1). Supplementary information on the predicted noise level and noise impacts, both airborne and underwater, on sensitive receivers arising from the use of percussive piling for the construction of wind farm structures of 5 to 7m in diameter.

As discussed in the EIA Report (*Section 5*), the components for the wind farm will not be procured until the Detailed Design Phase, which will commence once the EIA has been approved. However, based on early discussions with wind turbine manufacturers, monopiles for 2.3 to 3.6MW class wind turbines may have diameters of 5 to 7 m. Such dimensions have hence been taken forward for assessment.

In the case of the potential for airborne and underwater sound generated from the project, due to the differing media and unit of measurement, further information on the assessment of potential impacts related to these sounds are discussed separately below.

Airborne Sound

The potential effects from the airborne noise generated by percussive piling works for the installation of wind turbine foundations are considered in accordance with the *Technical Memorandum on Noise from Percussive Piling* (PP-TM) issued under the *Noise Control Ordinance* (NCO) for the nearest Noise Sensitive Receivers (NSRs) at Lo So Shing on Lamma Island and Seascape Peninsula on Cheung Chau. For the calculation of noise levels at the two NSRs, it is assumed that a double-acting hydraulic hammer, which is the type of percussive piling method with the highest sound power level (SWL) listed under *Table 2* of the PP-TM, will be used to drive the steel pile (noisier percussive piling methods involving the use of diesel or steam hammers will not be adopted for the foundation works) and only one pile will be driven at any one time.

Based on the above, the percussive piling noise levels at Lo So Shing and Seascape Peninsula are predicted to be 41 dB(A) and 50 dB(A), respectively, which are substantially lower than the Acceptable Noise Level (ANL) of 85 dB(A) published in the PP-TM for the corresponding type of NSRs (ie NSRs with windows or other openings but without central air conditioning system. The detailed noise calculations are provided in *Attachment 1* of this document.

Notwithstanding the fact that the percussive piling noise levels predicted at the nearest NSRs are substantially lower than the ANL in the PP-TM, rigorous procedures are in place and enforced by the EPD under the NCO to control percussive piling activities for any construction projects in Hong Kong such that the general public will not be unduly affected. Under the current control regime, a Construction Noise Permit (CNP) will need to be obtained from the EPD for any percussive piling works to be undertaken for the Project. The CNP to be issued by EPD will include the permitted hours of piling operation as a condition, and may include such other conditions as the Authority

considers appropriate, such as the permissible piling methods and pile types which may be used, the area within which percussive piling may take place, and any special noise control measures that must be adopted.

Judging from the predicted airborne noise levels, no adverse noise impact is anticipated from the percussive piling activities for the Project. In addition, stringent statutory controls that are already in place will provide further assurance that noise nuisance will not arise from the percussive piling for the Project.

Underwater Sound

The assessment of underwater sound impacts to noise sensitive receivers through percussive piling works are presented in *Section 9.7.1* of the EIA Report. Specifically those sections relate to underwater sound impacts to the following noise sensitive receivers: sea turtles, specifically the Green Turtle (*Chelonia mydas*), and marine mammals, specifically the Finless Porpoise (*Neophocaena phocaenoides*). These are discussed in turn below.

Impacts to Sea Turtles

As stated in the EIA Report (*Section 9.10.1*), 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. The Southwest Lamma wind farm site is located some distance from the shore and recorded nesting site at Sham Wan (>5km as the crow flies), 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.

It is considered that the soft-start/ramp-up procedures to be employed during percussive piling works would allow sea turtles sufficient time to avoid close proximity to construction works. In addition, the exclusion zone that will be adopted for marine mammals will also be enforced for sea turtles, hence the 500m area will be confirmed to be clear of sea turtle prior to piling operations and piling will cease should sea turtles enter this area during piling activities. With the adoption of these mitigation measures, impacts on sea turtles from underwater sound through piling works are expected to be of negligible significance.

Impacts to Finless Porpoise

It is noted within the EIA Report that recent studies undertaken by the UK Government's body on Wind Farm Research (COWRIE - Collaborative Offshore Wind Research Into The Environment) have 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 µPa at 1 metre, having an average value of 250 dB re 1 µPa at 1 metre. Whilst it is acknowledged that the dimensions of the monopiles used in these wind farms range from 4m to 4.7m, and hence are likely to be smaller in diameter than those proposed for the wind farm at Southwest Lamma (5m to 7m), it is also acknowledged that the seabed in which the UK wind farm piles were driven into consistently composed of compacted sand in shallow water environments (2.5 m to 4 m water depth). According to the pile driving records at the Kentish Flats wind farm in UK, more than 3,000 blows were required to drive the pile to the required level. Compared to the Kentish Flats wind farm in UK, the ground conditions encountered for the proposed offshore wind farm are expected to be much softer and the soft materials are much thicker (the seabed at Southwest Lamma is typically made up of soft mud and silt with a soft alluvium layer down to depths of > 20m). Therefore, the hammer that will be selected for pile driving at the project site can be at least 20 percent less powerful than those used in the UK wind farm projects. In course of piling, ramping-up procedure will be adopted; as such pile driving will be started off with hammer at a low rated energy (about 30% of the full power) for the first 20 m to 30 m of an estimated total of pile travel of about 80 m. The pile driving duration and noise level that can be generated by a less powerful hammer shall be greatly reduced accordingly. In addition, according to the nature of foundation in need for the proposed wind farm, no final set is required for the pile driving. The designed pile is required to be driven to a designed length. No prolong driving for final set is expected. Noting that lower drive power will result in lower source levels and hence sound propagation, it is considered reasonable to assume that both source levels and sound levels at distances generated from percussive piling activities at the Southwest Lamma wind farm would be comparable to those measured from the UK regardless of the larger pile diameter.

In terms of the assessment of potential impacts to noise sensitive receivers from underwater sound generated from percussive piling activities, it is important to acknowledge that the measurement of sound must be evaluated for significance. In biological terms this is evaluated in terms of what effects a sound may have and the range in which effects may occur. Such a definition is important as it thus considers the ability for an animal, such as a porpoise, to perceive a sound rather than simply assess the absolute sound. On this basis the review provided by the UK Government uses the metric dB_{ht}, which is a frequency weighting level of sound relative to hearing threshold ($_{ht}$) of individual species.

It is important to note that the dB_{ht} metric is not a unit that can be measured in the field, but rather sounds that are recorded are passed through filters that

(1) R Nedwell J R , Parvin S J, Edwards B, Workman R , Brooker A G and Kynoch J E (2007) 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.

mimic the hearing ability of a particular species and as such the level of sound measured after the filter is termed dB_{ht} (*Species*) depending on the species it has mimicked. As both the Finless Porpoise (*Neophocaena phocaenoides*) and Harbour Porpoise (*Phocoena phocoena*) typically use high-frequency, narrowband clicks and are ultrasonic specialists with similar hearing capablities [1], the dB_{ht} (*Phocoena phocoena*) levels presented in the UK Government Study are appropriate for use for the Finless Porpoise in Hong Kong.

Of the measurements of underwater sound taken during percussive piling operations at the UK wind farms, it is considered that those recorded for the Barrow wind farm may be the most conservative for current assessment purposes. The reason for this is that these levels are typically higher than those recorded for other wind farms due to a larger pile diameter (4.7m) and deeper water.

On the basis of the various measurements at the Barrow wind farm, the UK Government report states that the area where a mobile Harbour Porpoise may experience an unacceptable noise dose, i.e. where injury may occur (stated as the $130dB_{ht}$ (*Phocoena phocoena*) sound level), has been calculated to be 84 m from a pile with a Peak-to-Peak Source level of 252dB re 1 µPa @ 1m. In terms of mitigation and management, therefore, it is commonly recommended that this area be clear of all porpoises during piling works, i.e. act as the exclusion zone. Outside of this area porpoises were expected to show short term behavioural responses to the sounds, such as temporarily moving out of an area while the noise source is present.

Based on an understanding of the above, mitigation and management measures to prevent unacceptable impacts to Finless Porpoises from occurring during percussive piling works for the Southwest Lamma site have been developed. These measures have been prepared with the input of Hong Kong's leading marine mammal expert, Dr Samuel Hung, have been based on marine mammal survey data gathered during the EIA work as well as the long term dataset held by the AFCD which covers the last 14 years and draw reference to measures that have been successfully implemented in Hong Kong in the past.

In the first instance, HK Electric has committed to limiting piling activities to a period outside of the peak, and hence biologically significant season, for the finless porpoise in the development area and around southern Lamma. Noting the historical data and upon recommendations by the AFCD, this period has thus been taken as an avoidance of piling works between December through May each year. As such, through committing to only undertake works during a period that is not considered to be the peak season for Finless Porpoises, any porpoises that are present and decide to move away

(1) Goold JC & Jefferson TA. 2002. Acoustic signals from free-ranging finless porpoises (*Neophocaena phocaenoides*) in waters around Hong Kong. The Raffles Bulletin of Zoology Supplement 10:131-139

from piling activities will not be adversely affected as this is not considered to be a biologically significant period. Furthermore, studies in Hong Kong have shown that marine mammals returning to areas of percussive piling activities following cessation of works, suggesting that disturbance impacts are transient and only present during the construction phase [1].

Although unlikely, it is acknowledged that isolated finless porpoises may be present during piling works outside of the biologically significant season and as such, additional mitigation will be applied to ensure adverse impacts do not occur should individuals be present. In this second instance, HK Electric has committed to employing an Exclusion Zone around all piling activities and employing soft-start procedures to promote avoidance of the area by marine mammals when sounds levels are not injurious. Based on such zones successfully employed in Hong Kong previously around percussive piling activities, this area has taken to be a 500m radius from the pile. This area is considerably larger than that where mobile porpoises were predicted from the UK wind farm experience to have the potential to experience an unacceptable noise dose (84 m). This is thus considered to be both conservative and in line with previously accepted practices in Hong Kong which have shown no change in marine mammal abundance from before or after piling operations through enforcement of such an exclusion zone [2].

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 (with a degree in biological sciences, prior experience and approved by the Independent Environmental Checker) 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.

Finally, it is acknowledged that the calculated distances where Finless Porpoises may experience an unacceptable noise dose or demonstrate a temporary behavioural response have been based on field measurements taken for a wind farm in the UK with piles of a smaller diameter than that proposed for the Southwest Lamma wind farm. However, it is considered fair to assume that so long as underwater sounds do not exceed those measured for the UK wind farms (i.e. Peak-to-Peak Source level of 252dB re 1 µPa @ 1m from the pile), no additional concerns should be present for the percussive piling activities being undertaken for the proposed project. On

(1) 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.

(2) ACE-EIA Sub-Committee Paper (2005) Permanent Aviation Fuel Facility - Selection of a Bubble Jacket to Attenuate Noise from Underwater Percussive Piling.

that basis, HK Electric are committed to undertaking underwater sound measurements as part of the piling activities for the Southwest Lamma wind farm as part of the Environmental Monitoring and Audit (EM&A) Programme.

These measurements will be undertaken as follows:

- Underwater sound measurements will be taken during the installation of the first pile for the wind turbines to be installed for the proposed wind farm;

- Measurements shall be undertaken at 250m, 500m and 1,000m from the piling work, using calibrated hydrophones with calibrated precision amplifiers, analog to digital converters and a high speed data-logging system (with frequency response approximately flat from 100Hz to 50kHz). In view that the surface and bottom depth may be affected by potential surface or bottom reflection, the sound measurements shall be measured at a mid depth (or a minimum of 10m);

- Measurements will record ambient noise level for one hour prior to any pile driving activities, for a minimum period of 30 pile driving blows and for a period of one hour after piling ceases;

- Piling activities must represent those for installation of all piles, such that the equipment to be used during the first pile should match closely to the equipment to be used during the remainder of construction piling; and,

- Measurements should be taken at a sampling rate of 100 kHz. Both broadband and one octave bandwidth from 10Hz to 100kHz shall be measured.

The results of the underwater sound measurements will be provided to the EM&A Programme Independent Environmental Checker (IEC) and the Environmental Protection Department (EPD) to demonstrate that the piling activities do not exceed a Peak-to-Peak Source level of 252dB re 1 µPa @ 1m from the pile.

Through the above measures, no significant adverse impacts are expected to occur to finless porpoises. These can be summarised below:

- No percussive piling activities will occur during the peak season for marine mammals in the development area;

- Marine mammals are not expected to be present in significant numbers during the piling period and hence although individuals may be present and may perceive underwater sound and demonstrate a temporary behavioural response, these waters would not be considered to be biologically significant for this species during the piling period;

- Marine mammal observers will enforce an exclusion zone to ensure the area of water where should a finless porpoise be present it may experience an unacceptable noise dose is completely clear of all finless porpoise before piling can commence;

- Soft starts of all piling activities will act as a further deterrent for finless porpoises thereby allowing these mobile animals to leave the area;

- All piling works will cease should a finless porpoise enter the exclusion zone during piling operations to further prevent any potential for adverse impacts;

- Underwater sound measurements will be undertaken during piling of the first wind turbine foundation to verify that underwater sounds follow those recorded in UK wind farms which have been used to support the design of the mitigation measures;

- Long term monitoring of marine mammals use of the waters will be collected to provide greater understanding of the use of the waters by finless porpoise in Hong Kong and identify any longer term changes.

Impacts on Fisheries Resources

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 will 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, will include, for example, soft-start or ramp-up approaches for piling activity (slowly increasing the energy of the emitted sound) (see *Section 10.7* of the EIA report).

Calculation of airborne noise and underwater noise

We wish to clarify that the data quotes for underwater noise is a sound pressure level but the data used as the noise source term for the calculation of airborne noise impact from the percussive piling is a sound power level.

Sound pressure levels are commonly expressed in decibels (dB). A sound pressure level in decibels expresses a ration between the measured pressure and a reference pressure. Owing to the differences in the behaviour of sound waves in air and in water, the reference pressure values used for the derivation of sound pressure level in decibels for the two media are different. A reference pressure level of 20μPa at 1 metre is typically used for sound in air, which is selected to match typical human hearing sensitivity. A different reference pressure level of 1μPa at 1 metre, on the other hand, is typically

adopted for sound in water. Because of the difference the reference pressure values, sound pressure levels in air do not equal to those in water (for the same sound source, the value of the former is much lower than that of the latter).

Another important factor relates to the fact that the value of 250dB (re 1µPa at 1 metre) is an unweighted sound pressure level. For describing sound in air, A-weighting is applied to sound pressure levels. The A-weighting corresponds to the human hearing response and puts an emphasis of frequencies in the approximate range of 3 to 6 kHz for which the human ear is most sensitive. Compared with an unweighted sounds pressure level, an A-weighted value would have incorporated substantial attenuations for the very low and high frequencies, thereby reflected as a lower value.

For the calculations of percussive piling noise impacts, the sound power level referenced is published in the PP-TM for typical land-based construction in Hong Kong. The offshore percussive piles for this Project will be driven through much softer materials than those commonly encountered on land, and therefore is it anticipated that the energy required in driving the piles, hence the sounds power levels generated will only be less than or equal to that indicated (ie 129 dB SWL [1]).

(2) Supplementary information on a more detailed construction programme for the detailed design and construction phases.

Further to the indicative schedule for the construction of the offshore wind farm at Southwest Lamma presented in the EIA Report (see Section 5.7) a more detailed schedule is presented in *Figure 1* below. Within this programme the activities associated with the percussive piling works, as well as those period committed to be closed for piling works are presented.

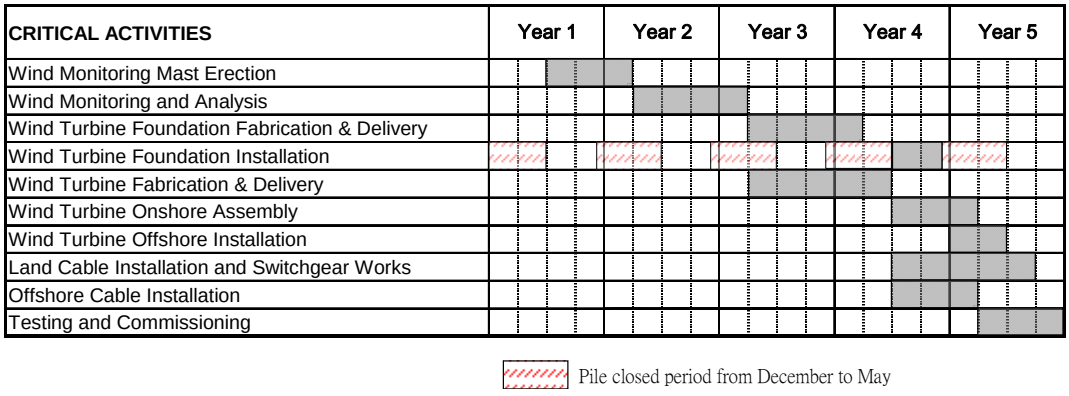

Figure 1 Preliminary Schedule for Design and Construction Works for the Southwest Lamma Wind Farm

[1] The sound power level of 129dB adopted for the percussive piling calculations corresponds to a sound pressure level of 121 dB(A), re 20µPa at 1 metre.

(3) Further explanation of the cumulative impacts of the Project and other projects including (a) projects near Lamma Island in foreseeable future; and (b) the Black Point Gas Supply Project and the Hong Kong-Zhuhai-Macao Bridge Project.

Response to (a)

In accordance with the *EIA Study Brief (No. ESB-151/2006)* and the *Technical Memorandum of the Environmental Impact Assessment Process (EIAO-TM),* cumulative impacts of the project and any other projects near Lamma Island in the foreseeable future have been examined within the EIA Report.

Information from publicly available sources indicates 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 (currently not in use), 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 Waters, which is at least 30 km from the wind farm site.

Of the above projects, only marine dumping activities at the South Cheung Chau uncontaminated mud disposal site are activities that may occur near Lamma Island in the foreseeable future. Potential issues related to these concurrent activities are cumulative impacts to water quality and subsequently marine ecology.

Results of water quality modelling undertaken as part of the EIA Study showed that sediment plumes from the construction of wind farm were limited to within 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 the wet or dry seasons. Since the water quality mixing zone of

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

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.

The findings of the assessment thus predict that no unacceptable cumulative impacts to water quality and marine ecology due to the proposed wind farm and other developments near Lamma Island will occur. No cumulative waste management impacts, terrestrial ecological impacts, landscape and visual impacts or cultural heritage impacts are expected.

Response to (b)

The Environmental Impact Assessments presented for the Black Point Gas Supply Project (BPGSP) and the Hong Kong-Zhuhai-Macao Bridge Project (HKZMBP) have been reviewed to determine the potential for combined effects on the environment. It is noted that within these marine based projects, the potential for impacts which may be considered to have the highest potential in causing cumulative concerns would be impacts related to changes in water quality through dredging or other seabed activities or combined effects on marine mammals that use Hong Kong waters.

With regard to water quality, from the publicly available EIAs, it is noted that the maximum horizontal spread of any sediment releases related to the BPGSP would be about 3km. Similarly, that predicted for the HKZMBP would be about 8km. As the project sites for each project are about30km and about 18km, respectively, from the proposed development area and cable installation works for the HK Electric wind farm, no cumulative concerns with regard to water quality are expected. Furthermore, it is noted that as each Project will implement a dedicated water quality monitoring programme examining potential exceedances above Action Limit Levels for water quality, any adverse changes in water quality will be tracked and appropriate actions taken in consultation with the Environmental Protection Department.

With regard to 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*). Distribution of Indo-Pacific humpback dolphins is limited to the western waters of Hong Kong [1] [2], which are influenced by freshwater input from the Pearl River, whereas, 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

(1) 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

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

strandings) [1]. Based on their habitat range, potential impacts to the Indo-Pacific humpback dolphin have been considered a concern for the BPGSP and HKZMBP and are addressed within their respective EIA Reports. In contrast, the Finless Porpoise is considered to be the key marine mammal which periodically may be found within or within close proximity to the wind farm development area and hence potential impacts to this species is addressed within the HK Electric Offshore Wind Farm EIA Report. As the habitats of these two marine mammal species within Hong Kong waters do not significantly overlap, cumulative impacts are not expected to occur through concurrent construction and / or operation periods of the three projects in question.

(4) Further explanation of the following ecological aspects in response to the comments raised by some members of the public:

- **potential impacts on Green Turtle with respect to the migratory pathways, effects of potential electromagnetic field generated by the Project and underwater sound generated during construction works**

In accordance with the *EIA Study Brief (No. ESB-151/2006)* and *EIAO-TM*, the EIA Study has assessed the potential for impacts to green turtles and other marine turtles as part of the proposed project. The assessment has been based on the most up-to-date information available on marine turtles in Hong Kong, including information from the Agriculture, Fisheries and Conservation Department (AFCD) on green turtle tracking studies in Hong Kong [2], and other international data on marine turtles [3].

The finding of the assessment is that the proposed wind farm is likely to have negligible impacts on the post-nesting migratory pathway of sea turtles. Sea turtles show plasticity in the post-nesting migratory routes, with observations of sharp deviations in migration to avoid underwater obstacles [4]. While there is currently no evidence to suggest that the wind farm will directly obstruct the turtle migratory route, the plasticity in migration indicates that even if the routes were obstructed marine turtles could make deviations to avoid the wind farm structures. In addition, it is noted that there is a tendency of marine turtles to use coastal areas during migration, which has been documented in studies by AFCD and international literature (see *Figure 2* below).

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

(2) AFCD (2006). Conservation of Sea Turtle in Hong Kong. http://www.afcd.gov.hk/english/conservation/con_fau/con_fau_sea/con_fau_sea_con/con_fau_sea_con_sat.html

(3) http://www.seaturtle.org/tracking/

(4) http://www.seaturtle.org/tracking/

With regard to electromagnetic fields, it is noted that during migration, magnetic fields may be one of many factors that may aid in the navigation of sea turtles, although evidence to support this is generally conflicting. Even if the magnetic fields of the earth do indeed orientate turtles during migration, the small variation resulting from the wind farm will be minor compared to the natural variations of the earth's surface as the wind turbine generators are located 80 m above sea surface and the submarine cables are buried at least 3 m below seabed. Thus, sea turtles are unlikely to be disorientated by the minor magnetic fields created by the proposed project and this is not considered as a potential impact.

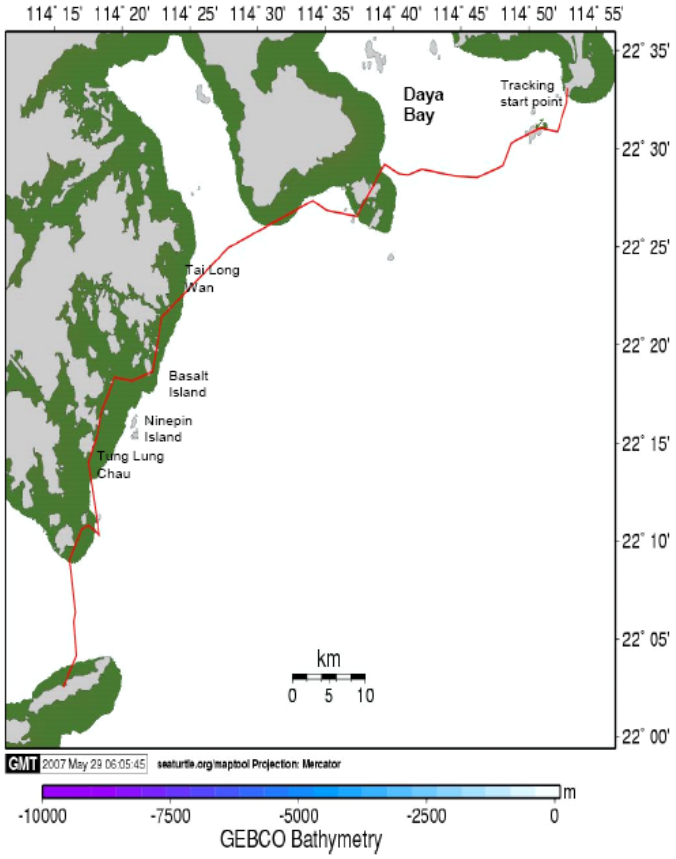

Figure 2- Migration route of a foraging green turtle in Gangkou (China) in the summer of 2007 and passed through Hong Kong waters during its migration to the Wanshan Archipelago (Map provided by AFCD).

With regard to the potential for impacts through underwater sound generated during construction works, it is noted that marine turtles only hear over a very narrow frequency range, the behavioural effects of the noise associated with pile driving are expected to be minimal. Being agile swimmers with good underwater vision, marine turtles are also considered likely to be able to avoid construction works and submerged structures during the inter-nesting period. Please also refer to the information provided above under **Item (1)**.

– **potential underwater sound impact generated by the percussive piling on Finless Porpoises and consideration of the selection of percussive piling construction method and the application of bubble jacket**

Potential underwater sound impacts are discussed above under **Item (1)**.

In accordance with the *EIA Study Brief (No. ESB-151/2006)* and *EIAO-TM*, the EIA Study has assessed the potential for impacts to finless porpoises.

The assessment has been based on the collection of quantitative vessel based survey data on the use of the study area waters by marine mammals coupled with long term data provided by the AFCD. The assessment has concluded that no significant adverse impacts were expected to occur to marine mammals, in particular the finless porpoise which is the most common marine mammal in southern waters of Hong Kong, provided appropriate mitigation has been implemented.

One of the key mitigation measures for the protection of finless porpoises is to be applied specifically to address concerns of disturbance to finless porpoises through underwater sound generated during piling activities. This mitigation is the commitment for no piling works for the wind turbines to take place during the peak season for finless porpoise within the waters of the development area. This period has been agreed with the AFCD as well as Hong Kong's leading Marine Mammal Expert, Dr Samuel Hung, as being the period between the beginning of December through to the end of May. Outside this period, the potential for finless porpoise to be within the waters of the development area, or within an area of sufficient proximity to be a potential concern, are considered to be low. On this basis, the commitment to delay works to avoid this period follows the first principle of mitigation under the *EIAO*, i.e. avoidance of impacts. Through applying this commitment, additional mitigation such as the use of a bubble jacket are not considered necessary as marine mammals are unlikely to be present.

With regard to the selection of percussive piling works, a review of alternative construction methods was conducted and the percussive piling method chosen for the following reasons:

- Environmental Impacts
  - *No waste generation with percussive piling*
- Proven Method
  - *Suction caissons are not proven in the long term. Only tests conducted to date with no actual installations*
- Proven Mitigation
  - *Marine mammal monitoring procedures well defined in Hong Kong*
- Schedule
  - *Percussive piling for 35 turbines would take ~5 months*
  - *Bored piling for 35 turbines would take ~6 years or up to ~10 years*

with closed periods applied

Whilst it is noted that other projects in Hong Kong have been conducted using bored piling, it is also noted that these projects have been able to select this due to the preferential geotechnical and depth consideration for those projects. It is considered important to note that the increased duration of bored piling in Southwest Lamma waters would result in a prolonged exposure to increased levels of marine traffic and underwater works and would be deemed to be less preferred for marine mammals than a construction period of shorter duration.

– **Methodology for survey and assessment of birds and the mitigation measures and monitoring programme proposed in the EIA.**

In accordance with the *EIA Study Brief (No. ESB-151/2006)* and *EIAO-TM*, the EIA Study has assessed the potential for impacts to birds. The Collision Risk Model (CRM) used in the EIA Study, which was adopted from Scottish National Heritage, has been generally accepted to estimate bird collision risk in impact assessment of bird for various wind farm development projects in the UK. Importantly, this method was also adopted in the CLP Wind Farm Project in Hong Kong, recently approved under the *EIAO*.

With regard to the findings of this EIA study, the predicted collision numbers for the identified bird species are considered to be negligible as the collision risk is less than 1% of the population (estimated from historical abundance data recorded). As stated above, this finding has been derived using methodologies applied in international wind farm EIAs as well as that of Hong Kong's other offshore wind farm [1] [2] .

The EIA study has assessed potential impacts associated with the light generated from the operating wind turbines on nocturnal migrants such as some seabirds and shorebirds. As part of this assessment it was noted that within the Project Site the abundance of such birds were relatively low and the majority of flight heights recorded was found to be below the proposed rotor height for the turbines. Noting this and the fact that only aviation warning lights of low intensity will be installed, it is considered that any potential impacts to birds due to the light of these structures would be expected to be minimal.

The collection of data during the night time (e.g. radar monitoring) was raised, however, note that this has been considered as impractical in calculating collision risk as birds cannot be identified into species levels which is an

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

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

important aspect of identifying risk to bird populations. If these data are used in the risk assessment, it may lead to an unreasonably over-estimation of the risk and hence impractical application of mitigation and management. It is uncommon to use such data in international assessments.

As part of the EM&A programme, one year pre-construction, construction and operation monitoring using internationally accepted vessel-based survey techniques will be conducted. Note that data will be fully analyzed and reviewed as they are collected and, finally following the completion of the operation monitoring period, using the entire dataset. HK Electric is fully committed to undertake additional monitoring should bird abundance be significantly different to the pre-construction activity and changes be able to be attributed to the operation of the wind farm. In such a case, recommendations for further operational monitoring will be made and additional measures (e.g. radar/camera surveys) will be considered. HK Electric also commits to reviewing the need for additional management measures for the wind farm should the monitoring data demonstrate sufficient cause for concern.

Attachment 1 – Noise Calculations

Percussive Piling Noise Assessment - Unmitigated Scenario																				
NSR:	N1	Lamma Island - Lo So Shing																		
Distance from NSR to Nearest Noise Source Position						*Correction Factor*														
Distance from NSR to W28			4338	*m*		Distance Attenuation =			*-81*	*dB(A)*		Facade =		*3*	*dB(A)*		Barrier Correction [2]		-10	*dB(A)*
Construction Item																				
ID	Activity																			
I)	**Wind Turbine Foundation Installation**																			
		Total SWL	*129*																	
		Noise Level at NSR (dB(A))	**41**																	
NSR:	N2	Cheung Chau - Seascape Peninsula																		
Distance from NSR to Nearest Noise Source Position						*Correction Factor*														
Distance from NSR to W01			4901	*m*		Distance Attenuation =			*-82*	*dB(A)*		Facade =		*3*	*dB(A)*		Barrier Correction =		0	*dB(A)*
Construction Item																				
ID	Activity																			
I)	**Wind Turbine Foundation Installation**																			
		Total SWL	*129*																	
		Noise Level at NSR (dB(A))	**50**																	
Notes:																				
[1] Distance Correction = $10*\log(2*\pi*r^2)$, assuming hemi-spherical propagation																				
[2] Correction of 10 dB(A) provided where there is no direct line of sight from the NSR to the work site																				