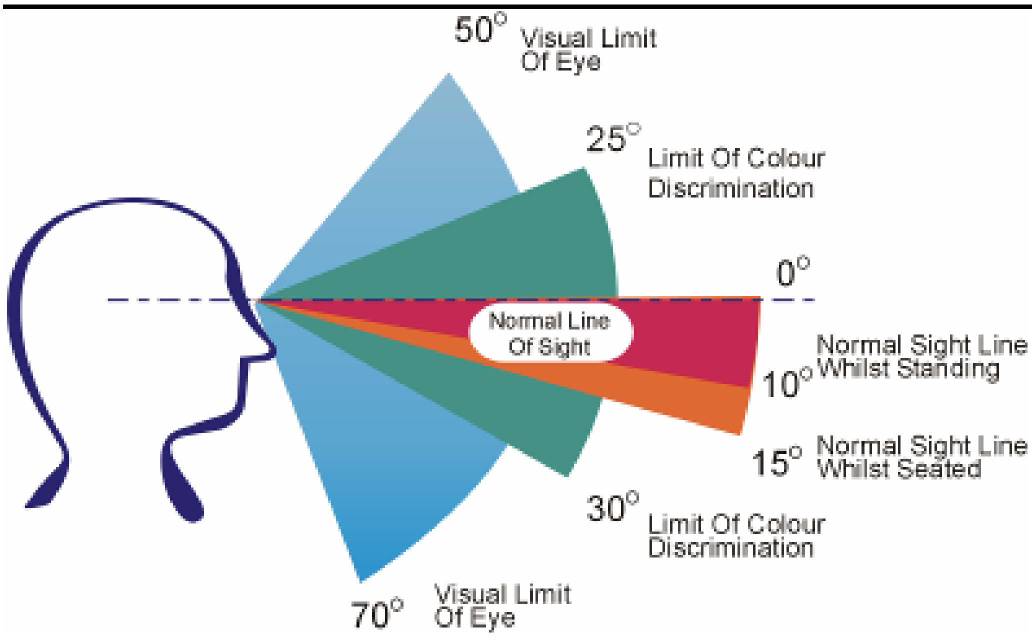
Table 11.7 Visual Impact Based on the Horizontal Field of View

Horizontal Field of View	Impact	Distance from an Observer to a 111m Rotor
<2.5° of view	***Insignificant*** The development will take up less than 5% of the central field of view. The development, unless particularly conspicuous against the background, will not intrude significantly into the view. The extent of the vertical angle will also affect the visual impact.	>2.6km
2.5° – 30° of view	***Potentially noticeable*** The development may be noticeable and its degree of visual intrusion will depend greatly on its ability to blend in with its surroundings.	200m – 2.6km
>30° of view	***Potentially visually dominant*** Developments that fill more than 50% of the central field of vision will always be noticed and only sympathetic treatments will mitigate visual effects.	< 200m

11.7.7 *Vertical Field of View*

A similar analysis can be undertaken based upon the vertical field of view for human vision. As can be seen in the *Figure 11.17* the typical line of sight is considered horizontal or 0°. A person's natural or normal line of sight is normally a 10° cone of view below the horizontal and, if sitting, approximately 15°.

Figure 11.17 Vertical Field of View



Objects which take up 5% of this cone of view (5% of 10° = 0.5°) would only take up a small proportion of the vertical field of view, and are only visible when one focuses on them directly. Objects that take up such a small proportion of the vertical view cone are not dominant, nor do they create a significant change to the existing environment when such short objects are placed within a disturbed or man-modified landscape.

Table 11.8 shows the relationship between impact and the proportion that the development occupies within the vertical line of sight.

Table 11.8 Visual Impact Based on Vertical Field of View

Vertical Line of Sight	Impact	Distance from an Observer to a 136m Tall Wind Turbine
< 0.5° of vertical angle	***Insignificant*** A thin line in the landscape.	>15.5 km
0.5° – 2.5° of vertical angle	***Potentially noticeable*** The degree of visual intrusion will depend on the development's ability to blend in with the surroundings.	3.0 – 15.5 km
> 2.5° of vertical angle	***Visually evident*** Usually visible, however the degree of visual intrusion will depend of the width of the object and its placement within the landscape.	< 3.0km

These calculations suggest distances at which the magnitude of visual impact of the wind turbine will reduce with distance. At distances greater than 15.5km, a fully visible wind turbine would be an insignificant element within the landscape.

These calculations seem closer to the observed distances at which levels of impact seem to change. It is stressed that these ranges will only provide a guide for the visual impact assessment.

11.7.8 *Determining the Visual Extent of Impact*

Generally, the more conservative, or worse-case distances form the basis for the assessment of visual impacts. Therefore for this development the greater impacts would be associated with the vertical field of view. It is therefore proposed to use the vertical field of view and extend the view shed to 15.5 km.

11.7.9 *GIS Analysis*

A GIS view shed analysis has identified those areas that can potentially be visually impacted by the wind turbine (*see Figure 11.18*). Such analysis is based on topography only, and shows those areas that would be screened by intervening hills etc. It does not take into account intervening vegetation or buildings, nor does it take into account small variations in topography, such as road cuttings. Therefore it is a conservative assessment of those areas that may be potentially able to view the wind turbine.

Table 11.9 below shows the land based viewing areas and marine based viewing areas that may be affected for the South-West Lamma site.

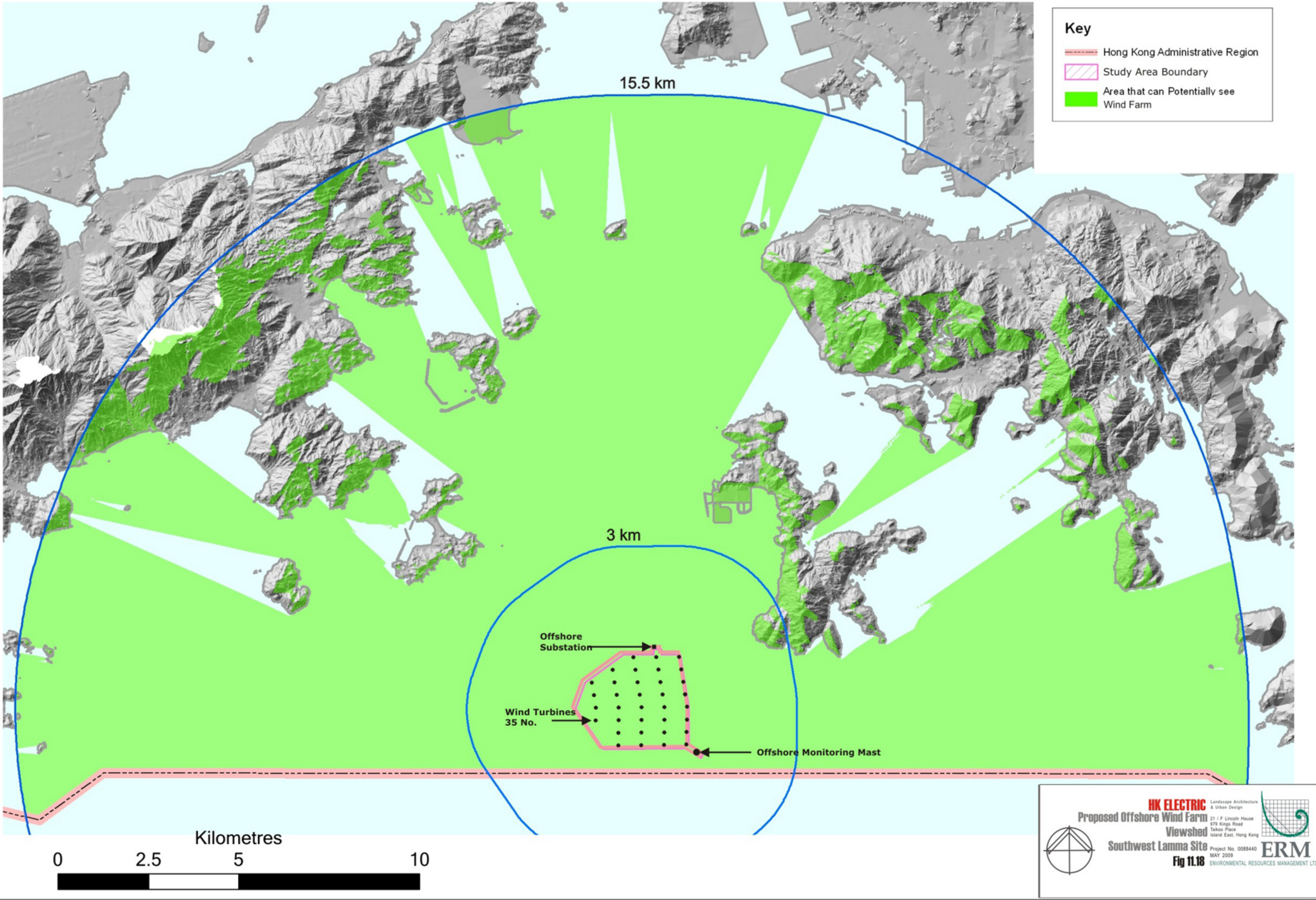
Table 11.9 Potential View shed of Land and Marine Based VSRs

Site	<3.0km		3.0-15.5km	
	Land Area	Marine Area	Land Area	Marine Area
South-West Lamma	0.49 km^2	42 km^2	35 km^2	273 km^2

Generally, land areas contain a higher concentration of VSRs particularly permanent residents, and recreational hikers, bathers etc. These VSRs may have a higher sensitivity to change and are more likely to experience a higher significance threshold. For the Project Site, 0.49 km^2 of land area lies within the 3.0 km 'Visually Evident Zone' that may experience a significant impact. The vast majority of this zone is a marine area that will only comprise transient marine based VSRs on commercial or recreational vessels that are moving past the site (refer *Figure 11.18*).

However, within the 3.0-15.5 km zone there is 35 km^2 of land area that contains a number of potential VSRs with varying sensitivities. There is also 273 km^2 of marine area that may contain transient marine vessels.

There are a number of different types of VSRs that may be affected by the wind farm, with varying sensitivities that will affect the significance threshold of any visual impact. These are discussed below.



Key
Hong Kong Administrative Region
Study Area Boundary
Area that can Potentially see Wind Farm
15.5 km
3 km
Offshore Substation
Wind Turbines 35 No.
Offshore Monitoring Mast
Kilometres
0
2.5
5
10
HK ELECTRIC
Proposed Offshore Wind Farm
Viewshed
Southwest Lamma Site
Fig 11.18
Landscape Architecture & Urban Design
21 / F Lincoln House
979 Kings Road
Taikoo Place
Island East, Hong Kong
Project No. 0088440
MAY 2009
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11.7.10 *Atmospheric Factors Which Will Affect Visual Impact*

Many climatic conditions result in changes to visibility. For example, sea haze, rainfall and other atmospheric conditions will alter the visibility of the wind farm. The diminution of visual clarity bought about by atmospheric conditions also increases with distance.

Sea Haze

Sea haze is a climatic condition along coastlines that can reduce visibility even on days when the weather is fine. Wind which blows across the ocean or other atmospheric conditions can cause a sea haze, limiting views to the wind farm from surrounding areas.

However, sea haze is unlikely to have much impact on the visibility of the development when viewed from close proximity, say less than 3.0km. When the same features are viewed from greater distances within the view shed the effect of sea haze will greatly reduce visibility and any potential visual impact.

Cloud Cover

Cloudy days can also reduce the visibility of a wind farm. During site inspections of similar facilities it was apparent that a backdrop of grey cloud reduced the visual impact of the turbines. Full cloud cover also reduced the apparent contrast on elements that extend above the landscape backdrop and as these elements were neither strongly shadowed nor reflective.

Figure 11.19 shows that in Hong Kong, for much of the year the percentage of cloud cover exceeds 50%.

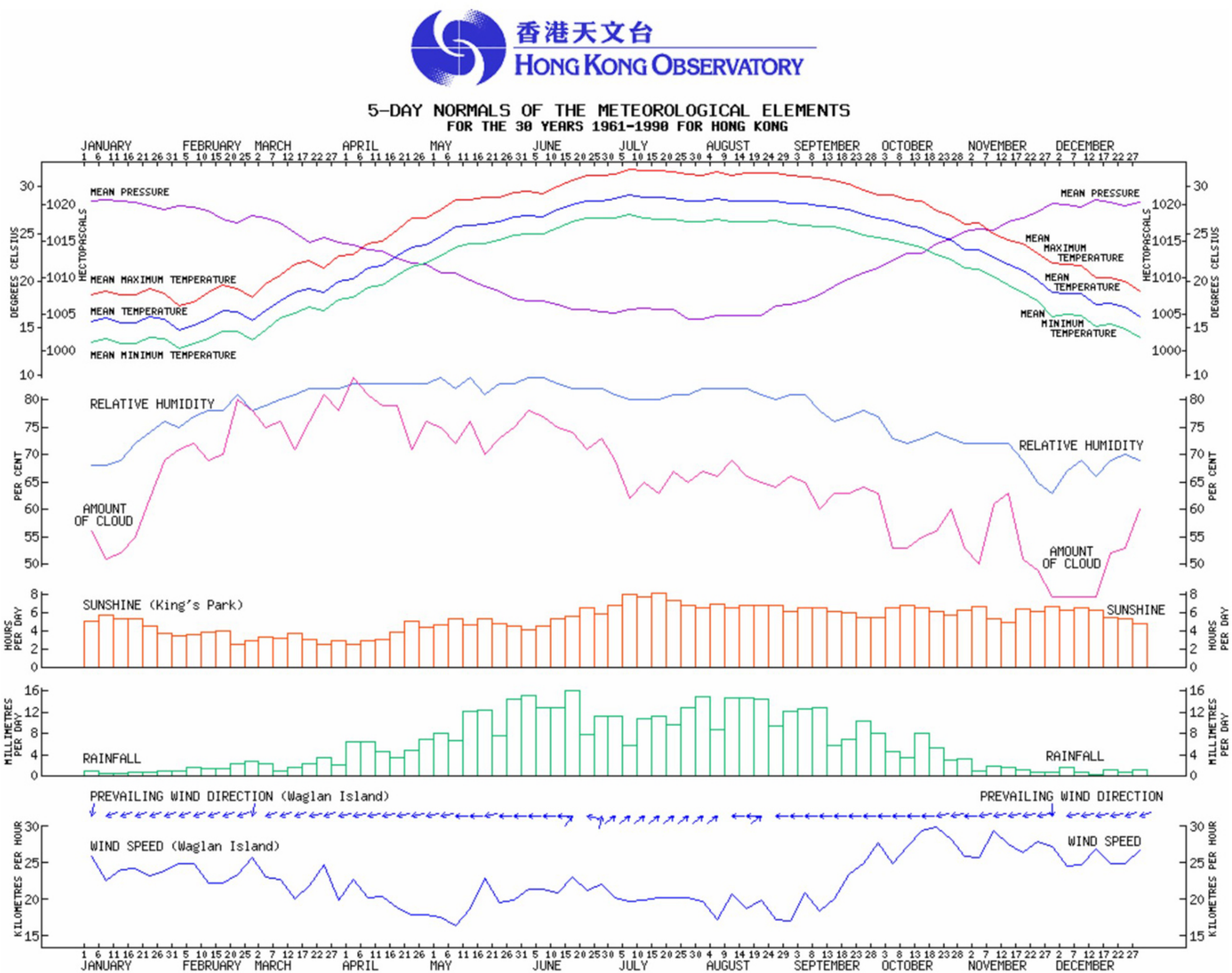
Rainfall

The effect that rainfall has on visibility can be measured in two ways. Firstly, the event of falling rain reduces visibility as the water droplets obscure vision. This varies greatly depending on the heaviness of the precipitation, but even light rain obscures distant objects greatly. Secondly, the event of rain, particularly sustained rain periods, reduces visitor numbers. Therefore, the visual impact is reduced on those days as lesser viewers are visiting the area and looking at the development.

Figure 11.19 also shows that during the wet season, particularly from May through September, Hong Kong receives on average approximately 10mm of rain per day. These rain events can reduce visibility.

Reduced Visibility

The Hong Kong Observatory noted that in 2008 there were a total of 1951 hours of reduced visibility in Hong Kong. Reduced visibility is defined as:



HK ELECTRIC
Climatic Data Of Hong Kong
Southwest Lamma Site

Landscape Architecture & Urban Design
21 / F Lincoln House
979 Kings Road
Taikoo Place
Island East, Hong Kong

Project No. 0088440
MAY 2009

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Figure 11.19

Reduced visibility refers to visibility below 8 kilometres when there is no fog, mist, or precipitation.

On days when reduced visibility is being experienced in Hong Kong, the maximum view shed (15.5km) for the wind farm would reduce to below 8 kilometres.

Assessment Scenarios

Whilst the above describes some of the climatic conditions that reduce the visibility of the wind farm, the following assessment is based on a worst case impact scenario on visual quality assuming perfectly clear viewing conditions. Mitigation measures are proposed to reduce these impacts.

11.7.11 Wind Farm Construction Impacts

The assembly and installation of the wind turbines will be undertaken over a period of approximately 9 months (see *Section 5*). The wind monitoring mast will be erected at the wind farm well before the wind turbines and offshore substation. During the construction period there will be two sources of temporary construction based impacts. The first will be from the erection of the turbines, offshore substation and monitoring mast at the wind farm site. The second source of impacts will be the onshore assembly of wind farm components in preparation for their delivery to the wind farm site.

Figures 11.20 and *11.21* show the typical examples of turbine assembly at the onshore laydown area. The maximum height of the structures being assembled is approximately 70 metres.

Figure 11.20 Typical Rotor Assembly[1]

Figure 11.21 Typical Mast Assembly [2]

[1] 'Vestas' Construction and Installation document

[2] 'Vestas' Construction and Installation document

11.7.12 *VSR Assessment*

The following factors have been considered in the visual impact assessment.

VSR Sensitivity

The first set of criteria relate to the sensitivity of the VSRs. They include:

- Value and quality of existing views;
- Type and estimated number of receiver population;
- Duration of frequency of view; and
- Degree of visibility.

The views available to the identified VSRs were rated in accordance with their sensitivity to change using high, medium or low and are defined as follows:

- High
  - i. The nature of the viewer groups who expect a high degree of control over their immediate environment; and
  - ii. The viewer groups are in close proximity to the Proposed Development.
- Medium
  - iii. The nature of the viewer groups who have some degree of control over their immediate environment, eg people in transit.
- Low
  - iv. The nature of the viewer groups does not expect a high degree of control over their immediate environment.

It should be noted that the above only provides guidance, and each VSR regardless of type has been assessed according to its specific circumstances.

11.7.13 *Magnitude of Change*

This set of criteria is related to the specific details of the proposed development and how it relates to the existing landscape and the visible magnitude of change it will cause. The criteria to be assessed are:

- Compatibility of the Proposed Development with the surrounding landscape;
- Reversibility of change;
- Viewing distance;

- Potential blockage of view; and,
- Duration of impact under construction and operation phases.

The magnitude of change to a view was rated as large, intermediate, small or negligible and are defined as follows:

- Large: eg major change in view;
- Intermediate: eg moderate change in view;
- Small: eg minor change in view; and,
- Negligible: eg no discernible change in view.

The degree of visual impact or significance threshold was rated in a similar fashion to the landscape impact, ie significant, moderate, slight and negligible. Where the matrix table indicates a range within the significance threshold, eg; *Moderate – Significant*, the final significance threshold is assigned based on the overall severity of the impact.

The visual impact is a product of the magnitude of change to the existing baseline conditions, the landscape context and the sensitivities of VSRs. The significance threshold of visual impact was rated for the construction phase and for Day 1 and Year 10 of the operation phase.

11.7.14 *Visual Impact Assessment from Visually Sensitive Receivers (VSR)*

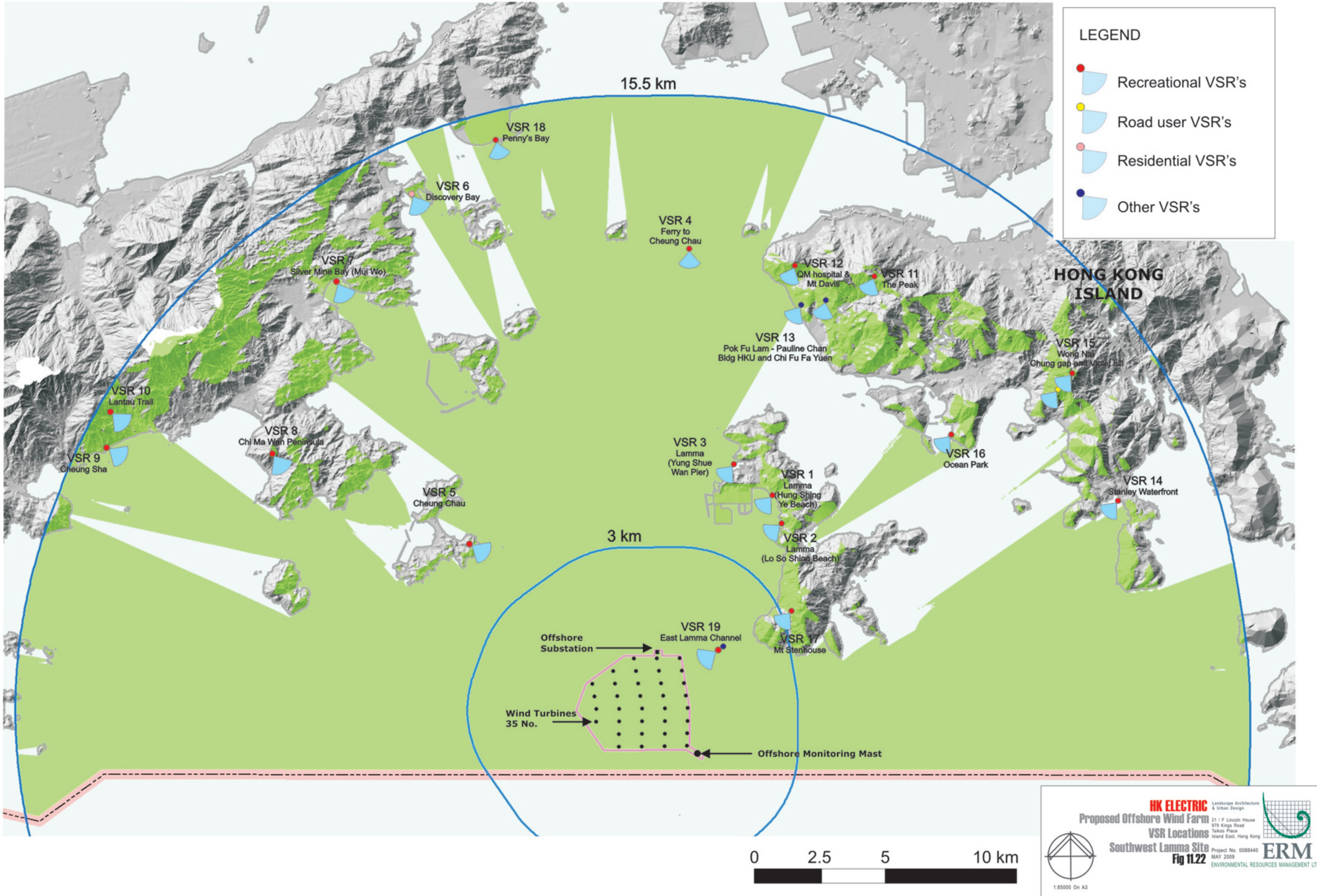
Figure 11.22 shows the locations of the VSRs from publicly accessible locations, which have been selected for analysis. The views of the wind farm have been selected to represent the range of views from accessible locations. In accordance with *EIAO Guidance Note No. 8/2002* Significance thresholds of residual impact (upon mitigation): Operation Day 1 and Year 10 are shown.

VSR1 – View from Lamma Island (Hung Shing Ye beach)

This VSR is located approximately 7 km north-east of the wind farm. This beach is a popular location on Lamma Island and contains recreational and permanent residential VSR's.

Table 11.10 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	Medium
Visitor numbers	High
Availability and amenity of alternative views	Low
Duration and frequency of views to development	Medium
Degree of visibility of Development	High
Sensitivity/Quality of VSR	High



LEGEND
Recreational VSR's
Road user VSR's
Residential VSR's
Other VSR's
15.5 km
3 km
VSR 18
Penny's Bay
VSR 6
Discovery Bay
VSR 4
Ferry to
Cheung Chau
VSR 7
Silver Mine Bay (Mui Wo)
VSR 12
QM hospital &
Mt Davis
VSR 11
The Peak
HONG KONG
ISLAND
VSR 13
Pok Fu Lam - Pauline Chan
Bldg HKU and Chi Fu Fa Yuen
VSR 15
Wong Nai
Chung gap and Violet hill
VSR 10
Lantau Trail
VSR 8
Chi Ma Wan Peninsula
VSR 9
Cheung Sha
VSR 3
Lamma
(Yung Shue
Wan Pier)
VSR 1
Lamma
(Hung Shing
Ye Beach)
VSR 16
Ocean Park
VSR 14
Stanley Waterfront
VSR 5
Cheung Chau
VSR 2
Lamma
(Lo So Shing Beach)
VSR 19
East Lamma Channel
VSR 17
Mt Stenhouse
Offshore
Substation
Wind Turbines
35 No.
Offshore Monitoring Mast
0
2.5
5
10 km
HK ELECTRIC
Proposed Offshore Wind Farm
VSR Locations
Southwest Lamma Site
Fig 11.22
Landscape Architecture
& Urban Design
21 / F Lincoln House
979 Kings Road
Taikoo Place
Island East, Hong Kong
Project No. 0088440
MAY 2009
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Table 11.10 shows the value and quality of view for these VSRs is considered medium as the Power Station is clearly visible on the right which detracts from the view quality. Visitor numbers are considered high as this is a popular destination, particularly on weekends. The availability and amenity of other views is considered low as the main view corridor is out to sea towards the wind farm. The duration and frequency of views is considered medium however the degree of visibility of the development will be high. The sensitivity of these VSRs is therefore considered high.

Table 11.11 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Medium	Medium
Viewing Distance to Proposed Development	7000 m	7000 m
Potential blockage of view	Low	Low
Duration of impacts	9 months	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Intermediate	Intermediate

Table 11.11 shows that the compatibility with the surrounding landscape is considered medium as the existing Power Station is within the view corridor. The potential blockage of view is considered low due to the slender design of the turbines, however due to the height, the scale of development is considered large. The magnitude of change is considered to be Intermediate.

Table 11.12 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-Significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.12 shows the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *moderate* towards the end of the construction process for the offshore wind farm site.

The onshore laydown area will be closer to the VSRs (approximately 1.4 km), and the height of the development will be a maximum of approximately 70 m. The partial construction of the turbines will also be adjacent to the existing Lamma Power Station, so the compatibility of the laydown area with the existing visual environment will be high. The visual impacts arising from the temporary onshore laydown area are therefore also expected to be *moderate*.

As the temporary laydown area will be sited on the existing Lamma Power Station extension, the surrounding topography will screen off any potential visual impact arising from this area, greatly reducing visual impacts to other VSRs.

Table 11.13 Significance Threshold during Operation

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">Sensitivity / Quality</th><th rowspan="2">Beneficial</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td rowspan="4">Magnitude of Change</td><td>Large</td><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><td>Intermediate</td><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><td>Small</td><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><td>Negligible</td><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

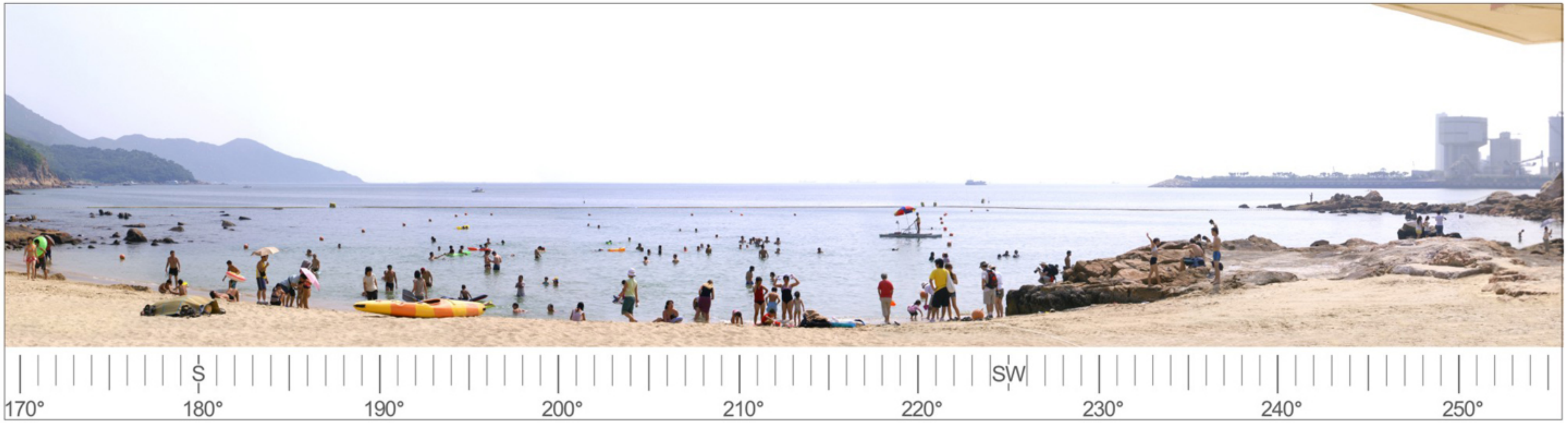
Figure 11.23 shows a photomontage of the view of the wind farm from this location. It is important to note the two contrasting elements within this field of view, the peaks of Lamma Island on the left and the Power Station to the right. The above assessment shows that due to the high numbers of visitors, and high quality view afforded from this location that the sensitivity of this VSR is medium. The combination of the wind turbines being located over 7 kilometres away and the existing Power Station in the view results in an intermediate magnitude of change. *Table 11.13* shows the resulting significance threshold for this VSR is considered to be *moderate* adverse during operation.

VSR2 – View from Lo So Shing Beach

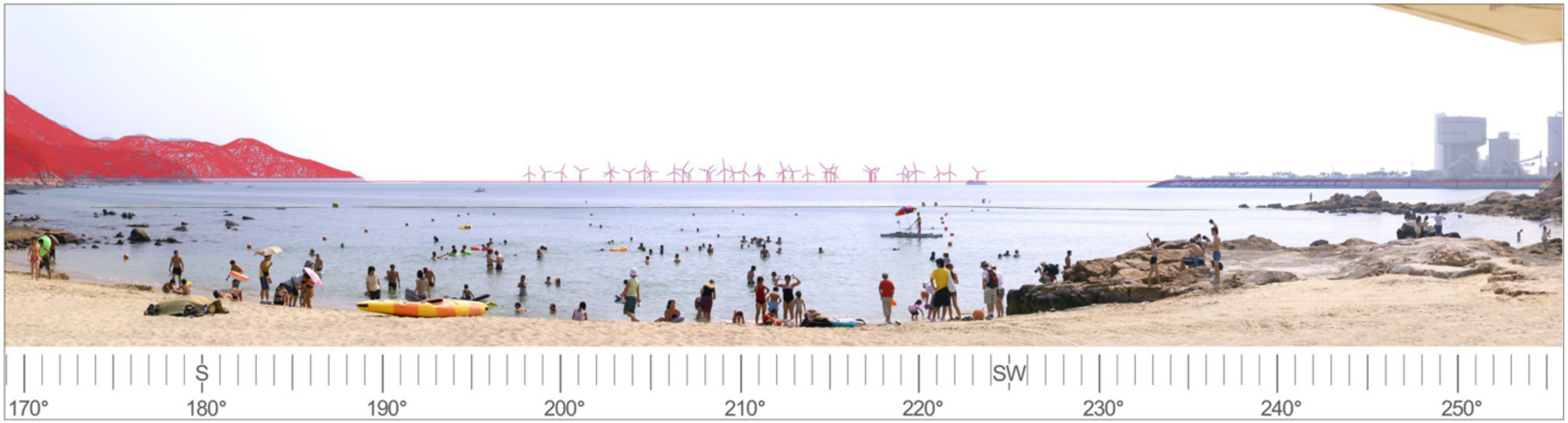
This VSR is located approximately 5.5 km north-east of the wind farm. This beach is a more secluded location on Lamma Island, with low visitor numbers and contains recreational and permanent residential VSR's.

Table 11.14 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Visitor numbers	Low
Availability and amenity of alternative views	Low
Duration and frequency of views to development	Medium
Degree of visibility of Development	High
Sensitivity/Quality of VSR	Medium



VSR 1- View from Hung Shing Ye Beach - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

HK ELECTRIC
Proposed Offshore Wind Farm
VSR-1 Photomontage From
Hung Shing Ye Beach, Lamma

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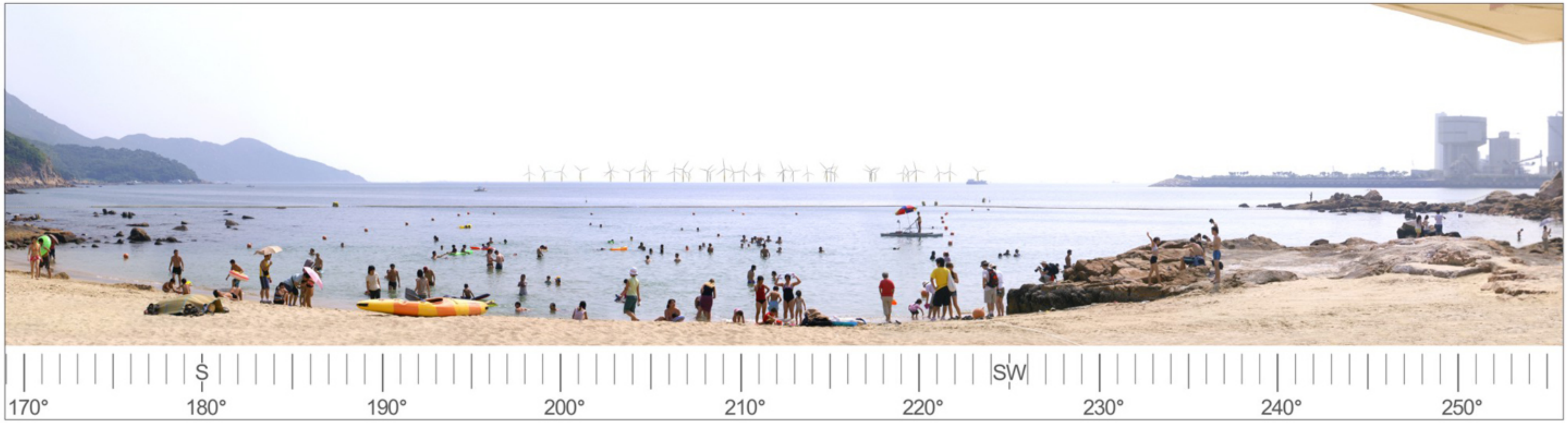
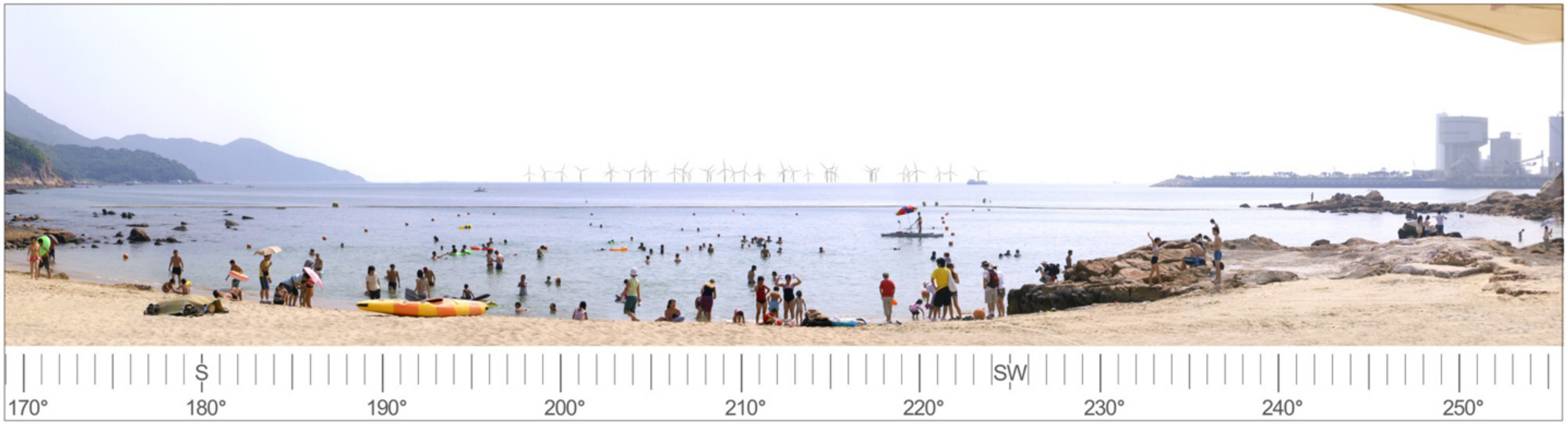
Fig 11.23



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

Key Plan

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Fig 11.23

Table 11.14 shows the value and quality of view for these VSRs is considered high as this beach looks to the west and the Power Station is a greater distance away. Visitor numbers are considered low as this is a more remote and secluded beach on Lamma. The availability and amenity of other views is considered low as the main view corridor is out to sea. However, the wind farm will be to the left of the view as opposed to Hung Shing Ye beach where the Wind Farm is directly in front. The duration and frequency of views is considered medium however the degree of visibility of the development will be high. The sensitivity of these VSRs is therefore considered medium.

Table 11.15 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Medium	Medium
Viewing Distance to Proposed Development	5500 m	5500 m
Potential blockage of view	Low	Low
Duration of impacts	9 months	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Large	Large

Table 11.15 shows that the compatibility with the surrounding landscape is considered medium as the existing Power Station is within the view corridor to the right. The potential blockage of view is considered low due to the slender design of the turbines, however due to the height, the scale of development is considered large. The magnitude of change is considered to be Large.

Table 11.16 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-Significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.16 shows the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to m*oderate adverse* towards the end of the construction process for the offshore wind farm site.

As the temporary laydown area will be sited on the existing Lamma Power Station extension, the surrounding topography will screen off any potential visual impact arising from this area, greatly reducing visual impacts to other VSRs.

Table 11.17 ***Significance Threshold during Operation***

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Figure 11.24 shows a photomontage of the view of the wind farm from Lo So Shing beach. It is important to note that from Lo So Shing beach, the wind farm will be to the left of the view corridor and it is likely that not all turbines will be visible from this beach. The above assessment shows that due to the low numbers of visitors, but high quality view afforded from this location that the sensitivity of this VSR is medium. The combination of the wind turbines being located approximately 5 kilometres away results in a large magnitude of change. *Table 11.17* shows the resulting significance threshold for this VSR is considered to be *moderate* adverse during operation.

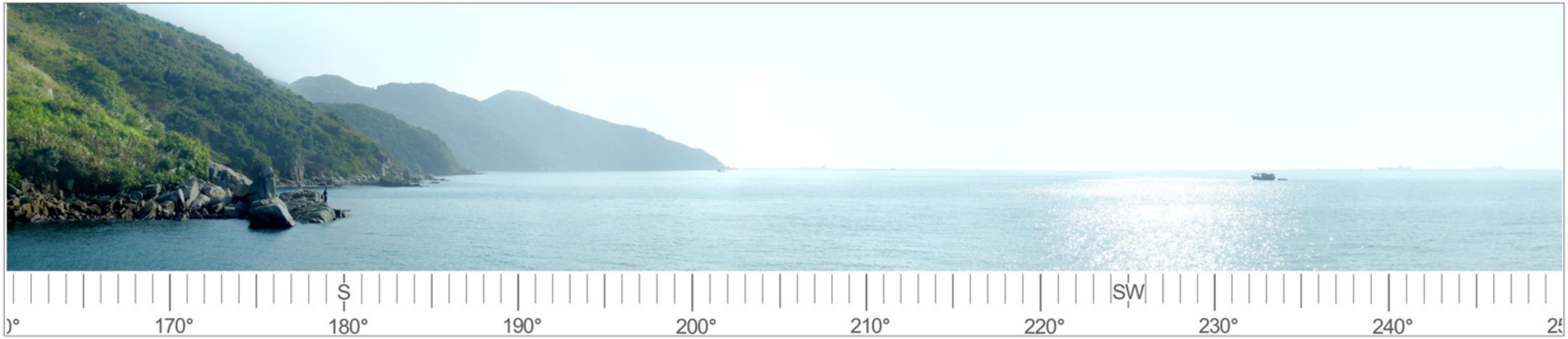
VSR3 – View from Yung Shue Wan ferry Pier

This VSR is located at about 6.2 km north-east of the wind farm site. The ferry pier has high numbers of visitors and the ferry from this location is the most frequent method of transport for both residents and tourists to Lamma Island.

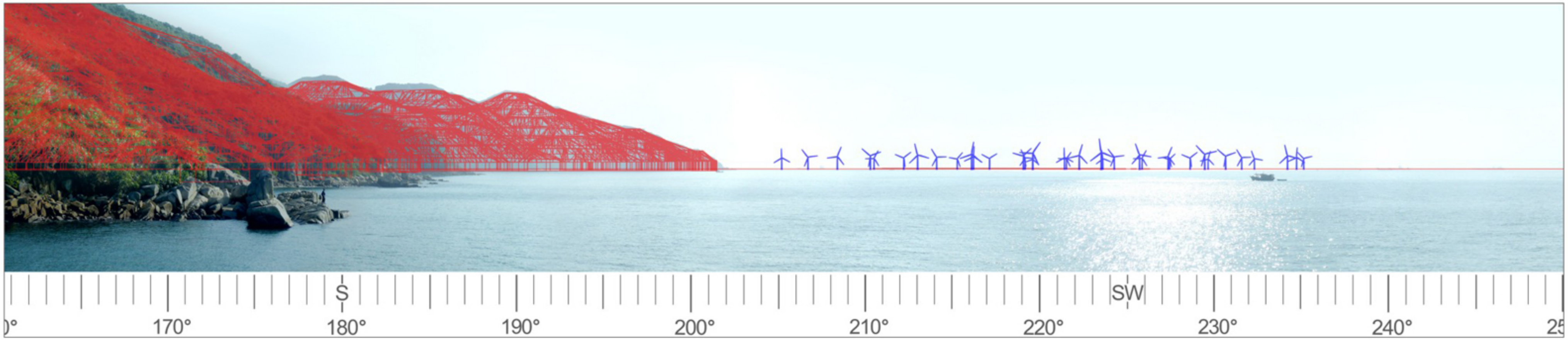
Table 11.18 ***Sensitivity / Quality***

Items	**Sensitivity / Quality**
Value and quality of view	Medium
Visitor numbers	High
Availability and amenity of alternative views	High
Duration and frequency of views to development	Low
Degree of visibility of Development	Nil
Sensitivity/Quality of VSR	Medium

Table 11.18 shows that the value and quality of view is considered medium particularly in closer proximity to Lamma Island. Whilst there are high visitor numbers to this location, they are all transient and the availability and



VSR 2 - View from Lo So Shing Beach - Existing condition at the Development Site.



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VSR-2 Photomontage From
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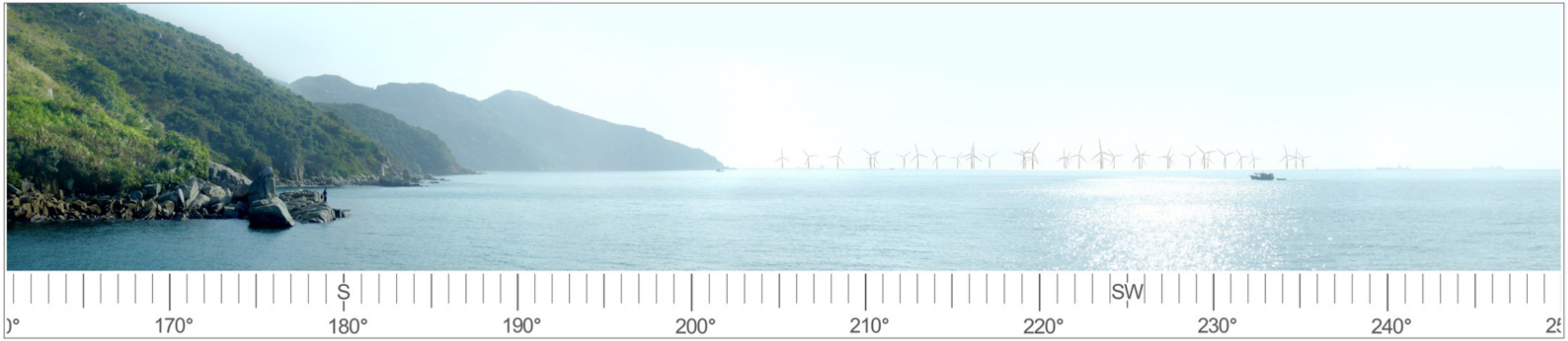
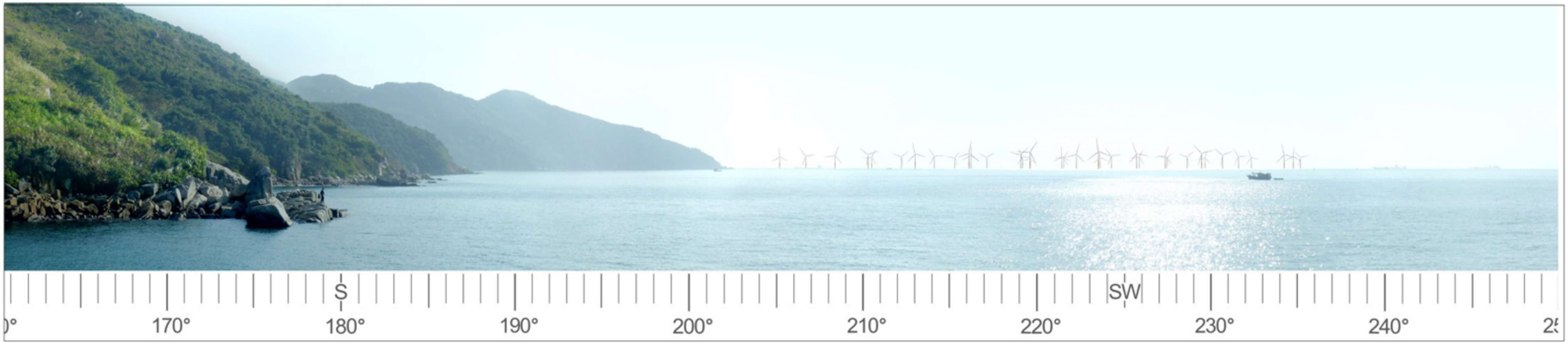
Fig 11.24



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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Fig 11.24

amenity of alternative views is high in the changing view corridor. The duration and frequency of views to the development is low as the existing landforms screen the development from these VSRs. This results in a *medium* sensitivity for these VSRs.

Table 11.19 *Magnitude of Change*

Items	Construction	Operation
Compatibility with surrounding landscape	Moderate	Moderate
Viewing Distance to Proposed Development	6200 m	6200 m
Potential blockage of view	Low	Low
Duration of impacts	9 months	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Negligible	Negligible

Table 11.19 shows the wind farm is not visible for these VSRs at this location resulting in a negligible magnitude of change.

Table 11.20 *Significance Threshold during Construction*

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Neither the onshore laydown area nor the offshore wind farm construction site will be visible for these VSRs. *Table 11.20* shows that during construction the significance threshold will be *negligible.*

Table 11.21 Significance Threshold during Operation

<table>
<tr><td colspan="2" rowspan="2"></td><th colspan="3">Sensitivity / Quality</th><th rowspan="2">Beneficial</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><th rowspan="4">Magnitude of Change</th><th>Large</th><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><th rowspan="2">Neither beneficial nor adverse</th></tr>
<tr><th>Intermediate</th><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><th>Small</th><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><th rowspan="2">Adverse</th></tr>
<tr><th>Negligible</th><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

Figure 11.25 shows that the wind turbines will not be visible from this location. Whilst the sensitivity of the VSRs is considered medium, mainly due to the high visitor numbers, there is a negligible magnitude of change. *Tables 11.20* and *11.21* show the significance threshold for this VSR during construction and operation will be *negligible.*

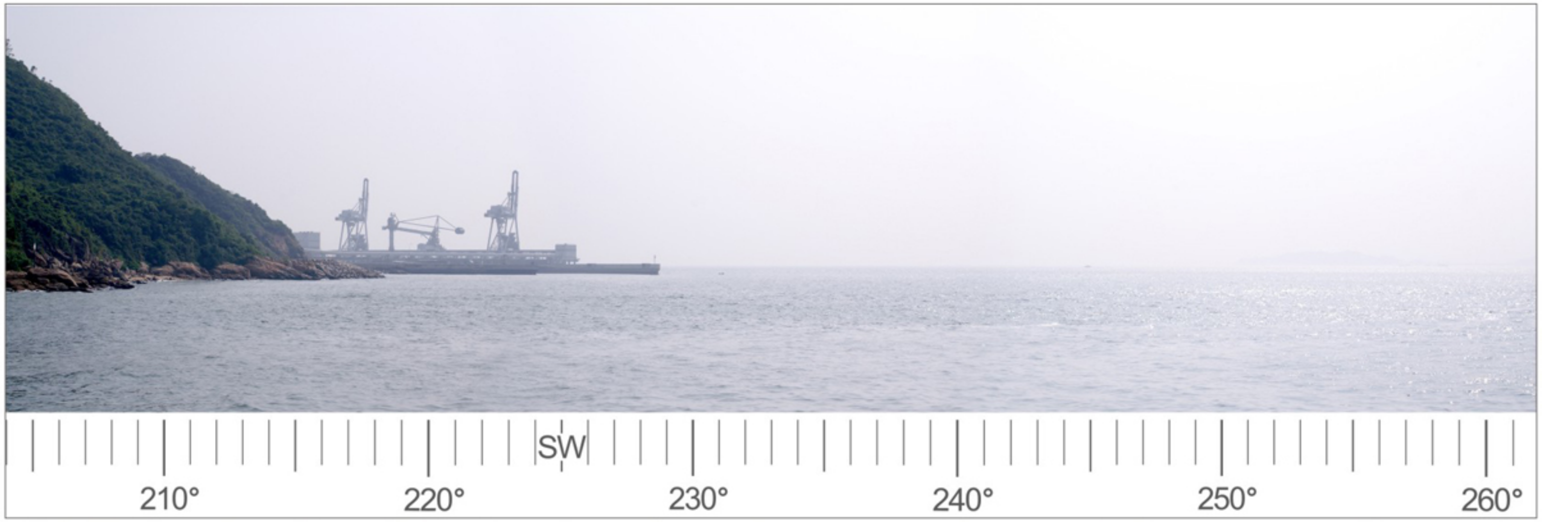
VSR4 – View from Ferry to Cheung Chau

This VSR is located at approximately 11.5 km north of the wind farm. The VSRs in this location are both recreational, visitors travelling to Cheung Chau, and residential, residents travelling to and from their homes on Cheung Chau.

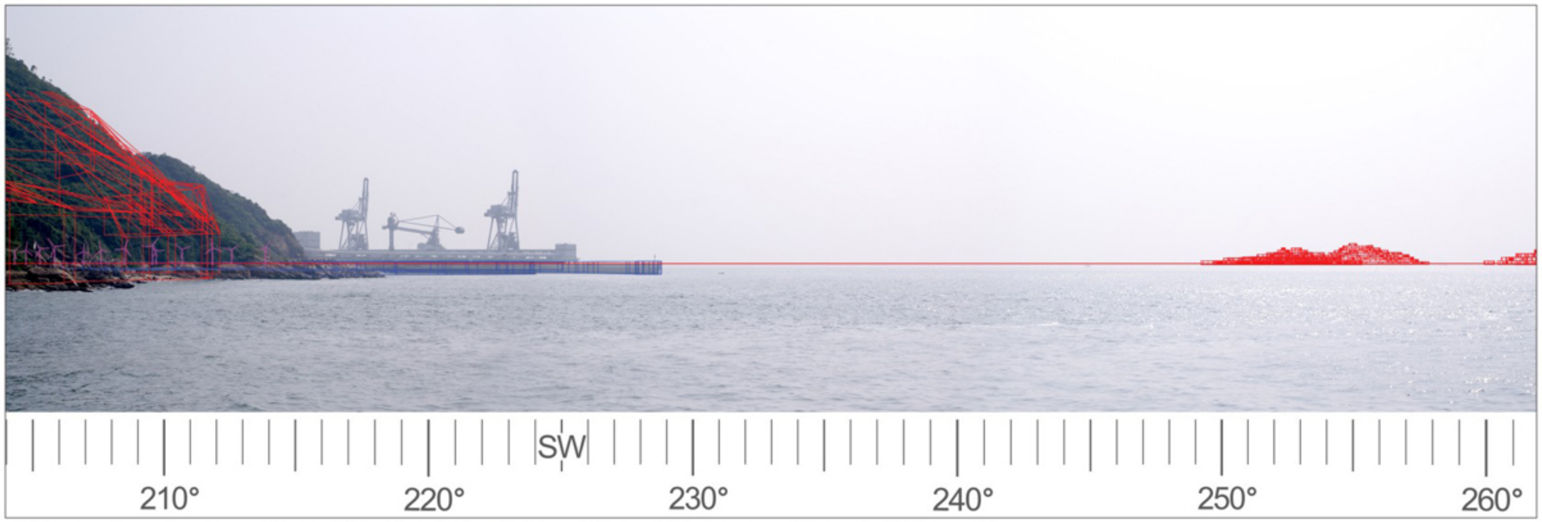
Table 11.22 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Visitor numbers	Medium
Availability and amenity of alternative views	High
Duration and frequency of views to development	Medium
Degree of visibility of Development	Medium
Sensitivity/Quality of VSR	Medium

Table 11.22 shows that whilst the value and quality of view is considered to be high, the medium visitor numbers are transient with a high availability and amenity of other views. The duration and frequency of views to the development is medium as the view corridor is constantly changing. The degree of visibility of the development is also considered medium. This results in a medium sensitivity for these VSRs.



VSR 3- View from Yung Shue Wan Ferry Pier - Existing condition at the Development Site.



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VSR-3 Photomontage From
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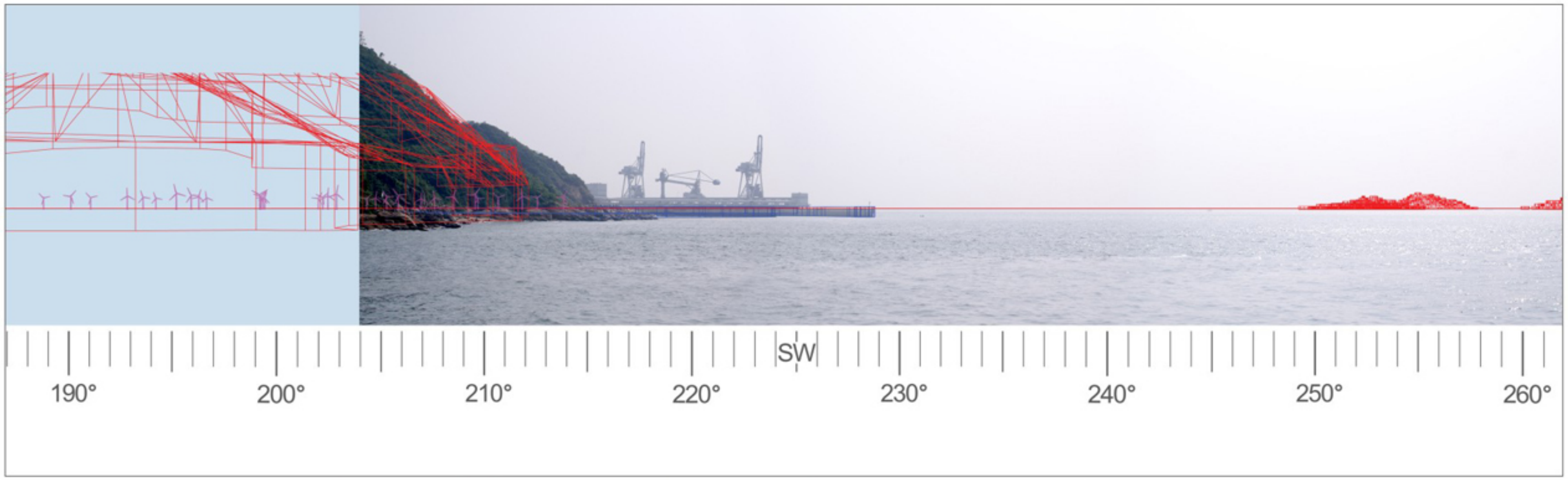
Fig.11.25

View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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Fig.11.25

Table 11.23 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	11,500 m	11,500 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

The wind farm is generally considered to have a low compatibility with the surrounding landscape. However, it could be argued that a higher compatibility could be valid as the Power Station is clearly visible. Due to the large distance and low potential blockage of view the magnitude of change is considered small.

Table 11.24 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.24 shows the significance threshold of the wind farm during construction. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts arising from both the onshore laydown site and the offshore wind farm site will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

Table 11.25 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.26* shows the view towards the wind farm from this location. The sensitivity of these VSRs is considered to be medium, mainly due to the medium degree of visibility of the wind farm, and the medium visitor numbers. The magnitude of change is considered to be small due to the long distance to the wind turbines and the small scale of development from this distance. *Table 11.25* shows the resulting significance threshold for operation is considered to be *slight adverse*.

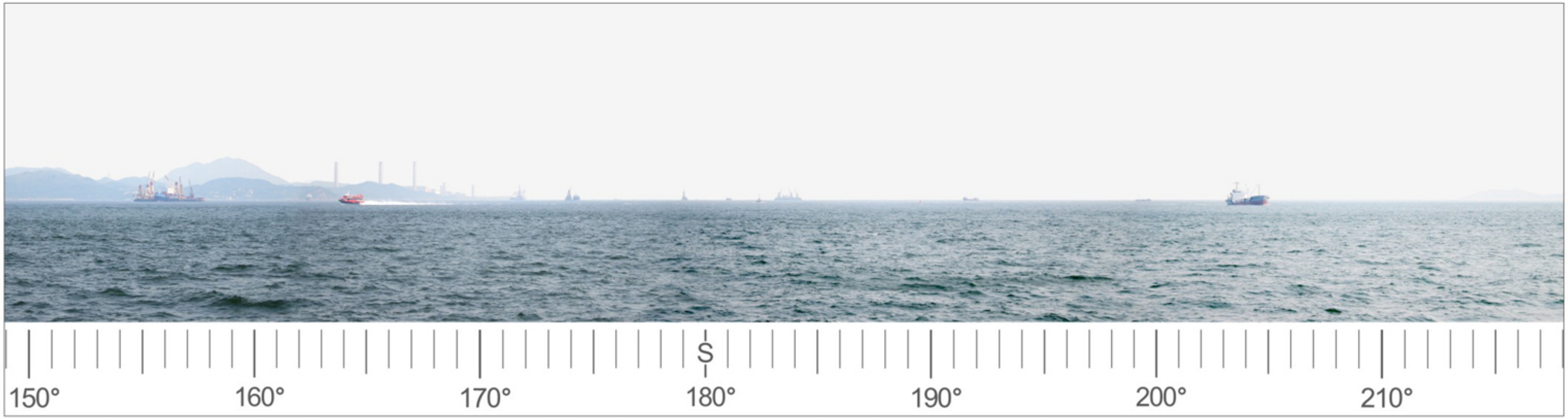
VSR5 – View from Cheung Chau

These VSRs are located approximately 5.3 km north west of the wind farm at the closest point. There are both recreational VSRs, mainly walkers particularly along Peak Road West, and residential VSRs located in the vicinity.

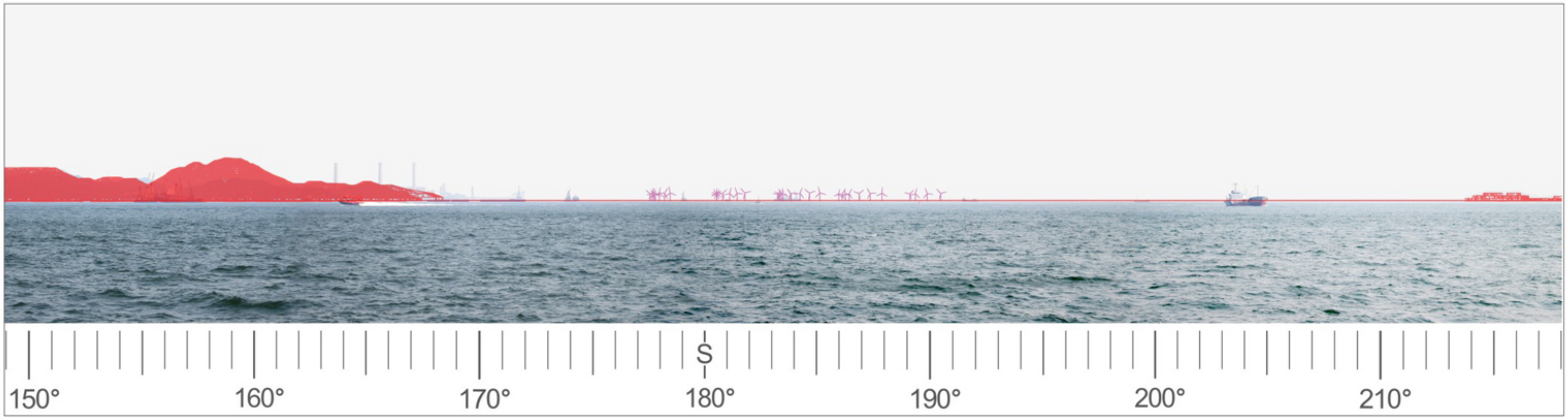
Table 11.26 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	Low
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	High
Degree of visibility of Development	High
Sensitivity/Quality of VSR	High

Table 11.26 shows the value and quality of the view is considered to be high and there will be high duration and frequency of views to the wind turbines. This results in a high sensitivity for these VSRs.



VSR 4- View from Ferry to Cheung Chau - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

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VSR-4 Photomontage From
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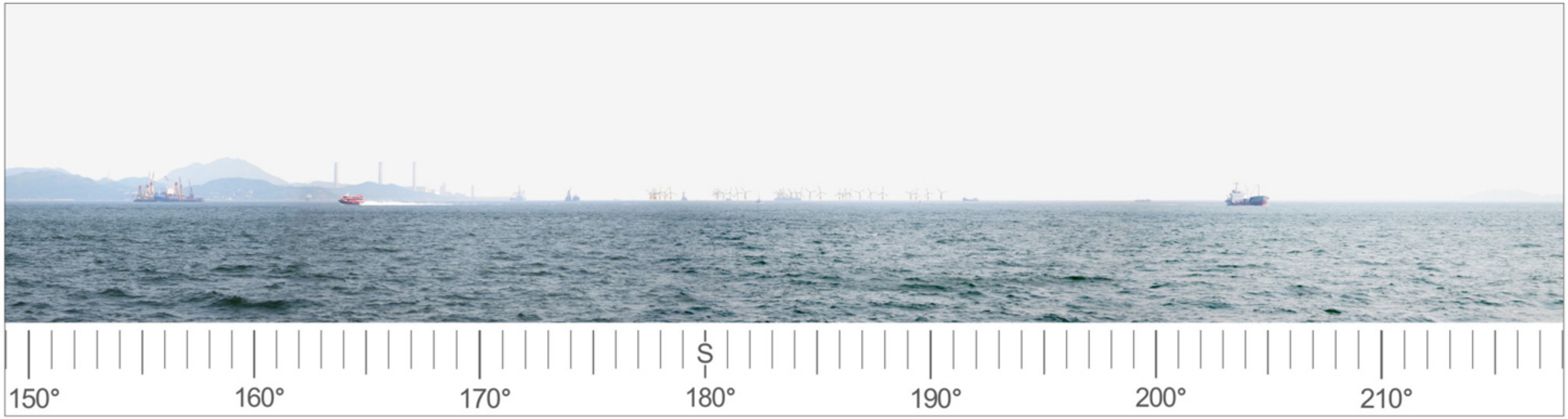
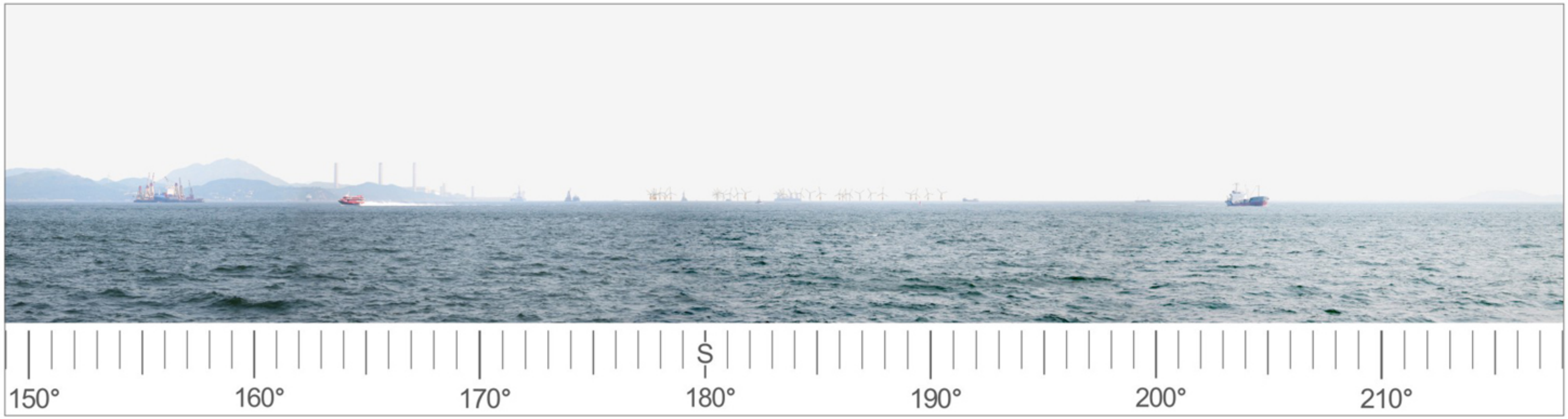
Fig 11.26



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

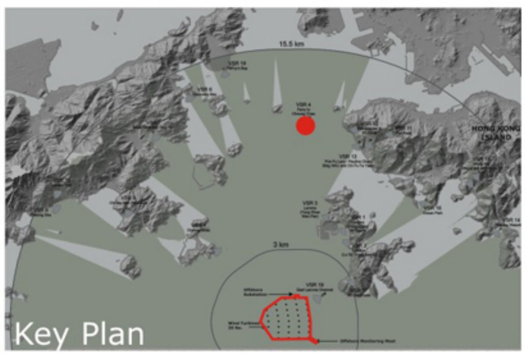


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Fig 11.26

Table 11.27 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	5300 m	5300 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Medium	Medium

Table 11.27 shows that whilst the compatibility of the wind turbines is low for these VSRs, there is also a low potential blockage of view due to the slender design of the turbines. The turbines are also over 5 kilometres away, reducing their visibility. The magnitude of change is considered medium for these VSRs.

Table 11.28 Significance Threshold during Construction

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">Sensitivity / Quality</th><th rowspan="2">Beneficial</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><th rowspan="4">Magnitude of Change</th><th>Large</th><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><th>Intermediate</th><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><th>Small</th><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><th>Negligible</th><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

Table 11.28 shows the significance threshold of the wind farm during construction. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts arising from both the onshore laydown and offshore wind farm sites will increase from *negligible* at the beginning of construction, to *moderate adverse* towards the end of the construction process.

Table 11.29 Significance Threshold during Operation

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.27* shows the wind farm from this location. The sensitivity of these VSRs is considered high due to the high quality of the view with relatively few man-made objects in the field of view. Due to the wind farm being over 5 kilometres away, the magnitude of change is considered to be medium. *Tables 11.28 and 11.29* show the resulting significance threshold during both construction and operation is considered to be *moderate adverse.*

VSR6 – View from Discovery Bay

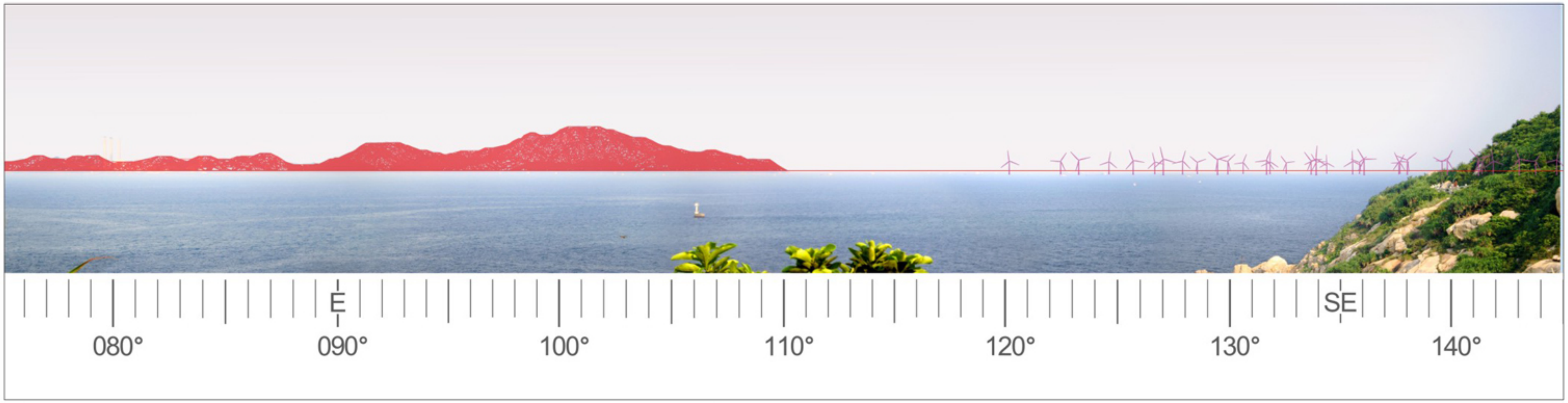
These VSRs are located approximately 13 km north of the wind farm. These VSRs are mainly residential and are high in number.

Table 11.30 Sensitivity / Quality

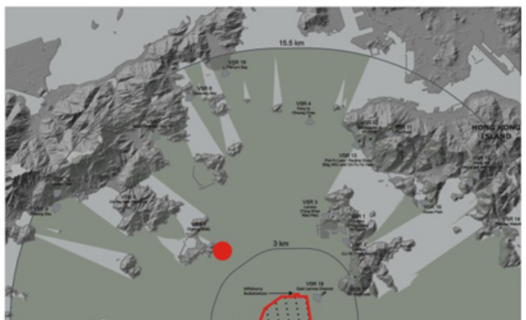
Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	High
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Medium
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	High

Table 11.30 shows the value and quality of view is considered high as it overlooks the waters and offshore water ways of this region of Hong Kong. The number of VSRs is also considered high as it is a popular residential area. The duration and frequency of views to the development is considered medium as the wind farm is located to the south east and is obscured by the existing Islands. The degree of visibility is therefore also considered low. The overall sensitivity is considered *high* for these VSRs.

VSR 5- View from Cheung Chau Lookout - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation



Key Plan

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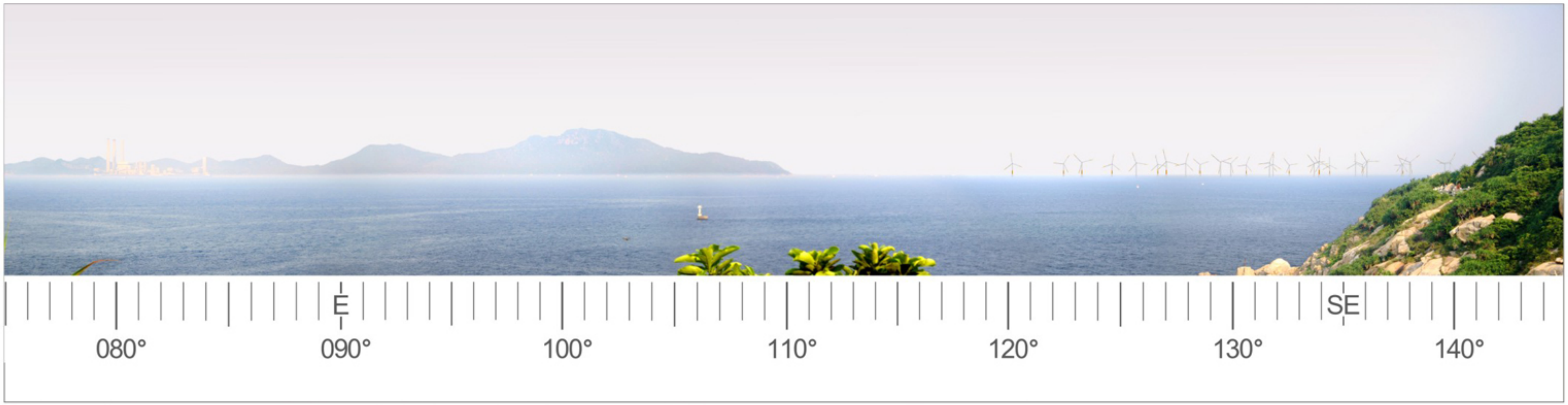
Fig 11.27

View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

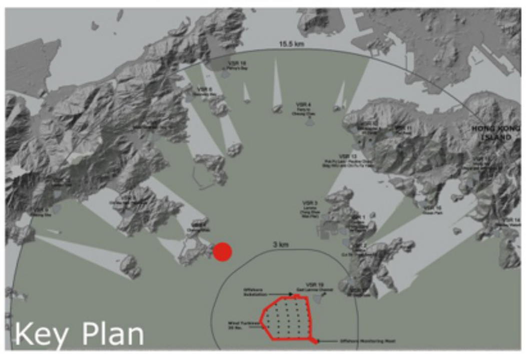


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Fig 11.27

Table 11.31 *Magnitude of Change*

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	13,070 m	13,070 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.31 shows the magnitude of change is considered small due to the long distance to the wind turbines and the low potential blockage of view.

Table 11.32 *Significance Threshold during Construction*

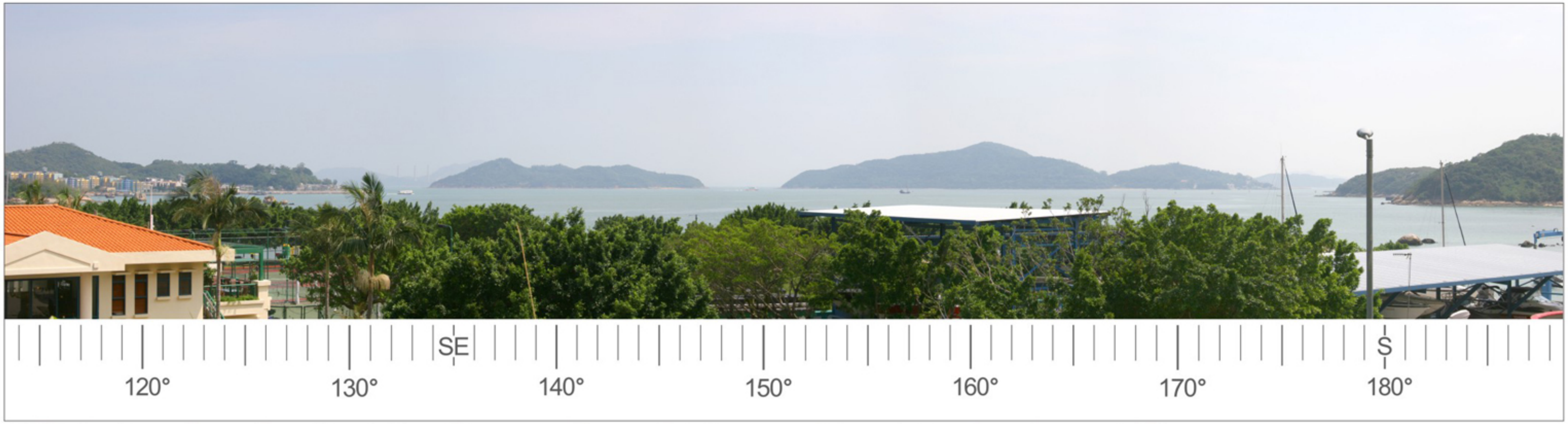
		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.32 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *moderate adverse* towards the end of the construction process.

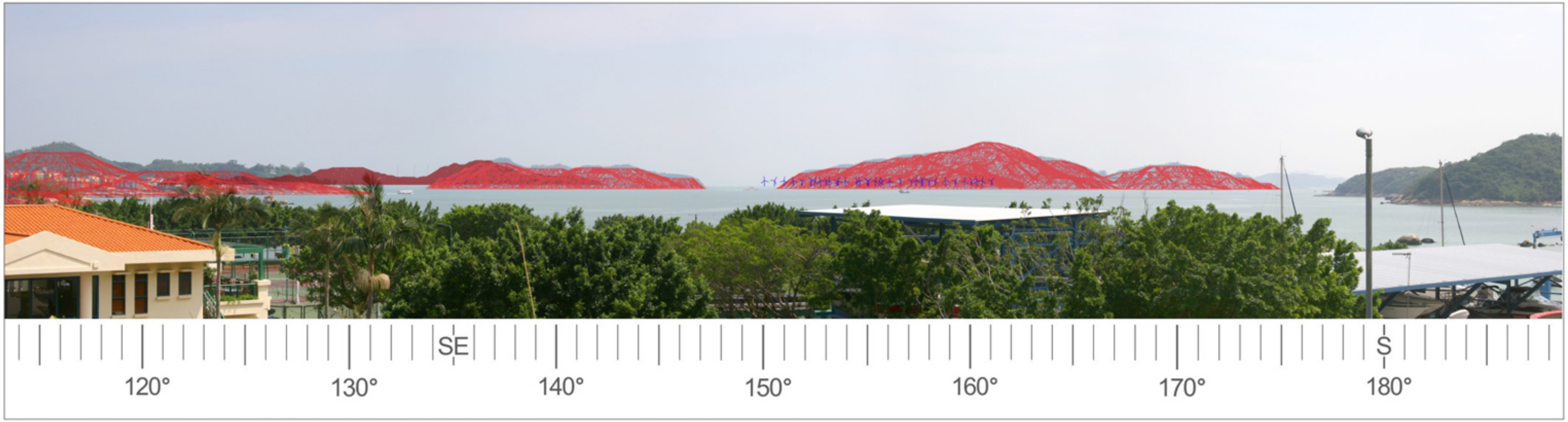
Table 11.33 *Significance Threshold during Operation*

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.28* shows the wind farm from this location. The sensitivity of these VSRs is considered high mainly due to the fact that



VSR 6 - View from Coastline Villa, Discovery Bay - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

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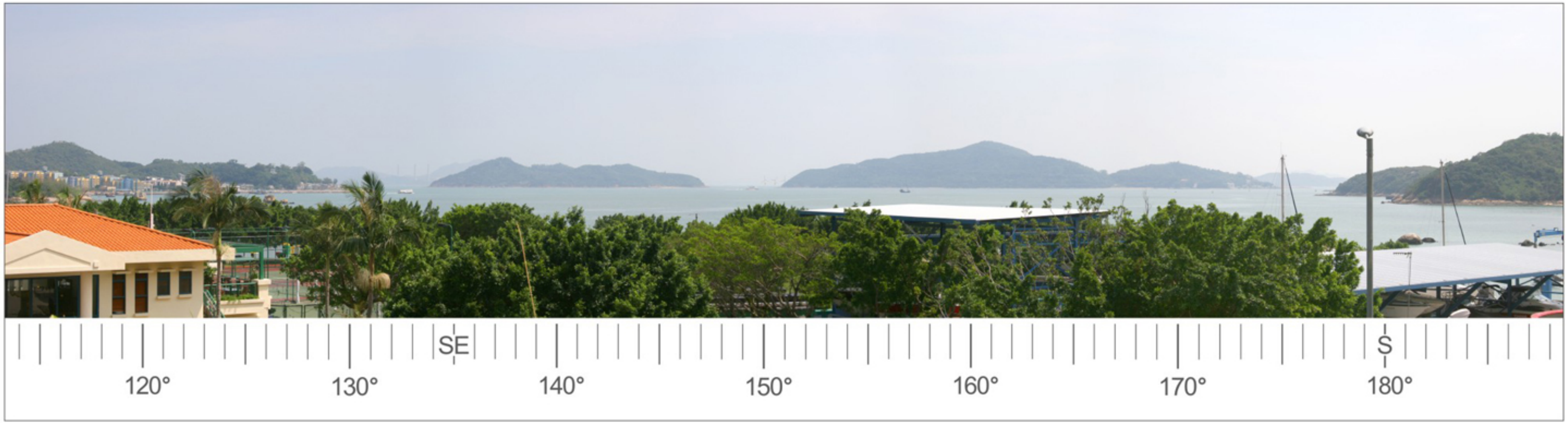
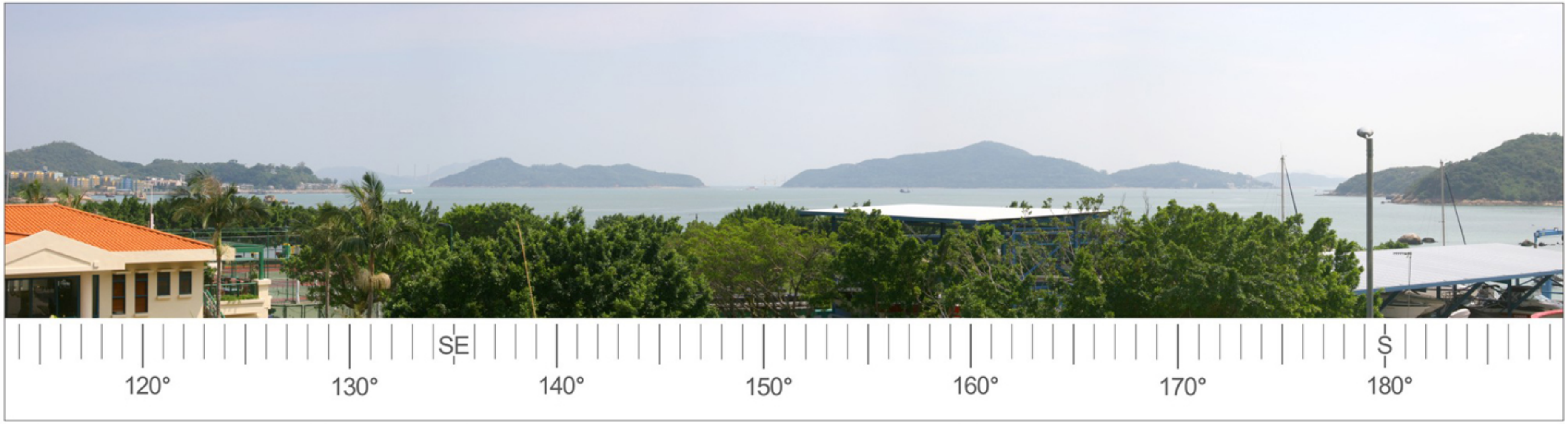
Fig 11.28



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

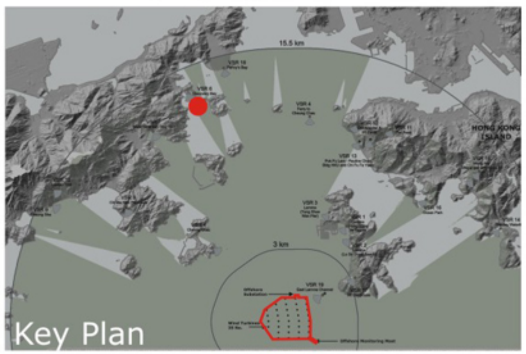


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Fig 11.28

there are large numbers of residential VSRs in this location. However, there is a relatively large distance to the wind farm, over 13 kilometres. In addition, many of the turbines are obscured by Hei Ling Chau. As a result, the magnitude of change is considered small. Whilst the above matrices in *Tables 11.32* and *11.33* would indicate that the significance threshold is moderate adverse for these VSRs, the photomontage shows that the wind farm will be barely discernible. Therefore the significance threshold is reduced to slight adverse for both construction and operation.

VSR7 - View from Silvermine Bay (Mui Wo)

These VSRs are located approximately 10 km north west of the wind farm. These VSRs are both residential and recreational and whilst numbers vary they can be high during peak hour transit and holiday periods.

Table 11.34 Sensitivity / Quality

Items	**Sensitivity / Quality**
Value and quality of view	High
Number of VSR	Large
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	High
Degree of visibility of Development	Medium
Sensitivity/Quality of VSR	High

Table 11.34 shows the value and quality of view is considered high as it overlooks the islands and inshore water ways of this region of Hong Kong. The number of VSRs is also considered high as it is a popular residential area and tourist destination. The duration and frequency of views to the development is considered high as the wind farm is clearly visible, albeit from a relatively long distance.. The degree of visibility is therefore considered medium. The overall sensitivity is considered *High* for these VSRs.

Table 11.35 Magnitude of Change

Items	**Construction**	**Operation**
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	10,100 m	10,100 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.35 shows the magnitude of change is considered small due to the long distance to the wind turbines and the low potential blockage of view.

Table 11.36 Significance Threshold during Construction

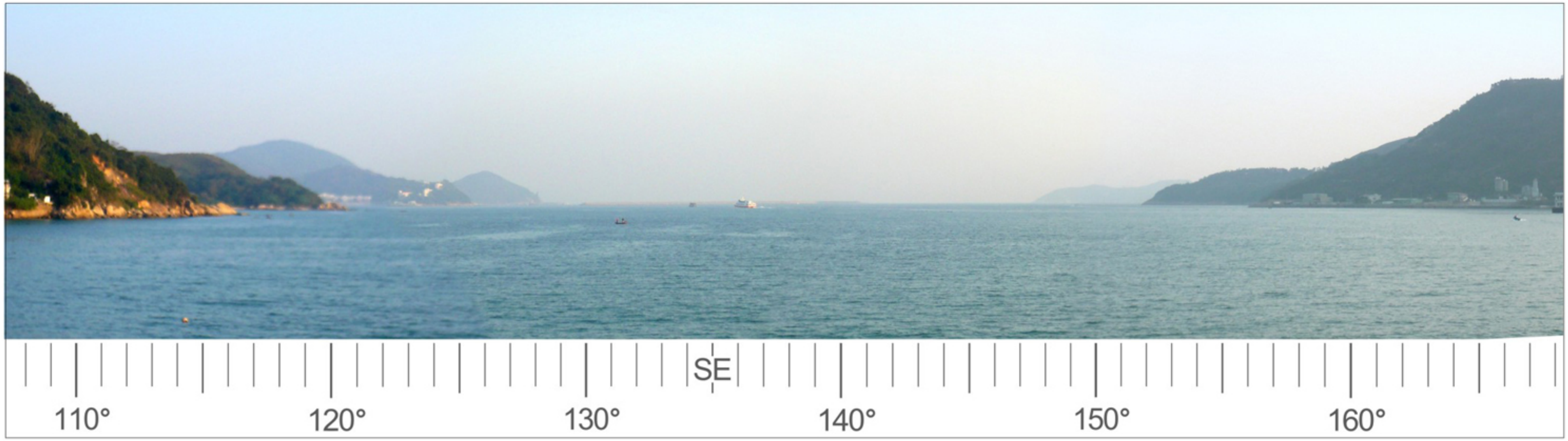
		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.36 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *moderate adverse* towards the end of the construction process.

Table 11.37 Significance Threshold during Operation

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.29* shows the wind farm from this location. The sensitivity of these VSRs is considered high mainly due to the fact that there are large numbers of residential VSRs in this location. However, there is a relatively large distance to the wind farm, over 10 kilometres. In addition, many of the turbines are obscured by Hei Ling Chau. As a result, the magnitude of change is considered small. Whilst the above matrices in *Tables 11.36* and *11.37* would indicate that the significance threshold is moderate adverse for these VSRs, the photomontage shows that the wind farm will be barely discernible. Therefore the significance threshold is reduced to *slight* adverse for both construction and operation.



VSR 7 - View from Silver Mine Bay - Existing condition at the Development Site.

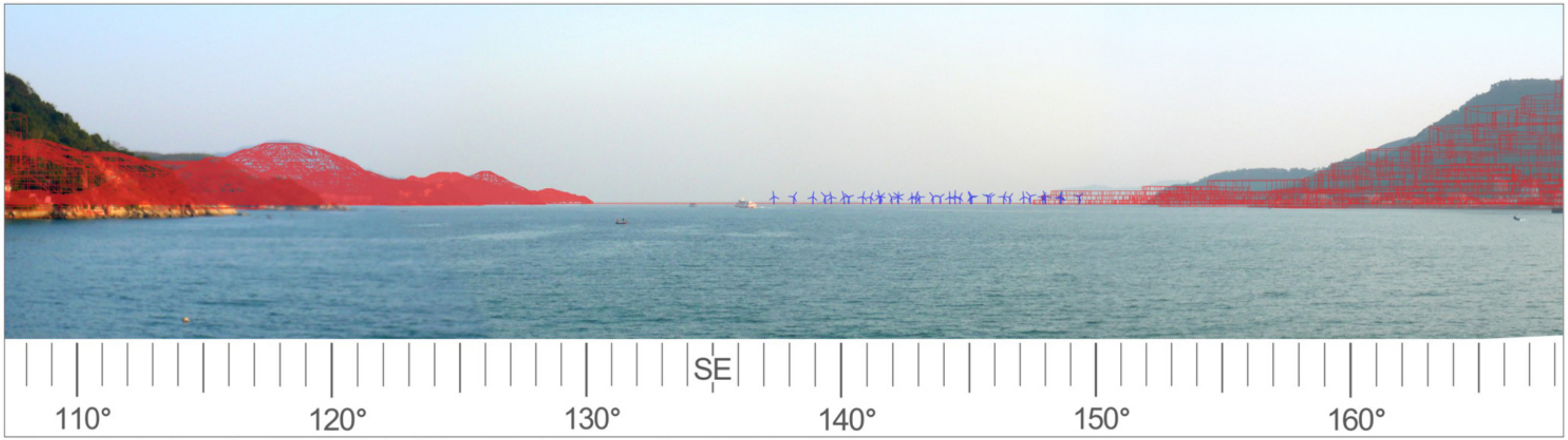


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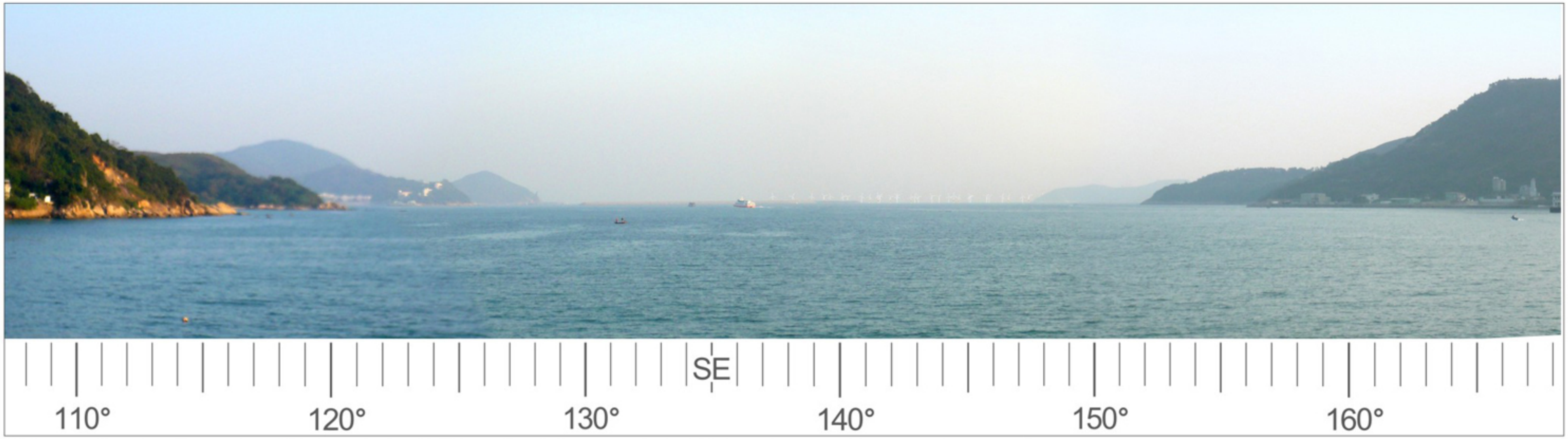
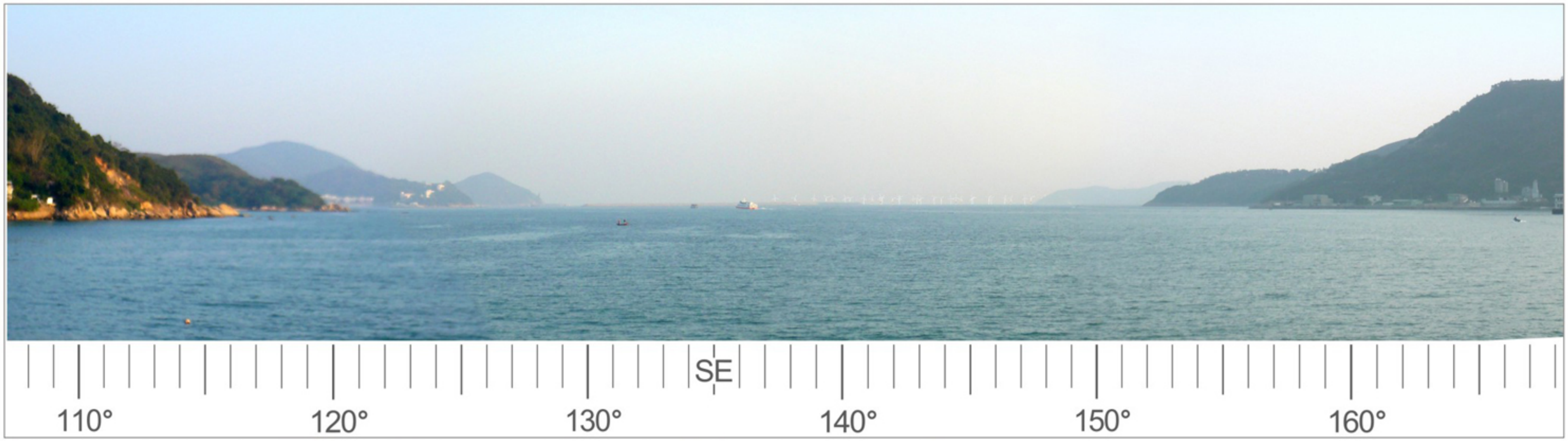
Fig 11.29



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

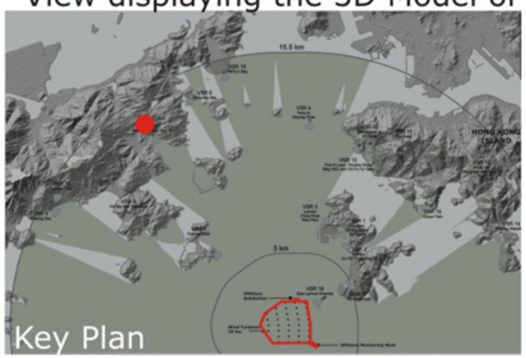


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Fig 11.29

VSR8 - View from Chi Ma Wan Peninsula

These VSRs are located approximately 8 km north west of the wind farm. These VSRs are mostly recreational and the walking trails in the area and destinations such as Yi Long Wan. Due to the relatively remote location, visitor numbers are generally low.

Table 11.38 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	Low
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	Medium

Table 11.38 shows the value and quality of view is considered high as it overlooks the isalnds and inshore water ways of this region of Hong Kong. The number of VSRs is also considered small due to the relatively difficulty in accessing this location. The duration and frequency of views to the development is considered low as the wind farm is located to the south east and is obscured by the existing Islands. The degree of visibility is therefore also considered low. The overall sensitivity is considered *Medium* for these VSRs.

Table 11.39 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	8,100 m	8,100 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.39 shows the magnitude of change is considered small due to the long distance to the wind turbines and the low potential blockage of view.

Table 11.40 Significance Threshold during Construction

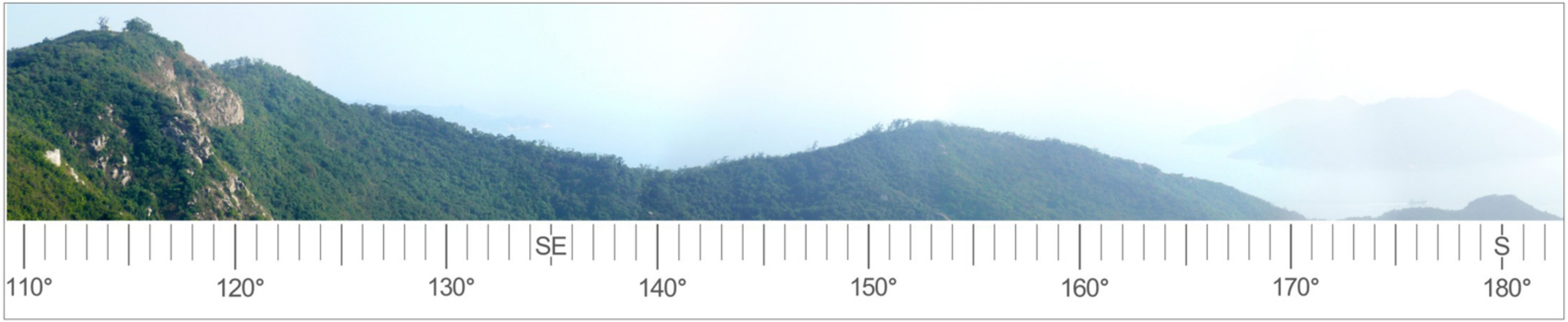
		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11. 40 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

Table 11.41 Significance Threshold during Operation

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.30* shows the wind farm from this location. The sensitivity of these VSRs is considered medium mainly due to the low visitor numbers. However, there is a relatively large distance to the wind farm, over 8 kilometres. In addition, many of the turbines will be obscured by intervening topography and offshore islands such as Hei Ling Chau. As a result, the magnitude of change is considered small. Therefore the significance threshold is considered *slight* adverse for both construction and operation.



VSR 8 - View from Chi Ma Wan Peninsula - Existing condition at the Development Site.

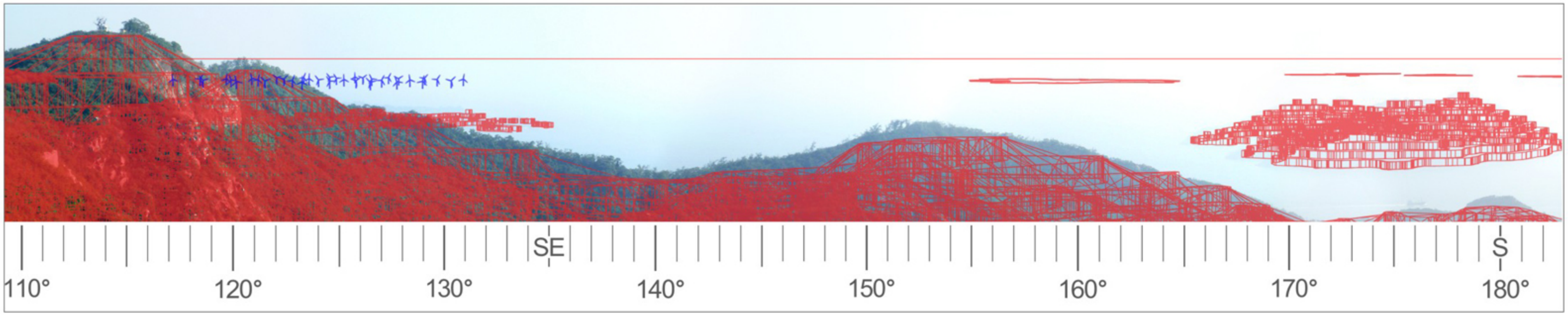


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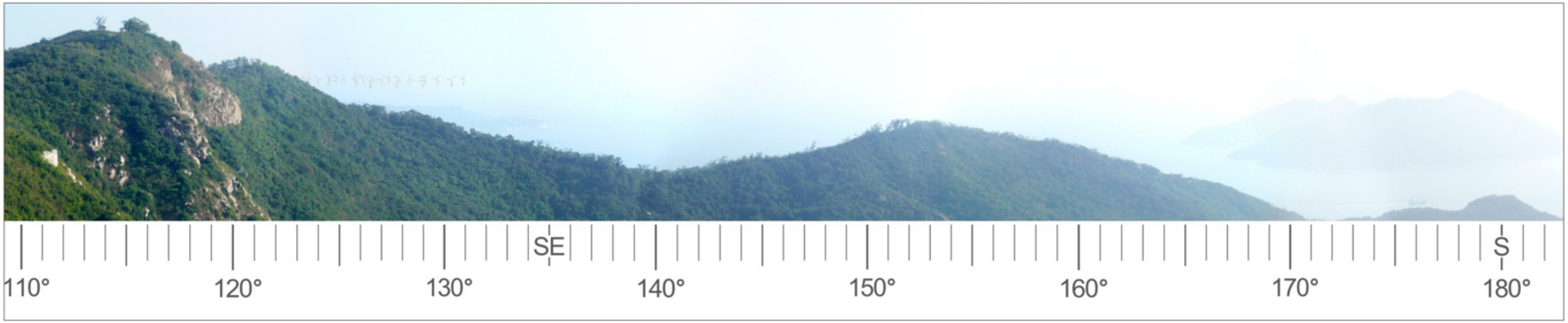
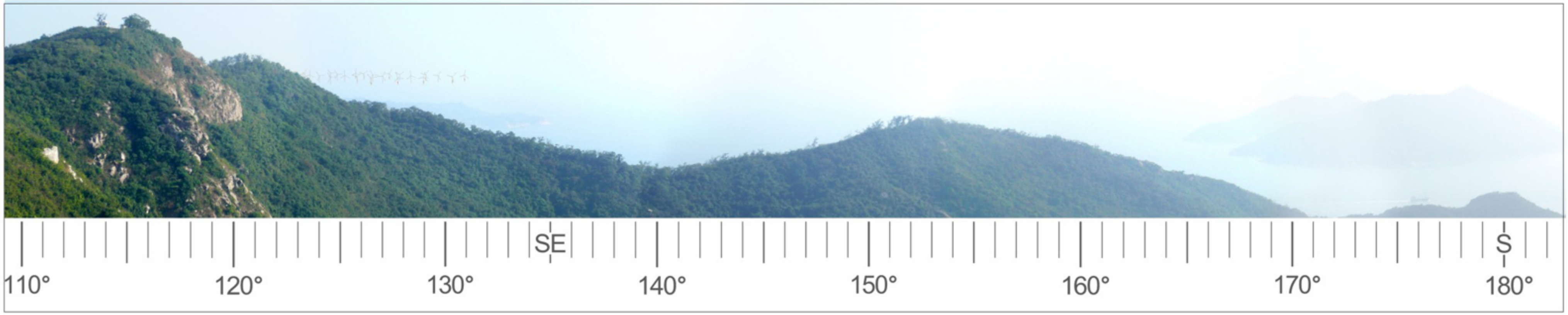
Fig 11.30



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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Fig 11.30

VSR9 - View from Cheung Sha

These VSRs are located approximately 14 km north west of the wind farm. These VSRs are both residential and recreational. There are medium numbers of these VSRs

Table 11.42 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	Medium
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	Medium

Table 11.42 shows the value and quality of view is considered high as it overlooks the islands and inshore water ways of this region of Hong Kong. The number of VSRs is also considered medium and comprises of both recreational visitors and residents in the surrounding Cheung Sha village. The duration and frequency of views to the development is considered low as the wind farm is located to the south east and is obscured by the existing Islands. The degree of visibility is therefore also considered low. The overall sensitivity is considered *Medium* for these VSRs.

Table 11.43 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	14,400 m	14,400 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.43 shows the magnitude of change is considered small due to the long distance to the wind turbines and the low potential blockage of view.

Table 11.44 Significance Threshold during Construction

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Sensitivity / Quality</td><td rowspan="2">Beneficial</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="4">Magnitude of Change</td><td>Large</td><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><td>Intermediate</td><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><td>Small</td><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><td>Negligible</td><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

Table 11.44 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

Table 11.45 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.31* shows the wind farm from this location. The sensitivity of these VSRs is considered medium. However, there is a relatively large distance to the wind farm, over 14 kilometres. In addition, many of the turbines will be obscured by intervening topography. As a result, the magnitude of change is considered small. Therefore the significance threshold is considered *slight* adverse during operation.

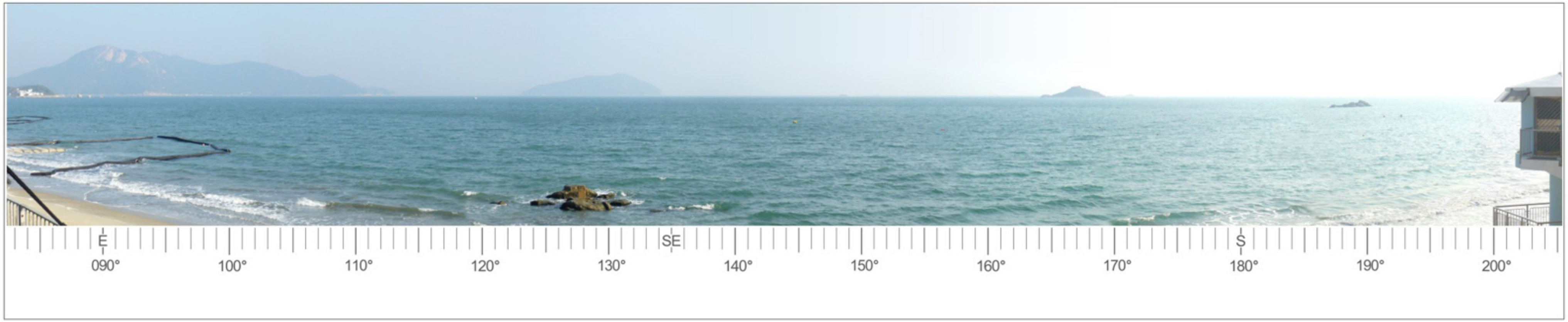
VSR10 - View from Lantau Trail

These VSRs are located approximately 15 km north west of the wind farm. These VSRs are comprised of recreational hikers and they are low in number.

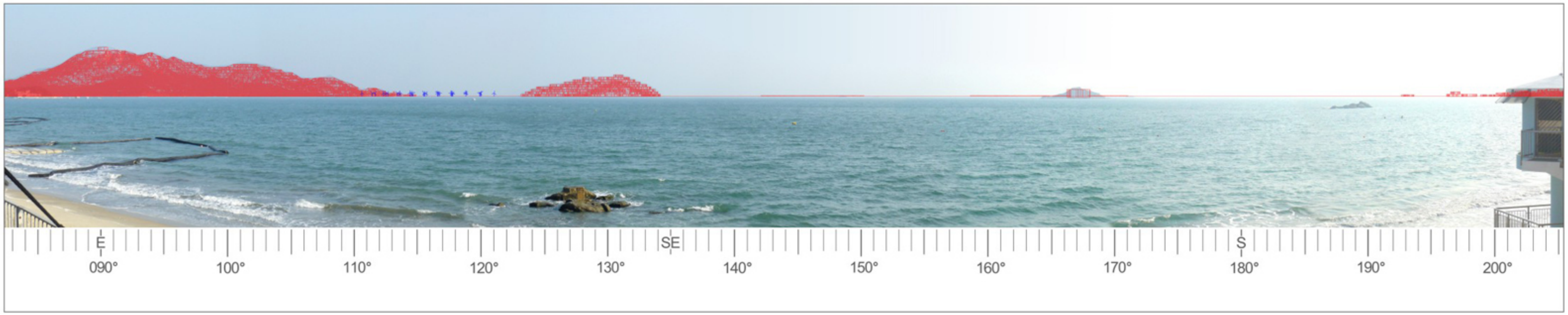
Table 11.46 Sensitivity / Quality

Items	**Sensitivity / Quality**
Value and quality of view	High
Number of VSR	Low
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	Medium

Table 11.46 shows the value and quality of view is considered high as it overlooks the islands and inshore water ways of this region of Hong Kong. The number of VSRs is low. The duration and frequency of views to the development is considered low as the wind farm is located to the south east and is obscured by the existing Islands. The degree of visibility is therefore also considered low. The overall sensitivity is considered *Medium* for these VSRs.



VSR 9 - View from Cheung Sha Beach - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

Key Plan

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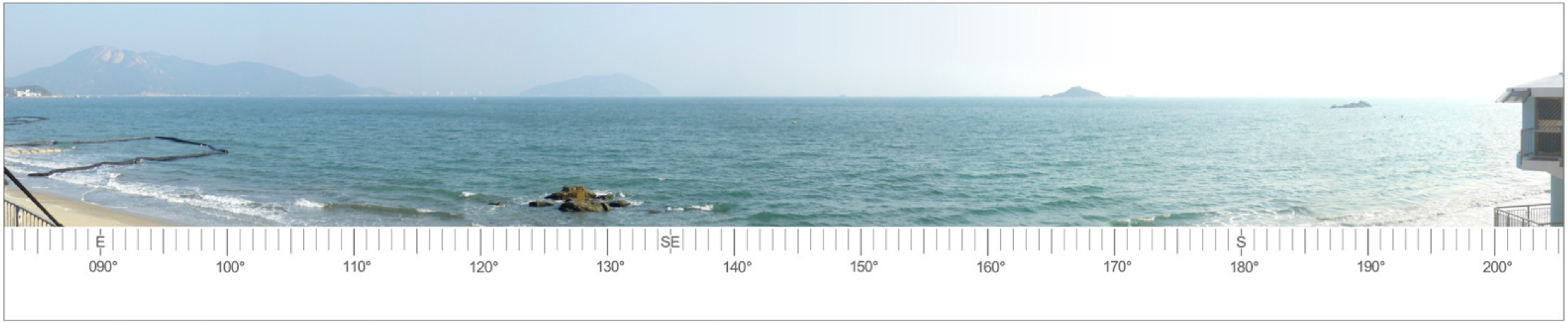
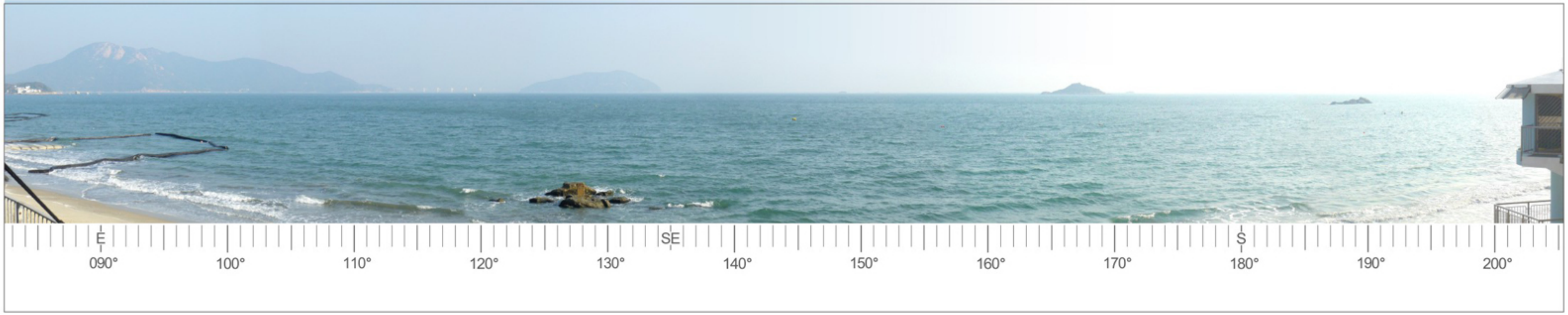
Fig 11.31



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

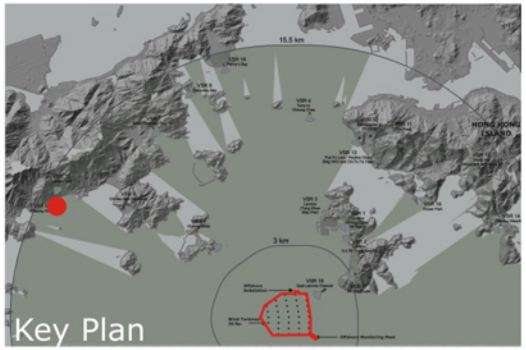


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Fig 11.31

Table 11.47 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	15,400 m	15,400 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.47 shows the magnitude of change is considered small due to the long distance to the wind turbines and the low potential blockage of view.

Table 11.48 Significance Threshold during Construction

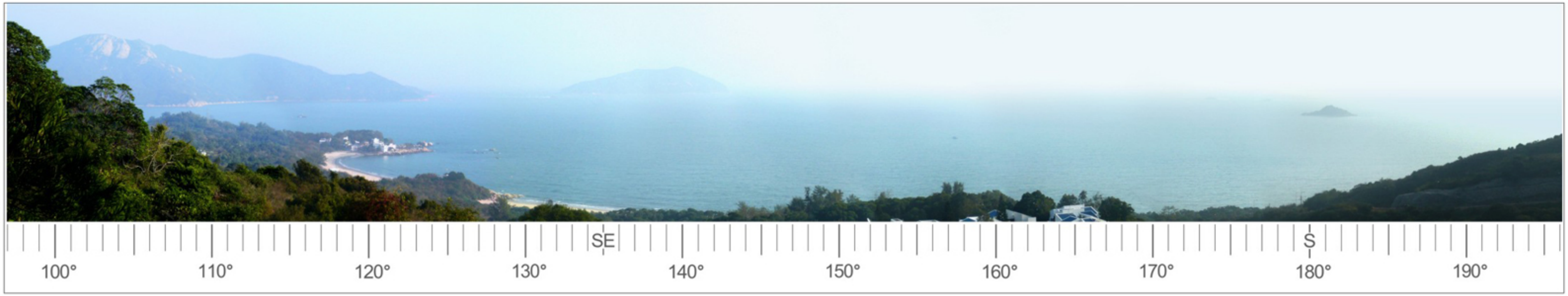
<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Sensitivity / Quality</td><td rowspan="2">Beneficial</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="4">Magnitude of Change</td><td>Large</td><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><td>Intermediate</td><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><td>Small</td><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><td>Negligible</td><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

Table 11.48 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

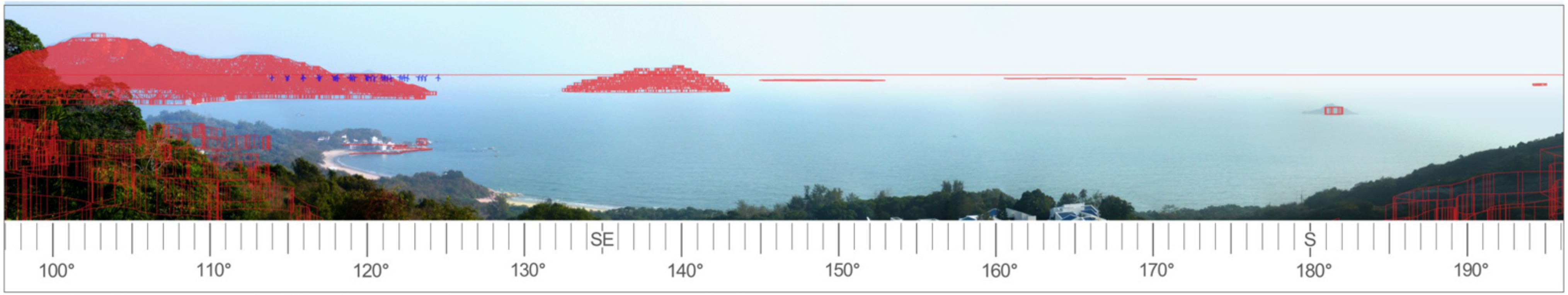
Table 11.49 Significance Threshold during Operation

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Sensitivity / Quality</td><td rowspan="2">Beneficial</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="4">Magnitude of Change</td><td>Large</td><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><td>Intermediate</td><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><td>Small</td><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><td>Negligible</td><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

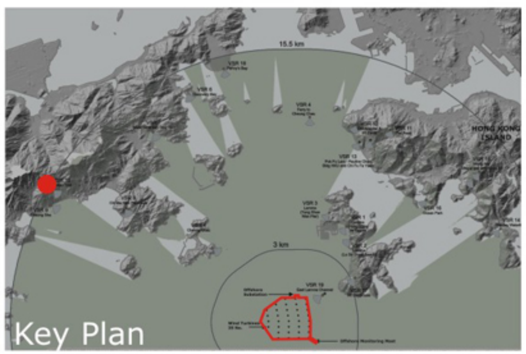
The photomontage in *Figure 11.32* shows the wind farm from this location. The sensitivity of these VSRs is considered medium. However, there is a



VSR 10 - View from Lantau Trail - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation



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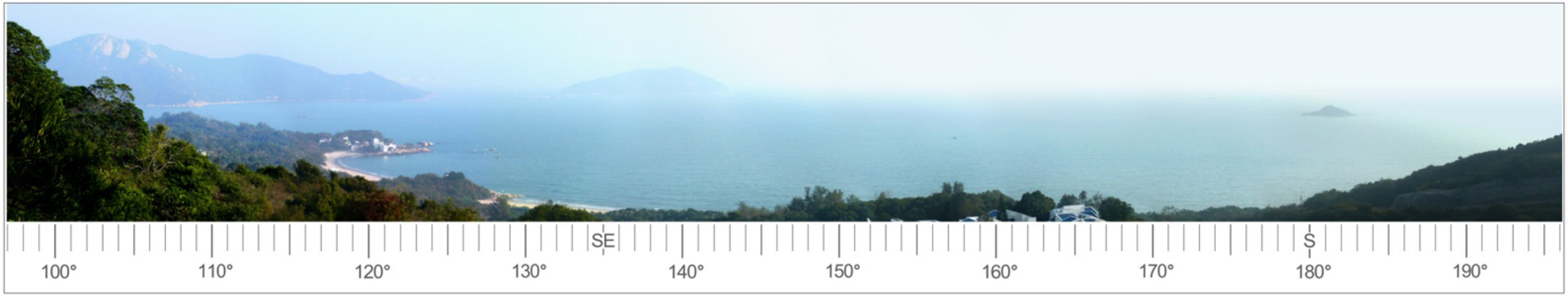
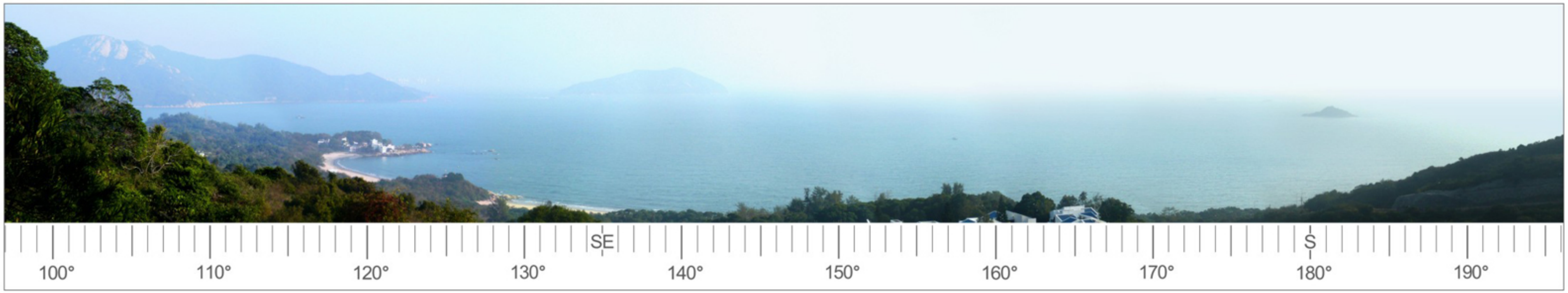


View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

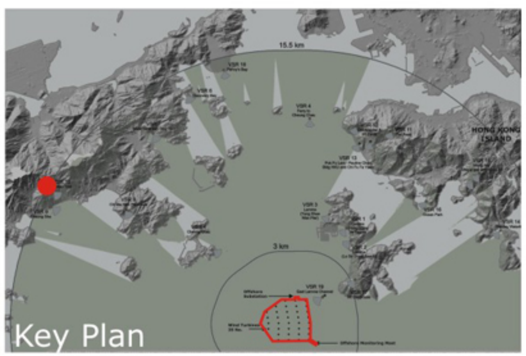


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Fig 11.32

relatively large distance to the wind farm, over 15 kilometres. In addition, many of the turbines will be obscured by intervening topography and offshore islands. As a result, the magnitude of change is considered small. Therefore the significance threshold is considered *slight* adverse during operation.

VSR11 – View from the Peak

This VSR is located approximately 10 km north-north-east of the wind turbines. This location is one of the most popular viewing areas in Hong Kong and is visited by very high numbers of tourists year round. The peak also contains many residential VSRs.

Table 11.50 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	High
Availability and amenity of alternative views	High
Duration and frequency of views to development	Medium
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	High

Table 11.50 shows the value and quality of view is considered high as there are spectacular views available from this location particularly to the north and south. The visitor numbers are considered high as this is a popular destination year-round and there are numerous residential VSRs in the vicinity. The availability and amenity of alternative views is considered high as there are excellent alternate views to the north and east. The duration and frequency of views is considered medium as the more popular views are to the north towards Kowloon. The degree of visibility of the development is considered low as the wind farm is located beyond Lamma Island. The sensitivity for these VSRs is therefore considered high.

Table 11.51 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	10,640 m	10,640 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.51 shows the magnitude of change is considered small mainly due to the relatively long distance to the wind turbines and low potential blockage of view.

Table 11.52 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.52 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind farm will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *moderate adverse* towards the end of the construction process.

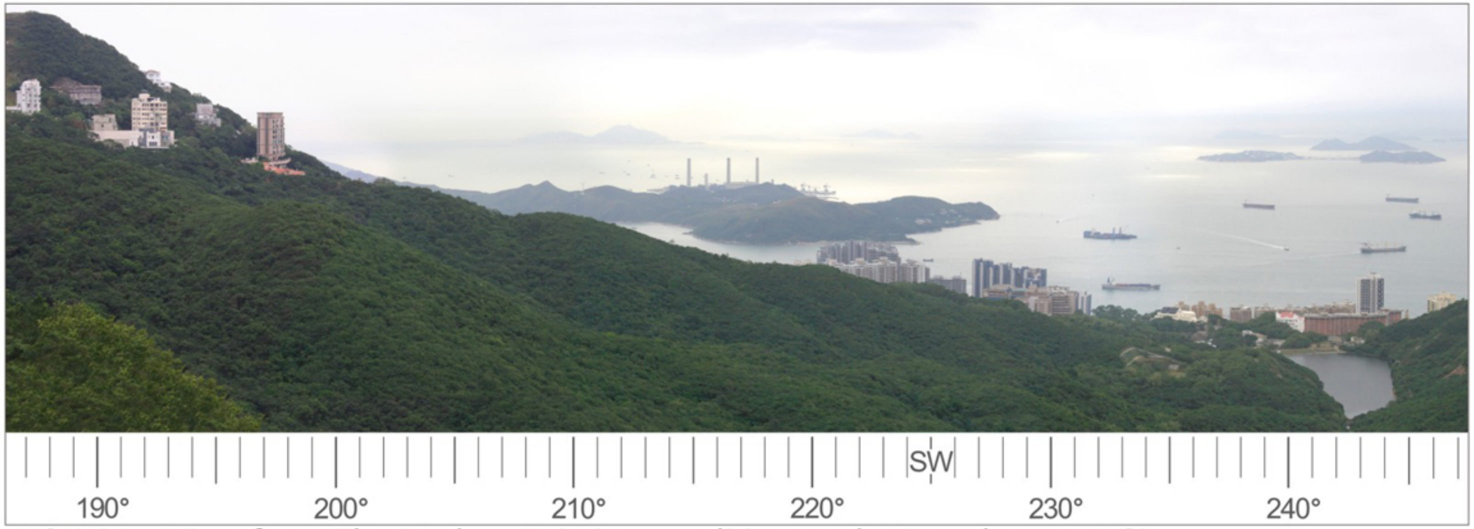
Table 11.53 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

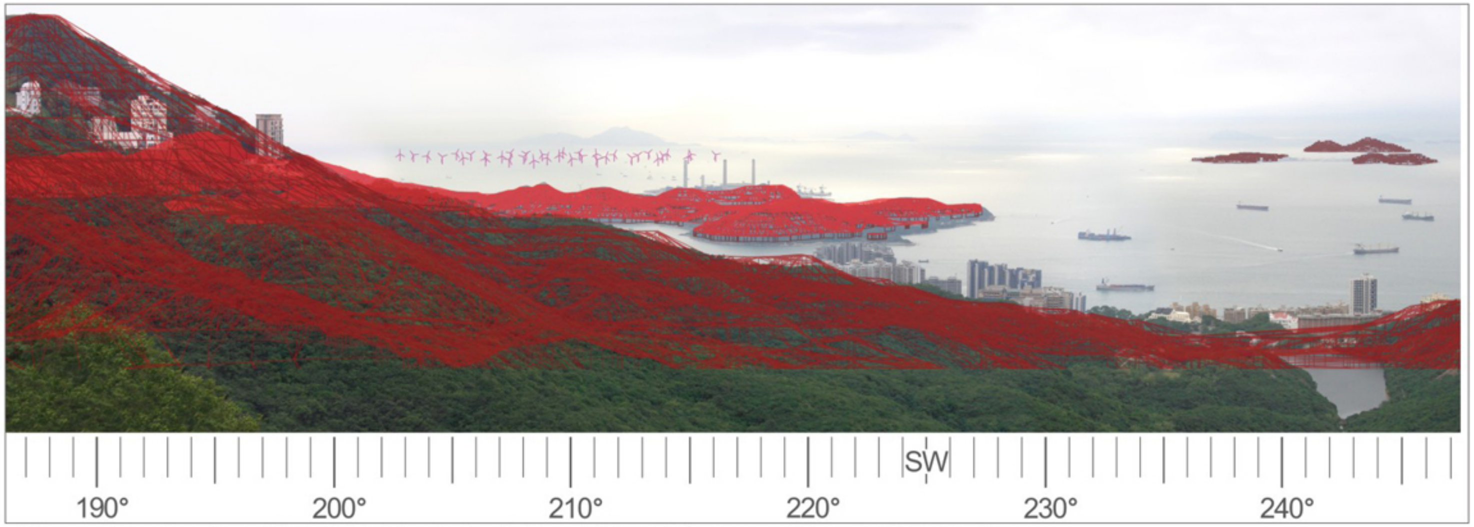
The photomontage in *Figure 11.33* shows the proposed wind farm from this viewpoint. Due to the high numbers of visitors and quality of the view, these VSRs are considered to have a high sensitivity. However, due to the relatively long distance to the wind turbines, over 10 kilometres, the turbines will be noticeable, but the magnitude of change is considered to be small. *Table 11.53* shows the resulting significance threshold during operation is considered to be *moderate adverse.*

VSR 12 – View from Queen Mary Hospital and Mount Davis

These VSRs are located approximately 10.4 km north of the wind farm site. The VSRs located here are a mix of workers at the hospital, patients at the hospital and visitors at the hospital site. At Mount Davis they are more likely to be recreational VSRs.



VSR 11 - View from The Peak - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

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VSR-11 Photomontage From The Peak

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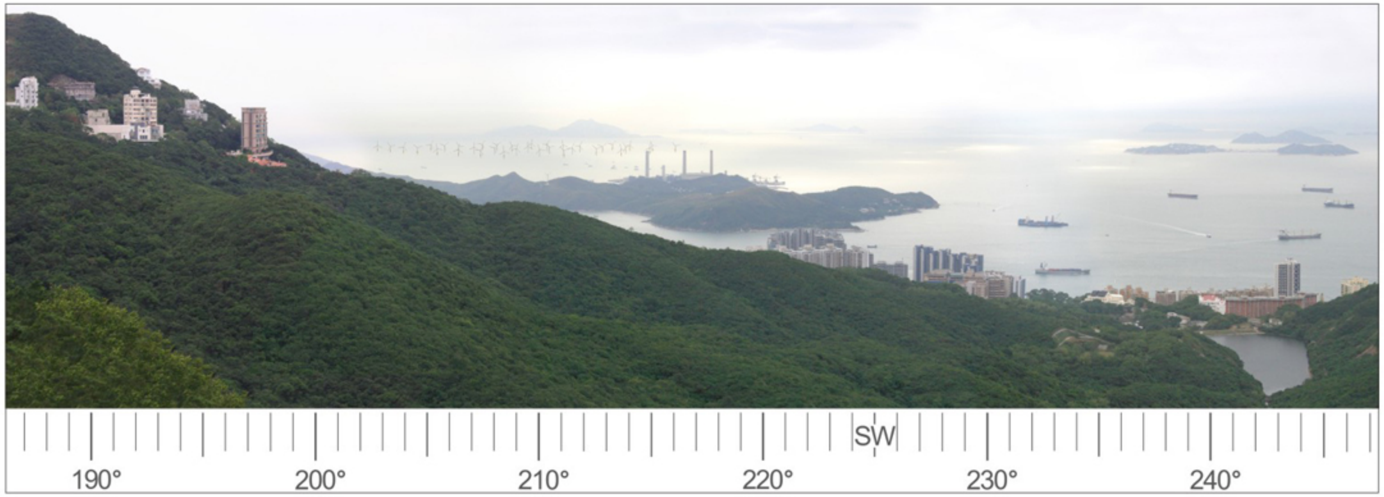
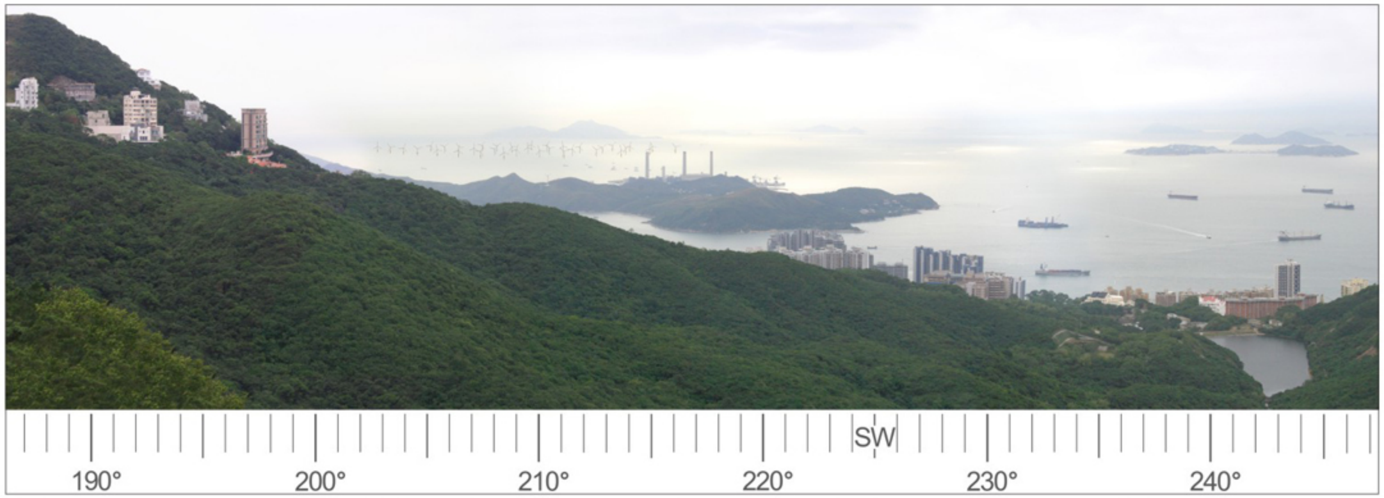
Fig.11.33



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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Fig.11.33

Table 11.54 ***Sensitivity / Quality***

Items	Sensitivity / Quality
Value and quality of view	Medium
Number of VSR	High
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	Medium

Table 11.54 shows the value and quality of the view is considered medium due to the prominence of other buildings and the Power Station which somewhat detracts from the view. There are high numbers of VSRs at this location as there are many visitors to the Hospital facilities and the many other residential VSRs in the near vicinity. The availability and amenity of alternative views is considered medium as there are other views available to the west. The duration and frequency of views and the degree of visibility are considered low as the wind farm is located beyond Lamma Island. Overall these VSRs are considered to have a medium sensitivity.

Table 11.55 ***Magnitude of Change***

Items	Construction	Operation
Compatibility with surrounding landscape	Medium	Medium
Viewing Distance to Proposed Development	10,400 m	10,400 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.55 shows the magnitude of change is considered to be small mainly due to the relatively long distance between these VSRs and the wind turbines.

Table 11.56 *Significance Threshold during Construction*

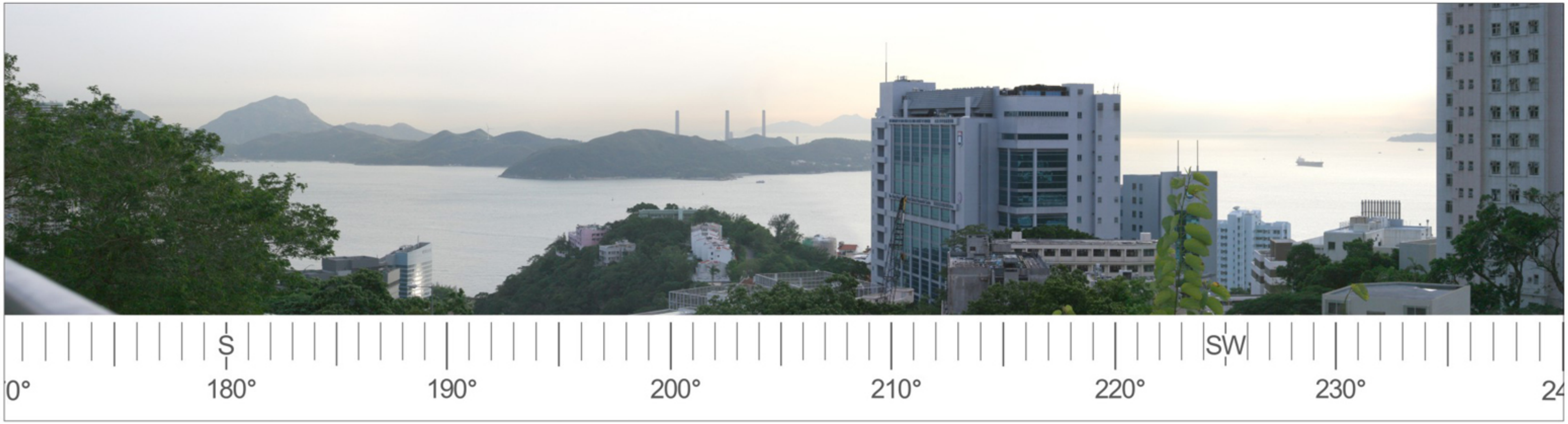
		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.56 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

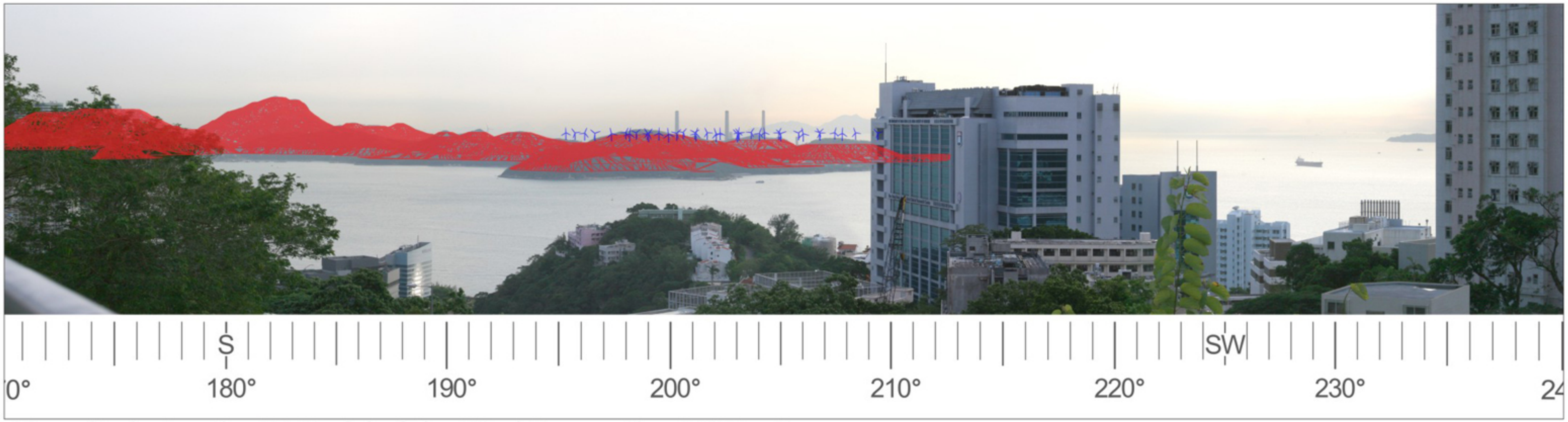
Table 11.57 *Significance Threshold during Operation*

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.34* shows the view of the wind turbines from this location. The medium sensitivity is mainly due to the presence of other buildings and infrastructure in the field of view. The magnitude of change is considered small due to the long distance. *Table 11.57* shows the resulting significance threshold is considered to be *slight adverse.*



VSR 12 - View from Queen Mary Hospital and Mt Davis - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

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VSR-12 Photomontage From
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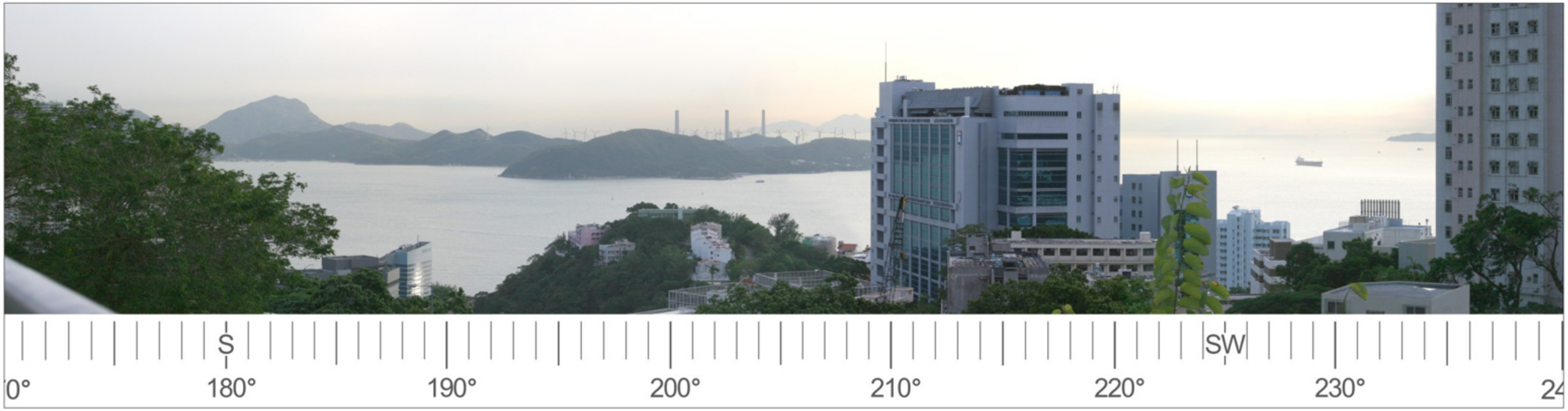
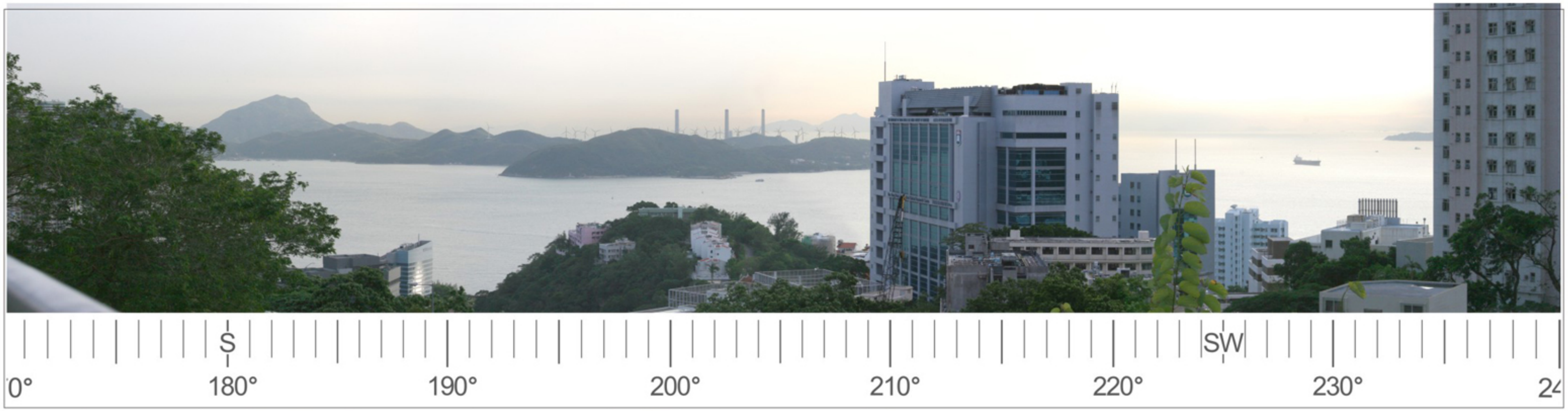
Fig 11.34



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

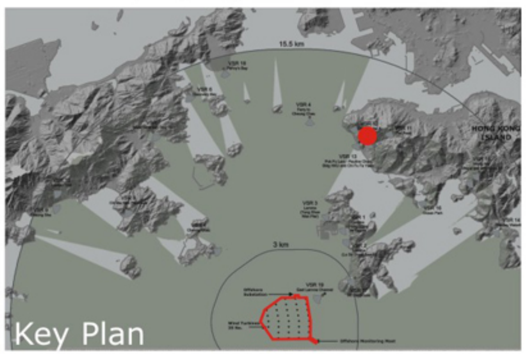


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Fig 11.34

VSR 13 – View from Pok Fu Lam - Pauline Chan Building, Hong Kong University and Chi Fu Fa Yuen

These VSRs are located approximately 10.2 km north of the wind farm site. The VSRs at this location are workers and students at HKU, as well as the high number of residential VSRs in the vicinity..

Table 11.58 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	Medium
Number of VSR	High
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Low
Degree of visibility of Development	Nil
Sensitivity/Quality of VSR	Medium

Table 11.58 shows the value and quality of the view is considered medium due to the prominence of other buildings and the Power Station which somewhat detracts from the view. There are high numbers of residential and employee VSRs at this location. The duration and frequency of views to the development is low and the degree of visibility of the wind farm is nil. Overall these VSRs are considered to have a *medium* sensitivity.

Table 11.59 Magnitude of Change

Items	**Construction**	**Operation**
Compatibility with surrounding landscape	Medium	Medium
Viewing Distance to Proposed Development	10,200 m	10,200m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.59 shows the magnitude of change is considered to be *small* mainly due to the relatively long distance between these VSRs and the wind turbines.

Table 11.60 Significance Threshold during Construction

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Sensitivity / Quality</td><td rowspan="2">Beneficial</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="4">Magnitude of Change</td><td>Large</td><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><td>Intermediate</td><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><td>Small</td><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><td>Negligible</td><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

Table 11.60 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

Table 11.61 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage in *Figure 11.35* shows the view of the wind turbines from this location. The sensitivity of these VSRs is considered medium due to the high viewer numbers and low visibility of the site. The magnitude of change is considered to be small due to the long distance to the turbines. *Table 11.61* shows the significance threshold is considered to be *slight adverse* during operation.

VSR 14 – View from Stanley Waterfront

This VSR is located approximately 13 km east of the wind farm. This location contains various VSRs, residential, recreational and workers. Stanley Waterfront is one of the most popular visitor destinations on Hong Kong Island.

Table 11.62 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	High
Availability and amenity of alternative views	Low
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	High

Table 11.62 shows the value and quality of view of the sea and offshore islands from this location is considered to be high. The number of VSRs is high due to the popularity of this location with both tourist and residential VSRs. The availability and amenity, duration and frequency and degree of visibility of the development are all low as the wind farm is located beyond the offshore

VSR 13 - View from Pauline Chan Building, University of Hong Kong and Chi Fu Fa Yuen, Pok Fu Lam - Existing condition at the Development Site.

View displaying the 3D Model of the Wind Farm without Mitigation

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VSR-13 Photomontage From
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Fig 11.35

View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation

View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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Fig 11.35

islands. However, due to the high visitor numbers and the high quality of view the sensitivity is also considered to be *high.*

Table 11.63 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	13,200 m	13,200 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Negligible	Negligible

Table 11.63 shows the wind turbines will not be visible from this location therefore the magnitude of change is considered to be *negligible.*

Table 11.64 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.64 shows that as neither of the construction sites will be visible, there will be a negligible impact during the temporary construction period.

Table 11.65 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage shown in *Figure 11.36* shows that the wind turbines will not be visible from this location. The GIS analysis shown in *Figure 11.18* indicates that from the most southern portion of the Stanley Peninsula some of the turbine may be visible. However due to the intervening topography and the distance to the wind turbines, the magnitude of change is also likely to be negligible. Therefore the high quality of view and VSRs resulted in a high sensitivity, however the wind turbines are not visible to these VSRs. *Tables 11.64* and *11.65* show the resulting significance threshold is *negligible* during both construction and operation.

VSR 15 – View from Wong Nai Chung gap and Violet Hill

These VSRs are located approximately 13 km north-east of the wind turbines. The VSRs from this location are mainly transient road using visitors or residents to the south side of Hong Kong Island.

Table 11.66 Sensitivity / Quality

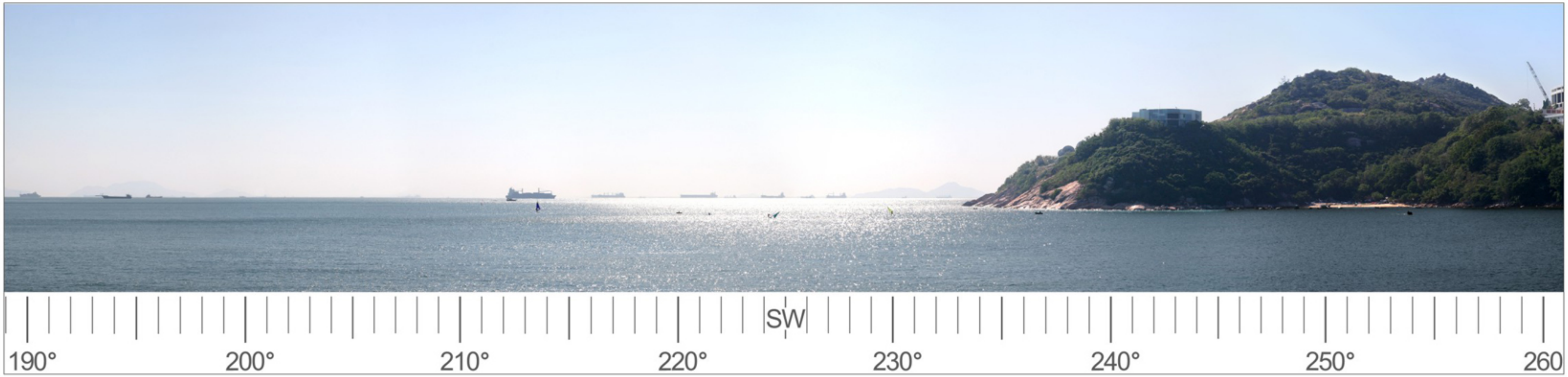
Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	Medium
Availability and amenity of alternative views	Low
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	Medium

Table 11.66 shows the value and quality of view from this location is considered to be high as there are attractive views of the water and offshore islands south of Hong Kong. The number of VSRs is considered medium. The availability and amenity, duration and frequency and degree of visibility of the development are all low as the wind farm is located beyond the offshore islands. The overall sensitivity is also considered to be *medium* for the VSRs at this location.

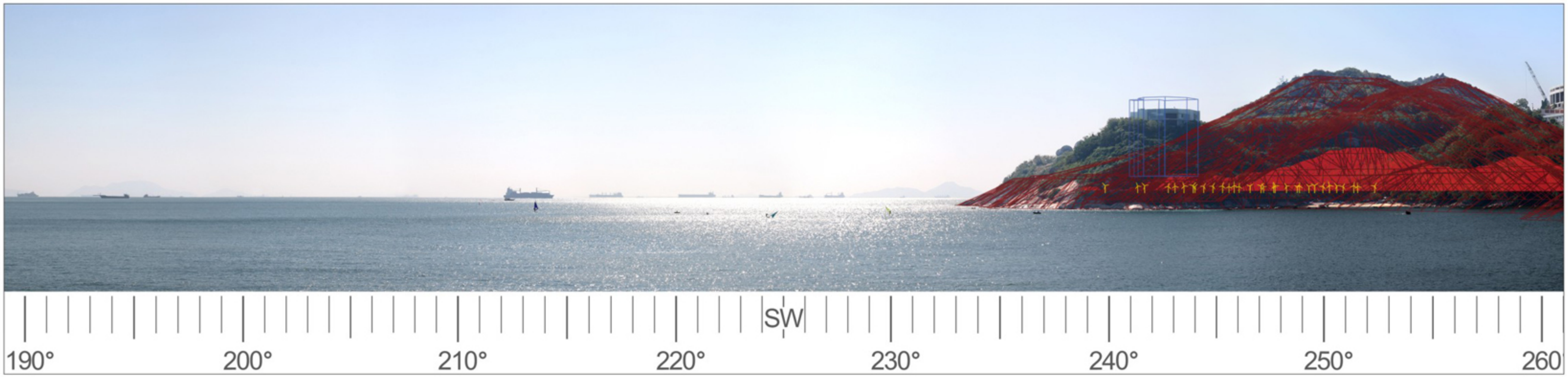
Table 11.67 Magnitude of Change

Items	**Construction**	**Operation**
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	13,200 m	13,200 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Negligible	Negligible

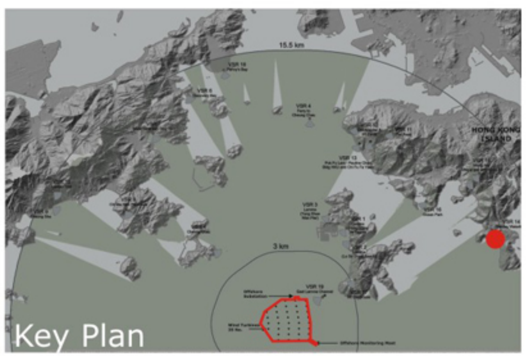
Table 11.67 shows the wind turbines will not be visible from this location therefore the magnitude of change is considered to be *negligible.*



VSR 14 - View from Stanley Waterfront - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation



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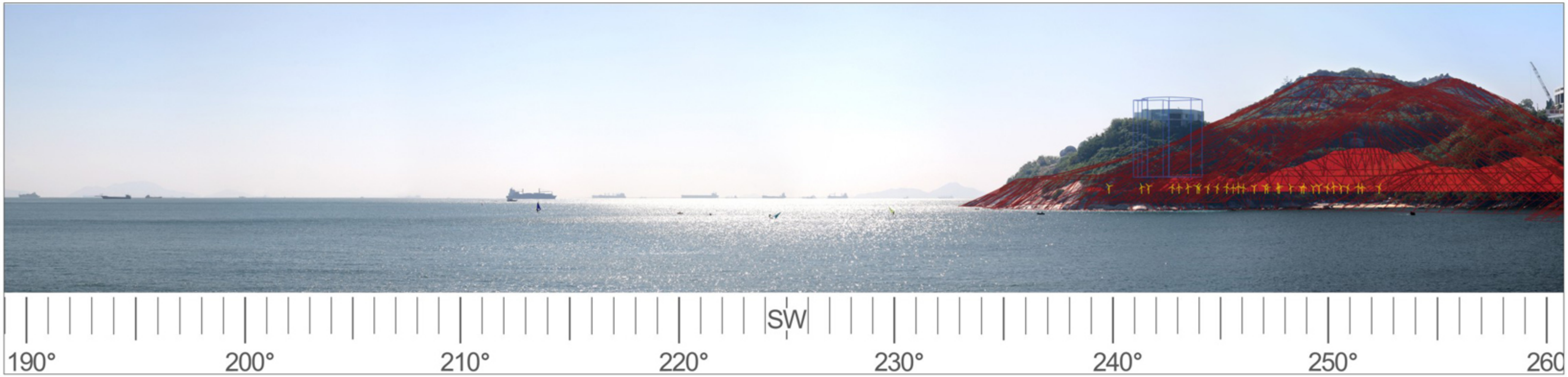
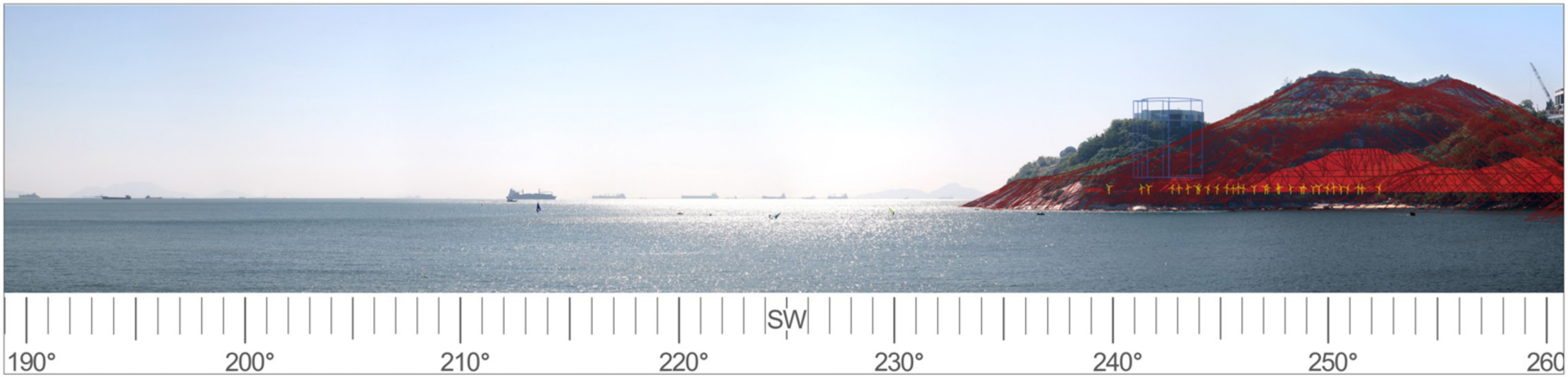


View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

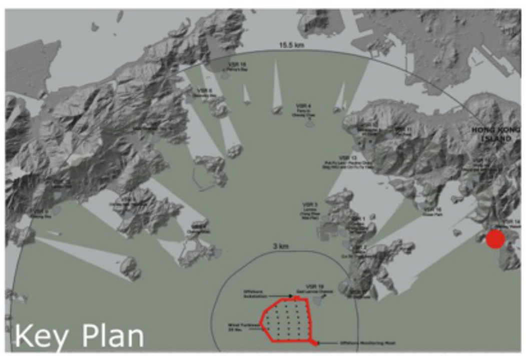


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Fig 11.36

Table 11.68 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.68 shows that as neither of the construction sites will be visible, there will be a negligible impact during the temporary construction period.

Table 11.69 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

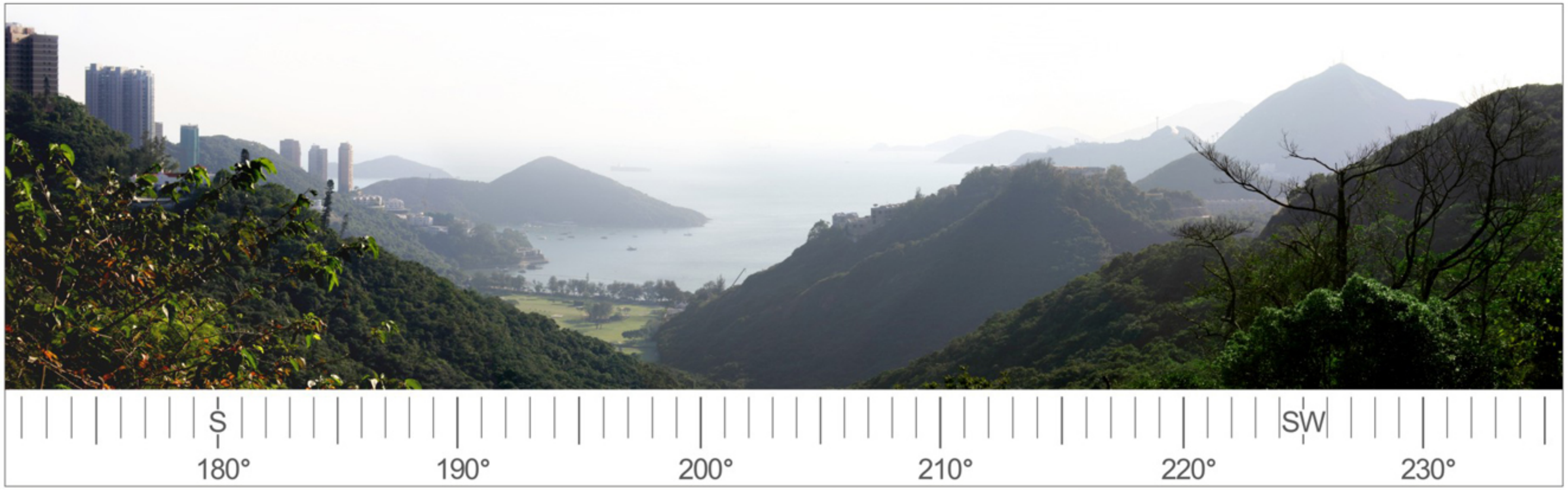
The photomontage shown in *Figure 11.37* shows that the wind turbines will not be visible from this location. *Table 11.69* shows the resulting significance threshold during both construction and operation will be *negligible.*

VSR 16 – View from Ocean Park

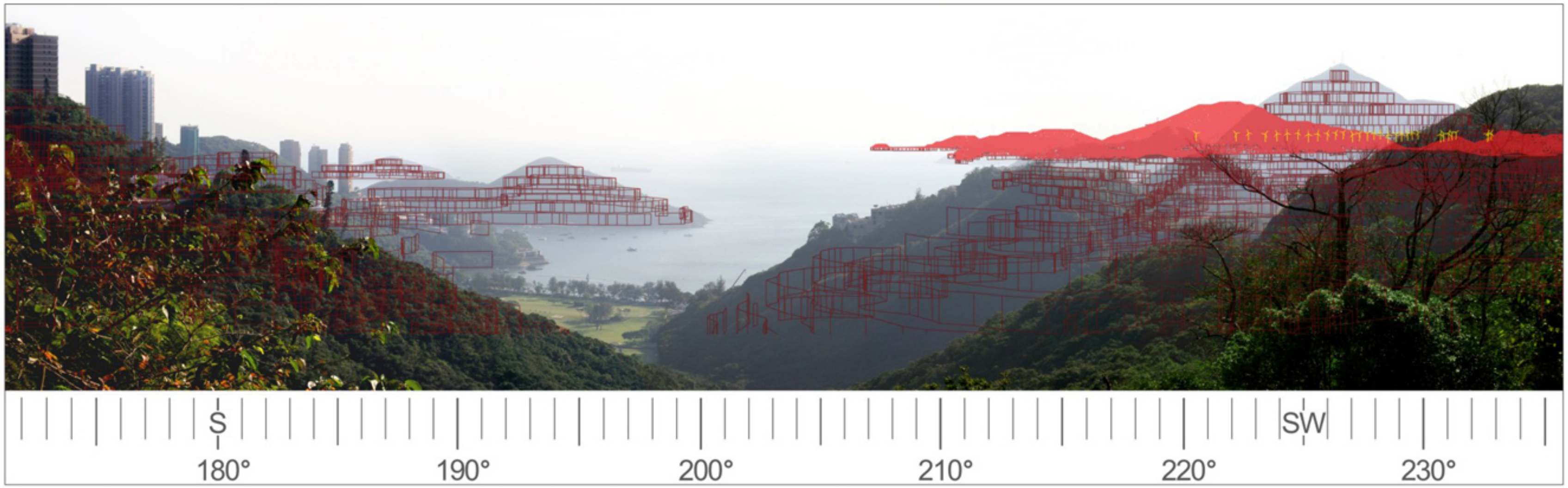
This VSR is located approximately 9 km north-east of the wind turbines. The VSRs from this location are mainly recreational visitors to the Ocean Park complex.

Table 11.70 Sensitivity / Quality

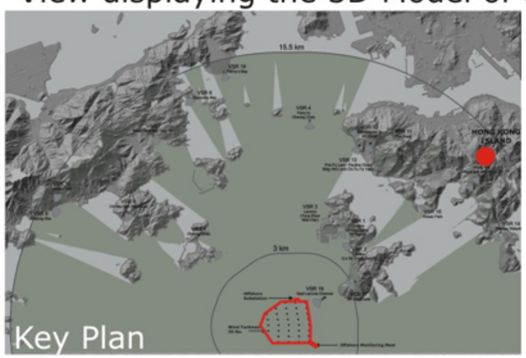
Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	High
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Low
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	Medium



VSR 15 - View from Wong Nai Chung Gap - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation



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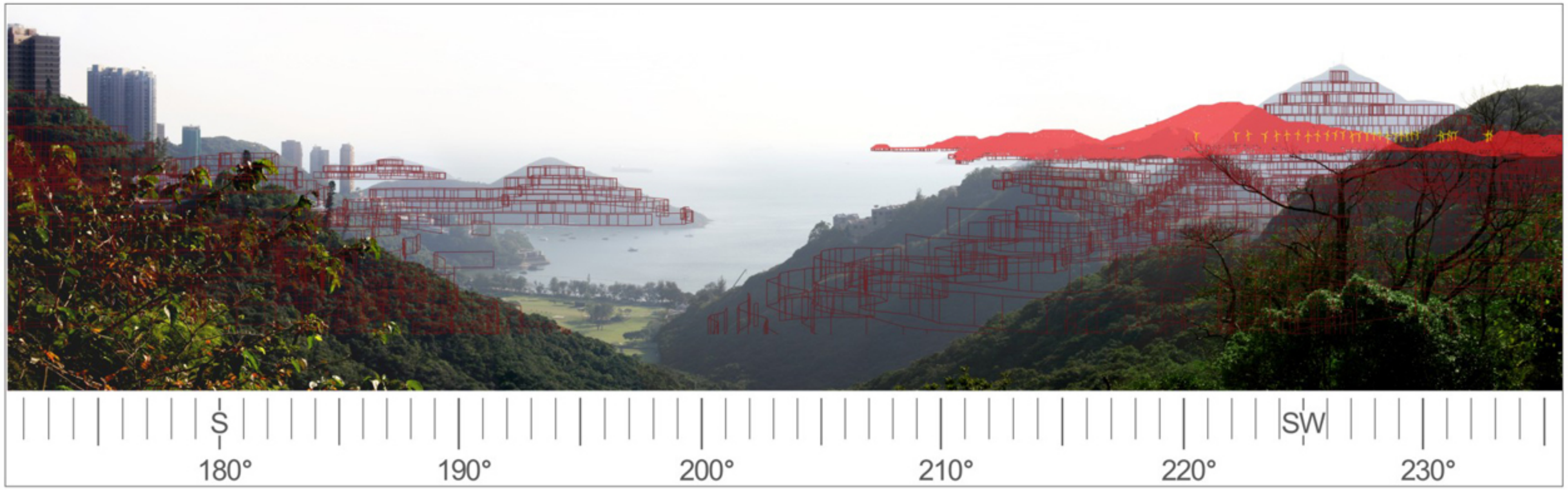
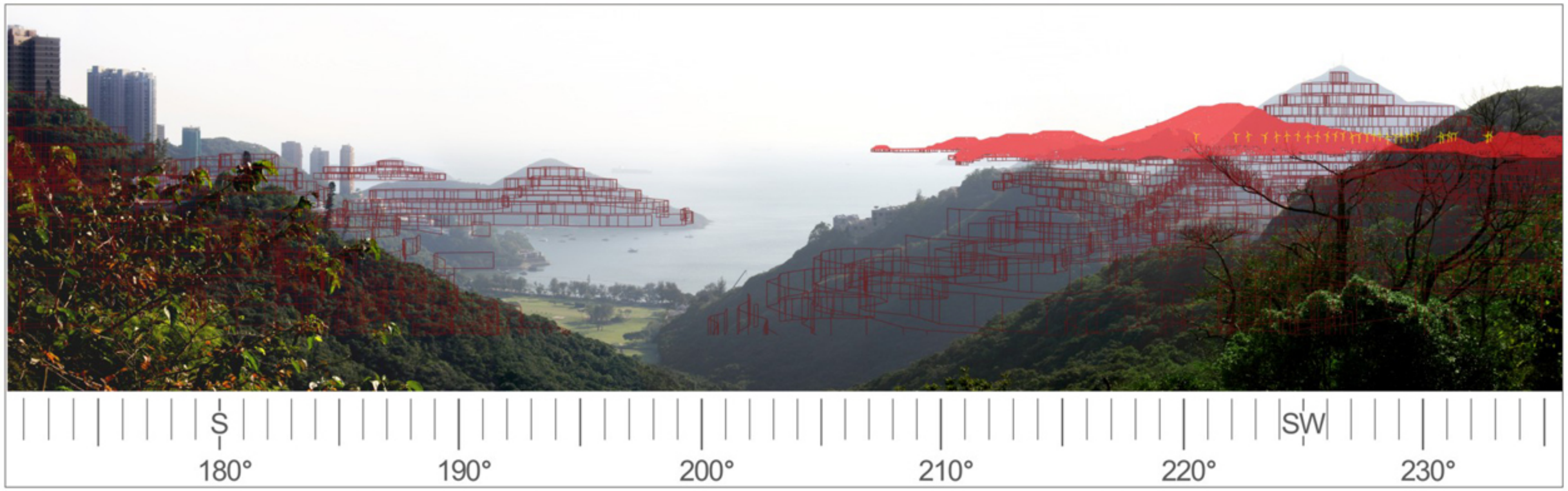


View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

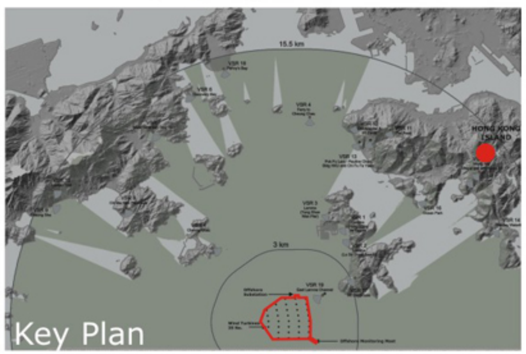


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Fig 11.37

Table 11.70 shows the value and quality of the views is considered to be high as there are attractive views afforded from Ocean Park across the East Lamma Channel to Lamma Island and beyond. The number of VSRs is also considered high as Ocean Park is a very popular Hong Kong tourist attraction. The availability and amenity of alternative views is considered medium as a variety of other views are available further to the east and west. The duration and frequency of views to the development and degree of visibility of the development, are considered low as much of the development is screened by the peaks of Lamma Island. The overall sensitivity of these VSRs is considered to be *medium.*

Table 11.71 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	9,480 m	9,480 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

Table 11.71 shows that the magnitude of change is considered *small* due to the relatively long viewing distance and low potential blockage of view.

Table 11.72 Significance Threshold during Construction

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.72 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *slight adverse* towards the end of the construction process.

Table 11.73 Significance Threshold during Operation

<table>
<tr><td colspan="2"></td><td colspan="3">Sensitivity / Quality</td><td rowspan="2">Beneficial</td></tr>
<tr><td colspan="2"></td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="4">Magnitude of Change</td><td>Large</td><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><td rowspan="2">Neither beneficial nor adverse</td></tr>
<tr><td>Intermediate</td><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><td>Small</td><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><td rowspan="2">Adverse</td></tr>
<tr><td>Negligible</td><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

The photomontage shown in *Figure 11.38* shows the view of the wind turbines from this location. The sensitivity of these VSRs is considered medium due to the high viewer numbers and low visibility of the site. The magnitude of change is considered to be small due to the long distance to the turbines. *Table 11.73* shows the significance threshold is considered to be *slight adverse* during operation.

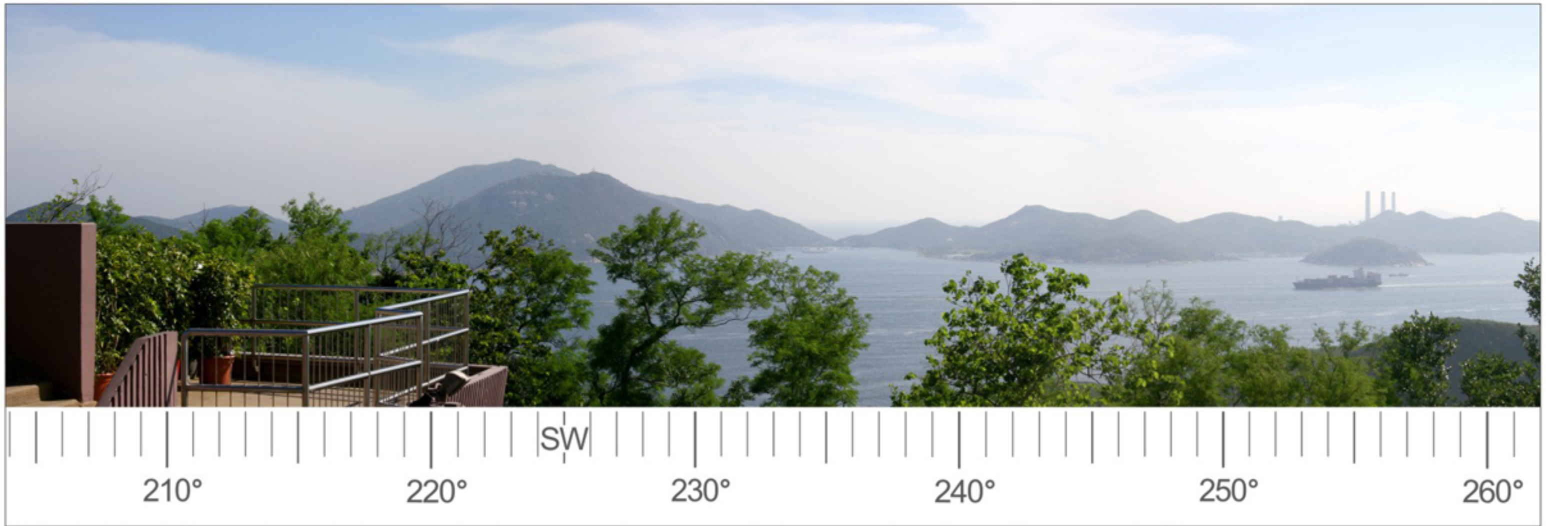
VSR 17 – View from Mt Stenhouse

This VSR is located approximately 3 kilometres north-east of the wind farm and is the closest accessible land based viewing location. This location is visited by low numbers of recreation VSRs who complete the challenging hike to the summit.

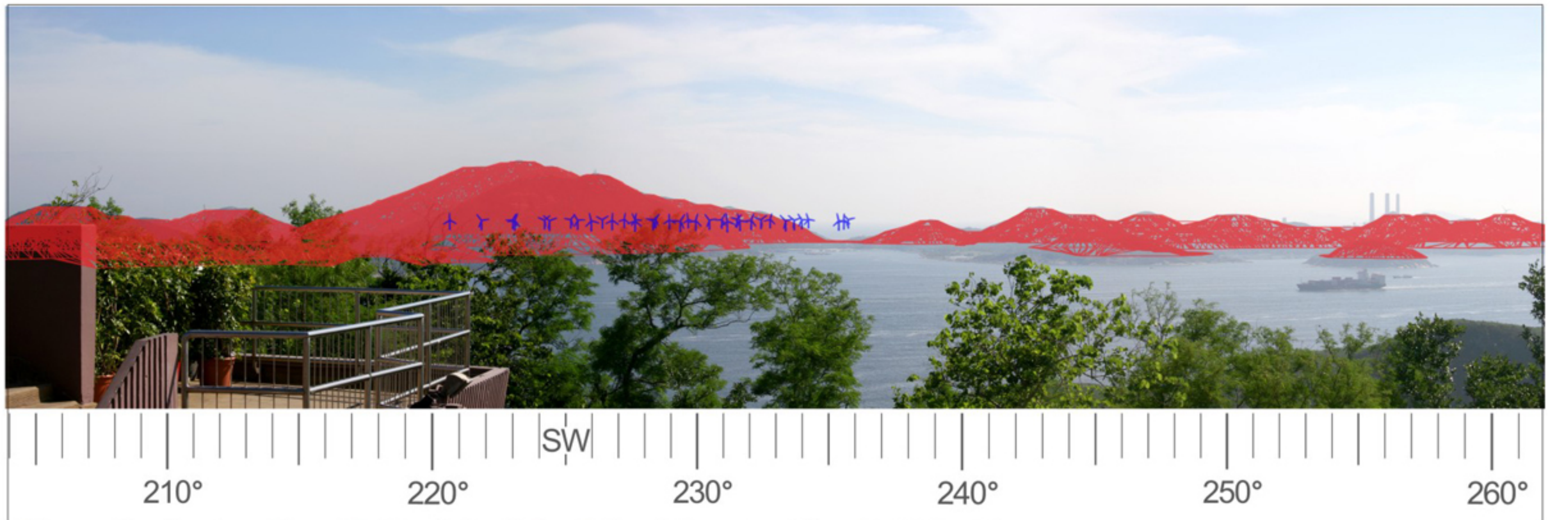
Table 11.74 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	Low
Availability and amenity of alternative views	High
Duration and frequency of views to development	High
Degree of visibility of Development	High
Sensitivity/Quality of VSR	High

Table 11.74 shows the value and quality of view is considered to be high as there are excellent views from this location in all directions. The number of VSR is relatively low as this location can only be reached by completing a challenging hike. The availability and amenity of other views is considered high as there are views in all directions. The duration and frequency of views to the development and the degree of visibility of the development are both considered high, due to the relatively close proximity to the wind farm. The overall sensitivity of these VSRs is considered *high.*



VSR 16 - View from Ocean Park - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

Key Plan

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Proposed Offshore Wind Farm

VSR-16 Photomontage From Ocean Park

Landscape Architecture & Urban Design

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Taikoo Place
Island East, Hong Kong

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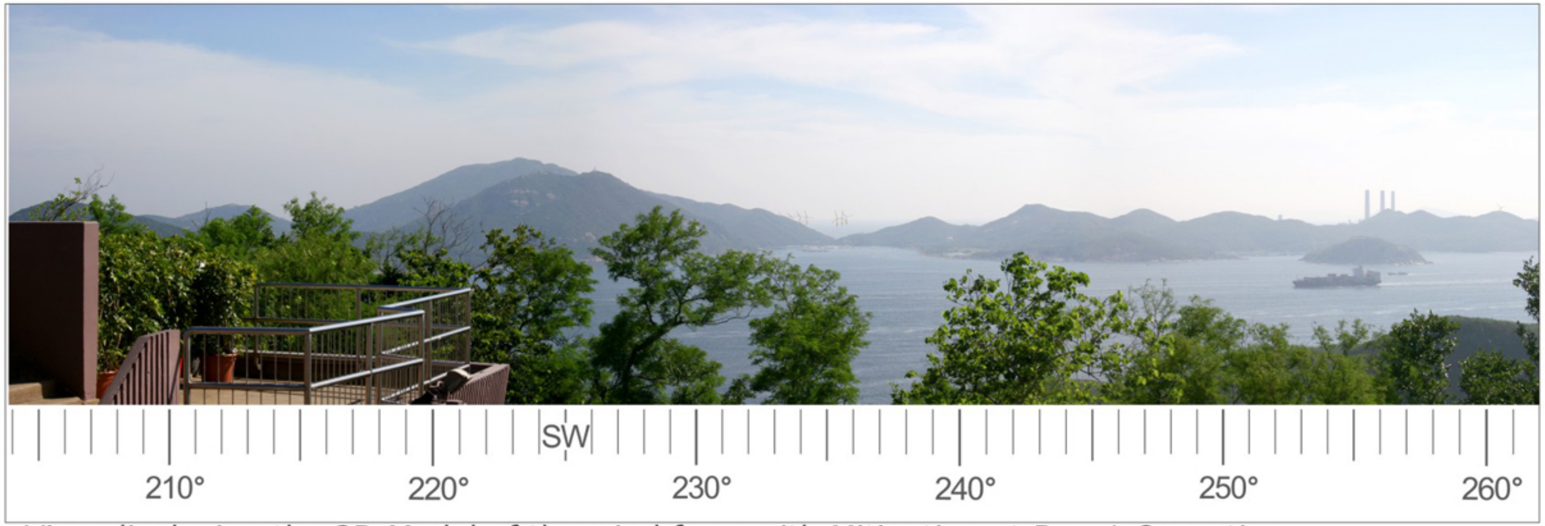
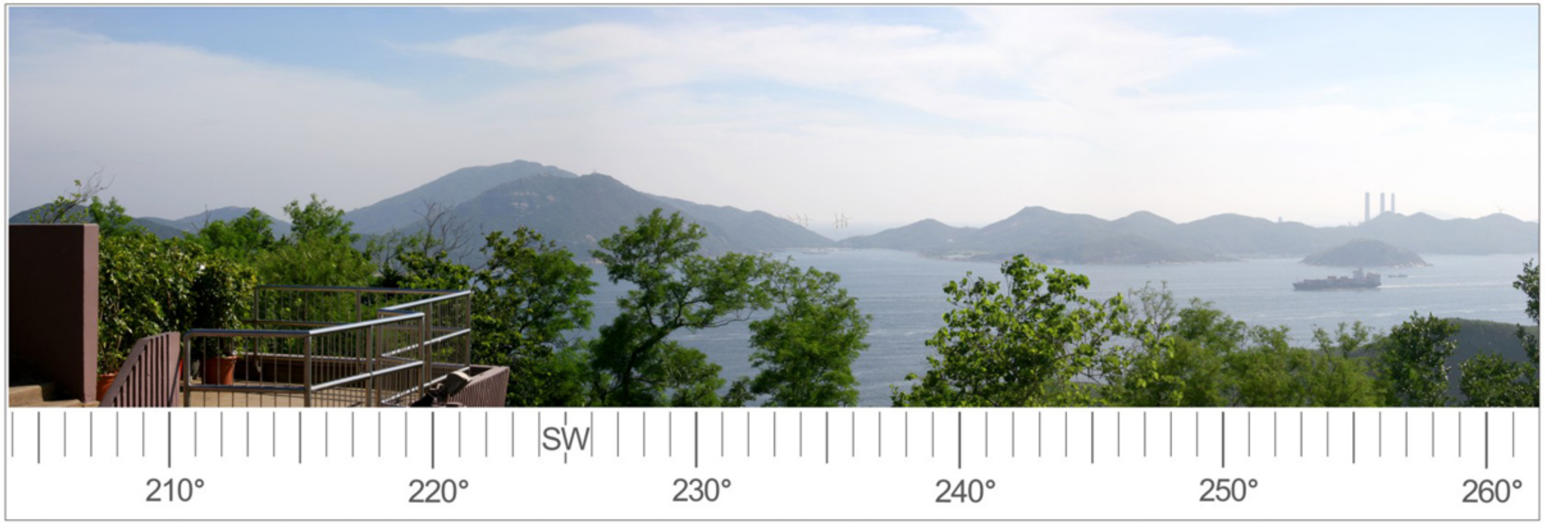
Fig 11.38



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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Fig 11.38

Table 11.75 Magnitude of Change

Items	Construction	Operation
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	3,200 m	3,200 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Large	Large

Table 11.75 shows the magnitude of change is considered large due to the relatively close proximity of these VSRs to the wind farm.

Table 11.76 Significance Threshold during Construction

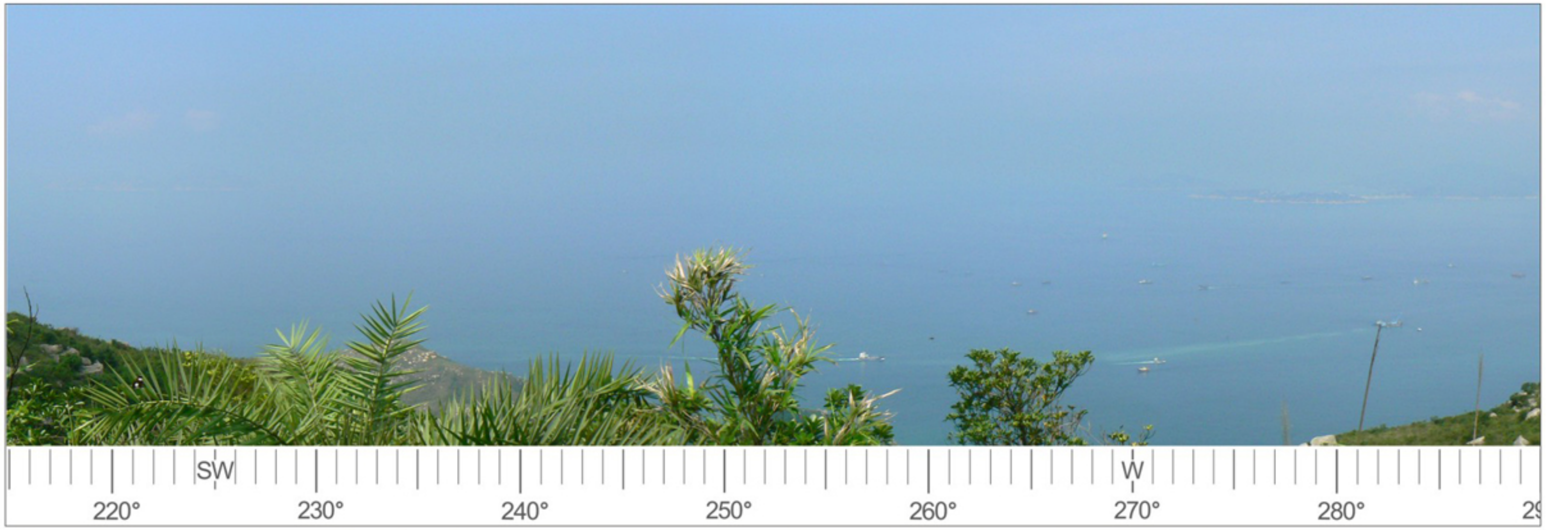
		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.76 shows the significance threshold of the wind farm during construction. Only the offshore wind farm site will be visible to these VSRs. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *significant adverse* towards the end of the construction process.

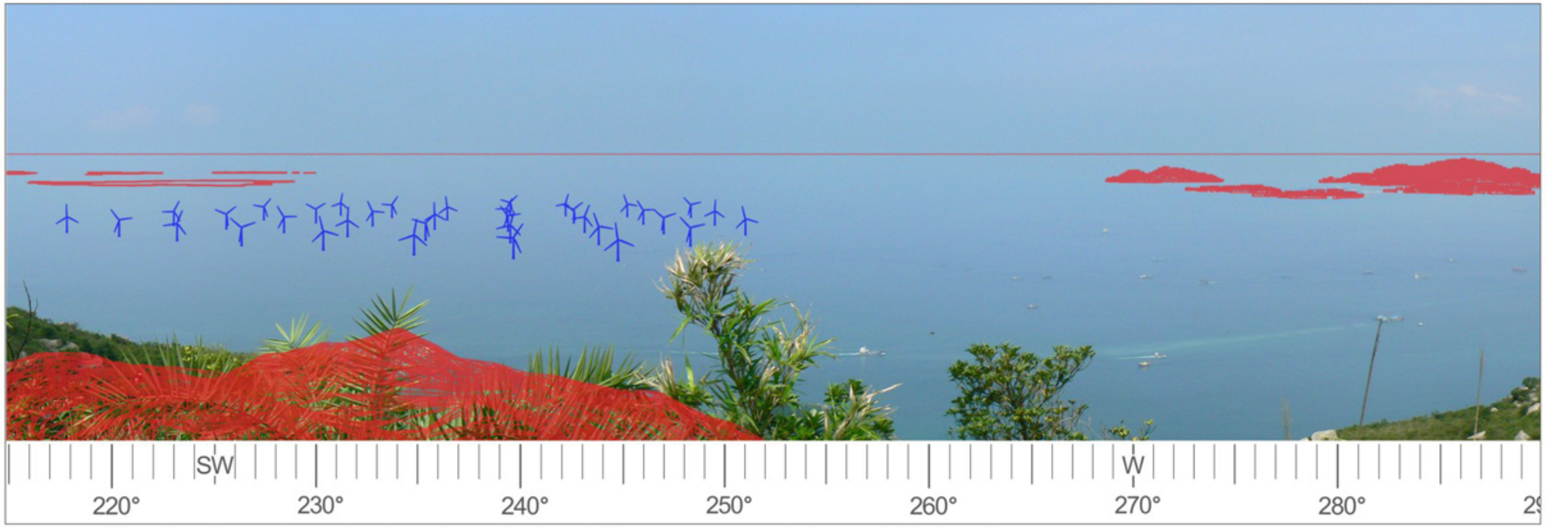
Table 11.77 Significance Threshold during Operation

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

The photomontage shown in *Figure 11.39* shows the view of the wind turbines from this location. The sensitivity of these VSRs is considered high due the



VSR 17 - View from Mt Stenhouse - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

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Proposed Offshore Wind Farm
VSR-17 Photomontage From
Mt. Stenhouse

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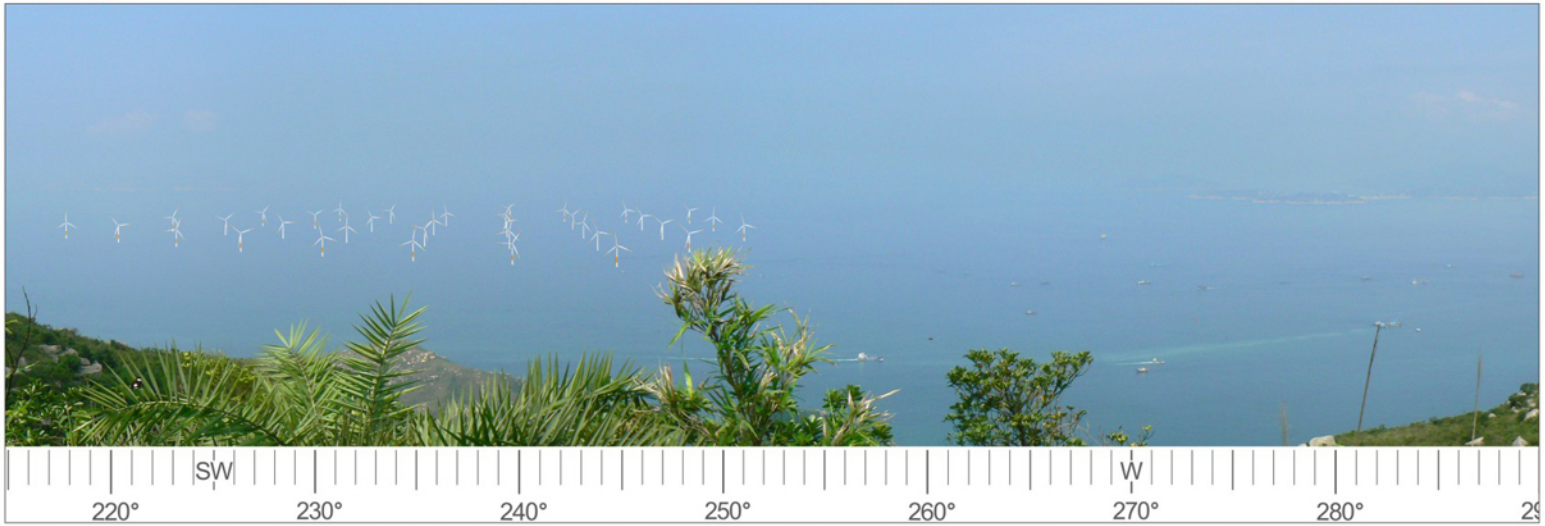
Fig 11.39



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation

View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.

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VSR-17 Photomontage From
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Fig 11.39

duration and frequency of views to the development and the degree of visibility of the development both being considered high. The magnitude of change is considered large due to the close proximity of these VSRs to the wind farm. *Table 11.77* shows the resulting un-mitigated significance threshold is considered significant. It should be also noted here that VSR numbers may actually increase to this location. The evidence provided in *Annex 11A* shows that in other parts of the world, wind farms are generally supported. Should this wind farm be the first constructed in Hong Kong, it is reasonable to expect a degree of curiosity from the general public, hence increased visitors to this location.

VSR 18 – View from Penny's Bay

This VSR is located at just under 15 km north of the wind farm site. The VSRs at this location are recreational and high in number.

Table 11.78 ***Sensitivity / Quality***

Items	Sensitivity / Quality
Value and quality of view	High
Number of VSR	High
Availability and amenity of alternative views	Medium
Duration and frequency of views to development	Medium
Degree of visibility of Development	Low
Sensitivity/Quality of VSR	High

Due to the high numbers of visitors and unique nature of the recreational development at Penny's Bay, the sensitivity of this VSR is considered to be high.

Table 1179 ***Magnitude of Change***

Items	**Construction**	**Operation**
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	14,900 m	14,900 m
Potential blockage of view	Low	Low
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Small	Small

The magnitude of change for these VSRs is considered to be small mainly due to the long distance to the wind turbines (nearly 15 km) and low potential blockage of view.

Table 11.80 Significance Threshold during Construction

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.80 shows the significance threshold of the wind farm during construction. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *moderate adverse* towards the end of the construction process.

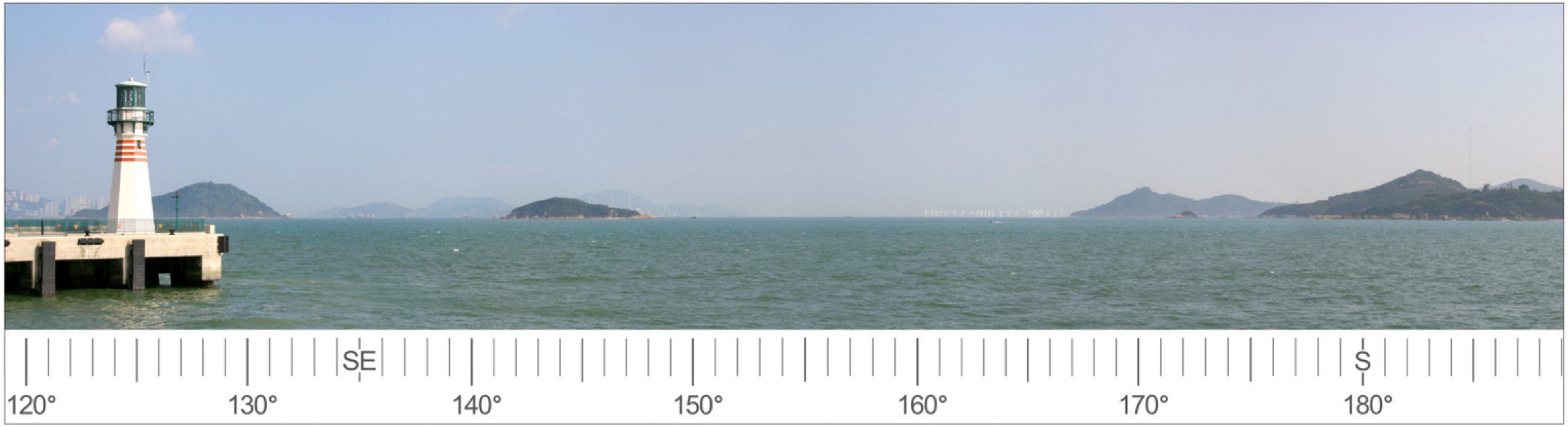
Table 11.81 Significance Threshold during Operation

		Sensitivity / Quality			Beneficial
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

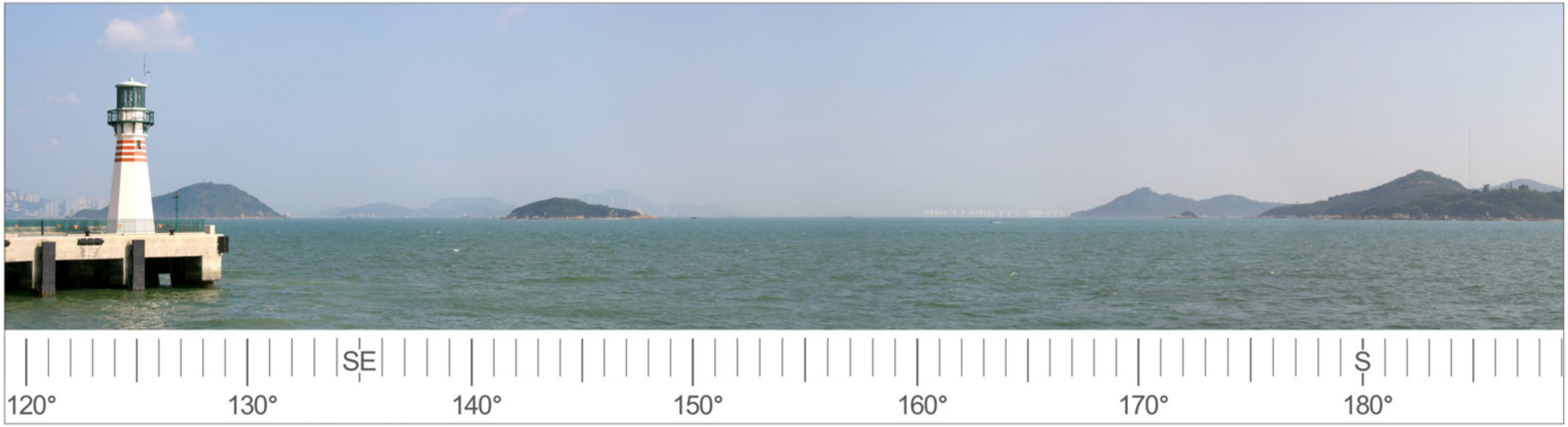
The photomontage in *Figure 11.40* shows the view of the wind turbines from Penny's Bay. The high number of recreational VSRs at this location and its unique recreational use result in a high sensitivity. However the magnitude of change is considered small due to the long distance to the turbines. *Table 11.81* shows the resulting significance threshold for these VSRs is considered to be *moderate adverse.*

VSR 19 - View From East Lamma Channel

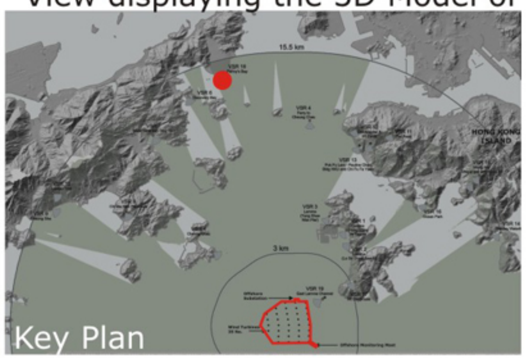
These VSRs may be located anywhere within the East Lamma Channel and may be both occupational; aboard commercial vessels, or recreational aboard pleasure craft. They are generally low in number.



View displaying the 3D Model of the wind farm with Mitigation at Day 1 Operation



View displaying the 3D Model of the wind farm with Mitigation at year 10 operation.



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VSR-18 Photomontage From
Penny's Bay

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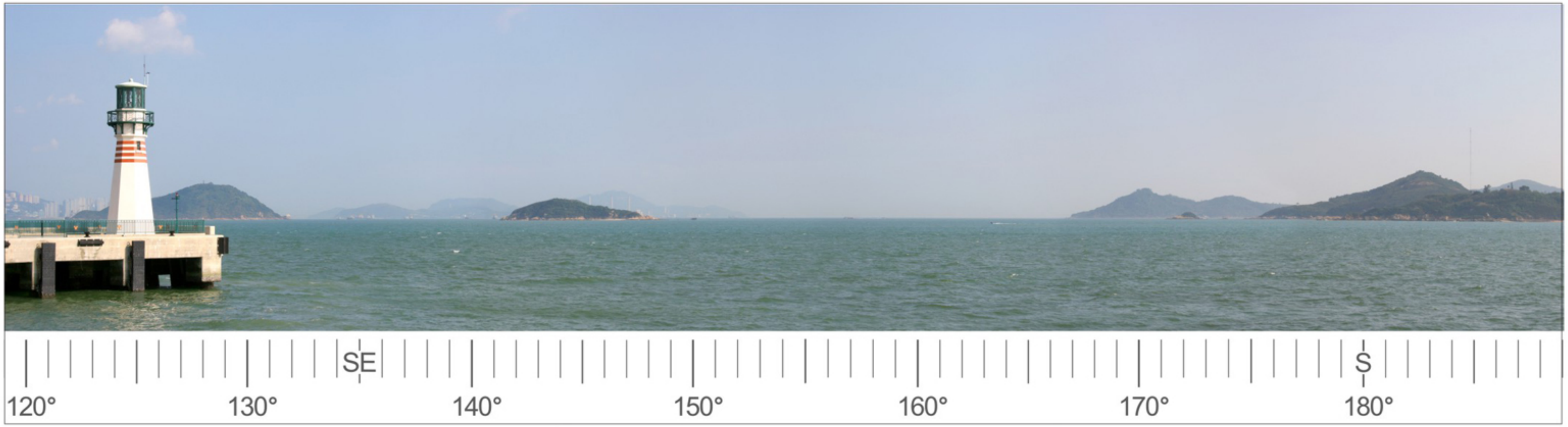
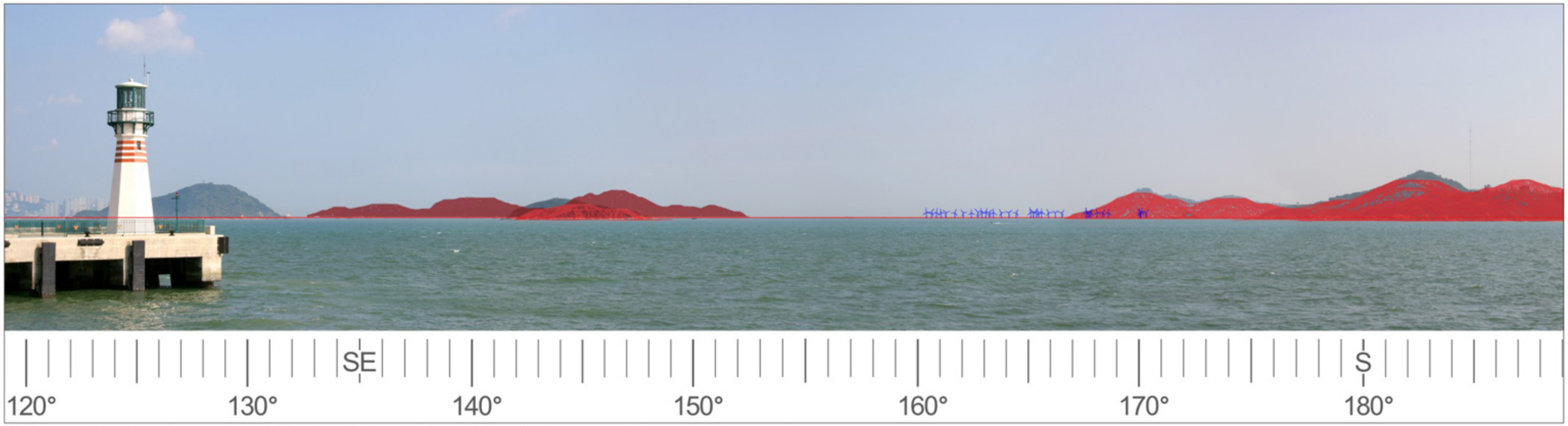
Fig 11.40



VSR 18 - View from Disneyland Resort Pier, Penny's Bay - Existing condition at the Development Site.



View displaying the 3D Model of the Wind Farm without Mitigation

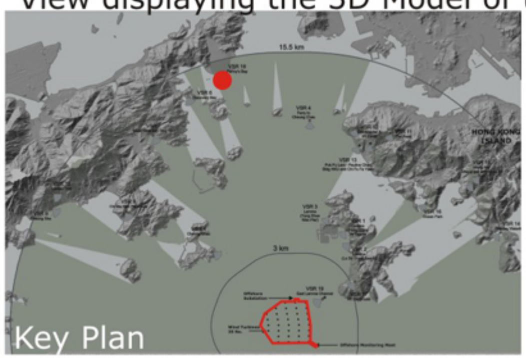


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Fig 11.40

Table 11.82 Sensitivity / Quality

Items	Sensitivity / Quality
Value and quality of view	Medium
Number of VSR	Low
Availability and amenity of alternative views	High
Duration and frequency of views to development	Medium
Degree of visibility of Development	High
Sensitivity/Quality of VSR	Medium

The transient nature of these groups of VSRs in this area will mean the value and quality will also vary, medium is allocated as an average. The numbers of VSRs is considered low as all VSRs must be aboard marine vessels. The availability and amenity of alternative views is considered high to the transient nature of the VSRs, and the duration and frequency of views to the development is hence considered medium. The degree of visibility of the development is considered high due to the large scale of the development. The sensitivity is overall considered to be medium.

Table 11.83 Magnitude of Change

Items	**Construction**	**Operation**
Compatibility with surrounding landscape	Low	Low
Viewing Distance to Proposed Development	Variable, min 500m	Variable, min 500m
Potential blockage of view	Medium	Medium
Duration of impacts	Temporary	Permanent
Scale of development	Large	Large
Reversibility of change	Reversible	Reversible
Magnitude of change	Large	Large

The magnitude of change for these VSRs is considered to be large, mainly due to the ability of these VSRs to come into relatively close proximity to the wind farm.

Table 11.84 Significance Threshold during Construction

<table>
<tr><td colspan="2" rowspan="2"></td><th colspan="3">Sensitivity / Quality</th><th rowspan="2">Beneficial</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><th rowspan="4">Magnitude of Change</th><th>Large</th><td>Moderate Impact</td><td>Moderate - significant impact</td><td>Significant impact</td><th rowspan="2">Neither beneficial nor adverse</th></tr>
<tr><th>Intermediate</th><td>Slight – Moderate impact</td><td>Moderate Impact</td><td>Moderate-significant impact</td></tr>
<tr><th>Small</th><td>Slight impact</td><td>Slight – Moderate impact</td><td>Moderate impact</td><th rowspan="2">Adverse</th></tr>
<tr><th>Negligible</th><td>Negligible impact</td><td>Negligible impact</td><td>Negligible impact</td></tr>
</table>

Table 11.84 shows the significance threshold of the wind farm during construction. The assembly and installation of the wind turbines will be for a period of approximately 9 months. During this time, the significance threshold of the construction impacts will increase from *negligible* at the beginning of construction, to *moderate-significant adverse* towards the end of the construction process. Based on the transient nature of the VSRs, variable viewing locations and relatively small viewer numbers, the significance threshold is *moderate.*

Table 11.85 ***Significance Threshold during Operation***

		Sensitivity / Quality			**Beneficial**
		Low	**Medium**	**High**	
Magnitude of Change	**Large**	Moderate Impact	Moderate - significant impact	Significant impact	**Neither beneficial nor adverse**
	Intermediate	Slight – Moderate impact	Moderate Impact	Moderate-significant impact	
	Small	Slight impact	Slight – Moderate impact	Moderate impact	**Adverse**
	Negligible	Negligible impact	Negligible impact	Negligible impact	

Table 11.85 shows the significance threshold of the wind farm during operation. The sensitivity is considered medium due to the low numbers of transient VSRs in this location. The magnitude of change is considered large due to the ability of these VSRs to see the turbines from a close proximity. As for the significance threshold during construction, the resulting significance threshold during operation is considered *moderate adverse.*

11.7.15 *Visual Mitigation Measures*

Whilst some of the significance thresholds identified in the section above are considered moderate adverse, no significant adverse impacts have been identified. Due to the large scale of the wind turbines, visual mitigation is very difficult. However, the following measures have been considered to reduce impacts.

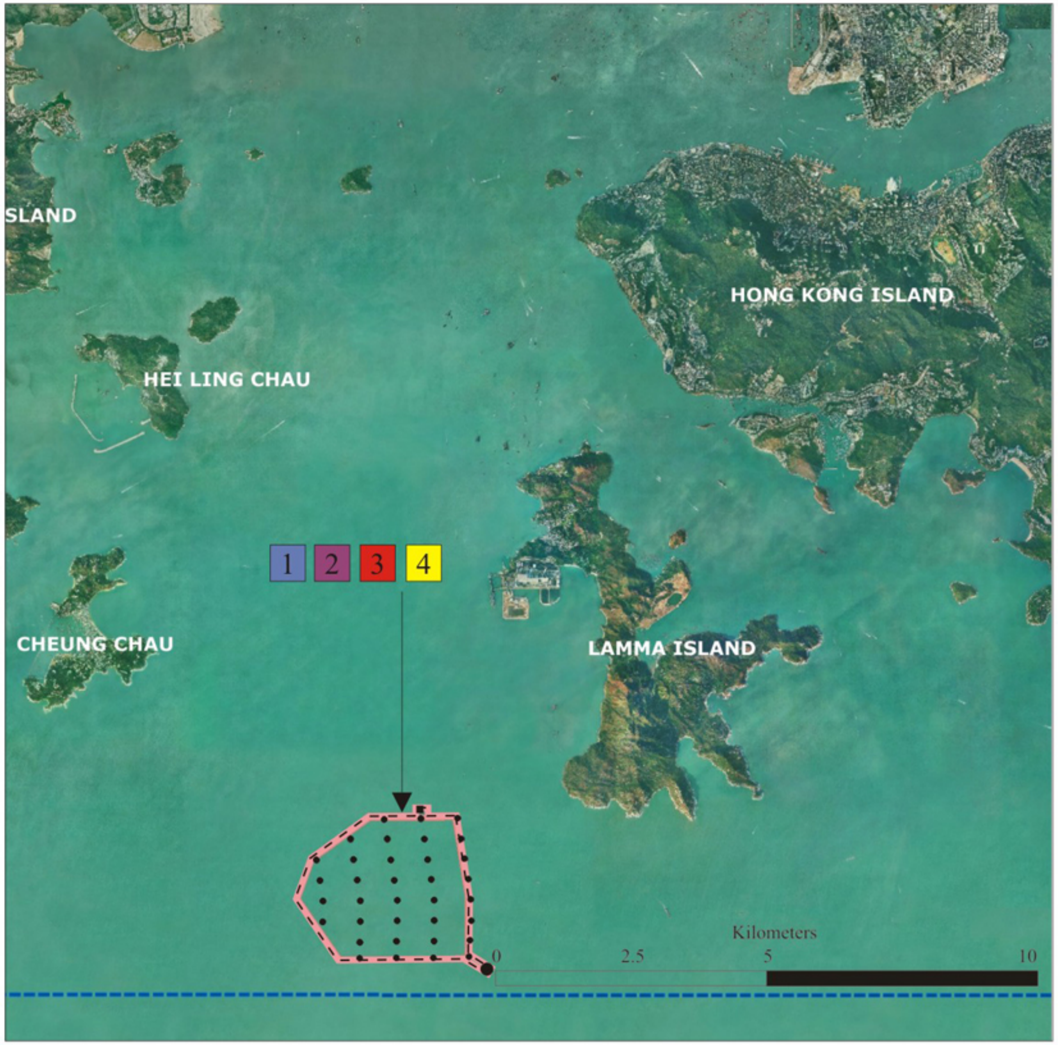
VMM1 Site Selection A detailed site selection process has been undertaken. One of the key considerations was to select a site that would minimise the potential visual impacts associated with the Project. *Section 3* provides a detailed analysis of the site selection process.

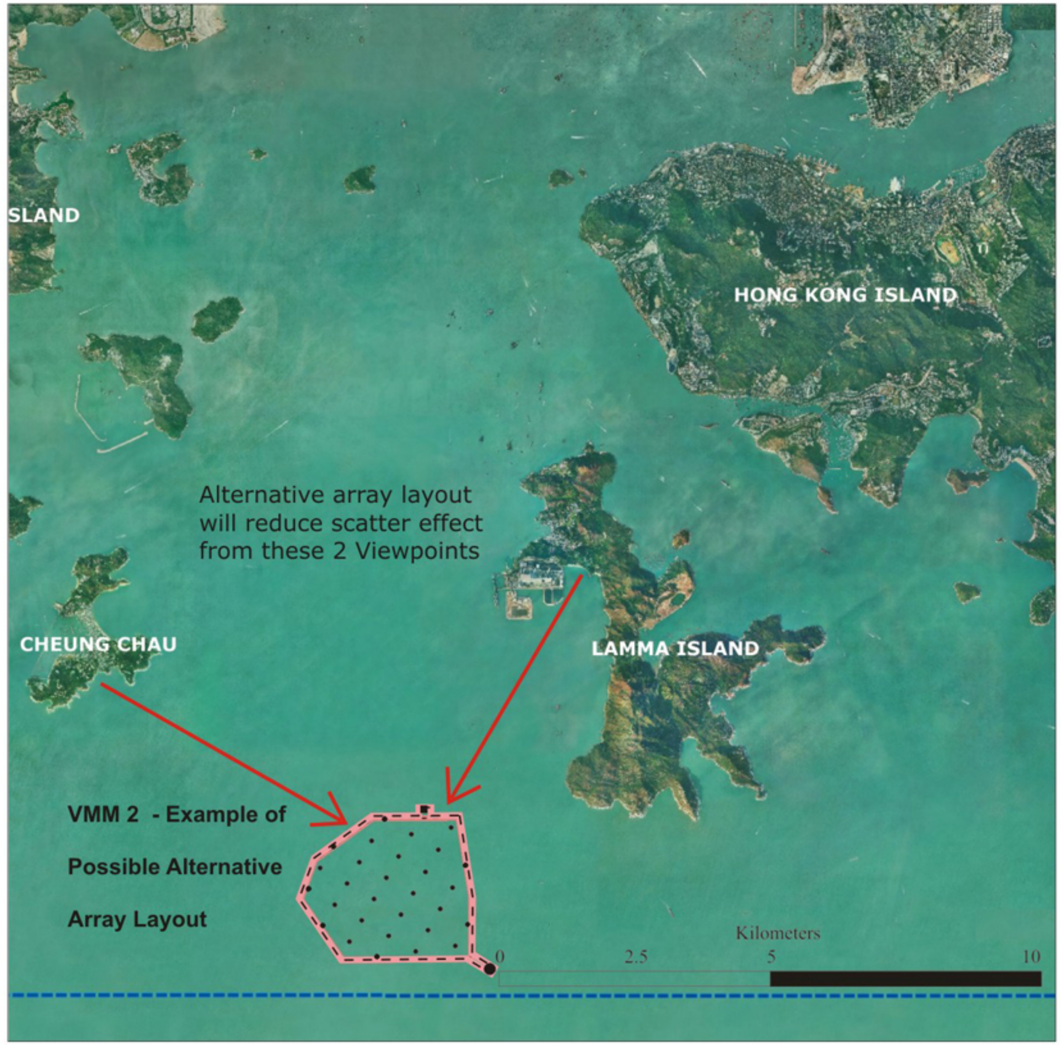
VMM2 Array Layout The array of wind turbines shown in this study is preliminary only. There is an opportunity to amend the layout of the array to reduce the number of turbines visible for the most sensitive viewpoints. It must be noted that visual impacts are only one consideration when determining the layout of the array. Changes to the array are only possible when other technical details, such as suitable sea bed, marine traffic and wind flow conditions are achievable.

VMM3 Colours Colour selection must be in accordance with guidelines imposed by CAD, however appropriate colours for the wind turbines should be selected to reduce their visibility where technically feasible.

VMM 4 Blade Rotation To create a more harmonious visual pattern the blades for all turbines should rotate in the same direction.

Figure 11.41 shows the locations of these measures and their application to each of the VSRs is shown in *Table 11.86.*





LANDSCAPE MITIGATION MEASURES

1 **VMM 1 Site Selection**
A detailed site selection process has been undertaken. One of the key considerations was to select a site that would the potential visual impacts associated with the Project.

2 **VMM 2 Array Layout**
The array of wind turbines shown in this study is preliminary only. There is an opportunity to amend the layout of the array to reduce the number of turbines visible for the most sensitive viewpoints. It must be noted that visual impacts are only one consideration when determining the layout of the array. Changes to the array are only possible when other technical details such as optimum sea floor and wind flow conditions are achievable.

3 **VMM 3 Colours.**
Appropriate colours for the wind turbines should be selected to reduce their visibility.

4 **VMM 4 Blade Rotation.**
To create a more harmonious visual pattern the blades for all turbines should rotate in the same direction.

KEY

Proposed Wind Farm Location

Hong Kong SAR Boundary

HK ELECTRIC
Visual Mitigation Plan Wind Farm
Location
Southwest Lamma Site
Figure 11.41

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Table 11.86 Un-mitigated and Mitigated Impacts at the VSRs

VSR	Un-Mitigated Visual Impact		Recommended Mitigation	Mitigated Impacts		
	Construction	Operation		Construction	Operation Day 1	Operation Year 10
1 Lamma Island (Hung Shing Ye beach)	Moderate	Moderate	VMM 1-4	Slight	Slight	Slight
2 Lo So Shing Beach	Moderate	Moderate	VMM 1-4	Slight	Slight	Slight
3 Lamma Ferry Pier	Negligible	Negligible	Nil	Negligible	Negligible	Negligible
4 Ferry to Cheung Chau	Slight	Slight	VMM 1-4	Slight	Slight	Slight
5 Cheung Chau	Moderate	Moderate	VMM 1-4	Slight	Slight	Slight
6 Discovery Bay	Moderate	Moderate	VMM 1,3,4	Slight	Slight	Slight
7 Silver Mine Bay (Miu Wo)	Moderate	Moderate	VMM 1,3,4	Moderate	Moderate	Moderate
8 Chi Ma Wan Peninsula	Slight	Slight	VMM 1,3,4	Slight	Slight	Slight
9 Cheung Sha	Slight	Slight	VMM 1,3,4	Slight	Slight	Slight
10 Lantau Trail	Slight	Slight	VMM 1,3,4	Slight	Slight	Slight
11 The Peak	Moderate	Moderate	VMM 1,3,4	Moderate	Moderate	Moderate
12 Queen Mary Hospital and Mount Davis	Slight	Slight	VMM 1,3,4	Slight	Slight	Slight
13 Pauline Chan Bldg HKU	Slight	Slight	VMM 1,3,4	Slight	Slight	Slight
14 Stanley Waterfront	Negligible	Negligible	Nil	Negligible	Negligible	Negligible
15 Wong Nai Chung gap and Violet Hill	Negligible	Negligible	Nil	Negligible	Negligible	Negligible
16 Ocean Park	Slight	Slight	VMM 1,3,4	Slight	Slight	Slight
17 Mt Stenhouse	Significant	Significant	VMM 1-4	Moderate	Moderate	Moderate
18 Penny's Bay	Moderate	Moderate	VMM 1,3,4	Slight	Slight	Slight
19 East Lamma Channel	Moderate	Moderate	Nil	Moderate	Moderate	Moderate

11.7.16 *Effectiveness of Visual Mitigation Measures*

The application of the visual mitigation measures will not reduce the significance threshold of the identified visual impacts for most of the VSRs. This is reflected in the photomontages showing the development at Day 1 of operation and Year 10 of operation. *Table 11.86* shows that for VSRs 1, 2, 5, and 17 however, improvements to the array layout will result in reductions to the significance threshold. The detailed studies undertaken in the Site Selection study (refer *Section 3*) have already reduced the potential visual impacts associated with the Project. The adoption of the other visual mitigation measures will further contribute to the reduction of the severity of these impacts.

11.7.17 *Residual Visual Impact Summary*

As described in *Section 11.7.16* above, the visual mitigation measures will not reduce the significance thresholds of many of the impacts. Therefore for many VSRs, the significance thresholds will be the same throughout construction, operation and following the application of the VMMs.

Negligible Impacts.

There will be *negligible* residual visual impacts from VSR3 Lamma Ferry Pier, VSR 14 Stanley Waterfront and VSR 15 Wong Nai Chung Gap and Violet Hill.

Slight Impacts

There will be *slight* residual visual impacts from VSR1 Lamma Island (Hung Shing Ye beach), VSR2 Lo So Shing Beach, VSR4 Ferry to Cheung Chau, VSR 5 Cheung Chau, VSR6 Discovery Bay, VSR 8 Chi Ma Wan Peninsula, VSR 9 Cheung Sha, VSR 10 Lantau Trail, VSR 12 Queen Mary Hospital and Mount Davis, VSR 13 Pok Fu Lam - Pauline Chan Building at HKU, VSR16 Ocean Park, and VSR 18 Penny's Bay.

Moderate Impacts

Moderate residual visual impacts have been identified at VSR7 Silver Mine Bay (Miu Wo) VSR11 The Peak, VSR 17 Mt Stenhouse and VSR 19 East Lamma Channel.

No significant residual visual impacts have been identified.

As discussed in *Section 11.2*, the viewshed analysis is based on a maximum height of 136m while the photomontages have been prepared based on the height of 125m as this would represent the case of having the highest numbers of wind turbine installed within the site boundary and hence represent the worst scenario from visual impact point of view. Nevertheless, it should also be noted that the option of height 125m is the most likely turbine option to be selected. This potential increase in height of 11m will not be perceptible to any VSRs with the only possible exception being VSRs at Mt Stenhouse. However, this small increase in height will not increase the significance threshold of any of the visual impacts to these VSRs.

11.7.18 *Night Lighting and Glare*

The above analysis examined the visual impacts of the proposal during daylight hours. Detailed lighting specifications are not available at this preliminary design stage, however, a preliminary assessment can be made based on similar developments.

The degree to which night lighting has an impact on the surrounding areas is dependent on the following criteria:

1. The spacing, intensity and operation hours of the source lighting;
2. The distance between the source lighting and the VSR;
3. The surrounding ambient lighting conditions of the VSR; and
4. The surrounding lighting conditions of the source.

Source Lighting

The aviation navigation lighting of the wind turbines will generally comprise the following:

For those turbines at the periphery of the wind farm, the highest practical point and an intermediate point on the supporting tower should be lighted in low intensity steady red lights.

Whilst the detailed lighting requirements will be different from the turbines, the wind monitoring mast will have a small number of lights in accordance with CAD requirements.

For all other turbines only the highest practical point on the supporting tower should be lighted in low intensity steady red light.

For marine lighting, each corner of the wind farm development, and mid-way along each side of the wind farm additional lights are required. The corner lights will be yellow flashing lights (5 second interval) visible for 5 nautical miles, located at least 12 m above HAT, with radar reflectors situated beside them. The intermediate lights will flash at 2.5 seconds and will be visible for 2 nautical miles. There will need to be two lights on each lit turbine so that the light is visible through 360° (refer *Section 5*).

Distances between Source Lighting and the VSRs

As described in the preceding sections of this report, most of the VSRs will be located a significant distance away from the wind farm site, the closest VSR's being located on Lamma and Cheung Chau both being over 5 kilometres away.

Surrounding Ambient Light of the VSR

Night lighting from the source is more highly visible when one is observing in darkness. As the surrounding ambient light increases, the visibility of distant objects reduces. This includes viewers in restaurants, near streetlights, or inside illuminated homes. The recreational VSRs will be viewing the wind farm in areas of generally low ambient light, however the numbers of recreational VSRs viewing the wind farm at night will be very low. All of the other VSRs will be generally viewing the wind farm from areas with ambient light.

Surrounding Lighting Conditions of the Source

There are numerous light sources in the areas surrounding the wind farm. These include the existing Power Station on Lamma Island, the marine traffic both transient and berthed and the residential areas on the surrounding islands.

Lighting Impact Summary

Whilst there will be an increase in the numbers of lighting sources in the waters south of Lamma Island, these light sources will generally be of low intensity. Given the presence of the other light sources and the distances to the VSRs, the night lighting and glare impacts are considered acceptable.

11.8 CONCLUSIONS

A Landscape and Visual Impact Assessment has been undertaken for the South West Lamma site. The landscape impacts where identified and some mitigation measures proposed. The residual landscape impacts are:

1. There will be *negligible* residual construction impacts on LCAs 2 Inshore Waters Landscape and LCA 4 Coastal Upland and Hillside Landscape.

2. There will be *slight* un-mitigated construction impacts LCA 3 Industrial Urban Landscape. Approximately 2.78ha of this LCA will be affected during construction, however this area will be fully mitigated with the adoption of the mitigation measures proposed resulting in a *negligible* residual construction impact.

3. There will be *moderate* adverse residual construction impacts on LCA1 Offshore Waters Landscape. Approximately 700ha of this LCA will be lost and can not be mitigated.

4. There will be *negligible* residual operational impacts on LCAs 2 Inshore Waters Landscape, 3 Industrial Urban Landscape and 4 Coastal Upland and Hillside Landscape. There will be *moderate* adverse residual operational impacts on LCA1 Offshore Waters Landscape.

5. There will be *negligible* residual construction and operation impacts on the following LRs:

    - LR 2 Man made rocky sea-wall. Approximately 0.001ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed.

    - LR 3 Industrial Area. Approximately 0.02ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed.

    - LR 4 Soft Landscape areas. Approximately 0.001ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed.

    - LR 5 Mixed Shrubland. There will be no impacts on this LR.

    - LR 6 Pond. There will be no impacts on this LR.

There will be *slight* residual construction and operation impacts on LR1 Seascape as 0.16ha will be lost and can not be mitigated.

A Visual Impact Assessment was undertaken with several conservative assumptions:

1. Whilst the review of Hong Kong's climatic conditions shows that they will reduce the visibility of the wind farm, clear visibility has been assumed;

2. Based on the analysis of the parameters of human vision, the more conservative limit of view of 15.5km has been adopted, and;

3. Intervening vegetation and buildings have not been considered during the identification of VSRs.

Nineteen VSRs were identified and assessed based on their sensitivity and magnitude of change. Whilst visual mitigation of the wind turbine structures is difficult, four VMM's were proposed, however the ability of these mitigation in reducing the significance threshold of the impacts is limited. The residual impacts identified were as follows:

1. There will be *negligible* residual visual impacts from VSR3 Lamma Ferry Pier, VSR 14 Stanley Waterfront and VSR 15 Wong Nai Chung Gap and Violet Hill.

2. There will be slight residual visual impacts from VSR1 Lamma Island (Hung Shing Ye beach), VSR2 Lo So Shing Beach, VSR4 Ferry to Cheung Chau, VSR 5 Cheung Chau, VSR6 Discovery Bay, VSR 8 Chi Ma Wan Peninsula, VSR 9 Cheung Sha, VSR 10 Lantau Trail, VSR 12

Queen Mary Hospital and Mount Davis, VSR 13 Pok Fu Lam - Pauline Chan Building at HKU, VSR16 Ocean Park, and VSR 18 Penny's Bay.

3. Moderate residual visual impacts have been identified at VSR7 Silvermine Bay (Mui Wo), VSR11 The Peak, VSR 17 Mt Stenhouse and VSR 19 East Lamma Channel.

Four Visual Mitigation Measures are proposed that will reduce the severity of these visual impacts.

According to *Annex 10* of the *Technical Memorandum on the Environmental Impact Assessment Process* (EIAO-TM) the Landscape and Visual Impacts are considered *acceptable with mitigation*.

Annex 11 A

Community Perception Studies

ANNEX 11 A COMMUNITY PERCEPTION STUDIES

The discussions in *Section 11.7.2* are also supported by many other studies undertaken in Australia, NZ, the UK and the USA. Some of these studies are summarised below in Annex A.

A.1 GULLEN RANGE WIND FARM– COMMUNITY PERCEPTION TOWARDS WIND FARMS

A study to ascertain the regions view towards wind farms was conducted from the 27th of July and concluded on the 2nd of August 2007. This study was previously quoted in the Planning Application Report for the Gullen Range Wind Farm. The study area included the Goulburn – Crookwell – Yass regions, which are located within the Southern Tablelands area in NSW. This area is known to high wind speeds and therefore has potential for wind energy projects.

The respondents in this study were located in small urban and rural locations within the immediate vicinity of the proposed Gullen Range Wind Farm; however the study also selected residents further to the west around Gunning and Yass, to the North West at Binalong, to the east towards Crookwell and to the south east towards Goulburn.

Within the study area, an existing wind farm, known as Crookwell I, is located to the immediate east of Crookwell Township and an approved wind farm (Crookwell II), to the immediate south of Crookwell I. Further approved wind farms are located to the south east known as Walwa-Gunning and Cullerin Range. Located further to the west, to the west of Yass, is the approved wind farm at Conroys Gap.

At the beginning of the study, it wasn't known just how much respondents knew of these wind farm projects, what they knew of wind farms, what the wind turbine that populated and powered them looked like, or know what it actually did. This study examines community perceptions towards renewable wind energy, derived from wind farms, for the region of south east NSW and establishes baseline data on community perceptions in the study area.

Results have shown an approval rating of almost 9 in 10 (89%) respondents in favour of wind farm projects being developed in the Southern Tablelands. With over 9 in 10 (96%) of respondents agreeing 'wind energy is a good alterative energy source', see *Figure A.1*.

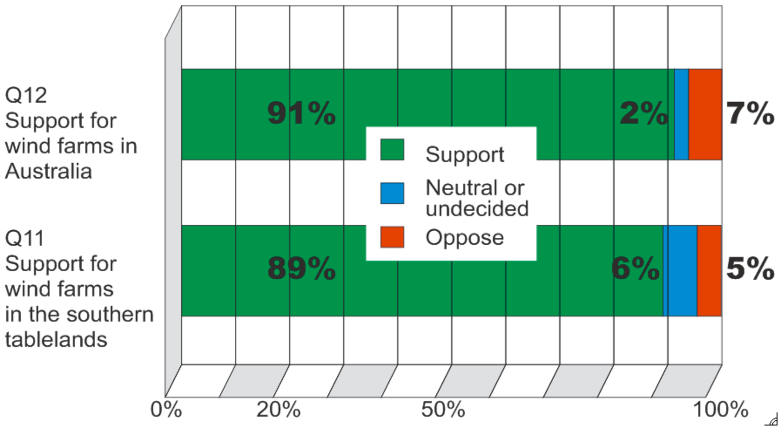

Figure A.1 *Support for wind farms*

Further to this, most respondents (83% favour, 8% opposed) were accepting of a wind farm set back 10 km from their home, with a slight decrease to 7 in 10 respondents (71% Favour, 19% opposed) accepting a wind farm set one kilometre from their home, see *Figure A.2*. This is a very similar level of acceptance that has been identified in other studies.

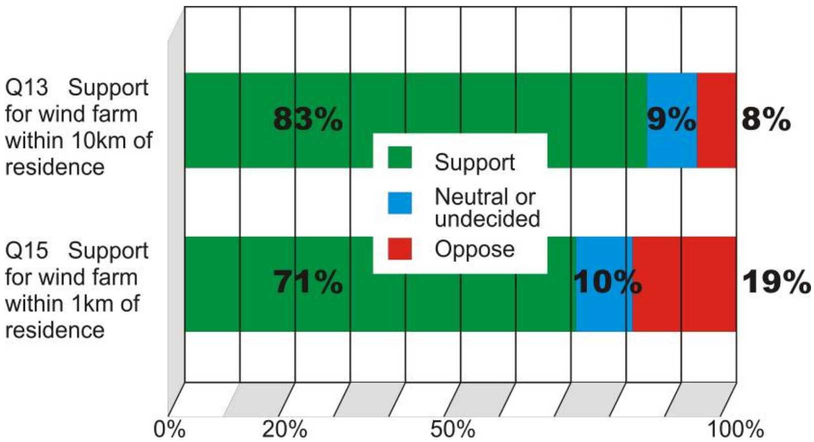

Figure A.2 *Support for wind farms near respondent's residence*

As well as the statistical similarity in the level of support between sites in Victoria and NSW, there is also a similarity ion the level of support when a wind farm is proposed within 1 km of a respondent's residence and if it is located on some of the most scenic of Victoria's coastline (Kanos & Quint, 2000, cited in Section 2.2.1).

In response to introducing the concept of multiple 'typical' (15 to 80 turbines) wind farms in the local rural area, respondents accepted 76% (19% opposed) one typical wind farm, with three typical wind farms accepted by 64% (27% opposed) see *Figure A.3*.

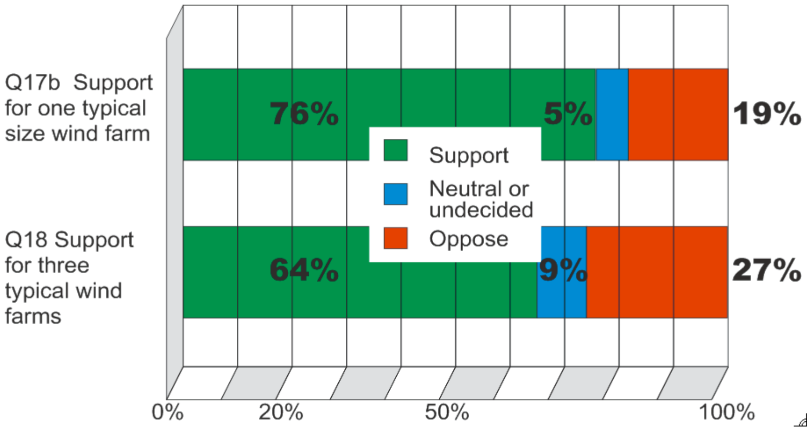

Figure A.3 *Support for multiple wind farms*

Figure A.3 again highlights the remarkably consistent levels of approval for one or more wind farms in the area. The lowest level of acceptance at 64% for three wind farms is again very similar to the levels of support shown for the most sensitive of locations, weather with one kilometre of the respondent's house or on coastal headlands along Victoria's coast.

The study also found that the community has no clear preference between a few clusters, close together, or spread out at reasonable intervals along the highway. Therefore it would seem that this landscape can absorb future wind farm developments, as the community has not a strong preference.

This study shows the adult residents in the survey area are concerned about global warming and are aware of the alternatives available. The study also shows respondents know and understand what a wind turbine is, how wind farms appear in the landscape and are supportive of them.

Moreover when it comes to locating wind farms, respondents are not averse to having them in their immediate locality, and a majority still approving of a wind farm within one kilometre of their home.

It is suggested that respondents feel the creation of wind farms is positive and this study shows that many are prepared to embrace them in their local area.

These outcomes are remarkably consistent with results from other surveys conducted both within Australia and overseas and a clear pattern is emerging on the acceptance of wind farms in rural communities.

A.2 Other Australian Community Perception Studies

The following section builds upon ERM's discussion of perception issues in past visual assessments of other wind farms and is pertinent to the visual and landscape assessment of the proposed Ararat Wind Farm.

A.2.1 Coastal Headlands

In 2000, a study was undertaken for the Department of Natural Resources and Environment (Kantos & Quint, 2000) on the many issues concerning the Victorian Coastline including the construction of wind farms on coastal headlands.

Figure A.4 summarises the results of this particular component. The study involved a series of nine workshops as well as telephone interviews (n = 700).

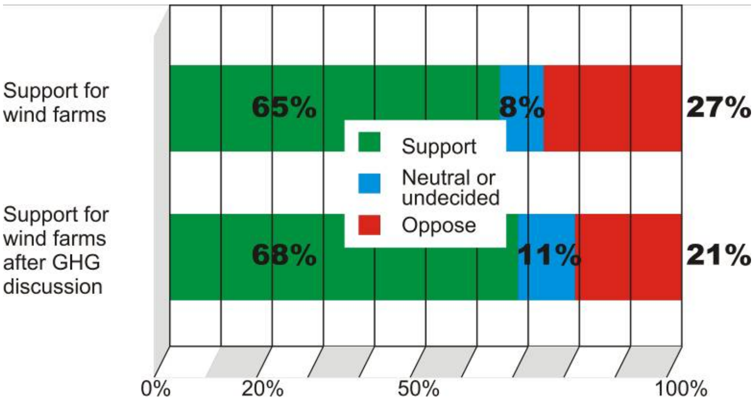

Figure A.4 Wind farms on Coastal Headlands – Participant Responses

Study participants initial support or opposition to the construction of wind farms on coastal headlands was measured. After being exposed to arguments on renewable energy, greenhouse gas emissions and climate change issues their responses were measured again. This study found that there was only a slight increase in participants' acceptance of wind farms on coastal headlands, from a 65% acceptance level before arguments on greenhouse gas emissions to 68% acceptance after these arguments were presented. However opposition reduced from 27% to 21%.

A.2.2 Nirranda Wind Farm

Similar figures have been found in a 2002 visitor survey undertaken for Stanwell Corporation Limited (Offer Sharp & Associates 2002) on the possible visual impacts of the proposed wind farm on the Bay of Islands viewing platform that is located adjacent to the Nirranda site, in the Shire of Moyne approximately 250 km west of Melbourne.

Approximately 80% of people were generally in support of wind farms, however when presented with a proposal for a wind farm visible from a scenic coastal lookout (the Bay of Islands) the support for a wind farm at this location reduced to approximately 71%, whilst opposition to the presence of a wind farm at this location increased from 3% to 12%.

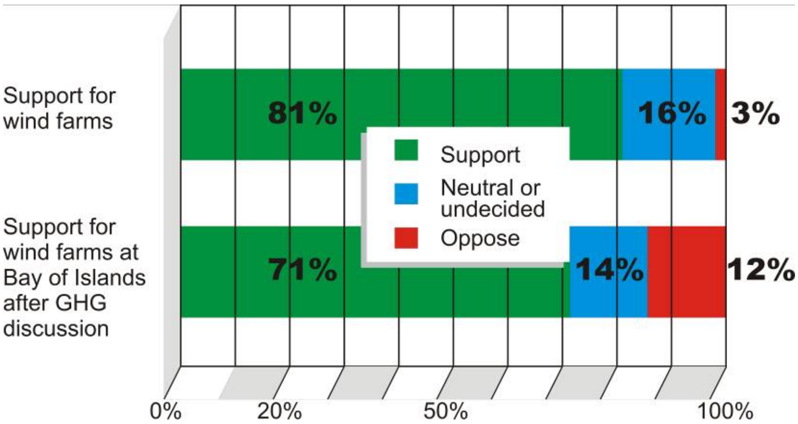

Figure A.5 ***Nirranda Wind Farm Respondents Attitudes to Wind Farms***

This figure of 71% support for wind farms is similar to the Kantos & Quint result of 68% reported previously for wind farms on exposed coastal headland.

A.2.3 Yaloak Wind Farm

Research undertaken by Offer Sharp & Associates, 2004 presented at the Yaloak Wind Farm panel hearing in 2005 showed a similar level of community acceptance to wind farms on this inland site near Ballan, Victoria.

The study assessed community reaction to images of a wind farm in the Yaloak landscape as well as at another site at Crowlands in Western Victoria. Neither location was identified, however the Yaloak proposal had been publicised for some time before the survey and the landscape may have been recognised by some, and particularly local, respondents. Community reaction to the siting of wind turbines in these landscapes was based on interviews with 200 respondents from each of Melbourne, Bacchus Marsh and Ballarat.

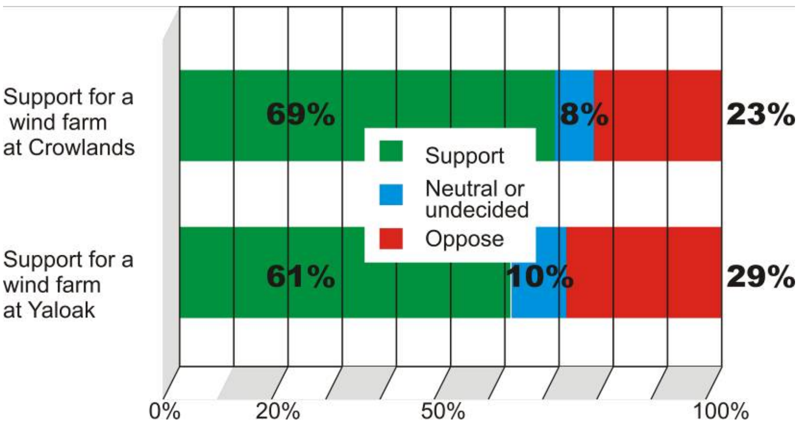

Figure A.6 ***Level of Support for Potential Wind Farms at Yaloak and Crowland***

This data has been extracted from *Table 15 Crowlands* and *Table 19 Yaloak* in the Offer Sharp & Associates 2004 report and illustrates the acceptance levels for wind farms of each of these sites. The study also found slight differences in levels of support at Crowlands (67%, 66% and 73%) for respondents from Melbourne, Bacchus Marsh and Ballarat respectively, and slightly larger differences (61%, 55% and 68%) in support for the proposed wind farm at Yaloak.

However, the overall findings are similar of the earlier studies from the earlier Kantos & Quinn 2000 and Offer, Sharp 2002. All these Australian studies continually show a level of acceptance greater than 60%. Overseas studies show similar results.

A.3 UNITED KINGDOM

A paper presented at the 20th British Wind Energy Association Conference (Anne Marie Simon Planning, 1996) gives an overview of thirteen studies undertaken between 1990 and 1996 by wind power proponents, opposition groups, the BBC, statutory authorities and a Liverpool University dissertation found that in all these studies:

- The overwhelming majority of respondents support the principal of development of wind power in the UK, and they also support their local wind farm;
- Those with direct experience of an operating wind farm are more supportive and positive than those without experience;
- Once wind farms are in operation, concerns about noise and visual impact decrease;
- The majority of people find the wind farms acceptable in the landscape and more find the wind turbines graceful than ugly; and
- A strong majority support and a small minority oppose wind farms, with more expressing no opinion than opposition (Freris 1998).

A summary of the results for eleven of these studies, which is taken from this paper (*Anne Marie Simon Planning, 1996*), are reproduced below.

Table A.1 Summary of Eleven Studies Conducted in the United Kingdom into Attitudes to Wind Power from 1990-96

Location	Sponsor/Organiser	Date	In favour	Against	Don't know
Delabole, England	DTI	1992/3	84%	4%	11%
Cemmaes, Wales	DTI	1992/3	86%	1%	13%

Llandinam & Llangwyryfon, Wales	CCW	1992/3	83% 78%	3% 8%	14% 14%
Llandinam Rhyd-y-Groes Taff Ely, Wales	BBC	1994	76% 61% 74%	17% 32% 9%	8% 7% 17%
Kirkby Moor, England	National Wind Power	1994	82%	9%	9%
Bryn Titli, Wales	NWP (pre construction) NWP (open day)	1996	68% 94%	14% 3%	19% 3%
Trysglwyn, Wales	NWP (open day)	1996	96%	4%	-
Coal Clough, England	Liverpool University Dissertation	1996	96%	4%	-

Notes
NWP = National Wind Power (a wind farm developer).
CCW = Countryside Council for Wales (a statutory body)
BBC = BBC (Wales) and the University of Wales

In all these studies between 61% and 96% of survey respondents were supportive of wind power.

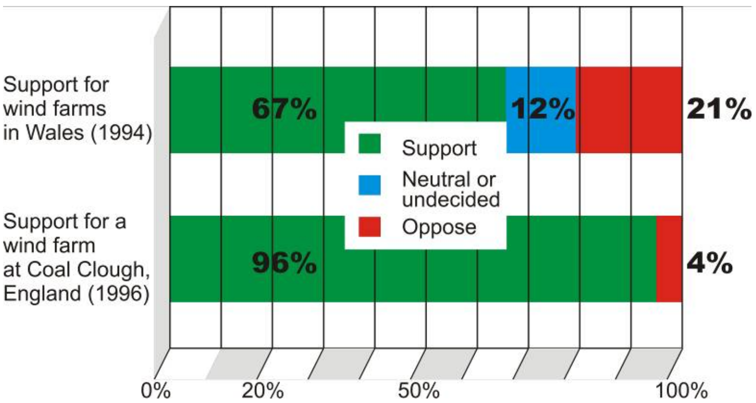

Figure A.7 ***Comparison of Selected Wind Farm Community Perception Studies in the United Kingdom***

The lowest level of acceptance was one area within the BBC 1994 study which looked at attitudes towards wind farms in Wales (Interviews with 268 respondents, conducted in two stages; stage one being just after the wind farm was built and stage two one year later). The BBC study also looked at three locations, Llandinam, Rhyd-y-Groes and Taff Ely) with the lowest support for the wind farm at Rhyd-y-Groes with 61% support and 32% against, whilst overall the BBC study found that 67% of respondents were in favour of the development of wind power in Wales, and 21% were opposed.

The highest approval was that reported in the Coal Clough (Lancashire, England) study (Questionnaire completed by face to face interviews, sample of 50) with 96% approval and 4% opposition.

These figures are similar to those reported in the Australian studies.

A.4 SCOTLAND & IRELAND

A recent study (November 2005) on community perception of wind farms in Scotland and Ireland also has similar, but higher approval ratings. (found at http://www.your-energy.co.uk/pdf/windfarmpaper121205.pdf).

Table A.2 Comparison of levels of acceptance between wind farms in Scotland and Ireland

	Strongly support		**Support**		**Neutral**		**Oppose**		**Strongly oppose**	
	DL (%)	BH (%)	DL (%)	BH (%)	DL (%)	BH (%)	DL (%)	BH (%)	DL (%)	BH (%)
A. Wind power is Scotland	55	55	35	22	6	16	2	0	2	7
B. Local wind farm	63	47	25	16	3	20	3	4	5	13

DL = Dun Law (operational site). BH = Black Hill (proposed site).

(from *Public Perceptions of Wind Power in Scotland and Ireland*, Charles R. Warren, Carolyn Lumsden, Simone O'Dowd & Richard V. Birnie, Journal of Environmental Planning and Management, Vol. 48, No. 6, 853 – 875, November 2005, Table 4, p862).

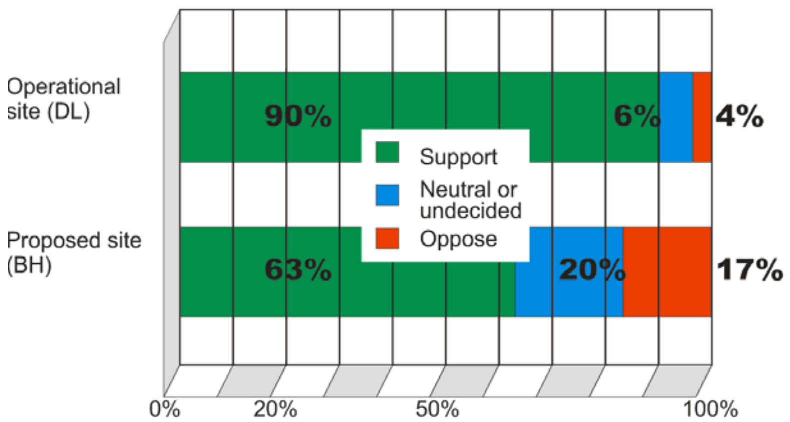

Figure A.8 Acceptance levels - Scotland and Ireland

Once again this reconfirms that the high level of acceptance, and this report also goes further and shows the increased level of acceptance within a community following construction. This is discussed in the next section of this report.

A.5 NORTH CAROLINA, USA

Reported attitudes in a study from North Carolina (NC) in the USA are also similar. A paper prepared on public attitudes (Grady 2004) towards wind energy in eastern NC, which included coastal areas, and western NC, which includes mountainous areas, presented to the 'Efficient NC Conference' also found similar degrees of approval. Note: There was no information in this paper on the sample size.

Table A.3 Public Attitude to Placement of Wind Farms in Eastern NC

Placement	% Prohibited	% Not prohibited	% Don't know
Mainland	11.9	72.8	15.3
Mainland clustered	14.1	69.6	15.1
Sounds	16.6	63.6	19.8
Sounds clustered	28.0	50.2	20.5
Offshore	13.9	68.6	17.6
Offshore clustered	14.4	68.6	15.8

Table A.3 shows the level of acceptance for clusters of wind turbines reduced to 50% for the Sounds which are the coastal areas along the eastern seaboard of North Carolina. The level of acceptance for clustered groups of wind turbines in the mainland area rose to 69.6%.

This paper (Grady, 2004) also presented levels of acceptance within the more mountainous areas of Western NC.

Table A.4 Public Attitudes to Wind Farm Placement – Western NC

Placement	% Prohibited	% Not prohibited	% Don't know
Ridge tops	20	64	17
Ridge tops clustered	28	57	15
Ridge tops with other towers	16	75	10

The western area of Northern Carolina is mountainous; many parts are uncleared and show few signs of human intervention. The level of acceptance for clustered groups of wind turbines on ridge tops in this area is less (57%) than the level of acceptance reported for the mainland areas of Eastern NC (69%), however if there are other towers on the ridge tops (i.e. there are obvious signs of human intervention) then the level of acceptance rises to 75%.

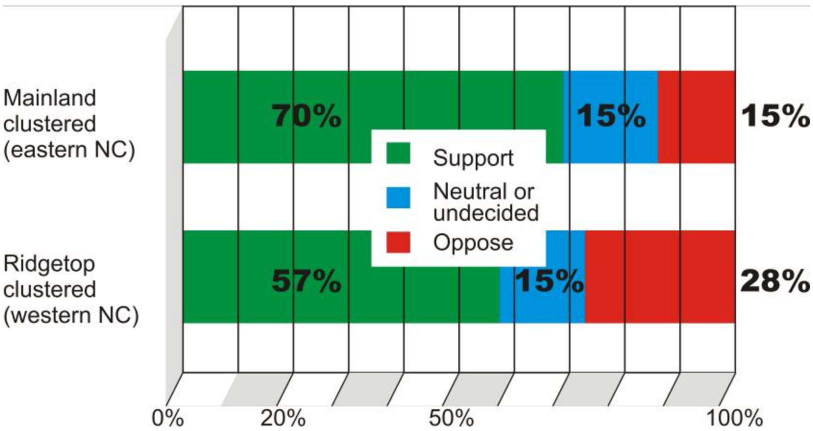

Figure A.9 Acceptance Levels - Northern Carolina, USA

In summary this paper reported that:

- *"Within groups of middle aged, middle class, pragmatic, year round residents of the mountain and coastal regions of NC, there is support for developing renewable energy as a future source of fuel for electricity generation.*
- *More than 3 out of 4 would prefer to see more future electricity derived from solar and wind*
- *Less support for turbines in sounds or national forests*
- *2 out of 3 support turbines visible from home*
- *Over 80% support turbines for residential use."*(Grady, 2004)

The degree to which the respondents believe that wind farms on mainland sites should not be prohibited is very similar to the previously cited United Kingdom and Australian studies; with between 69-73% believing that wind farms should not be prohibited.

A.6 *PERCEPTION ALTERATION AFTER CONSTRUCTION*

There has been no research done on the visual impact of wind farms in Australia after construction, however overseas studies suggest greater acceptance levels by people who live in the vicinity of wind farms after their construction (Gipe n.d.)

Anne Marie Simon Planning and Research in the previously cited study also found that all studies that looked at perceptions before and after construction, reported an increase in acceptance after the Wind Farm was completed.

It is also interesting to note that the study on Scotland and Ireland (cited above) also shows a 27% increase in acceptance following construction, although the greatest proportion of people who changed their mind were in the "neutral or undecided" group, there was still a significant reduction from 17% to 4% in the group that opposed the wind farms.

This study supports the view that familiarity does not increase opposition to a wind farm, but rather increases acceptance and support for wind turbines in the landscape.

CONTENTS

ANNEXES

12 CULTURAL HERITAGE IMPACT ASSESSMENT

12.1 INTRODUCTION

This Section presents the results of the Cultural Heritage Impact Assessment for the proposed construction and operation of the offshore wind farm. A literature review has been conducted to establish baseline cultural heritage conditions in the terrestrial and marine environment. In addition, a Marine Archaeological Investigation has been undertaken to identify the location of any unknown archaeology.

The Study Area for the terrestrial archaeological assessment included areas within 100 m from the boundary of onshore cabling works. The Study Area for the marine archaeological investigation included the seabed that will be affected by the marine works being proposed.

12.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

The following legislation and guidelines are applicable to the assessment of cultural heritage and archaeological sites in Hong Kong:

- *Environmental Impact Assessment Ordinance (Cap. 499) and the associated Technical Memorandum on the EIA Process (EIAO-TM)*;
- *Antiquities and Monuments Ordinance* (*AM Ordinance*) *(Cap. 53)*;
- *Hong Kong Planning Standards and Guidelines*;
- *Guidelines for Cultural Heritage Impact Assessment prepared by the Antiquities and Monuments Office (AMO)*; and
- *Guidelines for Marine Archaeological Investigation prepared by AMO*.

12.2.1 *Environmental Impact Assessment Ordinance Technical Memorandum on the EIA Process*

The *EIAO-TM* outlines the approaches required in investigating and assessing the impacts on archaeological sites. In particular, the EIA considered criteria set out in *Annexes 10* and *19*.

12.2.2 *Antiquities and Monuments Ordinance, Cap. 53*

The *AM Ordinance* provides statutory protection against the threat of development on Declared Monuments, historical buildings and archaeological sites to enable their preservation for posterity. The *AM Ordinance* also establishes the statutory procedures to be followed in making such a declaration.

"This Ordinance provides for the preservation of objects of historical, archaeological and paleontological interest…"

The *AM Ordinance* defines an antiquity as a relic (a movable object made before 1800) and a place, building, site or structure erected, formed or built by human agency before the year 1800. The *AM Ordinance* also states, amongst other things, that the discovery of an antiquity shall be reported to the Authority (Secretary for Development); that ownership of all relics discovered after 1976 shall be vested in the Government; that the Authority can declare a place, building, site or structure to be a monument, historical building or archaeological or paleontological site or structure (and therefore introducing certain additional controls for these sites); and that licences and permits can be granted for excavation and for other work.

Over the years, surveys have been undertaken to identify archaeological sites in Hong Kong. The *AMO* has established boundaries for the identified sites and a set of administrative procedures for the protection of the known archaeological sites. However, the present record of archaeological sites is known to be incomplete as many areas have not yet been surveyed. There is a need therefore to ensure that the procedures and mechanisms, which enable the preservation or formal notification of previously unknown archaeological resources that may be revealed or discovered during project assessment or construction, are identified and implemented at an early stage of the planning of a project.

Section 11 of the *AM Ordinance* requires any person who discovers an antiquity, or supposed antiquity, to report the discovery to the Antiquities Authority. By implication, construction projects need to ensure that the Antiquities Authority, the Antiquities Advisory Board (AAB) (1), is formally notified of archaeological resource which are discovered during the assessment or construction of a project.

12.2.3 Hong Kong Planning Standards and Guidelines (HKPSG)

Chapter 10, Conservation, of the *HKPSG* provides general guidelines and measures for the conservation of historical buildings, archaeological sites and other antiquities.

12.2.4 Cultural Heritage Impact Assessment Guidelines

Guidelines for Cultural Heritage Impact Assessment detail the standard practice, procedures and methodology which must be undertaken in determining the cultural heritage resources potentially impacted by developments and defining suitable mitigation measures to be adopted (see *Appendix C of the EIA Study Brief ESB-151/2006*).

(1) The Antiquities and Monuments Office is the entry point to pass information to the AAB. The AAB is a statutory body consisting of expertise in relevant fields to advise on any matters relating to antiquities and monuments.

12.2.5 *Marine Archaeological Investigation Guidelines*

Guidelines for Marine Archaeological Investigation detail the standard practice, procedures and methodology which must be undertaken in determining marine archaeological potential. Guidelines for determining the presence of archaeological artefacts and defining suitable mitigation measures can be found in *Appendix C of EIA Study Brief ESB-151/2006*. Baseline review, geophysical survey and establishing archaeological potential are considered the first stage of a Marine Archaeological Investigation. Subject to the results of the first stage Marine Archaeological Investigation, further investigation may or may not be required.

12.3 ASSESSMENT METHODOLOGY FOR CULTURAL HERITAGE IMPACT ASSESSMENT

A desk-based review was undertaken to identify terrestrial cultural heritage resources as defined in appropriate guidelines (see *Table 12.1*) and archaeological interest features.

Table 12.1 Categories of Cultural Heritage Resources

Categories	Description	Sub-Category
Declared Monuments	Statutorily protected against the threat of development under the Antiquities and Monuments Ordinance (AM Ordinance) to enable preservation for posterity.	Nil
Graded Historic Buildings	Graded by the Antiquities Advisory Board (AAB) based on an internal guidelines adopted by the AAB and the Antiquities and Monuments Office (AMO) for the preservation of historic buildings.	Grade I - Buildings of outstanding merit, which every effort should be made to preserve if possible. Grade II - Buildings of special merit; efforts should be made to selectively preserve. Grade III - Buildings of some merit: preservation in some form would be desirable and alternative means could be considered if preservation is not practicable.
Government Historic Sites	Historic sites owned by the government identified by AMO as heritage sites.	Nil
Archaeological Sites	Sites with archaeological interest listed by AMO.	Nil
Other Cultural Heritage Sites	Cultural heritage resources falling outside the above categories but need to be addressed within the Study Area boundary in accordance with Section 1.1(a) of the CHIA.	Historic Buildings and Structures; Landscape Features; Areas of Archaeological Potential

The desktop study also identified the potential for marine archaeological sites within the Study Area.

In addition, a geophysical survey has been conducted by the project proponent and the survey data has been reviewed by a qualified marine archaeologist to locate and define any sites of archaeological potential within the Study Area.

Information was obtained from references available over the internet, the Hong Kong Heritage Discovery Centre Reference Library, the United Kingdom Hydrographic Office 'Wreck' files and various government departments, public libraries and libraries from tertiary institutions.

12.4 BASELINE CONDITIONS

12.4.1 Terrestrial Resources and Archaeology

The landing site of the submarine cable will be at the Lamma Power Station seawall area. No declared monuments, graded historic buildings, government historic sites and archaeological sites listed by *AMO* have been identified within or adjacent to the proposed works. In addition, there are no known archaeological interest features present at the recently reclaimed Lamma Power Station Extension.

12.4.2 Marine Archaeology

Desk-top Literature Review

Coates [(1)] stated that 'Definite archaeological traces of prehistoric activity have been found on the beach at Shek Pik, on the south coast of Lantao [Lantau] Island. From these finds it is clear that about three thousand years ago the islands in the HKSAR were used as a seasonal entrepôt for trade between the Yangtse mouth, the tribal states of what is to-day Guangdong Province, and Indonesia'. The islands at the mouth of the Pearl River were seen as more suitable for trade between the Cantonese merchants and those from other regions, and 'Temporary settlements were built near the beaches. Cooking utensils have been found from this period on Lamma and Lantao, but no trace of buildings'.

Thirteen (13) archaeological sites and many archaeological finds have been recorded on Lamma Island which although would not be affected by the wind farm could indicate some interest in the offshore area within or adjacent to the footprint of the wind farm and cable route. Studies show a rich heritage on the island, including thirteen archaeological sites. Artefacts of note include lime kilns, shells, animal bones, ancient cultural relics, bronze weapons, bronze axe moulds, burials and a special 'Yazhang', a jade object from ritual purposes, which indicates that 3,000 years ago, the coastal area of Southern

(1) Braga, J. M., 1995, China Landfall 1513. Jorge Alvares Voyage to China. A compilation of some relevant material. Macao. Imprensa Nacional.

China had a cultural connection with the Yellow River basin. However, the literature reviewed has not identified any features of interest in the marine environment within the footprint of proposed works and any small unknown items located on the surface of the seabed are likely to have been disturbed by fishing and other shipping related activities.

The sediments of the Late Holocene period, considered to be relatively homogenous very soft to soft silty clay and with high moisture content, offers the greatest potential (as compared to the surface of the seabed which is often found to have been disturbed by fishing and other shipping related activities) to include well preserved remains associated with the occupation and use of the islands in Hong Kong waters. These remains could include shipwrecks. In the Study Area marine deposits vary in thickness from 2 metres to about 15 metres.

The United Kingdom Hydrographic Office in Taunton maintains a database of known shipwrecks/undefined sites in the HKSAR. This is the same data held by the Hong Kong Marine Department, Hydrographic Office. The Hydrographic Office classifies wrecks by their status as follows:

- *ABEY:* The wreck has been previously reported but not detected by survey, leading to doubts about its reported position or existence;
- *DEAD:* The wreck has not detected by repeated surveys, therefore considered not to exist;
- *LIFT:* A salvaged wreck; and
- *LIVE:* All other wrecks, charted or uncharted.

Annex 12C provides a list of these sites adjacent to the proposed development. A total of four shipwrecks / undefined sites were found. Three of these wrecks are classified as 'Live' and one wreck is classified as 'Dead'. The nearest site (Wreck No. 60016) is located 328 m southeast from the proposed cable route. However, this wreck is classified as 'Dead'. The remaining sites are located over 1.4 km from the proposed cable route or the wind farm site. *Figure 12.1* shows the location of these wreck sites.

Geophysical Survey

The objective of the geophysical survey (an investigation of the bathymetry, seabed features and geology) was to define the areas/sites of greatest archaeological potential and map any seabed and sub-bottom anomalies which may be archaeological material.

On 27 and 28 March 2009 EGS (Asia) Limited undertook a geophysical survey along the length of the cable route to the wind farm, and within the wind farm (comprising wind turbines, offshore substation, offshore monitoring mast and connecting cables). A survey methodology was formulated to fulfill the

Figure 12.1

Location of Wrecks Identified from UKHO Records

File: 0088440_WestLammaSite.mxd
Date: 03/05/2009

Environmental Resources Management

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requirements of the Marine Archaeological Investigation which provided seismic profiling of the seabed within the works area, and 25 m either side of it, in addition to side scan sonar surveys of an area 75 m either side of the seabed to be impacted. *Annex 12A* presents the *Marine Archaeological Investigation Method Statement*.

The equipment used during the survey included:

- DGPS positioning and navigation, provided by the C-NAV GcGPS 2000 system, and C-View NAV Navigation software;
- Knudsen 320m echo sounder used to collect depth soundings;
- Reson 8125 multibeam echo sounder
- DF 1000 side scan sonar system (employing a dual frequency system with nominal operating frequencies of 100 kHz and 500 kHz) and digital tow fish, used to map seabed features;
- C-Boom low voltage boomer system, used to provide profiles of seabed sediments; and
- C-View logging systems.

The geophysical survey data obtained by EGS were processed by in house geophysicists and reviewed by an experienced marine archaeologist. *Annex 12B* provides the location of geophysical survey tracts and results of the survey.

The geophysical survey showed how the seabed in the Study Area has been impacted by anchoring, trawling and dumping of materials (see *Figures 12.2* and *12.3*). Some Sonar Contacts were identified as debris/dumped material and this was confirmed through the review by the marine archaeologist (see *Figure 12.3*).

Figure 12.2 Seabed scar from an anchor dragging along the seabed

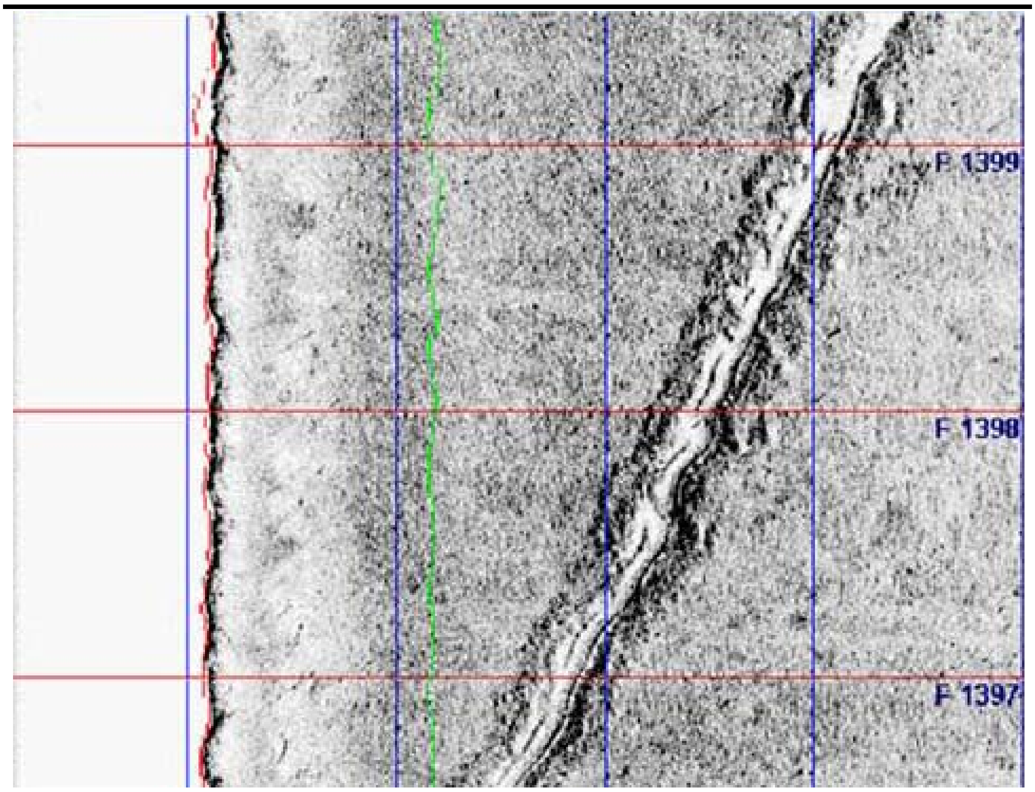
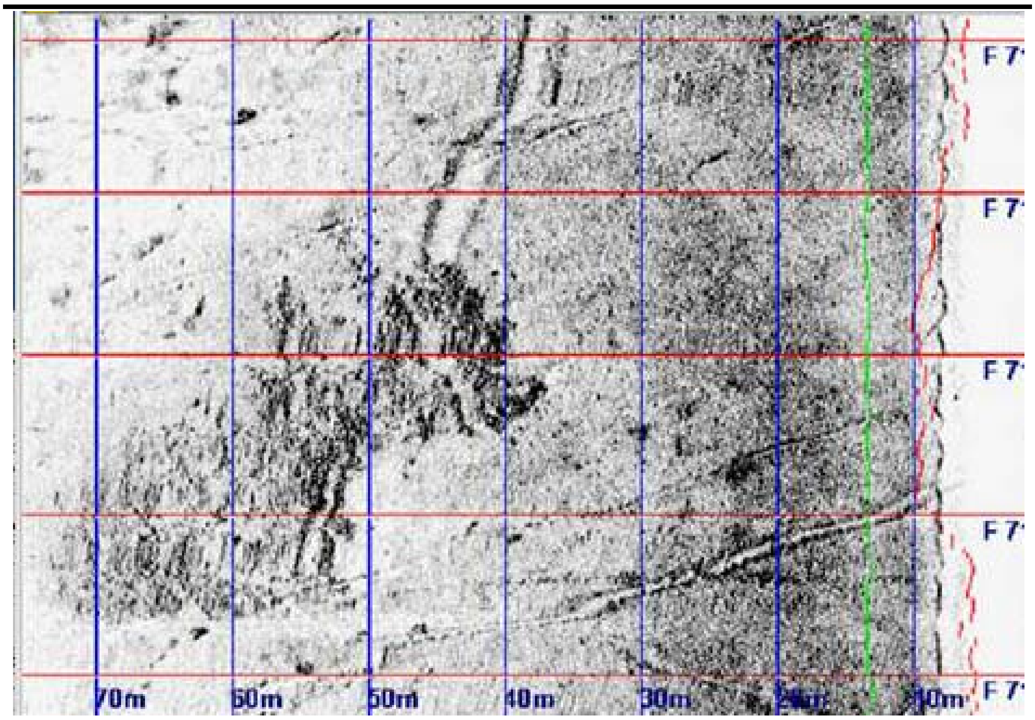


Figure 12.3 Dumped materials on top of seabed scarring from anchors and mixed with other trawling and anchoring scars

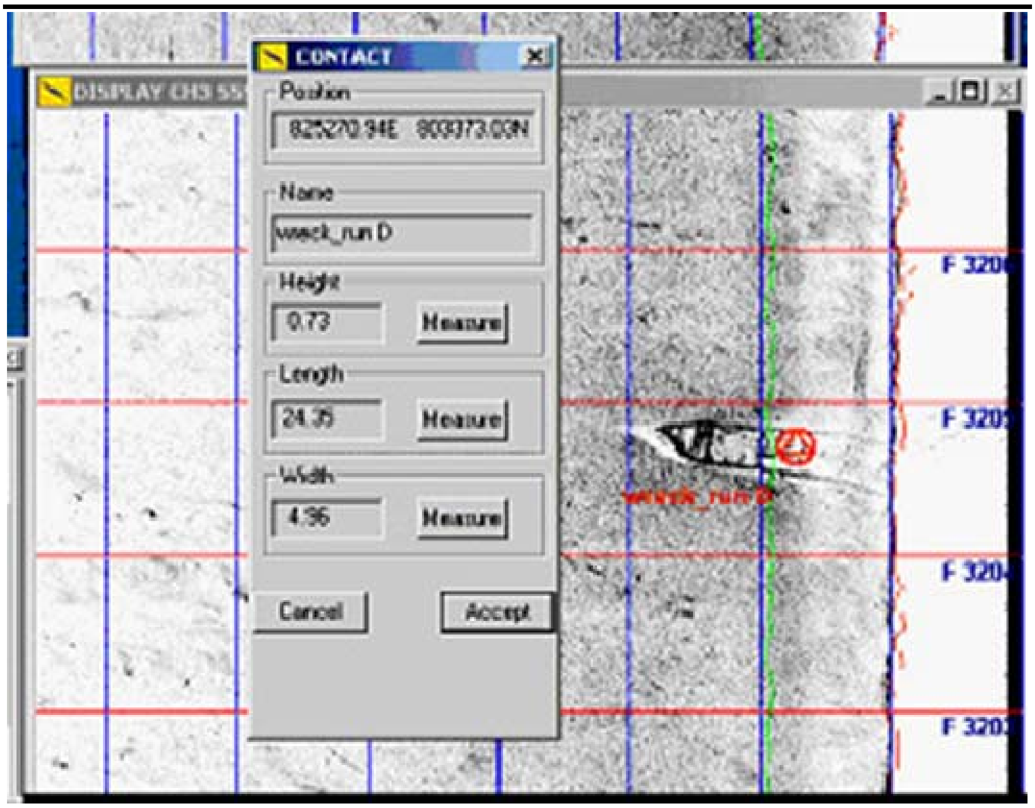


In addition, the geophysical survey identified a Sonar Contact located 72 metres west of the proposed cable joining two wind turbines, which has been interpreted as a shipwreck (see *Table 12.2*). *Figure 12.4* shows an image of the shipwreck and *Figure 12.5* shows its position in relation to the proposed wind farm. Although the shipwreck is located in the general wind farm development area, it lies outside of the footprint of any works. As stated in *Section 5*, the proposed width of seabed disturbance for the installation of the submarine cable is a maximum of 0.3 m (for jetting works) and therefore will not be impacted by the proposed works. If a decision is made to relocate the position of turbines during Detailed Design, the maximum width of disturbance from the construction of wind turbines will be 15 m in any direction from the centre point of the turbine (including scour protection which will has an overall width of 30 m), which means that any disturbance to this feature can be easily avoided. Therefore no disturbance to this feature is anticipated as result of the proposed wind farm development.

Table 12.2 Sonar Contact (Wreck) near the wind farm

Contact ID	Latitude Longitude	Easting Northing	Offset from Central Route	Dimensions (m)	Description
Lamma SC001	22° 10.132' N 114° 4.207' E	825257.0E 803379.7N	72m W	13.3m x 4.6m x 0.7m	Wreck

Figure 12.4 Image of the shipwreck SC001



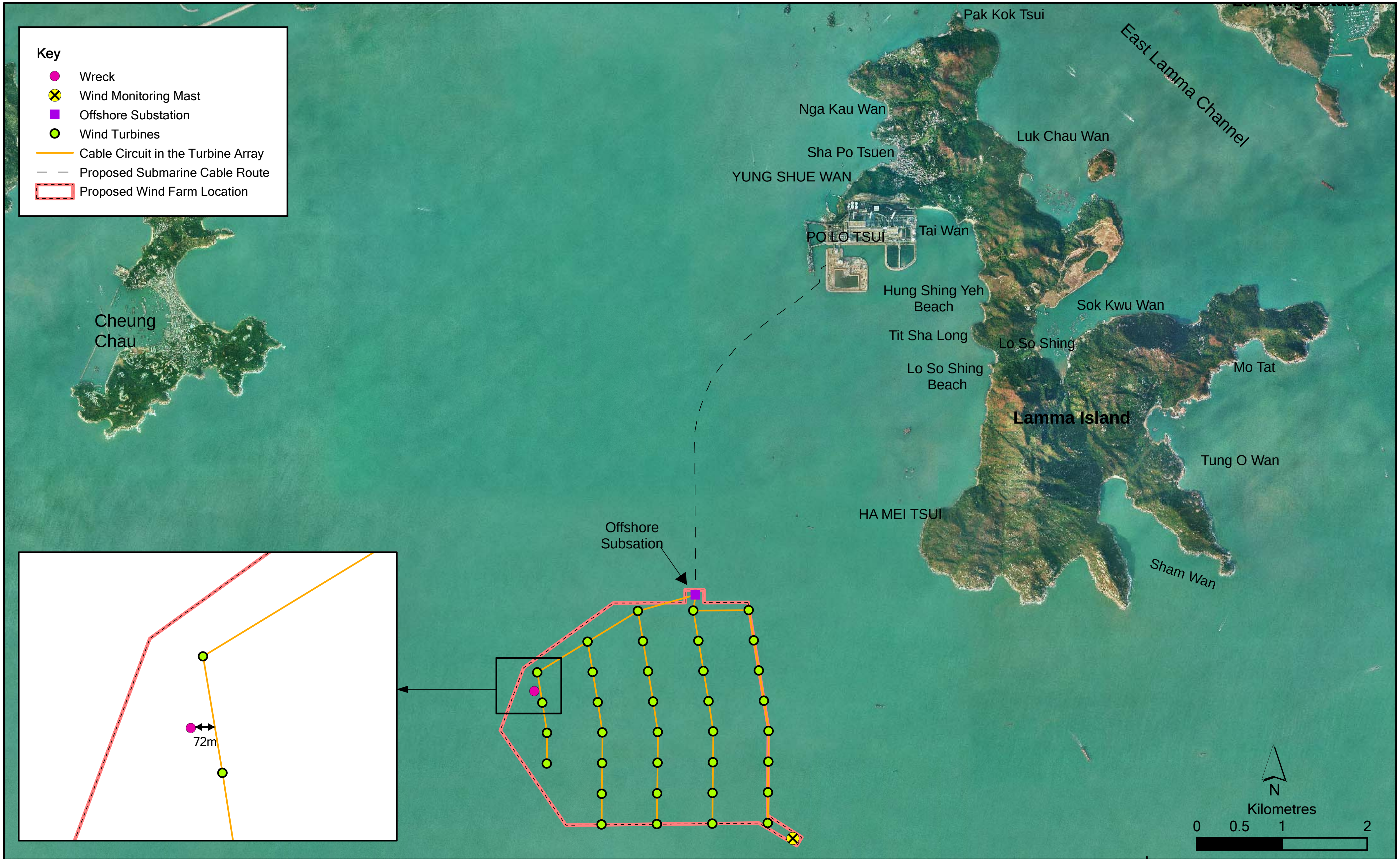


Figure 12.5

Location of Wrecks Found during Geophysical Survey

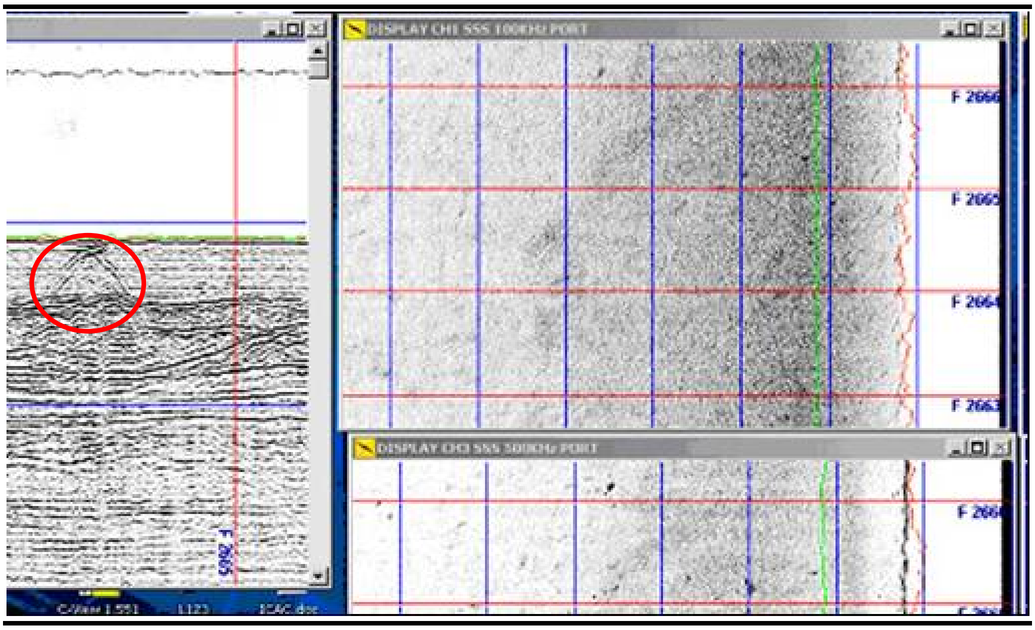
File: 0088440_WestLamma_wreck.mxd
Date: 03/05/2009

Environmental Resources Management

ERM

The only signs of sub-bottom anomalies within the proposed area of development were submarine cables. *Figure 12.6* provides an illustration of a submarine cable contact found during the marine archaeological investigation.

Figure 12.6 ***Submarine Cable***



12.5 *CULTURAL HERITAGE IMPACT ASSESSMENT METHODOLOGY*

As discussed above, a desktop literature review was conducted in order to establish the cultural heritage importance of the area surrounding the proposed wind farm and cable route. This has been supplemented by a Marine Archaeological Investigation in those areas that could be affected by works.

The importance of potentially impacted cultural heritage was assessed using the approach described in the *EIAO-TM*. The potential impacts due to the construction and operation of the Project and associated developments were then assessed (with reference to the *EIAO-TM Annex 10* guidelines) and the impacts evaluated (with reference to the criteria in *EIAO-TM Annex 19*).

12.6 *IDENTIFICATION OF CULTURAL HERITAGE IMPACTS*

12.6.1 *Construction Phase*

The construction activities associated with the proposed Project that have the potential to cause impacts to cultural heritage features are:

- Cable trenching on land to install cables to the Switching Station;

- Installation of turbine and wind monitoring mast foundations; and

- Dredging and jetting associated with the installation of the submarine cables.

12.6.2 *Operational Phase*

No potential impacts are identified with respect to the operation phase of the offshore wind farm.

12.7 ASSESSMENT OF IMPACTS

The following provides a discussion of the potential construction impacts with respect to terrestrial and marine archaeology.

12.7.1 *Construction Phase*

Terrestrial Archaeology/Heritage

The desk-top review has identified no known cultural heritage resources in the vicinity of the proposed onshore cable route. In addition, the reclaimed land where the cable circuit will be located is not considered to have any archaeological potential. Therefore no construction impacts are expected.

Marine Archaeology

The review of historical documents and literature indicates that the Study Area has the potential to contain archaeological material although no evidence was found as to specific sites contained within the Study Area. An investigation of the UKHO Wrecks database determined that Wreck No. 60016 is located 328 m southeast from the proposed cable route. However, this wreck is classified as 'Dead' and is therefore not considered to exist. However, disturbance to a wreck in this area would be avoided during construction. No other wrecks were identified during the baseline review that could be affected by the construction or operation of the proposed offshore wind farm development.

The geophysical surveys found only one shipwreck, at a distance of 72 m from the wind farm. As stated above, no disturbance to this feature is anticipated as result of the proposed wind farm development under the current design arrangements. If design arrangements change during the subsequent Detailed Design Phase then direct impacts on this vessel should be avoided. It is suggested that no works or structures are developed within 50 m of the wreck to safeguard any potential cultural heritage interest. No further consideration of the archaeological value of this wreck is therefore required. There are also numerous signs of seabed disturbances from anchoring, trawling and the recent dumping of materials. Submarine cables were the only signs of sub-bottom anomalies in the surveyed area.

The installation of the cable from Lamma Island to the wind farm, and the footprints and disturbances from the installation of the turbines, connecting cables, the substation and wind monitoring mast are well-defined and relatively small and will not impact any archaeological material. Any disturbance to these features will be avoided during construction through demarcation and appropriate construction planning with the Contractor.

12.8 MITIGATION MEASURES

Construction impacts on archaeological/heritage features have been avoided and minimised through the planning and design of the works. No additional mitigation is required.

12.9 ENVIRONMENTAL MONITORING AND AUDIT (EM&A)

As it is concluded that no archaeological material will be impacted by this Project no further marine archaeological investigation is required. The avoidance of direct impacts to the shipwreck identified during the geophysical survey will be verified by the Environmental Team and the Independent Environmental Checker through review of the final design prior to the installation of turbines and submarine cable. Designs will be checked to ensure that no works will occur within 50 m of the shipwreck.

12.10 RESIDUAL ENVIRONMENTAL IMPACTS

No residual impacts are anticipated associated with the proposed development of the offshore wind farm.

12.11 CUMULATIVE IMPACTS

Existing information indicates that no other projects are committed or planned in the area that could lead to cumulative impacts. In addition, as no impacts on archaeology have been identified with respect to this Project, no cumulative impacts would be expected.

12.12 CONCLUSIONS

The desk-top literature review has identified no terrestrial archaeological features that would be affected by the proposed offshore wind farm development. No further terrestrial archaeological investigation was considered necessary. The desk-top literature review also determined that no wrecks would be affected by the works. However, potential for marine archaeology in the proposed development area was identified. A Marine Archaeological Investigation was undertaken in the areas that could be affected by the proposed construction works. This investigation determined that no marine archaeological features would be impacted by the works and no further investigation is necessary.

In summary, no impacts are expected on terrestrial and marine cultural heritage features.

Annex 12A

Marine Archaeological Investigation Method Statement

CONTENTS

1 INTRODUCTION

This Method Statement presents the proposed approach for the implementation of a focused geophysical survey in the areas that could be impacted in order to fulfil the Marine Archaeological Investigation requirements of the *Study Brief*. *Appendix C* of the *Study Brief* requires that a side scan sonar, seismic boomer and echo sounder survey be conducted to 'define the exact definition of the areas of greatest archaeological potential' on the seabed and below it. *Section 3.4.6.2* of the *Study Brief* states that a marine archaeologist should review available information to identify whether there is any possible existence of sites of objects of cultural heritage, for example a shipwreck, within seabed that will be affected by the marine and dredging works of the Project.

2 PROPOSED SURVEY REQUIREMENTS

All geophysical surveys will need to be carried out by suitably qualified staff within a company that has clearly documented management, survey and calibration procedures. As a minimum, it is expected that surveyors commissioned to carry out the survey would include:

- A qualified geophysicist with experience in analysing and interpreting seabed and sub-bottom sonar contacts and anomalies and their delineation as natural or man-made features;
- An appropriately qualified and experienced team of boat operators, surveyors and remote sensing equipment operators who can implement an effective survey and provide input into the required outcomes; and
- An appropriately qualified and experienced team of cartographers to compile all the necessary maps and any other outcomes for the effective sonar contact and sub-bottom interpretation and documentation.

The area of seabed disturbance is concentrated around the following footprints:

- The turbine foundations (with a maximum physical footprint of approximately 38.5 m^2 without scour protection and 900 m^2 with scour protection);
- The pile driving vessel (using submersible legs to fix in position)
- Foundations of the sub-station;
- The cable circuit trench (burial depth of 5 m with a cross-sectional area of 0.75 m^2 (0.5 x 5 m x 0.3 m) for the majority of the circuit and a nearshore trench of 50~100 m x 8-12 m wide at the surface x 1.5~3.5 m deep; and
- The anemometer mast foundation.

The maximum width of disturbance for dredging will be 8 -12 m at the surface, 0.3 m for jetting and 15 m for foundation construction (from the centre point of turbines – scour protection has an overall width of 30 m), which is less than the width of the area of seismic survey (50 m) and sonar survey (150 m).

As a minimum, it is proposed that a side scan sonar, seismic and echo sound survey be completed. The general equipment requirements for these survey elements are:

- DGPS positioning and a navigation system;

- Single beam and multi-beam echo sounder, used to collect bathymetry data;
- Digital side scan sonar system (employing a dual frequency system with nominal operating frequencies of 100 kHz and 500 kHz), used to map seabed features;
- Seismic profiling system, used to provide profiles of seabed sediments;
- Boats and operators that can do this work effectively as well as qualified and experienced remote sensing equipment operators; and
- Integrated data management package to acquire, process, interpret and map all the geophysical, bathymetric and location data collected.

All equipment will need to be appropriately calibrated prior to the survey in accordance with documented and accredited procedures.

The side scan sonar uses dual frequencies to help in the quality and effectiveness of the coverage of seabed and therefore in its interpretation. Generally, the side scan sonar's cover an area of seabed of 50-75 m each side of the vessel's track. It is considered that the one tracking survey of the side scan sonar would cover all the seabed impacted areas, being a 100-150 m wide track (centred on the cable/supports/foundations) and provide the required information to discern any submerged archaeological sites sitting on the seabed.

The seismic boomer profiler surveys a vertical slice through the seabed directly below the boat; and in association with the echo sounder survey, a good resolution and depths of the seabed, sub-bottom features and geological layers/sedimentation is achieved. It is considered that three tracks of the seismic boomer profiler and echo sounder (one along the centre line of the cable/supports/foundations and one 25 m either side providing a total survey width of 50 m) would provide adequate coverage of the impacted areas and provide the required information to discern any submerged archaeological sites sitting below the seabed.

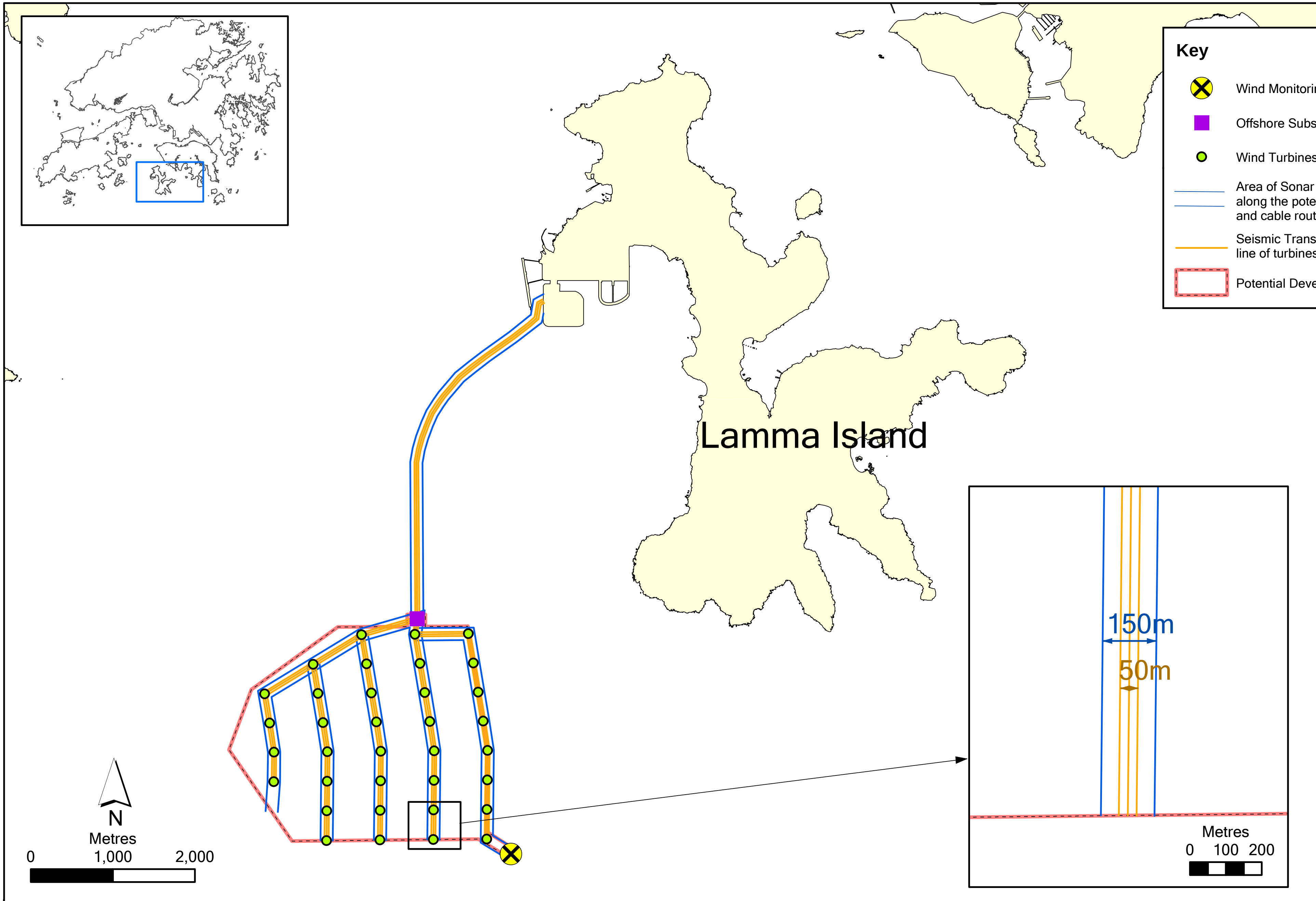
The proposed area of survey is presented *Figure 12A.1*.

Survey information should be collected, interpreted and documented by the geophysical surveyors and subsequently reviewed by the maritime archaeologist as part of the baseline information review for both sites.

Reporting requirements will include a soft copy of the mapped integrated data (side scan sonar, sub-bottom data, bathymetric and location data) that has been analysed and interpreted by appropriate geophysical staff. This information should be made available for viewing and analysis by ERMs marine archaeologist. Access to the software and the data for the period of ERM's analysis is also required. It is proposed that ERMs marine archaeologist undertakes the review from the surveyor's office as is normal practice for this type of work. In addition, a *Survey Report* should be provided to ERMs marine archaeologist that includes:

- The survey methodology;
- The implementation of the survey;
- The equipment used; and
- Results, including a description/location of any seabed and sub-bottom sonar contacts, the nature and description of the seabed and underlying sediments/geological formations.

Field notes on the implementation of the survey are also required to assist in ERMs review and analysis. Support documentation, such as photographs of the survey implementation should also be made and included in the report. All of this data (including the maps, graphics and images) should be documented in a manner that can be provided to ERM as digital copies so that they can be integrated into the EIA Report.



Southwest Lamma		
Wind Turbine No.	Location	
	E (M)	N (M)
1	825293.815	803596.854
2	825353.436	803241.825
3	825407.816	802885.956
4	825404.079	802525.976
5	825884.167	803957.474
6	825943.788	803602.446
7	826003.409	803247.417
8	826057.790	802891.548
9	826054.052	802531.567
10	826050.315	802171.587
11	826046.577	801811.606
12	826474.520	804318.095
13	826534.140	803963.066
14	826593.761	803608.037
15	826653.382	803253.009
16	826707.763	802897.140
17	826704.025	802537.159
18	826700.288	802177.178
19	826696.551	801817.198
20	827124.493	804323.686
21	827184.114	803968.658
22	827243.735	803613.629
23	827303.355	803258.600
24	827357.736	802902.731
25	827353.999	802542.751
26	827350.261	802182.770
27	827346.524	801822.790
28	827774.466	804329.278
29	827834.087	803974.249
30	827893.708	803619.221
31	827953.329	803264.192
32	828007.709	802908.323
33	828003.972	802548.342
34	828000.235	802188.362
35	827996.497	801828.381
Offshore Substation	827150.195	804510.597
Wind Monitoring Mast	828291.857	801650.666

Figure 12A.1

Southwest Lamma Survey Area

File: 0088440_windfarm_Lamma.mxd
Date: 13/02/2009

Environmental Resources Management

Annex 12B

Marine Archaeological Investigation Results

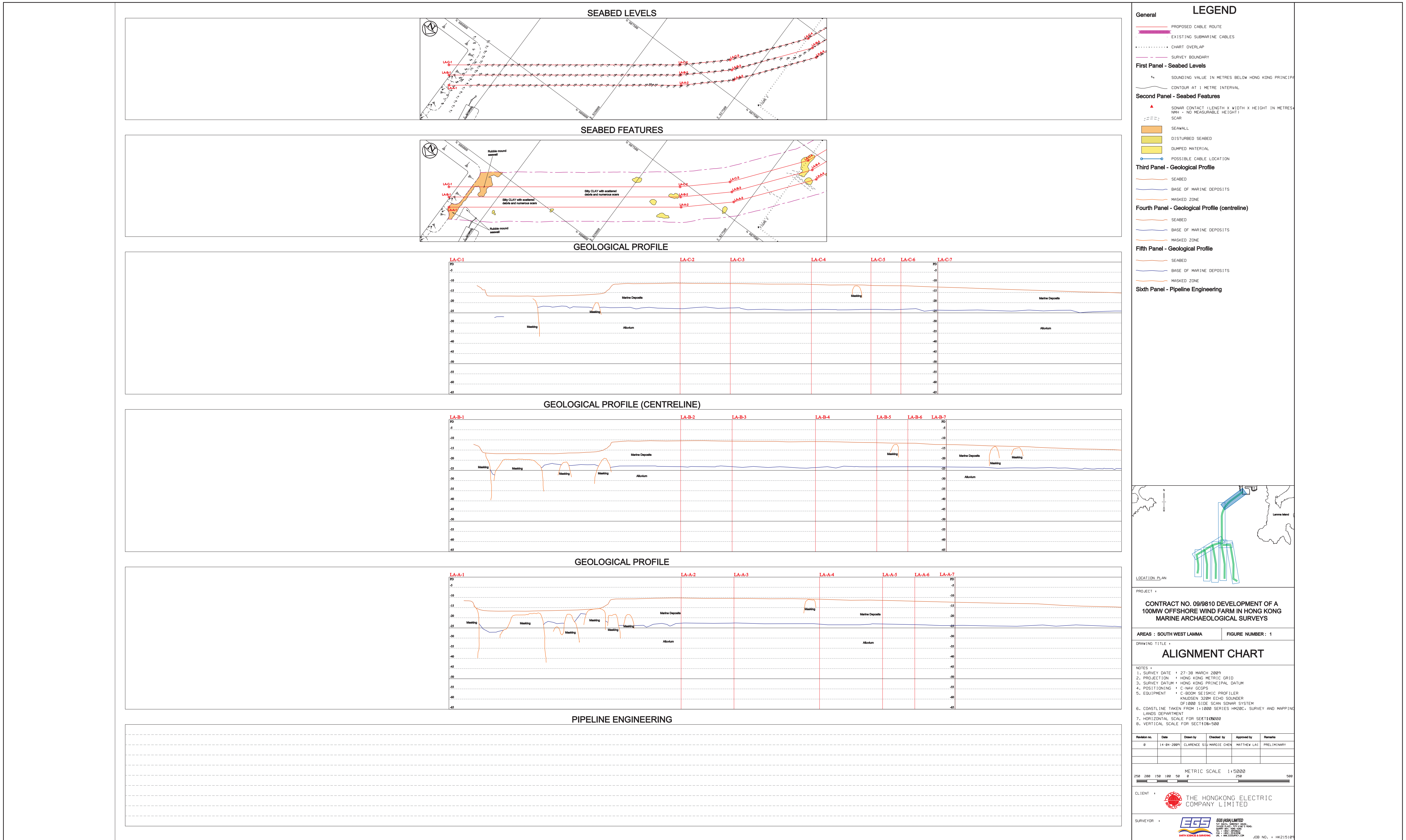
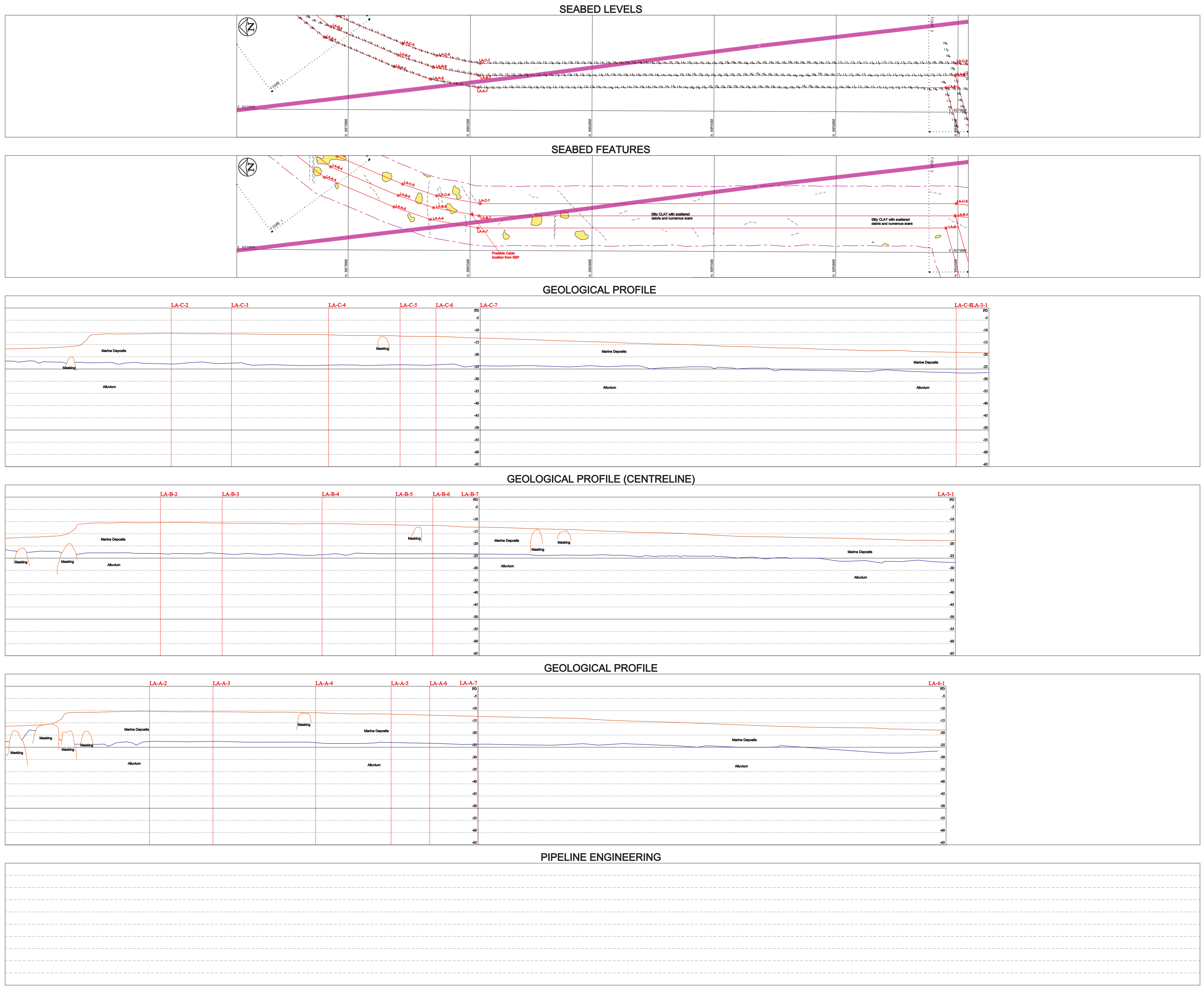


Figure 12B.1

Geophysical Survey Results

FILE: 0088440c
DATE: 04/05/2009

Environmental Resources Management



LEGEND

General

- PROPOSED CABLE ROUTE
- EXISTING SUBMARINE CABLES
- CHART OVERLAP
- SURVEY BOUNDARY

First Panel - Seabed Levels

- SOUNDING VALUE IN METRES BELOW HONG KONG PRINCIPA
- CONTOUR AT 1 METRE INTERVAL

Second Panel - Seabed Features

- SONAR CONTACT (LENGTH X WIDTH X HEIGHT IN METRES; NMH = NO MEASURABLE HEIGHT)
- SCAR
- SEAWALL
- DISTURBED SEABED
- DUMPED MATERIAL
- POSSIBLE CABLE LOCATION

Third Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

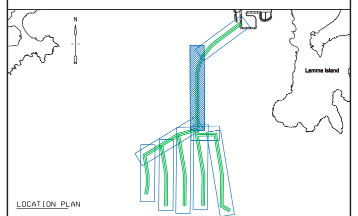
Fourth Panel - Geological Profile (centreline)

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Fifth Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Sixth Panel - Pipeline Engineering



PROJECT :

CONTRACT NO. 09/9810 DEVELOPMENT OF A 100MW OFFSHORE WIND FARM IN HONG KONG MARINE ARCHAEOLOGICAL SURVEYS

AREAS : SOUTH WEST LAMMA | **FIGURE NUMBER : 2**

DRAWING TITLE :

ALIGNMENT CHART

NOTES :
1. SURVEY DATE : 27-38 MARCH 2009
2. PROJECTION : HONG KONG METRIC GRID
3. SURVEY DATUM : HONG KONG PRINCIPAL DATUM
4. POSITIONING : C-NAV GCGPS
5. EQUIPMENT : C-BOOM SEISMIC PROFILER
   KNUDSEN 320M ECHO SOUNDER
   DF1000 SIDE SCAN SONAR SYSTEM
6. COASTLINE TAKEN FROM 1:1000 SERIES HM20C, SURVEY AND MAPPING LANDS DEPARTMENT
7. HORIZONTAL SCALE FOR SECTION: 1:5000
8. VERTICAL SCALE FOR SECTION: 1:500

Revision no.	Date	Drawn by	Checked by	Approved by	Remarks
0	14-04-2009	CLARENCE SIU	MARGIE CHEN	MATTHEW LAI	PRELIMINARY

METRIC SCALE 1:5000

250 200 150 100 50 0 250 500

CLIENT : THE HONGKONG ELECTRIC COMPANY LIMITED

SURVEYOR : EGS (ASIA) LIMITED
9/F SOUTH, SOMERSET HOUSE,
TAIKOO PLACE, 979 KING'S ROAD,
QUARRY BAY, HONG KONG
TEL : (852) 28948622
FAX : (852) 25763590
URL : WWW.EGSSURVEY.COM

JOB NO. : HK215109

Figure 12B.2

Geophysical Survey Results

FILE: 0088440c1
DATE: 04/05/2009

Environmental Resources Management

ERM

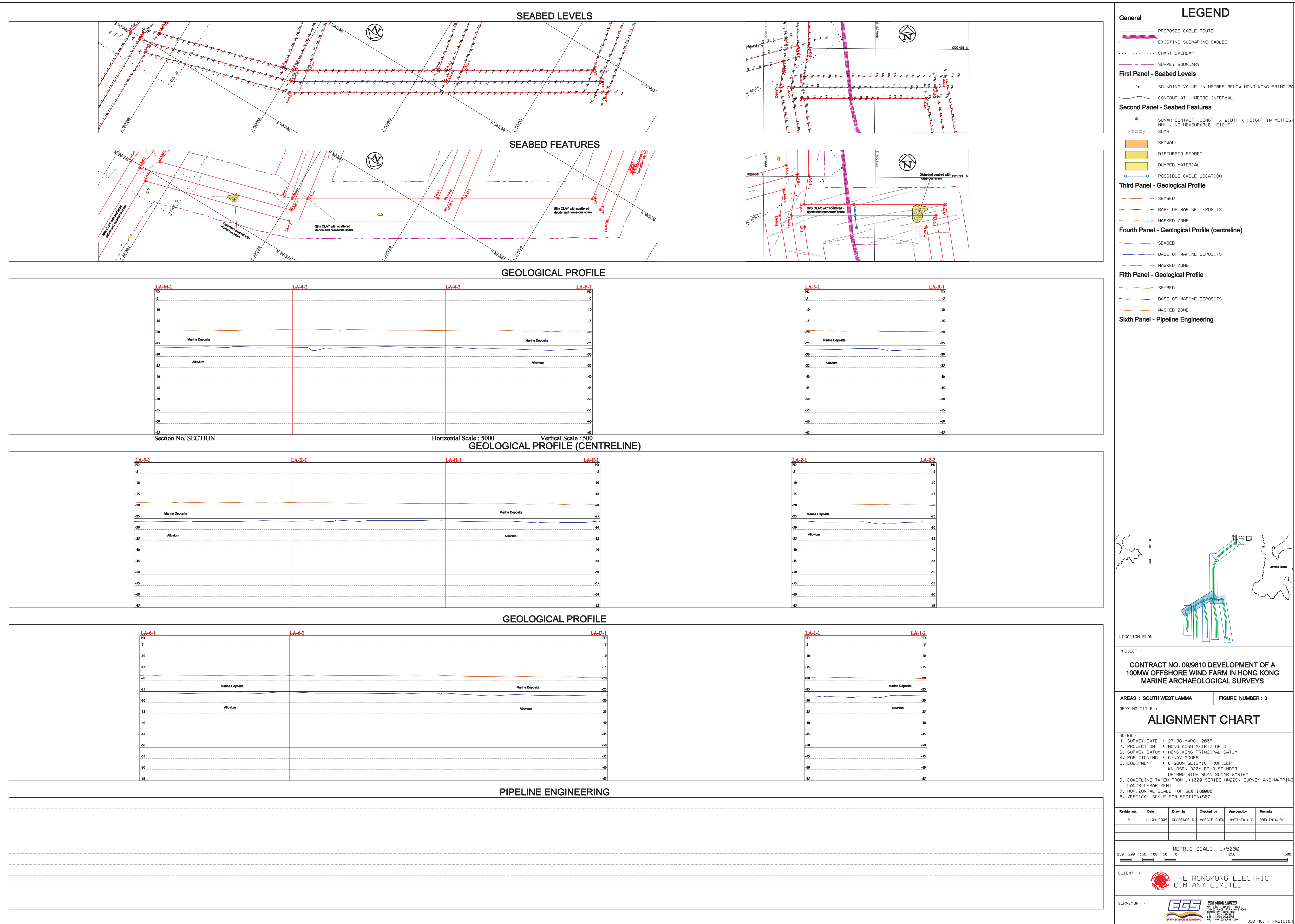


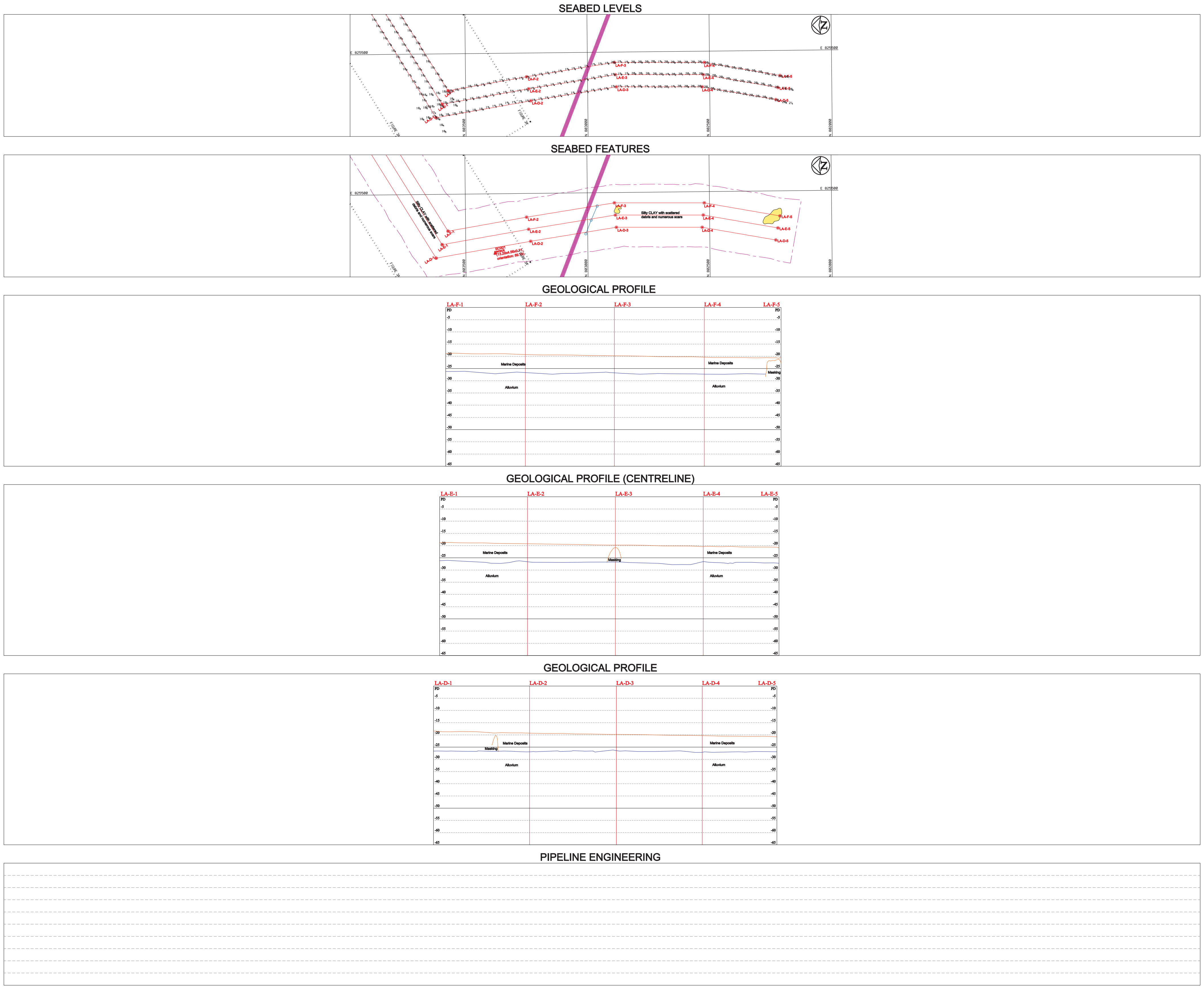
Figure 12B.3

Geophysical Survey Results

FILE: 0088440c2
DATE: 04/05/2009

Environmental Resources Management

ERM



LEGEND

General

- PROPOSED CABLE ROUTE
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First Panel - Seabed Levels

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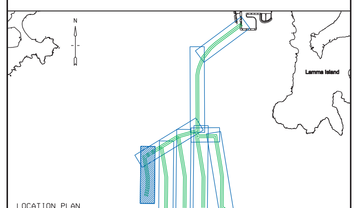
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Fifth Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Sixth Panel - Pipeline Engineering



LOCATION PLAN

PROJECT :

CONTRACT NO. 09/9810 DEVELOPMENT OF A 100MW OFFSHORE WIND FARM IN HONG KONG MARINE ARCHAEOLOGICAL SURVEYS

AREAS : SOUTH WEST LAMMA | FIGURE NUMBER : 4

DRAWING TITLE :

ALIGNMENT CHART

NOTES :
1. SURVEY DATE : 27-38 MARCH 2009
2. PROJECTION : HONG KONG METRIC GRID
3. SURVEY DATUM : HONG KONG PRINCIPAL DATUM
4. POSITIONING : C-NAV GCGPS
5. EQUIPMENT : C-BOOM SEISMIC PROFILER
   KNUDSEN 320M ECHO SOUNDER
   DF1000 SIDE SCAN SONAR SYSTEM
6. COASTLINE TAKEN FROM 1:1000 SERIES HM20C, SURVEY AND MAPPING LANDS DEPARTMENT
7. HORIZONTAL SCALE FOR SECTION: 1:5000
8. VERTICAL SCALE FOR SECTION: 1:500

Revision no.	Date	Drawn by	Checked by	Approved by	Remarks
0	14-04-2009	CLARENCE SIU	MARGIE CHEN	MATTHEW LAI	PRELIMINARY

METRIC SCALE 1:5000
250 200 150 100 50 0 250 500

CLIENT : THE HONGKONG ELECTRIC COMPANY LIMITED

SURVEYOR : EGS (ASIA) LIMITED
9/F SOUTH, SOMERSET HOUSE, TAIKOO PLACE, 979 KING'S ROAD, QUARRY BAY, HONG KONG
TEL : (852) 28948622
FAX : (852) 25763590
URL : WWW.EGSSURVEY.COM
JOB NO. : HK215109

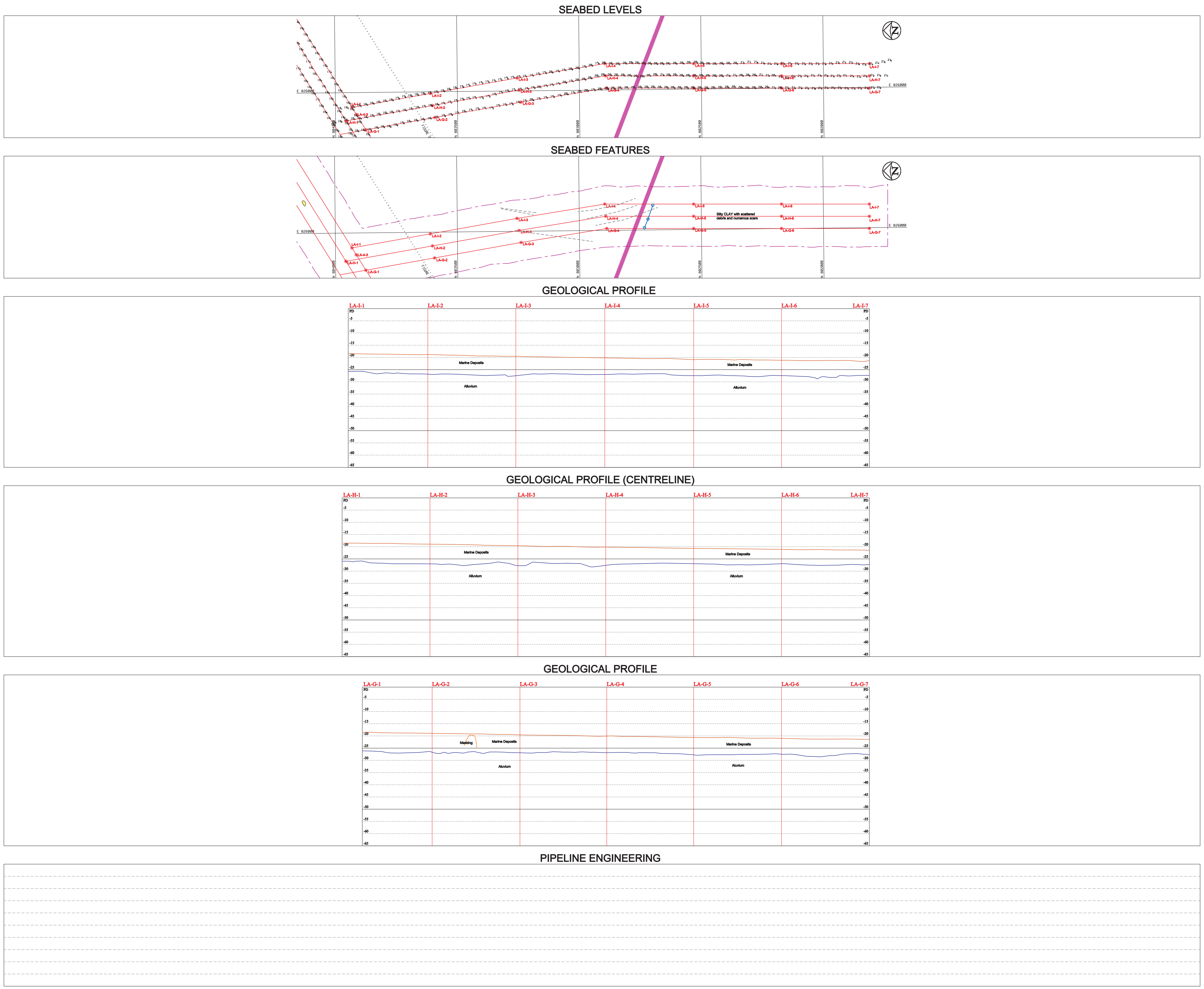
Figure 12B.4

Geophysical Survey Results

FILE: 0088440c3
DATE: 04/05/2009

Environmental Resources Management

ERM



LEGEND

General

- PROPOSED CABLE ROUTE
- EXISTING SUBMARINE CABLES
- CHART OVERLAP
- SURVEY BOUNDARY

First Panel - Seabed Levels

- SOUNDING VALUE IN METRES BELOW HONG KONG PRINCIPA
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- SEAWALL
- DISTURBED SEABED
- DUMPED MATERIAL
- POSSIBLE CABLE LOCATION

Third Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

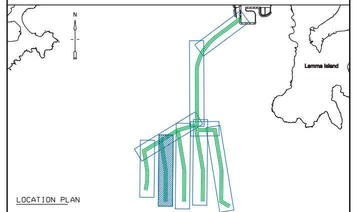
Fourth Panel - Geological Profile (centreline)

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Fifth Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Sixth Panel - Pipeline Engineering



PROJECT :

CONTRACT NO. 09/9810 DEVELOPMENT OF A 100MW OFFSHORE WIND FARM IN HONG KONG MARINE ARCHAEOLOGICAL SURVEYS

AREAS : SOUTH WEST LAMMA	FIGURE NUMBER : 5

DRAWING TITLE :

ALIGNMENT CHART

NOTES :
1. SURVEY DATE : 27-38 MARCH 2009
2. PROJECTION : HONG KONG METRIC GRID
3. SURVEY DATUM : HONG KONG PRINCIPAL DATUM
4. POSITIONING : C-NAV GCGPS
5. EQUIPMENT : C-BOOM SEISMIC PROFILER
   KNUDSEN 320M ECHO SOUNDER
   DF1000 SIDE SCAN SONAR SYSTEM
6. COASTLINE TAKEN FROM 1:1000 SERIES HM20C, SURVEY AND MAPPING LANDS DEPARTMENT
7. HORIZONTAL SCALE FOR SECTION 1:5000
8. VERTICAL SCALE FOR SECTION 1:500

Revision no.	Date	Drawn by	Checked by	Approved by	Remarks
0	14-04-2009	CLARENCE SIU	MARGIE CHEN	MATTHEW LAI	PRELIMINARY

METRIC SCALE 1:5000
250 200 150 100 50 0 250 500

CLIENT : THE HONGKONG ELECTRIC COMPANY LIMITED

SURVEYOR : EGS (ASIA) LIMITED
9/F SOUTH, SOMERSET HOUSE, TAIKOO PLACE, 979 KING'S ROAD, QUARRY BAY, HONG KONG
TEL : (852) 28948622
FAX : (852) 25763590
URL : WWW.EGSSURVEY.COM
EARTH SCIENCES & SURVEYING

JOB NO. : HK215109

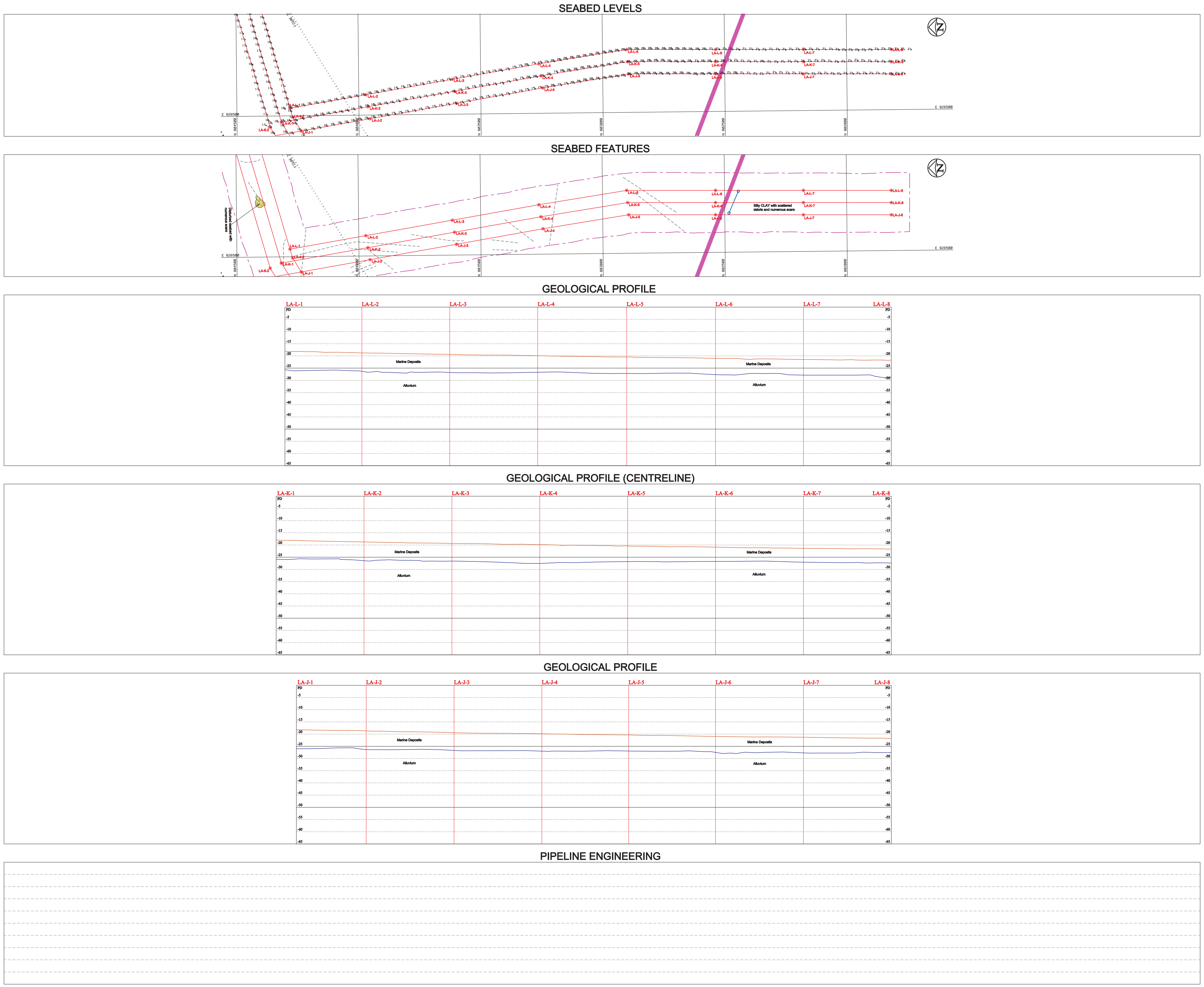
Figure 12B.5

Geophysical Survey Results

FILE: 0088440c4
DATE: 04/05/2009

Environmental Resources Management

ERM



LEGEND

General

- PROPOSED CABLE ROUTE
- EXISTING SUBMARINE CABLES
- CHART OVERLAP
- SURVEY BOUNDARY

First Panel - Seabed Levels

- SOUNDING VALUE IN METRES BELOW HONG KONG PRINCIPA
- CONTOUR AT 1 METRE INTERVAL

Second Panel - Seabed Features

- SONAR CONTACT (LENGTH X WIDTH X HEIGHT IN METRES; NMH = NO MEASURABLE HEIGHT)
- SCAR
- SEAWALL
- DISTURBED SEABED
- DUMPED MATERIAL
- POSSIBLE CABLE LOCATION

Third Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

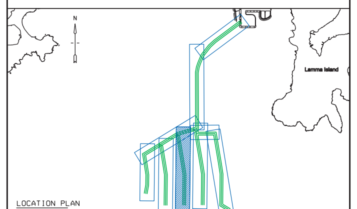
Fourth Panel - Geological Profile (centreline)

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Fifth Panel - Geological Profile

- SEABED
- BASE OF MARINE DEPOSITS
- MASKED ZONE

Sixth Panel - Pipeline Engineering



LOCATION PLAN

PROJECT :

CONTRACT NO. 09/9810 DEVELOPMENT OF A 100MW OFFSHORE WIND FARM IN HONG KONG MARINE ARCHAEOLOGICAL SURVEYS

AREAS : SOUTH WEST LAMMA | FIGURE NUMBER : 6

DRAWING TITLE :

ALIGNMENT CHART

NOTES :
1. SURVEY DATE : 27-38 MARCH 2009
2. PROJECTION : HONG KONG METRIC GRID
3. SURVEY DATUM : HONG KONG PRINCIPAL DATUM
4. POSITIONING : C-NAV GCGPS
5. EQUIPMENT : C-BOOM SEISMIC PROFILER
   KNUDSEN 320M ECHO SOUNDER
   DF1000 SIDE SCAN SONAR SYSTEM
6. COASTLINE TAKEN FROM 1:1000 SERIES HM20C, SURVEY AND MAPPING LANDS DEPARTMENT
7. HORIZONTAL SCALE FOR SECTION 1:5000
8. VERTICAL SCALE FOR SECTION 1:500

Revision no.	Date	Drawn by	Checked by	Approved by	Remarks
0	14-04-2009	CLARENCE SIU	MARGIE CHEN	MATTHEW LAI	PRELIMINARY

METRIC SCALE 1:5000
250 200 150 100 50 0 250 500

CLIENT : THE HONGKONG ELECTRIC COMPANY LIMITED

SURVEYOR : EGS (ASIA) LIMITED
9/F SOUTH, SOMERSET HOUSE, TAIKOO PLACE, 979 KING'S ROAD, QUARRY BAY, HONG KONG
TEL : (852) 28948622
FAX : (852) 25763590
URL : WWW.EGSSURVEY.COM

JOB NO. : HK215109

Figure 12B.6

Geophysical Survey Results

FILE: 0088440c5
DATE: 04/05/2009

Environmental Resources Management

ERM

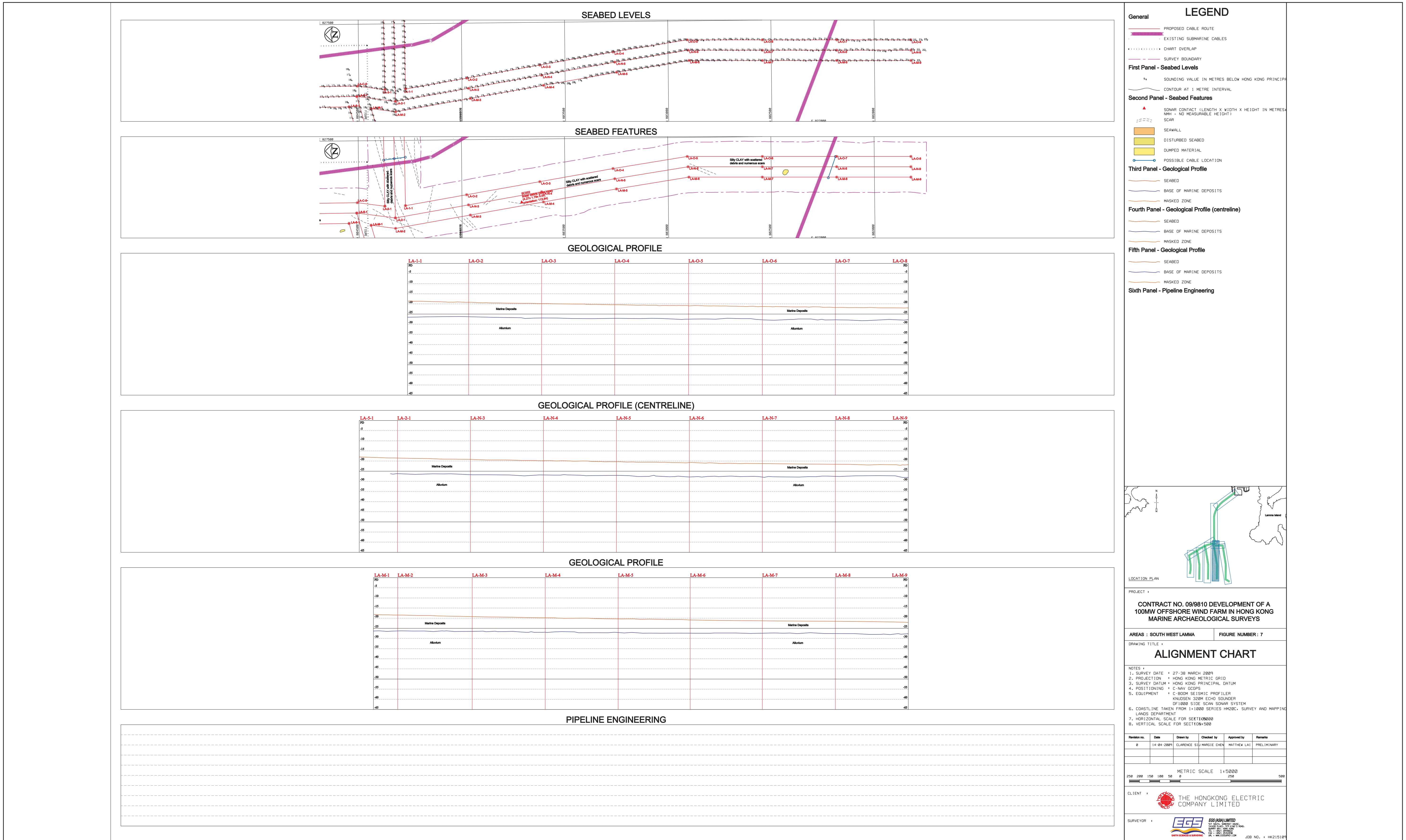


Figure 12B.7

Geophysical Survey Results

FILE: 0088440c6
DATE: 04/05/2009

Environmental Resources Management

ERM

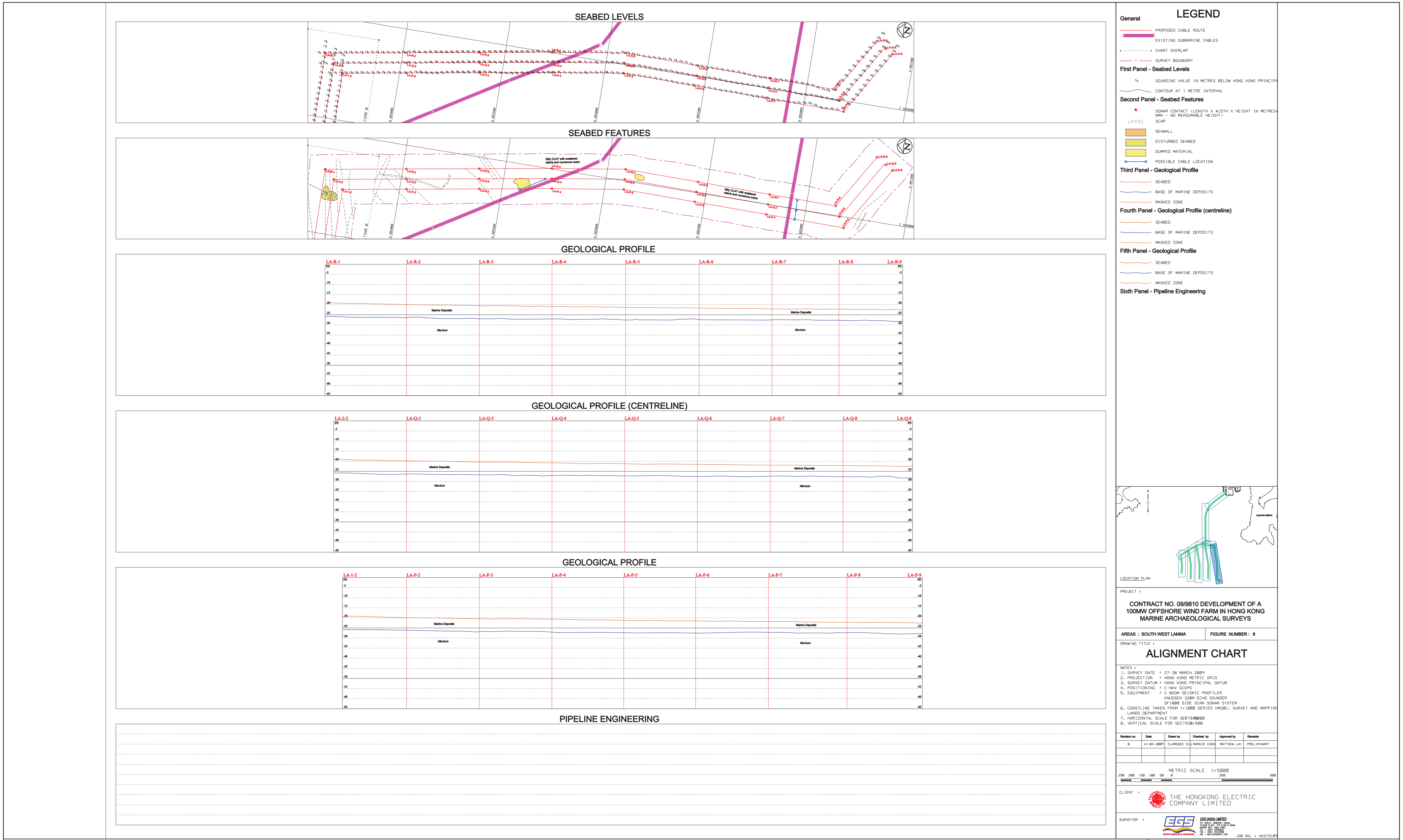


Figure 12B.8

Geophysical Survey Results

FILE: 0088440c6
DATE: 04/05/2009

Environmental Resources Management

ERM

Annex 12C

UK Hydrographic Office Wrecks Database

Latitude = 22 12'.400 N **Longitude =** 114 06'.005 E [WGD] **Square Number =** 1113 **State =** DEAD

Wreck Number 60016 **Classification** **=** Unclassified
Symbol OB 13.4 **Largest Scale Chart =** 4121
Charting Comments
Old Number
Category Undefined

WGS84 Position **Latitude =** 22 12'.400 N **Longitude =** 114 06'.005 E
WGS84 Origin Original
Horizontal Datum WGD WGS (1984)

Position Method
Position Quality Precisely known
Position Accuracy
Area at Largest Scale No

Depth 13.4 metres
Drying Height
Height
General Depth 13 metres
Vertical Datum Lowest astronomical tide
Depth Method
Depth Quality Depth known
Depth Accuracy
Conspic Visual NO **Conspic Radar** NO
Historic NO **Military** NO **Existence Doubtful** NO
Non Sub Contact NO

Last Amended 18/10/2005
Position Last Amended 23/06/2004
Position Last **Latitude =** 22 12'.402 N **Longitude =** 114 06'.002 E
Name
Type OBSTRUCTION
Flag
Dimensions **Length =** **Beam =** **Draught =**
Tonnage
Cargo
Date Sunk

Sonar Dimensions **Length =** **Width =** **Shadow Height =**
Orientation

Magnetic Anomaly
Debris Field
Scour **Depth =** **Length =** **Orientation =**

Markers
General Comments

Circumstances of Loss

Surveying Details
**13.10.01 OBSTN 12MTRS SHOWN IN 2212.400N, 11406.000E [WGD] ON HONG KONG 1501 [JAN'00 EDN]. NE 1918.
**12.7.03 OBSTN 12.1MTRS IN 2212.402N, 11406.002E [WGD]. (HONG KONG HO, NM 28/2003) NC 4121.
**HH550/410/07 23.6.04 NOW OBSTN 13.4MTRS IN 2212.400N, 11406.005E [WGD]. (HONG KONG NM 11/24/04). - NM 2853/04.
**HH550/432/01 18.10.05 NOT SHOWN NM BLOCK CORRECTION 02/04/05 FOR HONG KONG 1501. AMENDED TO DEAD. DELETE. - NM BLOCK 1374/05.

Latitude = 22 11'.140 N **Longitude =** 114 06'.721 E [WGD] **Square Number =** 1113 **State =** LIVE

Wreck Number 68058 **Classification =** Unclassified
Symbol OB 15.2 **Largest Scale Chart =** 4129
Charting Comments
Old Number
Category Undefined

WGS84 Position **Latitude =** 22 11'.140 N **Longitude =** 114 06'.721 E
WGS84 Origin Original
Horizontal Datum WGD WGS (1984)

Position Method
Position Quality Precisely known
Position Accuracy
Area at Largest Scale No

Depth 15.2 metres
Drying Height
Height
General Depth 17 metres
Vertical Datum Lowest astronomical tide
Depth Method
Depth Quality Least depth known
Depth Accuracy
Conspic Visual NO **Conspic Radar** NO
Historic NO **Military** NO **Existence Doubtful** NO
Non Sub Contact NO

Last Amended 15/06/2006
Position Last Amended
Position Last **Latitude =** **Longitude =**

Name
Type OBSTRUCTION
Flag
Dimensions **Length =** **Beam =** **Draught =**
Tonnage
Cargo
Date Sunk

Sonar Dimensions **Length =** **Width =** **Shadow Height =**
Orientation

Magnetic Anomaly
Debris Field
Scour **Depth =** **Length =** **Orientation =**

Markers
General Comments

Circumstances of Loss

Surveying Details
**HH550/432/01 15.6.06 OBSTN 15.2MTRS IN 2211.140N, 11406.721E [WGD]. (HONG KONG, CHINA, NM 11/15/06).
- NM 3309/06.

Latitude = 22 11’.080 N **Longitude =** 114 03’.890 E [WGD] **Square Number =** 1113 **State =** LIVE

Wreck Number 69098 **Classification =** Unclassified
Symbol WK 13.8 **Largest Scale Chart =** 4129
Charting Comments
Old Number
Category Dangerous wreck

WGS84 Position **Latitude =** 22 11’.080 N **Longitude =** 114 03’.890 E
WGS84 Origin Original
Horizontal Datum WGD WGS (1984)

Position Method
Position Quality Precisely known
Position Accuracy
Area at Largest Scale No

Depth 13.8 metres
Drying Height
Height
General Depth 15 metres
Vertical Datum Lowest astronomical tide
Depth Method
Depth Quality Depth known
Depth Accuracy
Conspic Visual NO **Conspic Radar** NO
Historic NO **Military** NO **Existence Doubtful** NO
Non Sub Contact NO

Last Amended 16/01/2007
Position Last Amended
Position Last **Latitude =** **Longitude =**

Name
Type
Flag
Dimensions **Length =** **Beam =** **Draught =**
Tonnage
Cargo
Date Sunk

Sonar Dimensions **Length =** **Width =** **Shadow Height =**
Orientation

Magnetic Anomaly
Debris Field
Scour **Depth =** **Length =** **Orientation =**

Markers
General Comments

Circumstances of Loss

Surveying Details
**16.1.07 WK 13.8MTRS SHOWN IN 2211.080N, 11403.890E [WGD] ON HONG KONG 3002 [DEC ‘06 EDN, LARGEST SCALE ADOPTION]. NE 4129.

Latitude = 22 10'.980 N **Longitude =** 114 06'.700 E [WGD] **Square Number =** 1113 **State =** LIVE

Wreck Number 62934 **Classification =** Unclassified
Symbol OB 16.3 **Largest Scale Chart =** 4129
Charting Comments
Old Number
Category Undefined

WGS84 Position **Latitude =** 22 10'.980 N **Longitude =** 114 06'.700 E
WGS84 Origin Original
Horizontal Datum WGD WGS (1984)

Position Method
Position Quality Precisely known
Position Accuracy
Area at Largest Scale No

Depth 16.3 metres
Drying Height
Height
General Depth 16 metres
Vertical Datum Lowest astronomical tide
Depth Method
Depth Quality Depth known
Depth Accuracy
Conspic Visual NO **Conspic Radar** NO
Historic NO **Military** NO **Existence Doubtful** NO
Non Sub Contact NO

Last Amended 16/01/2007
Position Last Amended
Position Last **Latitude =** **Longitude =**

Name
Type OBSTRUCTION
Flag
Dimensions **Length =** **Beam =** **Draught =**
Tonnage
Cargo
Date Sunk

Sonar Dimensions **Length =** **Width =** **Shadow Height =**
Orientation

Magnetic Anomaly
Debris Field
Scour **Depth =** **Length =** **Orientation =**

Markers
General Comments

Circumstances of Loss

Surveying Details
**9.9.03 OB 16.2MTRS SHOWN IN 2210.980N, 11406.700E [WGD] ON HONG KONG 3002 [AUG'02 EDN]. NC 4129.
**16.1.07 SHOWN AS OB 16.3MTRS ON HONG KONG 3002 [DEC '06 EDN, LARGEST SCALE ADOPTION]. NE 4129.

CONTENTS

13 SUMMARY OF ENVIRONMENTAL OUTCOMES

13.1 INTRODUCTION

This section summarises the key environmental outcomes arising from the assessments completed in this EIA Report for the proposed offshore wind farm. For each of the environmental components assessed, a summary of key environmental sensitive receivers is completed, together with an overview of the key potential environmental impacts and key mitigation measures, highlighting their benefits where necessary.

The summary of each of the components is structured as follows:

- List of sensitive receivers;
- Key Environmental Problems Avoided / Environmental Outcomes;
- Assessment Methodology and Criteria;
- Construction Impacts;
- Operational Impacts;
- Key Mitigation Measures;
- Residual Impacts; and
- Compliance with the guidelines and criteria of the *Environmental Impact Assessment Ordinance - Technical Memorandum* (*EIAO-TM*).

Prior to the discussion of the above, a summary of the *Identification of Alternative Sites* is presented below.

13.2 IDENTIFICATION OF ALTERNATIVE SITES

The assessment of siting alternatives has been undertaken in accordance with *Clause 3.3.1* of the Study Brief and the *EIAO-TM*. The preferred site for the wind farm has been identified through a detailed mapping exercise including a review of both the natural and man-made environment and the associated environment constraints. Eight alternative sites have been reviewed through a comparative assessment of wide-ranging environmental concerns, such as Landscape and Visual, Heritage, Marine Recreation and Amenity, Seabed Sediments, Water Quality, Noise, Nature Conservation and Fisheries. Social issues and physical aspects have also been examined and the potential environmental benefits / disbenefits that result as a consequence are also considered.

Taking into consideration the range of factors described in the previous sections, the Southwest Lamma (Site 1) is preferred. The principal differentiators between this site and the other options considered in this assessment are as follows:

- **Landscape** – Site 1 is located across areas of both 'Offshore Waters Landscapes' and 'Inshore Waters Landscape' and has a number of man-made elements in the vicinity (ie such as the Lamma Power Station, Victoria Harbour and designated marine anchorage areas) as such changes to Landscape Character are considered to be less significant at this site when compared to others.

- **Geoconservation** – Site 1 is the only site that is remote from the Hong Kong National Geopark.

- **Timeframe for Construction** – Site 1 would be considered to have the shortest construction timeframe, which would reduce the potential magnitude of impacts on receptors through prolonged exposure to pollutant sources or disturbance to key habitats. As such a shorter timeframe for construction was regarded to have a higher environmental benefit for the site.

- **Long term Maintenance Requirements** – Remote monitoring and operation of the wind farm has to be performed at the control room of Lamma Power Station. As larger transport distances will reduce the sustainability of the project with respect to fuel usage and air emissions, Site 1 was considered to be favoured due to this environmental benefit.

- **Distance to Connect to HK Electric Grid** – As above, a shorter distance to connect to the onshore grid, be it offshore or onshore, would reduce potential dredging / jetting / excavation requirements and reduce the overall footprint of the development. Potential impacts to subtidal marine benthos, hard coral communities and fisheries resources would hence be comparatively lower than those occurring from other sites. As Site 1 has the shortest distance to connect to the HK Electric Grid, this site was preferred due to these environmental benefits.

13.3 WATER QUALITY

Table 13.1 presents a summary of the findings of the assessment of impacts to water quality as a result of the construction and operation of the offshore wind farm components. Full details of the assessment are presented in *Section 6* of this *EIA Report*.

Table 13.1 Summary of Environmental Assessment and Outcomes – Water Quality

- WATER QUALITY-	
Sensitive Receivers (SRs)	Fisheries Resources: • Spawning/Nursery Grounds; and • Fish Culture Zone: Lo Tik Wan and Sok Kwu Wan. Marine Ecological Resources: • Potential Coral Communities: Nam Tsui to Tai Kok hard coral communities and Lamma Power Station Extension sea wall. • Horseshoe Crab Nursery Grounds: Sok Kwu Wan; • Marine Mammal habitat; • Green turtle habitat: Sham Wan; and • Potential South Lamma Marine Park. Water Quality SRs: • Gazetted Beaches: Cheung Chau Tung Wan, Kwun Yam, Hung Shing Yeh and Lo So Shing; and • Seawater Intakes: Cheung Chau, Lamma Power Station and Yuen Kok.
Key Environmental Problems Avoided / Environmental Outcomes	• Water quality impacts have been avoided by positioning the offshore wind farm away from nearshore sensitive areas of Lamma and Cheung Chau and where sightings of marine mammals and green turtles are greatest.
Assessment Methodology and Criteria	• The potential impacts due to the construction and operation of the Project and associated developments were assessed following the *EIAO-TM Annex 6* guidelines and the impacts evaluated based on the criteria in *EIAO-TM Annex 14*. • Impacts due to the dispersion of fine sediment in suspension during the construction of the offshore wind farm and submarine cable have been assessed using computational modelling. • The simulation of operational impacts on hydrodynamics has also been studied by means of computational modelling. The models have been used to simulate the effects of marine structures on currents and flows. • Analysis of EPD routine water quality data from the years of 1998 to 2007 has been undertaken to determine the allowable increase in suspended solids concentrations.
Key Construction Impacts	• *Suspended Sediments (SS)*: Potential impacts arising from the proposed grab dredging, jetting and foundation construction works are predicted to be largely confined to the specific works areas. The

- WATER QUALITY-	
	predicted elevations of suspended sediment concentrations are transient in nature and not predicted to cause adverse impacts to water quality at the sensitive receivers. In addition, sediment deposition related to construction is localised in nature and will not significantly affect the marine environment in the Study Area. • *Water Quality (Dissolved Oxygen, Nutrients, and Heavy Metals)*: The effects of increased SS concentrations as a result of the proposed works on levels of dissolved oxygen, biochemical oxygen demand and nutrients (as unionised ammonia) are predicted to be minimal. Where such effects exist, they will be transient, localised in extent and of a small magnitude. • *Vessel and Other Discharges:* Land based construction activities, vessel discharges and contaminants are not predicted to cause unacceptable impacts to the water quality sensitive receivers.
Key Operational Impacts	• *Hydrodynamics*: Modelling results show that the presence of the wind turbine farm structures will have very minor and localised effects on current flows and will not impact on local erosion and sedimentation patterns. • *Other Discharges:* Vessel discharges, accidental spill from ship collision and the release of other contaminants from wind turbines are not predicted to cause unacceptable impacts to the water quality sensitive receivers.
Key Mitigation Measures	The water quality modelling results have indicated that the works can proceed at the recommended working rates without causing unacceptable impacts to water quality sensitive receivers. In instances where there are exceedances of the applicable standards, they have been predicted to be transient and localised, and therefore, not of concern. Unacceptable impacts to water quality sensitive receivers have largely been avoided through the adoption of the following measures: • *Siting:* A number of locations were studied for the offshore wind farm and the associated and cable route, with the principal aim of avoiding direct impacts to sensitive receivers; • *Reduction in Indirect Impacts*: The offshore wind farm and cable route are located at a sufficient distance from a large number of water quality sensitive receivers so that the dispersion of sediments from the construction works does not affect the receivers at levels of concern (as defined by the WQO and tolerance criterion); and • *Adoption of Acceptable Working Rates*: The modelling work has demonstrated that the working rates (ie 2,500 m^3 day^{-1} for grab dredging; 360 m hr^{-1} for jetting operations) for the operations will not cause unacceptable impacts to the receiving water quality. Aside from these pro-active measures that have been adopted, a number of operational constraints and good site practice measures for dredging, jetting, construction run-off and other discharges are also recommended.
Residual Impacts	• No unacceptable residual impacts have been predicted to occur during the construction and operational phase.
Compliance with *EIAO-TM*	• The assessment and the impacts are acceptable and in compliance with the *EIAO-TM Annexes 6* and *14* and applicable assessment standards/criteria.

13.4 WASTE MANAGEMENT

Table 13.2 presents a summary of the findings of the assessment of impacts to waste management as a result of the construction and operation of the proposed offshore wind farm. The details of the assessment are presented in full in *Section 7* of this *EIA Report*.

Table 13.2 Summary of Environmental Assessment and Outcomes – Waste Management

- WASTE MANAGEMENT -	
Assessment Methodology and Criteria	The potential environmental impacts associated with the handling and disposal of waste arising from the construction and operation of the proposed wind farm components are assessed in accordance with the criteria presented in *Annexes 7* and *15* of the *EIAO-TM*: • Estimation of the types and quantities of the wastes to be generated; • Assessment of the secondary environmental impacts due to the management of waste with respect to potential hazards, air and odour emissions, noise, wastewater discharges and traffic; and • Assessment of the potential impacts on the capacity of waste collection, transfer and disposal facilities.
Key Environmental Problems Avoided / Environmental Outcomes	• Potential design and construction alternatives were examined on the basis of their potential environmental impacts. The resultant identification of preferred options has led to the reduction in the amount of waste that expected to be produced and therefore has brought about an overall reduction in waste management impacts.
Key Construction Impacts	The key potential impacts during the construction phase are related to wastes generated from dredging, site formation, seawall removal, filling and general waste production: • It is estimated that a total of approximate 3000 m^3 of marine sediment will be dredged at the landing point. These sediments are considered to be uncontaminated and are expected to be suitable for Open Sea Disposal; and • Other wastes produced during the construction phase are of small quantity and will be disposed of accordingly to their nature and relevant regulations, avoiding any potential adverse impact.
Key Operational Impacts	• Chemical waste, sewage and general refuse will be produced during the operational phase of the proposed wind farm. The potential environmental impacts associated with the storage, handling, collection, transport and disposal of these will meet the criteria specified in the *EIAO-TM*, thus no unacceptable operational waste management impacts are anticipated.
Key Mitigation Measures	• A number of mitigation measures have been proposed to avoid or minimise potential adverse environmental impacts associated with handling, collection and disposal of waste arising from the construction and operation of the proposed offshore wind farm. • Proposed measures are based on good management, control and good site practices.
Residual Impacts	• With the implementation of the recommended mitigation measures, in particular the establishment and implementation of the Waste Management Plan, minimal residual impacts are anticipated from the construction and operation of the offshore wind farm.

- WASTE MANAGEMENT -	
Compliance with *EIAO-TM*	• The assessment and the impacts are acceptable and in compliance with the *EIAO-TM Annexes 7* and *15* and applicable assessment standards/criteria.

13.5 TERRESTRIAL ECOLOGY & AVIFAUNA

Table 13.3 presents a summary of the findings of the assessment of impacts to terrestrial ecology particularly avifauna as a result of the construction and operation of the proposed offshore wind farm. The details of the assessment are presented in full in *Section 8* of this *EIA Report*.

Table 13.3 Summary of Environmental Assessment and Outcomes – Terrestrial Ecology & Avifauna

- TERRESTRIAL ECOLOGY -	
Flora and Fauna of Ecological Interest	• Terrestrial ecological resources of cable landing point at Lamma Power Station Extension is limited due to the high degree of disturbance in the area. • Five species of conservation interest have been identified within the Study Area including White-bellied Sea Eagle, Black Kite, Common Buzzard, Pacific Reef Egret and Ancient Murrelet. • Bird species identified to be potentially sensitive to the wind farm (via collision) within the Project Site include Aleutian Tern, White-winged Tern, Black Kite, Black-legged Kittiwake, Black-naped Tern, Common Tern, Heuglin's Gull, Red-necked Phalarope, and White-bellied Sea Eagle.
Key Environmental Problems Avoided / Environmental Outcomes	• Disturbance to terrestrial ecological resources including avifauna of acknowledged conservation significance has been avoided as a result of the site selection process of the proposed wind farm.
Assessment Methodology and Criteria	• Following a literature review of available ecological information characterising the Study Area, surveys were conducted over a period of 9 months to update and field check the validity of the information gathered in the review and to fill information gaps. • Vessel-based transect surveys were conducted for birds, with a particular emphasis on migratory birds/seabirds. • The potential impacts due to the construction and operation of the proposed wind farm were assessed following the *EIAO-TM Annex 16* guidelines and the impacts evaluated based on the criteria in *EIAO-TM Annex 8*.
Key Construction Impacts	• Permanent loss of open water habitat (approximately 0.16 ha) due to the construction of wind turbine foundations, offshore substation and offshore monitoring mast. • Potential loss of foraging and feeding ground of the birds. • The relatively small scale loss of open waters within the Project Site is not expected to be significant for bird/migratory bird populations.
Key Operational	• Potential disturbance to bird movement via barrier effect and glare/noise generated from the wind turbine.

- TERRESTRIAL ECOLOGY -	
Impacts	• Potential impact of collision between birds and wind turbines, including attraction to lights. • Collision risk assessment has been conducted and the predicted number of bird collision is considered not significant to these migratory bird species • In view of the offshore location of the proposed wind farm and limited usage by birds within the Project Site, it is anticipated that the collision risk due to the operation of the Project is low and will not cause any unacceptable impacts to these migratory bird species.

Key Mitigation Measures	• The general policy for mitigation of significant ecological impacts has been addressed on the basis of Annex 16 of the EIAO-TM.
	  • *Avoidance*: Disturbance to birds/habitats of acknowledged conservation significance has been avoided as a result of the site selection process of the wind farm.
	  • *Minimisation*: The impacts on birds due to the construction and operation of the wind farm are generally expected to be low and acceptable. The following appropriate measures will be taken to further reduce impacts to terrestrial ecological resources:
	    o Appropriate Construction Practice: Avoid pollution, damage and disturbance to the surrounding open water habitats

Residual Impacts	• The Project will involve the permanent loss of approximately 0.16 ha of open water habitat for some swimming and foraging birds. • No adverse residual impact due to the construction and operation of the wind farm is expected after the implementation of the proposed mitigation measures.
Compliance with *EIAO-TM*	• The assessment and the impacts are acceptable and in compliance with the *EIAO-TM Annexes 8* and *16* and applicable assessment standards/criteria.

13.6 *MARINE ECOLOGY*

Table 13.4 presents a summary of the findings of the assessment of impacts to marine ecology as a result of the construction and operation of the proposed offshore wind farm. The details of the assessment are presented in full in *Section 9* of this *EIA Report*.

Table 13.4 Summary of Environmental Assessment and Outcomes – Marine Ecology

- MARINE ECOLOGY -	
Marine Ecology Sensitive Receivers	The following ecological sensitive receivers were identified: • Habitats of the Finless porpoise; • Nesting areas for the green turtle: Sham Wan; • Potential Marine Park: South Lamma; and • Nearshore hard coral communities at Nam Tsui to Tai Kok and at the Lamma Power Station Extension Seawall.
Key Environmental	• Disturbance to marine ecologically sensitive habitats has been avoided as a result of the site/route selection process of the proposed wind farm

- MARINE ECOLOGY -	
Problems Avoided / Environmental Outcomes	and cable route. • Potential design and engineering alternatives have been examined on the basis of their potential environmental impacts and appropriate recommendations made. For example, jetting of the cable system has been adopted for the majority of the alignment to reduce volumes of sediment to be dredged and then disposed.
Assessment Methodology and Criteria	• A literature review was supplemented by detailed all season field surveys for intertidal and subtidal benthic assemblages, as well as marine mammals (vessel based surveys). • The potential impacts due to the construction and operation of the proposed offshore wind farm and submarine cables were assessed following the EIAO-TM Annex 16 guidelines and the impacts evaluated based on criteria in EIAO-TM Annex 8.
Key Construction Impacts	• Potential construction phase impacts to marine ecological resources, including marine mammals and sea turtles may result from seawall removal, changes to key water quality parameters and habitat disturbance as a result of cable laying or construction of foundations. In addition, turbine installation works may lead to short term increases in the levels of underwater sound that could affect marine mammals. • Dredging and jetting works will lead to a short term disturbance to 0.99 ha of low value subtidal habitat. Foundation construction will lead to a maximum loss of 3.6 ha of low value subtidal habitat for the offshore substation option, but this loss could be as low as 0.16 ha of habitat. Cable landing will involve the disturbance of 16.5 m of artificial seawall habitat. It would be expected that the onshore substation would lead to potentially similar losses of habitat depending on final detailed design. Although these habitats are of low value they are located in areas of medium-high importance for finless porpoises and low for sea turtles. All of these impacts are considered to be of low significance and are acceptable. • Water quality impacts arising from the proposed dredging or jetting works are predicted to be largely confined to the specific works areas and the predicted elevations of suspended sediment due to the Project are not predicted to cause large areal exceedances of the Water Quality Objectives (WQO), adverse impacts to water quality, and hence marine ecological resources or marine mammals, are not anticipated. • The generation of underwater sound during percussive piling and the potential effects on marine mammals was assessed. Although the sounds generated are expected to be audible to marine mammals the works were not predicted to lead to significant impacts. With the adoption of appropriate mitigation to promote avoidance of the area or to manage works so that sound generation is controlled.
Key Operational Impacts	• Potential operational phase impacts to marine ecological resources, as well as impacts to marine mammals and green turtles, may arise from the loss of subtidal habitat, adverse impacts to water quality, change in hydrodynamics and underwater sound generation. All of these impacts are considered to be of low magnitude and are acceptable. • Beneficial operational phase impacts to marine ecological resources are expected to occur through the generation of the creation of 'artificial reef' habitat. The use of rock scour material would be expected to lead to higher benefits in this regard. Such impacts may lead to increased productivity and biomass in the area and possibly increase food resource for marine mammals.

<table>
<tr><th colspan="2">- MARINE ECOLOGY -</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Key Mitigation and Precautionary Measures</td><td>

Impacts have largely been avoided during the construction and operation of the offshore wind farm through the following measures (in accordance with the EIAO-TM):

Avoid Direct Impacts to Ecologically Sensitive Habitats: Disturbance to marine ecologically sensitive habitats has been avoided as a result of the site selection process of the offshore wind farm away from more sensitive nearshore areas; and
Adoption of Acceptable Working Rates: The modelling work has demonstrated that the selected working rates for the dredging will not cause unacceptable impacts to the receiving water quality. Consequently, unacceptable indirect impacts to marine ecological resources have been avoided.

Mitigation measures specific to marine ecology include reinstatement of the existing Lamma Power Station Extension sea wall. Specific mitigation measures have also been designed to reduce impacts to the population of marine mammals and sea turtles which include restrictions on vessel speed, the use of pre-defined and regular routes by construction traffic, and the selection of acceptable working rates to control impacts to water quality to acceptable levels (compliance with Water Quality Objectives - WQOs).
Measures have been identified to assist the protection of marine mammals and sea turtles such as:

Piling works are undertaken using hydraulic hammers, which typically have lower sound output than traditional diesel hammers;
Piling works take place in daylight hours (e.g. 6am to 6pm);
Wind turbine founding piling works avoid peak seasons of marine mammals (ie December through May);
Piling works employ 'soft-starts';
Piling works are undertaken in marine mammal and sea turtle exclusion zones which are monitored by marine mammal observers; and,
Pre-, during and post-installation monitoring of marine mammal abundance and distribution.

A pre-construction dive survey will also be undertaken at the sites where isolated corals were identified along the cable route to confirm their existence. Should these corals be found present, mitigation will be applied, such as potential relocation away from the proposed area of works
</td></tr>
<tr><td>Residual Impacts</td><td>The loss of a maximum of 3.6 ha of low value soft bottom habitat and loss of 0.16 ha of water column habitat in an area of medium-high importance for finless porpoises and low for sea turtles.</td></tr>
<tr><td>Compliance with EIAO-TM</td><td>The assessment and the residual impacts are acceptable and in compliance with the EIAO-TM Annexes 8 and 16 and applicable assessment standards/criteria.</td></tr>
</table>

13.7 FISHERIES

Table 13.5 presents a summary of the findings of the assessment of impacts to fisheries as a result of the construction and operation of the proposed offshore wind farm. The details of the assessment are presented in full in *Section 10* of this *EIA Report*.

Table 13.5 Summary of Environmental Assessment and Outcomes – Fisheries

- FISHERIES -	
Fisheries Sensitive Receivers	• Spawning/Nursery Grounds; and • Fish Culture Zone: Lo Tik Wan and Sok Kwu Wan.
Key Environmental Problems Avoided / Environmental Outcomes	• Impacts to commercial fisheries have been avoided by positioning the offshore wind farm and cable route away from any sensitive areas.
Assessment Methodology and Criteria	• A literature review was conducted to establish the fisheries importance of the area surrounding the proposed wind farm and cable route. • Additional on-site information on fishing vessels has been gathered during marine surveys. • The potential impacts due to the construction and operation of the Project and associated developments were assessed following the *EIAO-TM Annex 17* guidelines and the impacts evaluated based on the criteria in *EIAO-TM Annex 9*.
Key Construction Impacts	• Potential construction phase impacts to fisheries may arise from the short term disturbance of marine habitat due to foundation construction, dredging and jetting or through changes to key water quality parameters, as a result of marine works, underwater sound generation, and restriction of fishing activity in proximity to the marine working areas. • Water quality impacts arising from the proposed dredging, jetting and foundation construction works are predicted to be largely confined to the specific works areas and to be temporary in nature. The predicted elevations of suspended sediment concentrations due to the Project are not predicted to exceed the assessment criteria over large areas or at sensitive receivers and they are not expected to cause adverse impacts to water quality or to any fishing grounds or species of importance to fisheries. • Restriction of access for fishing consists of a small area (500 m from works) and should not affect fisheries in the area in the context of similar or better fishing areas elsewhere. In additional, increases in vessel traffic are small scale and should not pose a significant risk to fishing vessels, particularly given the levels of marine traffic that currently exist in the area that fishing vessels contend with on a daily basis. • Underwater sound generation from marine construction works is not expected to have a significant impact on fisheries resources.

- FISHERIES -	
Key Operational Impacts	• A total of 700 ha of habitat will be closed to fishermen within and adjacent to the turbine array. This represents only 0.42% of Hong Kong's territorial waters. • Underwater sound generation from the operation of the wind turbines is not expected to have a significant impact on fisheries resources. • Changes to fishing pressure and creation of an 'artificial reef' may lead to beneficial impacts for fisheries in the long term in terms of increasing marine productivity and biomass in the immediate area of the wind farm.
Key Mitigation Measures	• Works have been designed to control water quality impacts to within acceptable levels and hence are also expected to control impacts to fisheries resources. • Mitigation to reduce the impacts associated with underwater sound generation as set out for marine mammals and sea turtles will minimise related potential impacts on fisheries resources. • Measures to promote navigational safety during the construction and operational phase will also reduce the potential for adverse impacts on fishing vessels. • The implementation of an initial Fisheries Review and Consultation Programme, potentially followed by a Fisheries Enhancement Plan, will address the potential for fisheries to be reintroduced into the area and / or possibly implementing fishery resource enhancement measures.
Residual Impacts	• The identified residual impact occurring during the construction phase is the loss of approximately 0.16 ha of seabed required for the construction of foundation for marine structures. • A total of 700 ha of habitat will be closed to fishermen within and adjacent to the turbine array. • The availability of similar habitat elsewhere will reduce the magnitude of this residual impacts. • The adoption of appropriate mitigation measures to manage navigational risks will also mean that the risk to fishing vessels would be low.
Compliance with *EIAO-TM*	• The assessment and the impacts are acceptable and in compliance with the *EIAO-TM Annexes 9* and *17* and applicable assessment standards/criteria.

13.8 LANDSCAPE AND VISUAL IMPACT

Table 13.6 presents a summary of the findings of the assessment of impacts to the landscape and visual environment as a result of the construction and operation of the proposed offshore wind farm. The details of the assessment are presented in full in *Section 11* of this *EIA Report*.

Table 13.6 Summary of Environmental Assessment and Outcomes – Landscape & Visual

- LANDSCAPE AND VISUAL -	
Visually Sensitive Receivers (VSRs), Landscape Resources (LRs) and Landscape Character Areas (LCAs)	• Landscape Character Areas (LCAs) include LCA 1 Offshore Water Landscape, LCA 2 Inshore Water Landscape, LCA 3 Industrial Urban Landscape, LCA 4 Coastal Upland & Hillsides • Landscape Resources (LRs) include LR 1 Seascape, LR2 Man made rocky sea wall, LR3 Industrial Area, LR4 Soft Landscape Areas, LR5 Mixed Shrubland, LR6 Pond Area • Visually Sensitive Receivers include VSR 1 Lamma Island (Hung Shing Ye beach), VSR 2 Lo So Shing Beach, VSR 3 Lamma Ferry Pier, VSR 4 Ferry to Cheung Chau, VSR 5 Cheung Chau, VSR 6 Discovery Bay, VSR 7 Silvermine Bay, VSR 8 Chi Ma Wan Peninsula, VSR 9 Cheung Sha, VSR 10 Lantau Trail, VSR 11 The Peak, VSR 12 Queen Mary Hospital and Mount Davis, VSR 13 Pauline Chan Bldg HKU, VSR 14 Stanley Waterfront, VSR 15 Wong Nai Chung gap and Violet Hill, VSR 16 Ocean Park, VSR 17 Mt Stenhouse, VSR 18 Penny's Bay, VSR 19 East Lamma Channel
Key Environmental Problems Avoided / Environmental Outcomes	• Many sensitive VSRs have been avoided by locating the wind farm offshore away from densely populated areas. • As the wind farm is to be located offshore, there will not be any significant impacts on any LCAs or LRs.
Assessment Methodology and Criteria	• The methodology of the LVIA is based on *Annexes 10* and *18* in the *EIAO-TM*) under the *EIA Ordinance* (Cap.499, S16) and applicable guidance notes. • The landscape assessment considers the impact of the proposed development on the existing landscape and particularly on the landscape character units within 500 m of the development site. • The visual assessment analyses the impact of the proposed development on the existing views and the visual amenity, particularly from the Visually Sensitive Receivers (VSR) within the viewshed. • In order to illustrate the visual impacts of the proposed wind farm, photomontages prepared from selected viewpoints compare the existing conditions with the view after construction. The residual impacts are evaluated qualitatively, in accordance with the requirements of *Annex 10* of the *EIAO-TM*.
Key Outcomes	• There will be moderate unmitigated impacts on LCA 1 Offshore Waters Landscape • There will be slight unmitigated impacts on LCA 3 Industrial Urban Landscape • There will be negligible impacts on LCA 2 Inshore Waters Landscape

- LANDSCAPE AND VISUAL -	
	and LCA 4 Coastal Upland and Hillside Landscape • There will be slight unmitigated impacts on LR1 Seascape LR2 Man made rocky sea-wall LR3 Industrial Area LR4 Soft Landscape areas and LR6 Pond • There will be negligible impacts on LR 5 Mixed Shrubland • There will be negligible visual impacts on VSR 3 Lamma Ferry Pier VSR 14 Stanley Waterfront and VSR 15 Wong Nai Chung gap and Violet Hill • There will be slight unmitigated visual impacts on VSR 4 Ferry to Cheung Chau, VSR 8 Chi Ma Wan Peninsula, VSR 9 Cheung Sha, VSR 10 Lantau Trail VSR 12 Queen Mary Hospital and Mount Davis, VSR 13 Pauline Chan Bldg HKU and VSR 16 Ocean Park • There will be moderate unmitigated visual impacts on VSR 1 Lamma Island (Hung Shing Ye beach), VSR 2 Lo So Shing Beach, VSR 5 Cheung Chau, VSR 7 Silvermine Bay, VSR 11 The Peak, VSR 18 Penny's Bay and VSR 19 East Lamma Channel. • There will be significant unmitigated visual impacts on VSR 17 Mt Stenhouse.
Key Mitigation Measures	Landscape mitigation measures are proposed to not only further reduce the above impacts but to generally improve the amenity of the development. *LMM 1 – Tree and Shrub Planting.* All plant materials affected by the works relating to the submarine cable landing are to be replaced with new plantings to match the existing situation. All planting of trees and shrubs is to be carried out in accordance with the relevant best practice guidelines. Plant densities are to be provided in future Detailed Design documents and are to be selected so as to achieve a finished landscape that matches the surrounding, undisturbed, equivalent landscape types. *LMM 2 - Relocation.* Established trees of value to be re-located where practically feasible. *LMM 3 – Site hoardings to be compatible with the surrounding environment.* Where possible, site hoardings should be coloured to complement the surrounding areas. Colours such as green and light brown are recommended. *LMM 4 – Reinstatement.* Landscape resources affected by the onshore cable trench are to be reinstated to match existing conditions. Due to the large scale of the wind turbines, visual mitigation is constrained. However, the following measures have been considered to reduce impacts. *VMM1 Site Selection.* A detailed site selection process has been undertaken. One of the key considerations was to select a site that would minimise the potential visual impacts associated with the Project. *Section 3* provides a detailed analysis of the site selection process. *VMM2 Array Layout.* The array of wind turbines shown in this study is preliminary only. There is an opportunity to amend the layout of the array to reduce the number of turbines visible for the most sensitive viewpoints. It must be noted that visual impacts are only one consideration when determining the layout of the array. Changes to the array are only possible when other technical details, such as suitable sea bed, marine traffic and wind

	flow conditions are achievable. *VMM3 Colours.* Colour selection must be in accordance with guidelines imposed by CAD, however appropriate colours for the wind turbines should be selected to reduce their visibility where technically feasible. *VMM 4 Blade Rotation.* To create a more harmonious visual pattern the blades for all turbines should rotate in the same direction.
Residual Impacts	1. There will be *negligible* residual construction impacts on LCAs 2 Inshore Waters Landscape and LCA 4 Coastal Upland and Hillside Landscape. 2. There will be *slight* residual construction impacts LCA 3 Industrial Urban Landscape. Approximately 2.78ha of this LCA will be affected during construction, however this area will be fully mitigated with the adoption of the mitigation measures proposed, resulting in a negligible residual construction impact. 3. There will be *moderate* adverse residual construction impacts on LCA1 Offshore Waters Landscape. Approximately 700ha of this LCA will be lost and can not be mitigated. 4. There will be *negligible* residual operational impacts on LCAs 2 Inshore Waters Landscape, 3 Industrial Urban Landscape and 4 Coastal Upland and Hillside Landscape. There will be *moderate* adverse residual operational impacts on LCA1 Offshore Waters Landscape. 5. There will be *negligible* residual construction and operation impacts on the following LRs: • LR 2 Man made rocky sea-wall. Approximately 0.001ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed. • LR 3 Industrial Area. Approximately 0.02ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed. • LR 4 Soft Landscape areas. Approximately 0.001ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed. • LR 5 Mixed Shrubland. There will be no impacts on this LR. • LR 6 Pond. There will be no impacts on this LR. 6. There will be slight residual construction and operation impacts on LR1 Seascape as 0.16ha will be lost and can not be mitigated. 7. There will be negligible residual visual impacts from VSR3 Lamma Ferry Pier, VSR 14 Stanley Waterfront and VSR 15 Wong Nai Chung Gap and Violet Hill. 8. There will be slight residual visual impacts from VSR1 Lamma Island (Hung Shing Ye beach), VSR2 Lo So Shing Beach, VSR4 Ferry to Cheung Chau, VSR 5 Cheung Chau, VSR6 Discovery Bay, VSR 8 Chi Ma Wan Peninsula, VSR 9 Cheung Sha, VSR 10 Lantau Trail, VSR 12 Queen Mary Hospital and Mount Davis, VSR 13 Pok Fu Lam - Pauline Chan Building

- LANDSCAPE AND VISUAL -	
	at HKU, VSR16 Ocean Park, and VSR 18 Penny's Bay. 9. Moderate residual visual impacts have been identified at VSR7 Silvermine Bay (Mui Wo), VSR11 The Peak, VSR 17 Mt Stenhouse and VSR 19 East Lamma Channel.
Compliance with *EIAO-TM*	• The assessment and the impacts are considered acceptable with mitigation and in compliance with the *EIAO-TM Annexes 10* and *18* and applicable assessment standards/criteria.

13.9 *CULTURAL HERITAGE*

Table 13.7 presents a summary of the findings of the assessment of impacts to cultural heritage as a result of the construction and operation of the proposed offshore wind farm. The details of the assessment are presented in full in *Section 12* of this *EIA Report*.

Table 13.7 Summary of Environmental Assessment and Outcomes – Cultural Heritage

- CULTURAL HERITAGE -	
Sensitive Receivers	• No terrestrial sites of cultural heritage importance have been identified; and • A Marine Archaeological Investigation has identified a wreck site located 72 m west of the western extent of the wind farm site.
Key Environmental Problems Avoided / Environmental Outcomes	• The siting of the proposed wind farm and cable route has avoided known marine wreck sites.
Assessment Methodology and Criteria	• The study methodology follows the criteria and guidelines as stated in *Annexes 10* and *19* of the *EIAO-TM* and the *Guidelines for Cultural Heritage Impact Assessment (CHIA)* and *Guidelines for Marine Archaeological Investigation (MAI)* as stated *EIA Study Brief No. ESB-126/2005.* • The baseline study included a desktop literature review and field surveys, namely a Marine Archaeological Investigation.
Key Impacts	• One potential marine archaeological site (SC001) was identified from a review of geophysical data. This site is located outside of any area of works and will not be directly or indirectly affected. The avoidance of direct impacts to the shipwreck identified during the geophysical survey will be verified through review of the final design prior to the installation of turbines and submarine cable. Designs will be checked to ensure that no works will occur within 50 m of the shipwreck.No impacts are therefore expected on marine archaeological resources.
Mitigations	• No impacts on terrestrial or marine cultural heritage is expected and thus no mitigation measures are considered necessary
Residual Impacts	• No residual impact is expected.
Compliance with	• The assessment and the residual impacts are acceptable and in

- CULTURAL HERITAGE -	
EIAO-TM	compliance with the *EIAO-TM Annexes 10* and *19* and applicable assessment standards and criteria.

13.10 SUMMARY OF ENVIRONMENTAL OUTCOMES

The above section summarises the key environmental outcomes arising from the assessments completed in this EIA Report for the proposed offshore wind farm. The assessment has demonstrated that for all environmental components, residual impacts are acceptable and in compliance with the *EIAO-TM* and applicable assessment standards and criteria.

13.11 STAKEHOLDER ENGAGEMENT

HK Electric has conducted consultations and engagement with project stakeholders to hear their views on the project plan while at the same time, addressing their concerns. These stakeholders include representatives from fishermen groups, green groups, District Councillors, Rural Committees Members, government advisory committee Members, various Government Departments, learned institutions, industry practitioners and members of the public. The feedback from these consultations has been considered in the preparation of this EIA Study Report.

Table 13.8 below provides a summary of the Stakeholder Engagement Record detailing the organizations and parties that HK Electric has consulted with regard to the proposed offshore wind farm project.

Table 13.8 *Stakeholder Engagement Record*

Meeting	Date	Organization
1	24 Apr 2007	Civil Aviation Department officials
2	2 May 2007	Marine Department officials
3	17 Apr 2008	Civil Aviation Department officials
4	29 Apr 2008	Sky Shuttle Limited
5	21 May 2008	Marine Department officials
6	29 May 2008	Agriculture, Fisheries and Conservation Department officials
7	27 Sep 2008	Customer Liaison Group
8	17 Oct 2008	Presentation for 2008 Hong Kong Awards for Industries: Environmental Performance
9	6 Jan 2009	1st International Conference on Applied Energy ICEA '09
10	10 Jan 2009	Customer Liaison Group officials
11	5 May 2009	Civil Aviation Department
12	11 Nov 2009	Chairman and Vice-chairman of Southern District Council
13	11 Nov 2009	Legislative Council member
14	24 Nov 2009	Energy Advisory Committee member
15	25 Nov 2009	Chairman and Vice-chairman of Lamma Island (North) Rural Committee Chairman of Lamma Island (South) Rural Committee Islands District Council member
16	25 Nov 2009	CEO of WWF – Hong Kong
17	26 Nov 2009	Representatives of Hong Kong Fishery Alliance Representatives of Hong Kong Fishermen's Association (1)
18	26 Nov 2009	Energy Advisory Committee member
19	2 Dec 2009	CEO of Green Power
20	2 Dec 2009	Islands District Council members
21	16 Dec 2009	Director and Environmental Affairs Manager of Friends of the Earth (Hong Kong)
22	17 Dec 2009	Vice -chairman of The Hong Kong Bird Watching Society
23	25 Jan 2010 (Planned)	Acting Chief Executive of Conservancy Association
24	26 Jan 2010 (Planned)	CEO of Business Environment Council
25	27 Jan 2010 (Planned)	Climate and Energy Campaigners, Greenpeace China

Majority of the consultees welcomed HK Electric's proposed development of an offshore wind farm in Hong Kong as an initiative for the wider application of renewable energy. Fishermen's concern of the project's impact on the future of fishing industry is also noted. *Table 13.9* below highlights some of the key issues that have been raised by the Consultees and how they were addressed in this EIA Report.

(1) Fisheries representatives noted that they had no preference in terms of location of an Offshore Wind Farm. Their preference was related to utilising existing available land and considered that all marine options could affect fishing operations irrespective of site location.

Table 13.9 Incorporation of Stakeholder Feedback into EIA

Issues	How it was addressed
Why do we need to develop the wind farm of this scale?	The 100MW offshore wind farm in southwest Lamma is adequate to produce 170 million kWh of electricity, which is equivalent to around 1 to 1.5% of HK Electric's annual unit sales. This can meet the annual consumption for 50,000 households in Hong Kong.
Why has HK Electric decided to build an offshore wind farm, and off Lamma Island? Why HK Electric does not consider building an onshore wind farm on Po Toi Island?	Given the scarcity of land resource in Hong Kong, construction of offshore wind farm is the only viable option for development of large scale wind energy generation project. Result of a territory wide site search study has confirmed Southwest Lamma offshore as the preferred site from environmental, programme, cost and other technical considerations (see *Section 3*). Lamma offshore wind farm has the advantage of being in proximity to Lamma Power Station with respect to cabling, connection with onshore grid and construction as well as subsequent operational and maintenance logistics. HK Electric carried out wind monitoring in Po Toi Island in 2000. Results indicated that wind resource is not adequate to support development of a large scale wind farm. Furthermore, the land resources and ecological considerations suggested development of an onshore wind farm in Po Toi island being not feasible.
Two wind farms are being planned in Hong Kong and can they be combined?	HK Electric believes it should avoid constructing another offshore wind farm next to the CLP's development to eliminate any potential for cumulative environmental impact. In addition, it can avoid adding additional visual impact in the Eastern offshore site which has already aroused much public attention. Should HK Electric builds its offshore wind farm next of CLP, a longer submarine cable will be required for connection to HK Electric's grid which is not preferred from environmental and cost considerations (see *Section 3.6.2 - Review of Offshore Potential Development Areas*, sub-section *Distance to Connect to HK Electric Grid)*.
Will the wind farm affect aviation and marine routes?	Preliminary Marine Traffic Impact Assessment has been conducted to assess the impact on marine traffic due to existence of the offshore wind farm. As a result, the current wind farm

Issues	How it was addressed
	site boundary is recommended to avoid areas with heavy marine traffic (see *Section 3.6.2 - Review of Offshore Potential Development Areas,* sub-section *Shipping and Navigation)*. HK Electric is in close liaison with Civil Aviation Department to ensure the offshore wind farm brings no impact to aviation safety (see *Section 3.6.2 - Review of Offshore Potential Development Areas,* sub-section *Aviation)*.
Will the development of the offshore wind farm affect water quality in the region? Can water quality monitoring be carried out during construction stage?	Environmental Monitoring & Audit will be carried out before, during and after the construction stage to monitoring water quality closely.
How will the construction of offshore wind farm affect the fishing industry? Upon the commissioning of the wind farm, would vessels be allowed to enter the wind farm boundary?	It is estimated that the foundation of wind towers will occupy 0.16 ha of fishing ground, which is equivalent to 0.0001% of the entire area of Hong Kong waters. The wind farm boundary occupies less than 0.4% of the entire area of Hong Kong waters. A Fisheries Management Plan will be developed for the wind farm area and HK Electric will study in consultation with the fishing sector whether fishing operations is desirable/feasible within the wind farm area.
The wind farm might reduce the fishery catches in the vicinity area. Will HK Electric consider compensation?	HK Electric is mindful of feedbacks from our stakeholders including fishermen. We will maintain close dialogue with the fishermen during the course of the wind farm development. We are prepared to listen to fishermen's concerns. It is envisaged that the potential for increased fish production and aggregation through the provision of new hard substratum and protected waters within the wind farm area during operational phase may lead to overall benefits for fisheries (see *Section 10.5.2 – Operation Phase*, sub-section *Long Term Changes in Benthic Habitat*).
Will HK Electric do anything to help promote the wind farm as a tourist attraction?	We believe the offshore wind farm will attract visitors to Lamma Island, just like our wind station, Lamma Winds at Tai Ling which has now become a landmark of the island. We will work with Lamma community and see what to do.
Would there be a safety navigation zone at the periphery of the wind farm boundary?	HK Electric will make reference to international practice and discuss with relevant government departments on such requirement if necessary (see *Section 10.7.3 –Mitigation Measures*, sub-

Issues	How it was addressed
	section *Vessel Navigation Measures*).
Does HK Electric have any other wind farm plans?	If the project is successful and well received by the general public, we will not rule out the possibility of developing more wind farm projects in Hong Kong.
Considering the cost involved in developing the offshore wind farm and its output efficiency, not sure if the project is worth.	HK Electric supports the development and application of renewable energy in Hong Kong as an initiative to improve air quality. The 100MW offshore wind farm in southwest Lamma will generate 170 million units of electricity, which is equivalent to around 1 to 1.5% of HK Electric's annual unit sales. The use of natural resources can also help offset some fuel cost in future.
Is it feasible to transmit electricity to Hong Kong from wind farms built in overseas or in the mainland?	Comparing with investing in wind farms overseas or in the mainland, developing a wind farm in Hong Kong is the most direct solution to reduce local pollutant emission. Moreover, power loss shall be considered for the options of transmitting electricity from overseas or mainland wind farms.

CONTENTS

ANNEXES

14 ENVIRONMENTAL MONITORING AND AUDIT MEASURES

14.1 INTRODUCTION

This EIA Study has focused on the assessment and mitigation of the potential impacts associated with the construction and operation of the Project at the Southwest Lamma site. One of the key outputs has been the identification of mitigation measures to be undertaken in order to ensure that residual impacts comply with regulatory requirements plus the requirements of the *EIAO TM*. To ensure effective and timely implementation of the mitigation measures, it is considered necessary to develop Environmental Monitoring and Audit (EM&A) procedures and mechanisms by which the Implementation Schedule (*Annex 14A and B)* may be tracked and its effectiveness assessed.

14.1.1 *Implementation of EIA Findings and Recommendations*

Sections 6 to *12* have, where appropriate, identified and recommended the implementation of mitigation measures to reduce the potential construction and operational impacts of the Project. These findings and recommendations form the primary deliverable from the whole EIA process and will form an agreement between HK Electric and the Government as to the measures and standards that are to be achieved. It is therefore essential that mechanisms are put in place to ensure that the mitigation measures prescribed in the Implementation Schedule are fully and effectively implemented during construction and operation.

The required format for the Implementation Schedule (*Annex 14A and B*) is specified in the EIA Study Brief. The format requires the specification of implementation agent(s), timing, duration and location for each of the recommended mitigation measures.

14.1.2 *Statutory Requirements*

As the Project constitutes a Designated Project under the *EIAO*, an Environmental Permit must be obtained before construction or operation of the proposed wind farm and associated facilities.

Upon approval of the EIA Report, HK Electric can apply for an Environmental Permit. If the application is successful, the Environmental Permit may have conditions attached to it, which must be complied with. In addition, HK Electric and its appointed Contractor(s) must also comply with other controlling environmental legislation and guidelines, which are discussed within the specific technical chapters of this report.

14.2 *ENVIRONMENTAL MANAGEMENT PLAN*

HK Electric's construction Contractors will be contractually bound to produce and implement an Environmental Management Plan (EMP). EMPs provide details of the means by which the Contractor (and all subcontractors working for the Contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined both in Hong Kong environmental legislation and in the Implementation Schedule. The primary reason for making the EMP a contractual requirement is to ensure that the Contractor is fully aware of his environmental responsibilities and to ensure his commitment to achieving the specified standards.

To evaluate a contractor's commitment, each contract bidder shall be required to produce a preliminary EMP as part of the tendering process. The skeletal EMP will indicate the determination and commitment of the contractor and indicate how the contractor intends to meet the environmental performance requirements laid out in the EIA. Upon Contract Award, the successful bidder(s) will be required to submit a draft and final version of the EMP for approval by HK Electric prior to the commencement of the work.

14.3 *EM&A MANUAL*

The EM&A Manual defines the mechanisms for implementing the EM&A requirements specific to each phase of the work. The EM&A Manual provides a description of the organisational arrangements and resources required for the EM&A programme based on the conclusions and recommendations of this EIA. It stipulates details of the construction monitoring required and actions that shall be taken in the event of exceedances of the environmental criteria. In effect, the EM&A Manual forms a handbook for the on-going environmental management during construction.

The EM&A Manual comprises descriptions of the key elements of the EM&A programme including:

- Appropriate background information on the construction of the Project with reference to relevant technical reports;
- Organisational arrangements, hierarchy and responsibilities with regard to the management of environmental performance during the construction phase. The EM&A team, the Contractor(s) team and the HK Electric's representatives are included;
- A broad construction programme indicating those activities for which specific mitigation is required and providing a schedule for their timely implementation;

- Descriptions of the parameters to be monitored and criteria through which performance will be assessed including: monitoring frequency and methodology, monitoring locations (typically, the location of sensitive receivers as listed in the EIA), monitoring equipment lists, event contingency plans for exceedances of established criteria and schedule of mitigation and best practice methods for reduced adverse environmental impacts;

- Procedures for undertaking on-site environmental performance audits as a means of ensuring compliance with environmental criteria; and

- Reporting procedures.

The EM&A Manual will be a dynamic document which will undergo a series of revisions, as needed, to accommodate the progression of the construction programme.

14.3.1 *Objectives of EM&A*

The objectives of carrying out EM&A for the Project include:

- Providing baseline information against which any short or long term environmental impacts of the projects can be determined;

- Providing an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;

- Monitoring the performance of the Project and the effectiveness of mitigation measures;

- Verifying the environmental impacts identified in the EIA;

- Determining Project compliance with regulatory requirements, standards and government policies;

- Taking remedial action if unexpected results or unacceptable impacts arise; and

- Providing data to enable an environmental audit to be undertaken at regular intervals.

The following sections summarise the recommended EM&A requirements and further details are provided in the EM&A Manual.

14.4 *Water Quality*

14.4.1 *Construction Phase*

The EIA indicated that water quality monitoring will be required during the construction phase for the following activities:

- Dredging works in the nearshore cable landing area; and,
- Jetting for the cable installation.

Water quality monitoring results will be compared to Action and Limit levels to determine whether impacts associated with the works are acceptable. An Event and Action Plan provides procedures to be undertaken when monitoring results exceed Action or Limit levels. The procedures are designed to ensure that if any significant exceedances occur (either accidentally or through inadequate implementation of mitigation measures on the part of the Contractor(s)), the cause is quickly identified and remedied, and that the risk of a similar event re-occurring is reduced.

Action and Limit levels will be used to determine whether modifications to the operations are required. Action and Limit levels are environmental quality standards chosen such that their exceedance indicates potential deterioration of the environment. Exceedance of Action levels can result in an increase in the frequency of environmental monitoring, modification of operations and implementation of the proposed mitigation measures. Exceedance of Limit Levels indicates a greater potential deterioration in environmental conditions and may require the cessation of works unless appropriate remedial actions, including a critical review of plant, working methods and mitigation measures, are undertaken. Before construction work commences four consecutive weeks of baseline monitoring will be undertaken at stations identified as detailed in the EM&A Manual.

In order to minimise the water quality impacts to the isolated coral colonies at the cable landing site, a silt curtain will be provided around the grab dredging works.

The full details of the EM&A programme for water quality is presented in the EM&A Manual for this Project.

14.4.2 *Operation Phase*

As no unacceptable impacts have been predicted to occur during the operation of the proposed wind farm, monitoring of impacts to marine water quality during the operational phase is not considered necessary.

14.5 *WASTE MANAGEMENT*

In order to ensure that the construction Contractor(s) has implemented the recommendations of the EIA Report, regular site audits will be conducted of the waste streams, to determine if wastes are being managed in accordance with the approved procedures and the site Waste Management Plan. The audits will look at all aspects of waste management including waste generation, storage, recycling, transport and disposal. An appropriate audit programme will be undertaken with the first audit conducted at the commencement of the construction works.

14.6 TERRESTRIAL ECOLOGY

The implementation of the ecological mitigation measures stated in *Section 8.11.2* should be checked as part of the environmental monitoring and audit procedures during the construction and operation period.

Although no adverse residual impacts are envisaged based on the results of impact assessment, monitoring for bird abundance and distribution for one year of pre-construction phase, one year of the construction phase (1) and the first year of operation phase is recommended.

The purpose of the construction and operation monitoring is to investigate the temporal variation in species occurrence, abundance and distribution of birds before and after the commencement of the wind farm. Particular focus will be made on species of conservation interest (especially the Birds of Prey including White-bellied Sea Eagle and Black Kite) and migratory birds (eg White-winged Tern, Heuglin's Gull),

Traditional vessel-based survey will be applied for pre-construction, construction and operation monitoring, which will be undertaken at once per week during migratory season (March to May) and at once/twice per month for the rest of the year. Line transects survey method will be used at designated sampling locations within the Project Site. Locations of sampling transects will be finalised during the detailed design stage (after confirmation of the types and siting of the turbines).

The results will be reviewed and analysed after the operation monitoring period. Should bird abundance be significantly different (taking into account naturally occurring alterations to distribution patterns such as due to seasonal change) to the pre-construction activity (following the operation monitoring), recommendations for a further operation monitoring survey will be made. Data should then be re-assessed and the need for any further monitoring established. Significance levels will be quantitatively determined following the operation monitoring which will review up-to-date publicly available information on bird distribution to allow for typical variance levels.

If, after the first-year operation monitoring period, insignificant variation in bird abundance have been reported then the monitoring will be ceased, as it will have been confirmed that the wind turbine is not having an adverse impact on bird species.

(1) Construction phase refers to the one year period including wind turbine construction and pre-commissiong phase, which is the fourth year of the construction programme as stated in *Section 5*.

The EM&A Manual provides details of the operational bird monitoring programme.

14.7 *MARINE ECOLOGY*

The following presents a summary of the Environmental Monitoring and Audit (EM&A) measures focussed on ecology during the construction and operation phases of the offshore wind farm. Full details are presented in the separate EM&A Manual.

During the construction phase, the following EM&A measures will be undertaken to verify the predictions in the EIA and ensure the environmental acceptability of the construction works:

- Water quality impacts will be monitored and checked through the implementation of a Water Quality EM&A programme (refer *Section 6* for details). The monitoring and control of water quality impacts will also serve to avoid unacceptable impacts to marine ecological resources.

- Marine piling works will be undertaken using hydraulic hammers, which typically have lower sound output than traditional diesel hammers;

- Marine piling works will take place in daylight hours, sunrise to sunset;

- Marine piling works for the wind turbines will avoid peak seasons of marine mammals (December to May);

- Marine piling works will employ 'soft-starts' using ramp-up piling procedures;

- Pre-, during and post-installation monitoring of marine mammal abundance, behaviour and distribution will be undertaken. Prior to the commencement of monitoring, methods may include the following to be agreed with the AFCD:

    - Vessel based surveys

    - Passive acoustic monitoring

- Land-based theodolite tracking A marine mammal/sea turtle exclusion zone will also be implemented and monitored by qualified observers (1) for the presence of marine mammals/sea turtles in waters surrounding any marine percussive piling works and dredging works during construction of the wind farm structures and cable route; and,

(1) A qualified person with a degree in biology or equivalent shall be employed to carry out monitoring and visual inspection of marine mammals / sea turtles. The qualification and experience of qualified person shall have a degree in marine or environmental sciences and experience in marine mammal observation techniques.

- As a total of four octocoral species and one black coral species were recorded during the baseline surveys on the dumped material in the vicinity of the cable route, prior to the commencement of jetting works for the cable route, a pre-construction survey will be undertaken at these sites to confirm the coral existence. Should these corals be present, mitigation will be applied to be agreed with the AFCD at that time. Potential mitigation may include relocation of these corals to a location away from the proposed area of works.

Details of the marine mammal/sea turtle exclusion zone monitoring components are presented in full in the EM&A Manual.

The assessment presented above as indicated that operational phase impacts are not expected to occur to marine ecological resources. No other marine ecology specific operational phase monitoring is considered necessary.

14.8 FISHERIES

As no unacceptable impacts have been predicted to occur during the construction and operation of the wind farm, monitoring of fisheries resources during the construction phase is not considered necessary. The Fisheries Impact Assessment of the EIA recommended a series of mitigation measures for the construction and operation phase of the project. Details of all the recommended mitigation measures are included within the Implementation Schedule provided in *Annex 14A and B.*

The water quality monitoring programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the Project.

There will be a need to ensure that the seabed affected by the cable installation works has restored to its original configuration to prevent impacts from occurring to fishing operations. Consequently, a geophysical survey will be conducted following completion of cable installation works.

A Fisheries Review and Consultation Programme will also be implemented prior to the operation of the wind farm. The general intention of the FRCP will be to outline, in consultation with the fishery sector, whether there is scope for fishing operations to be conducted within the development area. If deemed acceptable, a Fisheries Management Plan (FMP) will be developed for the wind farm area.

14.9 LANDSCAPE VISUAL

The Landscape and Visual Assessment of the EIA recommended a series of mitigation measures for the construction phase, including site selection, array layout, colour selection and blade rotation direction, to ameliorate the landscape and visual impacts of the project. Details of all the recommended mitigation measures are included within the Implementation Schedule provided in *Annex 14A and B.*

Implementation of the mitigation measures for landscape and visual resources recommended by the EIA will be monitored through the site audit programme.

During the operational phase, adverse impacts are not expected to occur. Therefore, no landscape and visual monitoring will be required for the operational phase.

14.10 CULTURAL HERITAGE

No impact to terrestrial and marine archaeology is predicted. The avoidance of direct impacts to the shipwreck identified during the geophysical survey will be verified by the Environmental Team and the Independent Environmental Checker through review of the final design prior to the installation of turbines and submarine cable. Designs and subsequent construction works will be checked to ensure that no works will occur within 50 m of the shipwreck.

Annex 14A

Implementation Schedule for Construction and Operation of Wind Turbines, Offshore Substation and Transmission Cable

TableA.1: Implementation Schedule for Construction and Operation of Wind Turbines, Offshore Substation and Transmission Cable

EIA Ref.	**Environmental Protection Measures**	**Location/Duration of Measures/Timing of Completion of Measures**	**Implementation Agent**	**Implementation Stage**				**Relevant Legislation & Guidelines**
				Des	**C**	**Post-C**	**O**	
1. Water Quality								
S 6.8 and EM&A Manual	Implement water quality monitoring programme prior and during construction phase for the following activities: • Dredging works in the nearshore cable landing area (2,500m[3] day[-1]); and, • Jetting for cable installation (360m hr[-1])	Relevant works areas / During Construction	ET		✓			-
S 6.8 and Annex 6C	Dredging and jetting plant will be required to comply with the rates modelled in the EIA report (*S6 Annex*) for the various activities assessed.	Dredged areas / During Construction	Contractor(s)		✓			-
S 6.8	Silt curtains will be deployed for dredging works at the seawall of the Lamma Extension Seawall to reduce the elevation of suspended solids to nearby sensitive receivers. Details of silt curtain installation should be proposed by the contractor prior to the commencement of construction works and submitted to the IEC for approval.	Dredged areas at the landing point of the Lamma Extension seawall/ During Construction	Contractor(s)		✓			
S 6.8	Dredged marine mud will be disposed of in a gazetted marine disposal area in accordance with the *Dumping at Sea Ordinance (DASO)* permit conditions.	Dredged areas / During Construction	Contractor(s)		✓			Dumping at Sea Ordinance
S 6.8	Closed grab dredgers should be used to reduce the potential for leakage of sediments	Dredged areas/ During Construction	Contractor(s)		✓			Dumping at Sea Ordinance
S 6.8	Disposal vessels will be fitted with tight bottom seals in order to prevent leakage of material during transport.	Dredged areas/ During Construction	Contractor(s)		✓			Dumping at Sea Ordinance

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 6.8	Barges will be filled to a level, which ensures that material does not spill over during transport to the disposal site and that adequate freeboard is maintained to ensure that the decks are not washed by wave action.	Dredged areas/ During Construction	Contractor(s)		✓			Dumping at Sea Ordinance
S 6.8	After dredging, any excess materials will be cleaned from decks and exposed fittings before the vessel is moved from the dredging area.	Dredged areas/ During Construction			✓			Dumping at Sea Ordinance
S 6.8	When the dredged material has been unloaded at the disposal areas, remove any material that has accumulated on the deck or other exposed parts of the vessel and place in the hold or a hopper. Do not wash decks clean in a way that permits material to be released overboard.	Dredged areas/ During Construction	Contractor(s)		✓			Dumping at Sea Ordinance
S 6.8	The Contractor(s) will ensure that the works cause no visible foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the area of marine works.	Dredged areas/ During Construction	Contractor(s)		✓			-
S 6.8	Control and monitoring systems will be used to alert the crew to leaks or any other potential risks.	Dredged areas/ During Construction	Contractor(s)		✓			-
S 6.8	All plant will be fully serviced and inspected before use to limit any potential discharges to the marine environment	Quayside / During Construction	Contractor(s)		✓			-
S 6.8	Avoid spillage of oil, fuel and chemicals from structures by adopting appropriate good site practices	Wind farm area / During Construction	Contractor(s)		✓			Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 6.8	Any grout used would conform to the relevant environmental standards. In addition, the adoption of appropriate operational management by the contractor should lead to low potential for leakage during the pumping phase.	Wind farm area / During Construction	Contractor(s)		✓			-
S 6.8	No debris shall be willingly discharged to sea. However, should debris be placed on the seabed, this will be removed (wherever practicable)	Wind farm area / During Construction	Contractor(s)		✓			-
S 6.8	Construction site runoff at the Laydown area should be prevented or minimised in accordance with the guidelines stipulated in the EPD's Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94).	Land Site / During Construction	Contractor(s)		✓			ProPECC PN 1/94
S 6.8	The permanent storage areas of oil fuel and chemical will be surrounded by bunds or other containment device to prevent spilled oil, fuel and chemicals from reaching the receiving waters	Land Site / During Construction	Contractor(s)		✓			Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes
S 6.8	The Contractors will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals	Land Site / During Construction	Contractor(s)		✓			-
S 6.8	Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system	Land Site / During Construction	Contractor(s)		✓			ProPECC PN 1/94

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
2. Waste Management								
S 7.6	The Contractor shall prepare and implement a Waste Management Plan which incorporates site-specific factors, such as the designation of areas for the segregation and temporary storage of reusable and recyclable materials.	Contract mobilisation / During Construction	Contractor(s)		✓			-
S 7.6	The Contractor shall ensure only licensed waste collectors are used to collect chemical waste for delivery to a licensed treatment facility	Contract mobilisation / During Construction	Contractor(s)		✓			Waste Disposal (Chemical Waste) (General) Regulation Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes
S 7.6	The Contractor shall apply for and obtain the appropriate licenses/permits for the disposal public fill and chemical waste.	Contract mobilisation / During Construction	Contractor(s)		✓			Waste Disposal (Chemical Waste) (General) Regulation Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes Waste Disposal (Charges for Disposal of Construction Waste) Regulation
S 7.6	Separation of chemical wastes for special storage and handling and appropriate treatment in accordance with the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes	Land Site / During Construction	Contractor(s)		✓			Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S7.6	A record system for the amount of wastes generated / recycled and disposal sites.	Land Site / During Construction	Contractor(s)		✓			-
S 7.6	All excavated materials shall be reused on site to the extent practical.	Land Site / During Construction	Contractor(s)		✓			-
S 7.6	Dredged marine mud shall be disposed of in a gazetted marine disposal ground under the requirements of the Dumping at Seas Ordinance. Marine mud shall be assessed in accordance with the ETWBTC No. 34/2002 prior to the dredging to identify the suitable disposal ground.	Dredging / During Construction	Contractor(s)		✓			Dumping at Sea Ordinance ETWBTC No. 34/2002, Management of Dredged/Excavated Sediment; Environment, Transport and Works Bureau, Hong Kong SAR Government
S 7.6	EM&A of waste handling, storage, transportation, disposal procedures and documentation through the site audit programme shall be undertaken.	All facilities / During Construction	ET		✓			-
3. Terrestrial Ecology								
S 8.13.2	Although no adverse residual impacts are envisaged based on the results of impact assessment. Monitoring for bird abundance and distribution will be undertaken for one year during the pre-construction phase, one year during the construction phase for the wind turbines and the first year of the operation of the turbines.	Wind Farm/ Pre-Construction, During Operation and First year of Operation	ET	✓	✓		✓	-

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
4. Marine Ecology								
S 9.12.2	The vessel operators will be required to control and manage all effluent from vessels.	During Construction / Marine works	Contractor(s)		✓			-
S 9.12.2	A policy of no dumping of rubbish, food, oil, or chemicals will be strictly enforced. This will also be covered in the contractor briefings.	During Construction / Marine works	Contractor(s)		✓			-
S 9.12.2	Vessel operators working on the Project construction or operation will be given a briefing, alerting them to the possible presence of marine mammals in the area, and guidelines for safe vessel operations in the presence of cetaceans. If high speed vessels are used, they will be required to slow to 10 knots when passing through a high density dolphin area.	During Construction / Marine works	ET & Contractor(s)		✓			-
S 9.12.2	The vessel operators will be required to use predefined and regular routes, as these will become known to porpoise using these waters. This measure will further serve to minimise disturbance to marine mammals due to vessel movements	During Construction / Marine works	ET & Contractor(s)		✓			-
S 9.12.3	A pre-construction dive survey will be undertaken at the sites where isolated corals were identified along the cable route to confirm their existence. Should these corals be found present, mitigation will be applied, such as potential relocation away from the proposed area of works	Pre-Construction	ET & Contractor(s)	✓				

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 9.12.4	To reduce underwater sound levels associated with percussive piling, the following steps will be taken: - Quieter hydraulic hammers should be used instead of the noisier diesel hammers; - Acoustic decoupling of noisy equipment on work barges should be undertaken.	During Construction / Marine works	Contractor(s)		✓			-
S 9.12.4	Best practices are recommended to reduce the impacts to marine mammals: - Instigate 'ramping-up' of the piling hammer to provide an advance warning system to marine mammals in the vicinity; - Activities will be continuous without short-breaks and avoiding sudden random loud sound emissions	During Percussive Piling works for Foundation Construction	Contractor(s)		✓			-
S 9.12.4	No piling works for the wind turbines will be conducted during the finless porpoise peak seasons between December and May.	During Percussive Piling works for Foundation Construction	Contractor(s)		✓			
S 9.12.4	An exclusion zone of 500 m radius will be scanned around the work area for at least 30 minutes prior to the start of percussive piling works. For dredging works, an exclusion zone of 250m radius shall apply. If marine mammals/green turtles are observed in the exclusion zone, piling will be delayed until they have left the area.	During Percussive Piling works for Foundation Construction / Dredging Works for Cable Installation	ET		✓			
S 9.15.1	Marine percussive piling works to be restricted to a daily maximum of 12 hours within daylight operations.	During Percussive Piling works for Foundation Construction	Contractor(s)		✓			

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 9.15.1	Long-term monitoring will be conducted for the distribution and abundance of marine mammals during the construction and post-construction phase of the project. Baseline marine mammal monitoring will also be conducted. Monitoring will include: • Vessel based surveys • Passive acoustic monitoring • Land-based theodolite tracking The protocols for this will be agreed with AFCD in advance.	Major marine works areas / Pre-construction, during construction and post-construction	ET	✓	✓	✓		
5. Fisheries								
S 10.7	The impacts to fisheries resources will be minimised by adopting the following measures: - The use of competent and experienced contractors and vessels operators; - Good planning of the installation sequence to avoid possible clashes; - Good promulgation of information relating to construction activities; - Thorough auditing of all vessels; - Observing good industry construction practices by the Contractors; and, - Surveying of the 'as-laid' cable positions and having good quality position fixing/surveying systems available	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	Inform fishermen of possible developments of the Project in advance	Marine Works / During Construction	Contractor(s) / Operator		✓			-

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 10.7	Using good engineering practice, including the use of appropriately sized piles (smaller piles generate lower levels of underwater sound) and piling equipment.	Marine Works / During Construction	Contractor(s)	✓	✓			-
S 10.7	Using ramp-up piling procedures. Blow frequency during this ramping up period should replicate the intensity that would be undertaken during full piling (e.g. one blow every two seconds) to provide cues for fish to localize the sound source. Pile blow energy should be ramped up gradually over the 'soft start' period.	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	A geometric layout design should been adopted to eases navigation between structures and reduces collision risk in times of low visibility.	Wind Farm / During Detailed Design	Contractor(s)		✓			-
S 10.7	The relevant authorities will be notified of activities in the wind farm area during construction activities, including dates of any works. In addition, the Marine Department will be notified of the final location of the wind farm structures so that these can be updated on marine charts.	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	All vessels engaged in construction activities will be equipped with a Maritime VHF radio and an agreed frequency channel maintained. All vessels involved in the construction works will show the correct lights and shapes and ensure that all movements are promulgated through the Marine Department	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	Consider the use of Guard Ship during the construction phase, particularly in periods of high activity.	Marine Works / During Construction	Contractor(s)		✓			-

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 10.7	A safety / exclusion zone of 500 m from any area of construction works will be established for all non-Project vessels. The working area will be marked in accordance with Marine Department Notice No. 23 (2009).	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	Temporary lighting should be provided for incomplete structures during construction	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	The wind farm should be marked according to the requirements of the Marine Department. The precise marking arrangement will be agreed during the Detailed Design Phase.	Ward Farm / Detail Design	Designer	✓				
S 10.7	The markings of wind turbines will need to be maintained at all times and should failure occur, the Marine Department should be notified immediately and repairs undertaken as soon as possible.	Wind Farm / Operation	Operator				✓	-
6. Landscape and Visual								
S 11.6	All plant materials affected by the works relating to the submarine cable landing are to be replaced with new plantings to match the existing situation. All planting of trees and shrubs is to be carried out in accordance with the relevant best practice guidelines. Plant densities are to be provided in future Detailed Design documents and are to be selected so as to achieve a finished landscape that matches the surrounding, undisturbed, equivalent landscape types.	Land site / Pre-Construction (Detail Design)	Designer	✓				-
S 11.6	Established trees of value to be re-located where practically feasible.	Land site / Pre-Construction (Detail Design)	Contractor(s)		✓			

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 11.6	Site hoardings to be compatible with the surrounding environment. Where possible, site hoardings should be colored to complement the surrounding areas	Land site / During Construction	Contractor(s)	✓	✓			
S 11.6	Landscape resources affected by the onshore cable trench are to be reinstated to match existing conditions.	Land site / Post-Construction	Contractor(s)		✓			
S 11.7	The layout of the wind farm array shall be designed to reduce the number of turbines visible for the most sensitive viewpoints	Wind Farm/ Detail Design	Designer	✓				-
S 11.7	Appropriate colours for the wind turbines should be selected to reduce their visibility	Wind Farm/ Detail Design	Designer	✓				-
S 11.7	The blades for all turbines should rotate in the same direction to create a more harmonious visual pattern	Ward Farm / Detail Design / Operation	Designer / ET	✓	✓			-
7. Cultural Heritage								
S 12.8	To verify the avoidance of direct impact to the shipwreck identified during the geophysical survey, the Environmental Team and the Independent Environmental Checker will be required to monitor the installation of turbines and submarine cable during the construction stage.	Detail Design / Construction	ET/IEC	✓	✓			-

Annex 14B

Implementation Schedule for Construction and Operation of Wind Monitoring Mast

Table 14B.1: Implementation Schedule for Construction and Operation of Wind Monitoring Mast

EIA Ref.	Environmental Protection Measures	Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
1. Water Quality								
S 6.8 and EM&A Manual	The contractor(s) will ensure that the works cause no visible foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the area of marine works.	During Construction	Contractor(s)		✓			-
S 6.8	Control and monitoring systems will be used to alert the crew to leaks or any other potential risks.	During Construction	Contractor(s)		✓			-
S 6.8	All plant will be fully serviced and inspected before use to limit any potential discharges to the marine environment	During Construction	Contractor(s)		✓			-
S 6.8	Avoid spillage of oil, fuel and chemicals from structures by adopting appropriate good site practices	During Construction	Contractor(s)		✓			Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes
S 6.8	Any grout used would conform to the relevant environmental standards. In addition, the adoption of appropriate operational management by the contractor should lead to low potential for leakage during the pumping phase.	During Construction	Contractor(s)		✓			-
S 6.8	No debris shall be willingly discharged to sea. However, should debris be placed on the seabed, this will be removed (wherever practicable)	During Construction	Contractor(s)		✓			-

EIA Ref.	Environmental Protection Measures	Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
2. Waste Management								
S 7.6	The Contractor shall prepare and implement a Waste Management Plan which incorporates site-specific factors, such as the designation of areas for the segregation and temporary storage of reusable and recyclable materials.	Contract mobilisation / During Construction	Contractor(s)		✓			-
S 7.6	The Contractor shall ensure only licensed waste collectors are used to collect chemical waste for delivery to a licensed treatment facility	Contract mobilisation / During Construction	Contractor(s)		✓			Waste Disposal (Chemical Waste) (General) Regulation Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes
S 7.6	The Contractor shall apply for and obtain the appropriate licenses/permits for the disposal public fill and chemical waste.	Contract mobilisation / During Construction	Contractor(s)		✓			Waste Disposal (Chemical Waste) (General) Regulation Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes Waste Disposal (Charges for Disposal of Construction Waste) Regulation
S 7.6	EM&A of waste handling, storage, transportation, disposal procedures and documentation through the site audit programme shall be undertaken.	During Construction	ET		✓			-

EIA Ref.	Environmental Protection Measures	Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
3. Marine Ecology								
S 9.12.2	The vessel operators will be required to control and manage all effluent from vessels.	During Construction / Marine works	Contractor(s)		✓			-
S 9.12.2	A policy of no dumping of rubbish, food, oil, or chemicals will be strictly enforced. This will also be covered in the contractor briefings.	During Construction / Marine works	Contractor(s)		✓			-
S 9.12.3	Vessel operators working on the Project construction or operation will be given a briefing, alerting them to the possible presence of marine mammals in the area, and guidelines for safe vessel operations in the presence of cetaceans. If high speed vessels are used, they will be required to slow to 10 knots when passing through a high density dolphin area.	During Construction / Marine works	ET & Contractor(s)		✓			-
S 9.12.3	The vessel operators will be required to use predefined and regular routes, as these will become known to porpoise using these waters. This measure will further serve to minimise disturbance to marine mammals due to vessel movements	During Construction / Marine works	ET & Contractor(s)		✓			-
S 9.12.4	To reduce underwater sound levels associated with percussive piling, the following steps will be taken: - Quieter hydraulic hammers should be used instead of the noisier diesel hammers; - Acoustic decoupling of noisy equipment on work barges should be undertaken.	During Construction / Marine works	Contractor(s)		✓			-

EIA Ref.	Environmental Protection Measures	Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 9.12.4	Best practices are recommended to reduce the impacts to marine mammals: - Instigate 'ramping-up' of the piling hammer to provide an advance warning system to marine mammals in the vicinity; - Activities will be continuous without short-breaks and avoiding sudden random loud sound emissions	During Percussive Piling works for Foundation Construction	Contractor(s)		✓			-
S 9.12.4	An exclusion zone of 500 m radius will be scanned around the work area for at least 30 minutes prior to the start of percussive piling. If marine mammals/sea turtles are observed in the exclusion zone, piling will be delayed until they have left the area.	During Percussive Piling works for Foundation Construction	ET		✓			
S 9.15.1	Marine percussive piling works to be restricted to a daily maximum of 12 hours within daylight operations.	During Percussive Piling works for Foundation Construction	Contractor(s)		✓			
4. Fisheries								
S 10.7	The impacts to fisheries resources will be minimised by adopting the following measures: - The use of competent and experienced contractors and vessels operators; - Good planning of the installation sequence to avoid possible clashes; - Good promulgation of information relating to construction activities; - Thorough auditing of all vessels; - Observing good industry construction practices by the Contractors; and,	Marine Works / During Construction	Contractor(s)		✓			-

EIA Ref.	Environmental Protection Measures	Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 10.7	Inform fishermen of possible developments of the Project in advance	Marine Works / During Construction	Contractor(s) / Operator		✓			-
S 10.7	Using good engineering practice, including the use of appropriately sized piles (smaller piles generate lower levels of underwater sound) and piling equipment.	Marine Works / During Construction	Contractor(s)	✓	✓			-
S 10.7	Using ramp-up piling procedures. Blow frequency during this ramping up period should replicate the intensity that would be undertaken during full piling (e.g. one blow every two seconds) to provide cues for fish to localize the sound source. Pile blow energy should be ramped up gradually over the 'soft start' period.	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	The relevant authorities will be notified of activities in the wind monitoring mast area during construction activities, including dates of any works. In addition, the Marine Department will be notified of the final location of the wind monitoring mast structures so that these can be updated on marine charts.	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	All vessels engaged in construction activities will be equipped with a Maritime VHF radio and an agreed frequency channel maintained. All vessels involved in the construction works will show the correct lights and shapes and ensure that all movements are promulgated through the Marine Department	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	Consider the use of Guard Ship during the construction phase, particularly in periods of high activity.	Marine Works / During Construction	Contractor(s)		✓			-

EIA Ref.	Environmental Protection Measures	Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	Post-C	O	
S 10.7	A safety / exclusion zone of 500 m from any area of construction works will be established for all non-Project vessels. The working area will be marked in accordance with Marine Department Notice No. 23 (2009).	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	Temporary lighting should be provided for incomplete structures during construction	Marine Works / During Construction	Contractor(s)		✓			-
S 10.7	The wind monitoring mast should be marked according to the requirements of the Marine Department. The precise marking arrangement will be agreed during the Detailed Design Phase.	Detail Design	Designer	✓				
5. Landscape and Visual								
S 11.7	Appropriate colours for the wind monitoring mast should be selected to reduce their visibility	Detail Design	Designer	✓				-
6. Cultural Heritage								
S 12.8	No mitigation measures or EM&A is required for cultural heritage aspect of the Project.	-	-					-

CONTENTS

15 CONCLUSIONS

15.1 INTRODUCTION

This *Section* presents a summary of the key conclusions of this EIA associated with the construction and operation of the proposed offshore wind farm. The purpose of the assessment was to thoroughly evaluate the offshore wind farm and its components in terms of predicted impacts to key environmental sensitive receivers and to determine whether this option can meet the requirements of the *EIAO-TM*.

15.2 CONSIDERATION OF ALTERNATIVES

This EIA Study has examined a series of Alternatives as follows:

- Consideration of Alternative Site Locations (*Section 3*); and
- Consideration of Design Options and Construction Methods (*Section 4*);

15.2.1 *Consideration of Alternative Site Locations*

The assessment of siting alternatives has been undertaken in accordance with *Clause 3.3.1* of the Study Brief and the *EIAO-TM*. The preferred site for the wind farm has been identified through a detailed and technical evaluation following similar methodologies applied in previously accepted EIA reports under the *EIAO*. The method has employed detailed mapping and a review of both the natural and man-made environment and the associated environment constraints. Eight alternative sites have been reviewed through a comparative assessment of wide-ranging environmental concerns, such as Landscape and Visual, Heritage, Marine Recreation and Amenity, Seabed Sediments, Water Quality, Noise, Nature Conservation and Fisheries. Physical aspects have also been examined and the potential environmental benefits / disbenefits that result as a consequence of those aspects are also considered. Taking into consideration the range of environmental and physical factors described in the previous sections, the Southwest Lamma (Site 1) is preferred.

15.2.2 *Consideration of Different Layouts and Design Options*

An assessment of different design options and construction methods was conducted to investigate not only the environmental considerations of each option, but to include an examination of the engineering feasibility. Options ranged from alternative foundation design to siting of an offshore vs. onshore substation. Where appropriate, options were discounted on environmental grounds. However, in general, a worse case assessment approach has been taken forward to ensure a precautionary level of assessment and to allow flexibility for future design changes during the subsequent Detailed Design

Phase. The options have been considered consistently across all of the EIA chapters, which address the requirements of the Study Brief (*ESB-151/2006*) and *EIAO-TM*. The following provides a summary of alternative design options and construction methods that have been considered.

Design Options

Wind Farm Layout: The preliminary layout has considered the influence of site constraints and spacing requirements in order to avoid wake loss across the wind farm. A geometric design has been taken forward for the purpose of informing the assessment as this would help to reduce visual impacts and navigational risk. The preliminary layout will, however, potentially be subject to amendment during the Detailed Design Phase.

Wind Turbines: A range of turbines are available on the market with various dimensions for height and rotor diameter. Preliminary dimensions are not expected to exceed a tip height of +125mPD. In the event the wind turbine model with a maximum rotor diameter of 111m be adopted, the maximum tip height would be +136mPD. The turbines with greatest rotor diameter have been used for the assessment as part of a precautionary assessment of impacts. It is, however, possible that a smaller rotor diameter could be used for the size of turbines being considered as these are available on the market.

Foundation Design: Three types of wind turbine foundation design were considered. It was concluded that a piled foundation (monopile or tripod pile) provided the best environmental and engineering option. However, monopiles (with rock scour protection) are likely to occupy the larger seabed footprint and hence were taken forward to the EIA stage in order to produce a more conservative assessment of impacts.

Lighting and Marking: A number of options were considered and the preferred option was identified in accordance with the requirements of the Civil Aviation Department and Marine Department. The requirements for lighting and marking are not expected to give rise to unacceptable adverse environmental impacts.

Substation: A sub-station will be required to transform the voltage of the electricity generated at the wind turbine to a high voltage suitable for transmission of power ashore. A base case of an offshore substation has been taken forward for assessment; however, there may be an option for an onshore substation subject to detailed engineering design.

Monitoring Mast: A wind monitoring mast will be required to measure wind, wave and current information for operational purposes. The wind monitoring mast foundation is comprised of 8 nos. of 1.6m diameter steel tubular piles fixed into seabed in which each pile individually can be considered as a small monopile. The structure has an overall height of 80m AMSL and will consist of a steel lattice tower supported on a piled foundation. Anemometry equipment will be installed on the lattice tower and wave and current sensors installed on the seabed/foundation structure.

Construction Methods

Foundation Installation: Percussive piling techniques have been selected as the most appropriate method of installation due to their proven mitigation for environmental protection, no generation of wastes required for off-site disposal, a proven industry method and a significantly reduced installation schedule. The percussive piling method for foundations of wind turbines and the wind monitoring mast has been taken forward for assessment in this EIA Report.

Subsea Cable Installation: Grab dredging and jetting techniques have been identified as being the preferred method for cable installation. The area of grab dredging is, however, restricted to the nearshore area to the Lamma Power Station Extension to allow for cable landing preparation works. This restriction will assist in reducing the amount of sediment that needs dredging and subsequent offsite disposal. It is also deemed necessary to install cable protection as appropriate where the proposed cable for the wind farm development crosses existing telecommunication cables.

15.3 WATER QUALITY

The potential impacts to water quality caused by construction and operational activities of the offshore wind farm and its components have been assessed in *Section 6* of this *EIA Report*. The impacts have been identified and assessed to be in compliance with the criteria and guidelines stated in the *EIAO – TM Annexes 6* and *14* respectively.

Sensitive receivers potentially affected by construction and operational activities of the proposed wind farm development have been identified and the potential impacts have been evaluated. The key sensitive receivers include finless porpoise, green turtles, the Potential South Lamma Marine Park, commercial fisheries spawning habitat, fish culture zones, ecologically sensitive areas (horseshoe crab habitat and coral communities), beaches (gazetted and non – gazetted) and sea water intakes. The assessment has included the potential impacts caused by marine works (i.e. foundation construction, dredging and jetting) on water quality due to the increases of suspended sediments concentrations, potential decreases of dissolved oxygen and increases of nutrient concentrations, as well as those caused by operational activities such as the alteration of the hydrodynamic regime.

Computational models have been used to simulate the variation in suspended sediments concentration during the construction phase and the impacts due to change in currents resulting from the presence of marine structures during the operation phase.

Potential impacts arising from the proposed dredging works are predicted to be largely confined to the specific works area adjacent to the Lamma Power Station Extension. Modelling results indicate that the SS elevations as a result of grab dredging, jetting and foundation construction are expected to localised to the mixing zone and largely compliant with the WQO and tolerance criterion at the majority of sensitive receivers. The exception is for isolated colonies of low value coral communities at the Lamma Power Station Extension seawall where through the application of silt curtains during dredging works no unacceptable impacts would be expected to occur. The predicted elevations of suspended sediment concentrations during the construction phase are transient in nature and not predicted to cause significant adverse impacts to water quality at the sensitive receivers.

During the operation phase, unacceptable adverse impacts to water quality are not expected to occur. Hydrodynamic modelling has shown that the wind farm development will have negligible near-field and far-field impacts on current flow and direction as well as flushing capacity at key channels in Hong Kong. There will be little change to existing hydrodynamics, water quality and local erosion and sedimentation patterns.

Unacceptable impacts to water quality sensitive receivers have been further avoided through the adoption of mitigation measures including the siting of the proposed wind farm and submarine cable away from many water quality sensitive receivers, the selection of acceptable working rates for the marine works, construction operational mitigations (i.e. dredging operational measures) and appropriate on-site land based construction activities. No mitigation measures are required during the operational phase.

The identified potential concurrent projects that could lead to cumulative water quality impacts are the marine dumping activities at the South Cheung Chau uncontaminated mud disposal site. Modelling carried out for this Project showed that impacts of the wind farm and submarine cable construction activities are very localised and transient. Sediment does not disperse at appreciable concentrations beyond the works areas. A review of modelling of disposal activities at the South Cheung Chau Disposal Ground shows that sediment plumes would not reach the wind farm area and plumes would not overlap with those generated from the jetting works, should they coincide. It is therefore anticipated that the works proposed for this Project would not lead to potential for increasing the loading of sediments within the wider marine environment that is associated with the uncontaminated mud disposal ground. No significant cumulative impacts associated with water quality are therefore expected.

Water quality monitoring and auditing is recommended for the construction phase and the specific monitoring requirements are detailed in the *Environmental Monitoring and Audit Manual* (*EM&A Manual*) associated with this EIA Report. As no unacceptable impacts have been predicted to occur during the operation of the wind farm, monitoring of impacts to marine water quality during the operational phase is not considered necessary.

15.4 WASTE MANAGEMENT

The potential impacts to waste management caused by construction and operational activities of the offshore wind farm have been assessed in *Section 7* of this *EIA Report*. The impacts have been identified and assessed to be in compliance with the criteria and guidelines stated in the *EIAO – TM Annexes 7* and *15* respectively.

The key potential impacts during the construction phase are related to waste generated from dredging, seawall removal, site works at the laydown area and excavation/filling of onshore cable trenches. The storage, handling, collection, transport, disposal and/or re-utilisation of these materials and their associated environmental impacts have been the primary focus of the assessment.

It is estimated that a total of approximately 3,000 m^3 of marine sediment will be dredged. These sediments are considered to be uncontaminated and are suitable for Open Sea Disposal and this will be confirmed during the detailed engineering design phase. Up to 2,145 m^3 of existing seawall will be removed and reinstated as part of the works. All excavated material will be stored at the Laydown Area and reused to reinstate the seawall. As such, it is not anticipated that any waste will be generated.

Other wastes produced during the construction phase are of small quantity and will be disposed of according to their nature, avoiding potential adverse impacts. The potential environmental impacts associated with the storage, handling, collection, transport and disposal of waste produced during operational activities have been estimated to be insignificant and will therefore meet the criteria specified in the *EIAO-TM*.

Unacceptable impacts as a result of the waste produced during the construction phase have been avoided through the adoption of specific mitigation measures and in particular through the establishment and implementation of a Waste Management Plan (WMP).

In order to ensure that the construction Contractor(s) has implemented the recommendations of the EIA Report, regular site audits will be conducted of the waste streams, to determine if wastes are being managed in accordance with the approved procedures and the site WMP.

15.5 TERRESTRIAL ECOLOGY

The proposed wind farm was studied in detail through a site selection study in order to select a site that avoided to the extent practical, adverse impacts to important habitats for birds particularly migratory birds or bird species of high ecological value.

A total of 14 identified species were recorded in the Project Site including Aleutian Tern, Ancient Murrelet, Barn Swallow, Black Kite, Black-headed

Gull, Black-naped Tern, Black-tailed Gull, Bridled Tern, Common Tern, Heuglin's Gull, Little Tern, Red-necked Phalarope, Whiskered Tern and White-winged Tern, two of which were considered bird species of conservation interest (Black Kite and Ancient Murrelet). In addition, in the wider Study Area a further three bird species of conservation interest were recorded, including White-bellied Sea Eagle, Common Buzzard and Pacific Reef Egret. Most of the birds that are of conservation interest are common and widespread in Hong Kong with the exception of Pacific Reef Egret (uncommon but widespread resident), White-bellied Sea Eagle (uncommon resident) and Ancient Murrelet (scarce winter visitor). The assessment revealed that the Project Site did not provide an important foraging ground for birds.

Potential construction phase impacts to birds may arise from the permanent loss of habitats due to the construction of wind turbine foundation, substation and monitoring mast; temporary disturbance and displacement of birds. The relatively small scale loss of approximately 0.16 ha of open waters within the Project Site is not expected to be significant for bird/migratory bird populations in view of similar habitats in the vicinity and the limited bird use in the area. The direct ecological impact due to the construction of the wind turbine is expected to be low, and will not contribute to any potential cumulative impact.

Barrier effect to bird movement and bird collisions during the operation of the wind farm were assessed. Aleutian Tern, Ancient Murrelet, Barn Swallow, Black Kite, Black-headed Gull, Black-naped Tern, Black-tailed Gull, Bridled Tern, Common Tern, Heuglin's Gull, Little Tern, Red-necked Phalarope, Whiskered Tern and White-winged Tern have utilised the Project Site and therefore are the species that may be affected by the operation of the wind farm. However, these species were recorded in relatively low numbers and most of them were flying over the area. Since the wind farm is not located within important bird habitat or on the flight path of migratory birds, the potential risk of bird collision will be low. In addition, collision risk assessment using the worse case scenario also predicted low number of bird collision. Overall, no adverse residual impacts are envisaged.

A bird monitoring programme will be undertaken to confirm that the construction and operation of the wind turbines will not cause adverse impacts to birds. Monitoring for bird abundance and distribution will be undertaken for one year during the pre-construction phase, one year during the construction phase for the wind turbines and the first year of the operation of the turbines.

15.6 *MARINE ECOLOGY*

The proposed offshore wind farm development and cable route area was studied in detail through a site selection study in order to select a preferred site that avoided to the extent practical, adverse impacts to habitats or species of high ecological value.

Potential construction phase impacts to marine ecological resources, as well as impacts to marine mammals and sea turtles, may arise from the permanent loss of habitat in the footprint of marine structures, disturbances to benthic habitats as a result of jetting and dredging and impacts on intertidal and subtidal habitats during seawall removal.

As impacts arising from the proposed dredging works are predicted to be largely confined to the specific works areas and the predicted elevations of suspended sediment due to the Project are not predicted to cause exceedances of the water quality objectives outside of the mixing zones, adverse impacts to water quality, and hence marine ecological resources or marine mammals and green turtles, are not anticipated.

Although the loss of 0.16 ha of water column habitat would be an inevitable and adverse consequence of the project, the residual impact is assessed to be acceptable after taking into consideration a number of factors, including the sizable ranges and mobility of affected animals and the fact that the habitat that would be lost is not be considered to be a critical habitat for marine mammal or sea turtles. The area is also subject to considerable disturbance by heavy marine traffic and trawling by fishing vessels.

The loss of 3.6 ha of soft bottom seabed habitat would also be an inevitable and adverse consequence of the project. However, this habitat is considered to be of low conservation value and is not significant in context to the amount of similar habitat available elsewhere in Hong Kong. In addition, the disturbance of approximately 0.99 ha of soft bottom habitat from dredging activities is considered to be of minor significance. A pre-construction dive survey will be undertaken at the sites where isolated corals were identified along the cable route to confirm their existence. Should these corals be found present, mitigation will be applied, such as potential relocation away from the proposed area of works

The removal of low ecological value artificial rocky shore as a result of seawall removal activities for cable landing (see *Section 5*) will not lead to unacceptable impacts for subtidal or intertidal ecology. The reinstatement of the seawall with materials that have been removed will mean that there will be no long term change in the amount of available artificial intertidal and subtidal hard bottom habitat.

Percussive piling has the potential to cause impacts to marine mammals, and to a lesser extent, sea turtles through underwater sound generation. Impacts to noise sensitive species from percussive piling operations associated with wind turbine installations in offshore waters has been shown to be significantly reduced by avoidance of works during peak seasons of finless porpoise, adopting soft-starts procedures and strictly controlled exclusion zones. Through the adoption of such mitigation for the proposed wind farm, i.e. marine mammal / sea turtle exclusion zones, adoption of closed periods for piling works during peak marine mammal season and noting that the wind farm site is away from Sham Wan and not a preferred habitat for sea turtles, no unacceptable impacts on these species are expected to occur.

Operational phase adverse impacts to marine ecological resources are not expected to occur. In particular, unacceptable impacts to marine mammals and sea turtles from the generation of underwater sound levels are not predicted to be of concern. In addition, the wind farm structures, and in particular rock scour material may have the potential to create an artificial reef, which could have beneficial impacts related to food supply for marine mammals.

No unacceptable residual impacts are predicted to marine ecological resources.

During the construction phase of wind turbines, pre-, during and post-installation monitoring of marine mammal abundance, behaviour and distribution, including vessel-based surveys, passive acoustic monitoring and land-based theodolite tracking, will be undertaken. Periodic re-assessment of mitigation measures for marine mammals and their effectiveness will also be undertaken during these periods.

15.7 FISHERIES

The potential impacts to commercial fisheries caused by construction and operational activities of the proposed offshore wind farm and its components have been assessed in *Section 10* of this *EIA Report*. The impacts have been identified and assessed to be in compliance with the criteria and guidelines stated in the *EIAO – TM Annexes 9* and *17* respectively.

Fisheries sensitive receivers have been identified and the potential impacts arising from the construction and operation phases of the offshore wind farm and its components have been evaluated. Potential impacts to fisheries resources and fishing operations may arise from the short term disturbance of marine habitat due to foundation construction, dredging and jetting or through changes to key water quality parameters, as a result of marine works, underwater sound generation, and restriction of fishing activity in proximity to the marine working areas. Water quality impacts arising from the proposed dredging, jetting and foundation construction works are predicted to be largely confined to the specific works areas and to be temporary in nature. The predicted elevations of suspended sediment concentrations due to the Project are not predicted to exceed the assessment criteria over large areas or at sensitive receivers and they are not expected to cause significant adverse impacts to water quality or to any fishing grounds or species of importance to the fishery. Restriction of access for fishing during construction consists of a small area (500 m from works) and should not significantly affect fisheries in the area in the context of similar or better fishing areas elsewhere. In additional, increase vessel traffic is small scale and should not pose a significant risk to fishing vessels, particularly given the high levels of marine traffic that currently exist in the area that fishing vessels contend with on a daily basis.

During the operation of the wind farm a total of 700 ha of habitat will be lost to fisheries operations within and adjacent to the turbine array. This represents 0.42% of Hong Kong's territorial waters. No unacceptable impacts associated with the loss of fisheries habitat and fishing ground during construction and operation of the wind farm is expected to be anticipated.

Underwater sound generation from marine construction and operation works is not expected to have a significant impact on fisheries resources.

No fisheries-specific mitigation measures are required during the construction or operation activities.

The water quality monitoring programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the Project. As impacts to the fisheries resources and fishing operations are small and of short duration, the development and implementation of a monitoring and audit programme specifically designed to assess the effects on commercial fisheries resources is not deemed necessary. In addition, the adoption of appropriate mitigation measures to manage navigational risks will also mean that the risk to fishing vessels would be low.

A Fisheries Review and Consultation Programme will also be implemented prior to the commencement of construction of the wind turbines. The general intention of the FRCP will be to outline, in consultation with the fishery sector, whether there is scope for fishing operations to be conducted within the development area. The FCRP will also aim to explore the possibilities of additional measures/projects to be undertaken within the development area for the enhancement of fisheries resources. If deemed acceptable, a Fisheries Enhancement Plan (FNP) will be developed for the wind farm area.

15.8 LANDSCAPE AND VISUAL IMPACT

A Landscape and Visual Impact Assessment has been undertaken for the South West Lamma site. The landscape impacts where identified and some mitigation measures proposed. The residual landscape impacts are:

1. There will be *negligible* residual construction impacts on LCAs 2 Inshore Waters Landscape and LCA 4 Coastal Upland and Hillside Landscape.

2. There will be *slight* residual construction impacts LCA 3 Industrial Urban Landscape. Approximately 2.78 ha of this LCA will be affected during

construction, however this area will be fully mitigated with the adoption of the mitigation measures proposed.

3. There will be *moderate* adverse residual construction impacts on LCA1 Offshore Waters Landscape. Approximately 700 ha of this LCA will be lost and can not be mitigated.

4. There will be *negligible* residual operational impacts on LCAs 2 Inshore Waters Landscape, 3 Industrial Urban Landscape and 4 Coastal Upland and Hillside Landscape. There will be *slight* adverse residual operational impacts on LCA1 Offshore Waters Landscape.

5. There will be *negligible* residual construction and operation impacts on the following LRs:

   - LR 2 Man made rocky sea-wall. Approximately 0.001 ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed.

   - LR 3 Industrial Area. Approximately 0.02 ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed.

   - LR 4 Soft Landscape areas. Approximately 0.001 ha of this LR will be lost during construction; however this will be fully mitigated with the adoption of the mitigation measures proposed.

   - LR 5 Mixed Shrubland. There will be no impacts on this LR.

   - LR 6 Pond. There will be no impacts on this LR.

6. There will be slight residual construction and operation impacts on LR1 Seascape as 0.16ha will be lost and can not be mitigated.

A Visual Impact Assessment was undertaken with several conservative assumptions:

1. Whilst the review of Hong Kong's climatic conditions shows that they will reduce the visibility of the wind farm, clear visibility has been assumed;

2. Based on the analysis of the parameters of human vision, the more conservative limit of view of 15.5 km has been adopted, and;

3. Intervening vegetation and buildings have not been considered during the identification of VSRs.

Nineteen VSRs were identified and assessed based on their sensitivity and magnitude of change. Whilst visual mitigation of the wind turbine structures is difficult, four VMM's were proposed, however the ability of these mitigation in reducing the significance threshold of the impacts is limited. The residual impacts identified were as follows:

1. There will be *negligible* residual visual impacts from VSR3 Lamma Ferry Pier, VSR 14 Stanley Waterfront and VSR 15 Wong Nai Chung Gap and Violet Hill.

2. There will be slight residual visual impacts from VSR1 Lamma Island (Hung Shing Ye beach), VSR2 Lo So Shing Beach, VSR4 Ferry to Cheung Chau, VSR 5 Cheung Chau, VSR6 Discovery Bay, VSR 8 Chi Ma Wan Peninsula, VSR 9 Cheung Sha, VSR 10 Lantau Trail, VSR 12 Queen Mary Hospital and Mount Davis, VSR 13 Pok Fu Lam - Pauline Chan Building at HKU, VSR16 Ocean Park, and VSR 18 Penny's Bay.

3. Moderate residual visual impacts have been identified at VSR7 Silvermine Bay (Mui Wo), VSR11 The Peak, VSR 17 Mt Stenhouse and VSR 19 East Lamma Channel.

Four Visual Mitigation Measures are proposed that will reduce the severity of these visual impacts.

According to *Annex 10* of the *Technical Memorandum on the Environmental Impact Assessment Process* (EIAO-TM) the Landscape and Visual Impacts are considered *acceptable with mitigation*.

15.9 CULTURAL HERITAGE

The potential impacts to cultural heritage caused by construction and operational activities of the proposed offshore wind farm and its components have been assessed in *Section 12* of this *EIA Report*. The impacts have been identified and assessed to be in compliance with the criteria and guidelines stated in the *EIAO – TM Annexes 10* and *19* respectively. The assessment has included a terrestrial and marine archaeological investigation as well as a built heritage investigation.

No declared monuments, graded historic buildings, government historic sites and archaeological sites listed by *AMO* have been identified within or adjacent to the proposed works. One potential marine archaeological site (SC007/57262) was identified from a review of geophysical data. This site, potentially a shipwreck, is located outside of any area of works and will not be directly or indirectly affected by construction or operation of the wind farm. The avoidance of direct impacts to the shipwreck identified during the geophysical survey will be verified by the Environmental Team and the Independent Environmental Checker through review of the final design prior to the installation of turbines and submarine cable. Designs will be checked to ensure that no works will occur within 50 m of the shipwreck.

No marine archaeological sites will be affected by works, and therefore, the proposed development imposes no marine archaeological impact and no mitigation measures are considered necessary.

15.10 *STAKEHOLDER ENGAGEMENT*

HK Electric has conducted consultations and engagement with project stakeholders to hear their views on the project plan while at the same time, addressing their concerns. These stakeholders include representatives from fishermen groups, green groups, District Councillors, Rural Committees Members, government advisory committee Members, various Government Departments, learned institutions, industry practitioners and members of the public. The feedback from these consultations has been considered in the preparation of this EIA Study Report.

15.11 *ENVIRONMENTAL MONITORING AND AUDIT (EM&A)*

The construction and operation of the proposed offshore wind farm development has been demonstrated in this EIA Report to comply with the *EIAO-TM* requirements. Actual impacts during the works will be monitored through a detailed Environmental Monitoring and Audit (EM&A) programme. Full details of the EM&A programme are presented in the *EM&A Manual* attached to this EIA Report. This programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the construction and operation of the proposed offshore wind farm development.

15.12 *ENVIRONMENTAL OUTCOME*

No unacceptable residual impacts have been predicted for the construction and operation of the offshore wind farm or its associated facilities. It must be noted that for all of the components assessed in the *EIA Report*, the assessments and the residual impacts have been shown to be acceptable and in compliance with the relevant assessment standards/criteria of the *EIAO-TM* and its associated *Annexes*.

15.13 *ENVIRONMENTALLY RESPONSIBLE DESIGNS*

The EIA Study has facilitated the integration of environmental considerations into the design process for the Project. One of the key environmental outcomes has been the ability to plan, design and ultimately construct the offshore wind farm so that direct impacts to sensitive receivers are avoided, as far as practically possible. A detailed assessment of alternative sites within the Study Area has been conducted as well as an assessment of the site layouts and construction methods (See *Section 15.2*).

15.14 *Environmental Benefits of the Project*

Implementation of the Project will make a contribution to managing emissions of air pollutants and climate change and will provide diversity of fuel supply. The purpose of the proposed project is to utilize wind as source of renewable energy for power generation to supplement fossil fuels, and to make contributions to the improvement of the air quality in Hong Kong.

The operation of the proposed 100MW offshore wind farm with an estimated annual generation of 175GWh electricity would offset approximately:

- Annual use of 62,000T of coal
- Annual emission of 150,000T of carbon dioxide
- Annual emission of 520T of sulphur dioxide
- Annual emission of 240T of nitrogen oxide

The electricity generation from the proposed wind farm would be adequate to meet the consumption for 50,000 families in Hong Kong and is roughly around 1.6% of HK Electric's total electricity sent out in 2008. This is in support of HKSAR Government policy of generating 1 - 2% of electricity output using renewable energy by 2012.