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10 ECOLOGICAL IMPACT

10.0.1 As discussed in **Section 3**, various options and combinations of options for the HKBCF and HKLR have been previously investigated, evaluated, assessed and ranked, and the selected option has also been further revised and refined. The ecological impact assessment for the HKBCF and HKLR was based upon the latest layout of the preferred option.

10.1 Legislation and Standards

10.1.1 Ordinances and regulations that are relevant to this study include the following:

- Forests and Countryside Ordinance (Cap. 96) and its subsidiary legislation, the Forestry Regulations;
- Wild Animals Protection Ordinance (Cap. 170);
- Country Parks Ordinance (Cap. 208) and its subsidiary legislation;
- Marine Parks Ordinance (Cap. 476);
- Environmental Impact Assessment Ordinance (Cap. 499) and the associated TM; and
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) and its subsidiary legislation.

10.1.2 This assessment also makes reference to the following guidelines and standards:

- Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10, "Conservation";
- PELB Technical Circular 1/97 / Works Branch Technical Circular 4/97, "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures";
- EIAO Guidance Note No. 6/2002 - Some Observations on Ecological Assessment from the Environmental Impact Assessment Ordinance Perspective;
- EIAO Guidance Note No. 7/2002 – Ecological Baseline Survey for Ecological Assessment;
- EIAO Guidance Note No. 10/2004 – Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys; and
- EIAO Guidance Note No. 11/2004 – Methodologies for Marine Ecological Baseline Surveys.

10.1.3 This assessment also makes reference to the following Mainland legislation:

- List of State Protected Wild Animals, promulgated by the State Council 國家重點保護野生動物名錄.

10.1.4 Other international conventions and guidelines that are relevant to this study include the following:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora ("CITES"). This Convention regulates international trade in animal and plant species considered to be at risk from such trade. Depending on the degree of threat posed by international trade, CITES classifies endangered species of animals and plants into three Appendices. **Appendix I** includes highly endangered species threatened with extinction. Commercial trade in specimens of these species is prohibited. **Appendix II** includes species which are not presently threatened with extinction but may become so unless trade is controlled. Their trade is allowed but subject to licensing controls. **Appendix III**

species are species identified by any Party to CITES as requiring cooperation in controlling their trade. Their trade is subject to permits or certificates of origin. Hong Kong's obligations under this Convention are enforced via the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586).

- IUCN - The World Conservation Union maintains, through its Species Survival Commission, a "Redlist" of globally threatened species of wild plants and animals (see http://www.iucnredlist.org/static/introduction). The Redlist is considered the authoritative publication to classify species into nine groups as **Extinct** (**EX**) - No individuals remaining; **Extinct in the Wild** (**EW**) - Known only to survive in captivity, or as a naturalized population outside its historic range; **Critically Endangered** (**CR**) - Extremely high risk of extinction in the wild; **Endangered** (**EN**) - Very high risk of extinction in the wild; **Vulnerable** (**VU**) - High risk of extinction in the wild; **Near Threatened** (**NT**) - Likely to become endangered in the near future; **Least Concern** (**LC**) - Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category; **Data Deficient** (**DD**) - Not enough data to make an assessment of its risk of extinction; **Not Evaluated** (**NE**) - Has not yet been evaluated against the criteria.
- United Nations Convention on Biological Diversity. This convention requires parties to regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use. It also requires parties to promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings. The People's Republic of China (PRC) ratified the Convention on Biological Diversity on 5th January 1993. The HKSAR Government has stated that it is "committed to meeting the environmental objectives" of the Convention (PELB 1996).
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the "Ramsar Convention"), which requires parties to conserve and make wise use of wetlands, particularly those supporting waterfowl populations. The PRC ratified the Ramsar Convention on 31st July 1992, and various wetlands have since been listed as wetlands of international importance (i.e. Ramsar sites). One of these, Mai Po Marshes and Inner Deep Bay Ramsar site in Hong Kong SAR, was listed on 4 September 1995.

10.2 Assessment Area

10.2.1 For HKLR, the alignment covers both marine and terrestrial areas, and there are assessment areas for terrestrial ecology and marine ecology respectively. The assessment area for marine ecology (i.e. aquatic ecology in the EIA Study Brief) is the same as the water quality impact assessment area, i.e. including the following 7 Water Control Zones (WCZ) within HKSAR (**Figure 10.1**) as well as any areas likely to be impacted by the Project.

- Deep Bay WCZ;
- North Western WCZ;
- North Western Supplementary WCZ;
- Victoria Harbour WCZ;
- Western Buffer WCZ;
- Southern WCZ; and
- Second Southern Supplementary WCZ.

10.2.2 The assessment area for terrestrial ecology in HKLR is defined as all areas within 500 m from the site boundary of the land based works areas or the areas likely to

be impacted by the Project. Owing to the changes of the alignment, HKLR would go through limited existing land areas, and the terrestrial ecological assessment area (**Figure 10.2**) has significantly reduced in size when compared with the original Study Area during the early stage of the EIA study, which is larger to cover the two conceptual alignment options in the EIA Study Brief No. ESB-110/2003.

10.2.3 For HKBCF, as it is mainly a marine project on new reclamation except some minor connecting slip roads which would involve modifications of the existing road system on Airport Island and most of them have been covered by the HKLR terrestrial ecology assessment area, the assessment area for HKBCF ecology is on marine basis. The marine ecological assessment area for HKBCF is smaller than that of HKLR, and covers the following 4 Water Control Zones (WCZ) within HKSAR as well as any areas likely to be impacted by the Project.

- North Western WCZ;
- North Western Supplementary WCZ;
- Deep Bay WCZ; and
- Western Buffer WCZ.

10.2.4 As the HKBCF marine ecological assessment area is completely covered by the larger HKLR marine ecological assessment area, the present ecological impact assessment (EcoIA) would consider the HKLR marine ecological assessment area.

10.2.5 Key issues of the EcoIA stipulated in the EIA Study Brief ESB-110/2003 and ESB-183/2008 include but are not limited to the following:

Recognized Sites of Conservation Importance

- Tai Ho Stream Site of Special Scientific Interest (SSSI): Tai Ho Stream and inner Tai Ho Wan, important for stream fish, seagrasses, mangroves, and horseshoe crab;
- Lantau North Country Park: a protected area;
- Lantau North (Extension) Country Park: a recently established protected area;
- San Tau Beach Site of Special Scientific Interest (SSSI): with records of seagrasses and mangroves, a horseshoe crab nursery site;
- Sha Chau and Lung Kwu Chau Marine Park: a protected area for the Chinese White Dolphin;
- The proposed marine parks at Fan Lau and Soko Islands; and
- Mai Po Inner Deep Bay Ramsar Site.

Important Habitats

- West Lantau and North Lantau waters (in particular the vicinities along the marine portion of the Project which are frequented by the Chinese White Dolphins);
- Inter-tidal mudflats;
- Mangroves;
- Seagrass beds;
- Horseshoe crab breeding and nursery grounds along the northwest Lantau coastlines including Sham Wat, Hau Hok Wan, San Tau, Tung Chung and Tai Ho Bay;
- Horseshoe crab nursery site at Shui Hau;
- Woodlands;
- Wetlands;

- Natural stream courses and rivers;
- Scenic Hill on Airport Island: supporting a remnant population of the Romer's Tree Frog; and
- Artificial reefs.

Species of Conservation Importance

- Vertebrates: fish, herpetofauna, avifauna, and mammals including bats;
- Macro-invertebrates: butterflies, odonates, crustaceans;
- Inter-tidal and sub-tidal benthic communities;
- Coral communities (including all hard corals, octocorals and black corals);
- Chinese White Dolphin *Sousa chinensis* (CWD);
- Horseshoe crabs and any other notable marine benthic or littoral communities;
- White-green sedge (*Carex leucochlora*); and
- Any other habitats and wildlife groups identified as a special conservation concern by this EIA study.

10.3 Methodology for Baseline Establishment

10.3.1 Introduction

10.3.1.1 The establishment of baseline conditions should include:

- Description of the physical environment;
- Description and quantification of the ecological resources (e.g. wildlife abundance, habitat sizes, food resources); and
- Identification of habitats or locations (e.g. feeding grounds, nursery grounds) that are important to wildlife.

10.3.1.2 Taking account of various factors, the present EIA study covers approximately 6 years (from 2003 – 2009) which is quite long when compared with other EIA studies. The ecological survey programmes for this Project (directly for this EIA or associated with other elements under the Project) were also covered a long time period. Since the commencement of the EIA study for the "Hong Kong – Zhuhai – Macau Bridge and North Lantau Highway Connection" (HZMB/NLHC) (now renamed as Hong Kong Link Road – HKLR) in 2003, ecological baseline data have been continuously collected.

10.3.1.3 To supplement the information obtained from literature reviews, an Ecological Baseline Survey for the HZMB/NLHC Project (i.e. Hong Kong – Zhuhai- Macao Bridge: Hong Kong Section and the North Lantau Highway Connection: Ecological Baseline Survey, hereafter referred as **EBS**) was started in September 2003, prior to the commencement of the EIA study. Based upon the results of an initial literature review, the field surveys of the **EBS** were conducted to provide specific and robust ecological data to prevent data gaps and to establish an ecological profile of its study area. This facilitated, during the early stage of EIA study, the identification, prediction and evaluation of ecological impacts potentially arising from the construction and operation of the Project.

10.3.1.4 The Study Area for the **EBS** covers a large area from Tai Ho to Sham Wat and the southern portion of Airport Island, and the marine waters near North Lantau. (see **Figure 10.3**). This Study Area is large enough to accommodate the two original alignment options shown in the EIA Study Brief ESB-110/2003. The duration of the field surveys is, following the requirements of the EIA Study Brief ESB-110/2003, 9 months covering both wet and dry seasons (September 2003 – May 2004), and the

approach and techniques used have made reference to other EIA studies in Lantau (**Appendix 10A**).

10.3.1.5 Since the completion of the **EBS**, the alignment of the HZMB and the NLHC were reviewed and significantly changed due to various considerations including potential ecological impacts on sensitive ecological resources. During this design review stage, field visits (mainly in the eastern and middle part of the study area of **EBS**) and update of literature information (mainly other EIA studies in the area e.g. "Extension of Siu Ho Wan Water Treatment Works – Investigation", and "Feasibility of Lantau Logistics Park") were continued.

10.3.1.6 In mid 2008, when the HKLR alignment (the original HZMB Hong Kong Section and NLHC) was formulated (see **Section 3**), a large-scale Ecological Verification Survey (hereafter referred as **EVS**) was conducted for a duration of 6 months (August 2008 to January 2009) covering wet and dry seasons to verify the validity of the ecological data and information collected in the previous **EBS** as well as from previous literature update and field visits, so as to establish an updated ecological baseline conditions. The items and survey methods applied in this **EVS** followed those in the **EBS,** but the area coverage was shifted to the 500m distance area of the new alignment which mainly follows the airport channel or is located on Airport Island, and would not contact North Lantau landmass.

10.3.1.7 Tuen Mun-Chek Lap Kok Link (TMCLKL), which is interfacing with the HKLR and HKBCF projects, is proposed to provide a traffic link between Tuen Mun and North Lantau. The survey programme for TMCLKL was also commenced in mid 2008, which covers a nine-month period and includes the North Lantau land area near Tai Ho. The area to the east of Tai Ho (e.g. Siu Ho Wan) was also covered by other EIA studies carried out recently, e.g. "Extension of Siu Ho Wan Water Treatment Works – Investigation" approved in end of 2004.

10.3.1.8 In late 2008, the section of HKLR to the east of Airport Island was further revised to reduce the potential visual impacts to Tung Chung Town. As the new alignment of this section would involve additional reclamation on the southeast shore of Airport Island, a Marine Supplementary Survey (hereafter referred as **MSS**) was thus performed to investigate the intertidal and subtidal habitats within the additional reclamation area.

10.3.1.9 All these survey programmes and studies since the commencement of the HKLR EIA study have provided sufficient ecological data over a long time period.

10.3.1.10 The HKBCF EIA study commenced in 2008 after the governments of Hong Kong, Zhuhai and Macau agreed to have separated boundary crossing facilities. Two major issues were considered during the formulation of the methodology for establishing HKBCF ecological baseline. First, the majority of the works of the Project would be limited to the construction and operation of newly reclaimed areas. Direct impacts resulting from these works would mainly be the loss of marine habitats. There would be very limited direct impacts on terrestrial habitats and/or associated fauna.

10.3.1.11 Secondly, there have been many EIA studies and research projects conducted in the vicinity of the Project Site as well as the marine ecological assessment area (particularly North Lantau waters).

10.3.1.12 Available information includes the studies of CT10 at Northwest Lantau, New Contaminated Mud Marine Disposal Facility at Airport East / East Sha Chau Area, Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities, and the ongoing EIA study of TMCLKL, etc.

10.3.1.13 "CT10 (Proposed Port Development at Northwest Lantau)" covered a comprehensive ecological survey programme including a 12-month dolphin survey on the Pearl River Estuary, intertidal survey and horseshoe crab survey in North Lantau area.

10.3.1.14 "New Contaminated Mud Marine Disposal Facility at Airport East / East Sha Chau Area" was an EIA study covering the waters to the north and to the east of Airport Island.

10.3.1.15 "Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities" included two option sites at Black Point and Soko Islands. The study area covered Northwest, West and Southwest Lantau waters.

10.3.1.16 Indirect impacts to habitats and communities within the 500m radius are also anticipated to be limited for the following reasons:

- Areas adjacent to the proposed reclamation site are existing urbanised/disturbed lands (i.e. Airport Island) already subject to high levels of disturbance from road traffic along the coastlines, and therefore of very low ecological value;
- The nearest natural terrestrial habitats (Scenic Hill) are over 500m boundary from the reclamation site and are separated from the reclamation site by urbanised/disturbed lands in between; and
- The only directly affected terrestrial areas would be the existing road system (developed areas) on Airport Island which would require modifications after the reclamation to facilitate road connections (see **Section 3**). The affected areas are located at the eastern Airport Island and are far away from any areas which are recognised of ecological importance.

10.3.1.17 The assessment area for marine ecology in the present EcoIA covers a large sketch of sea areas including 7 water control zones. Besides the four coastal and marine recognised sites of conservation importance in Northwest waters as stipulated in the EIA study brief (i.e. Tai Ho Stream SSSI which also covers the inner Tai Ho Wan, San Tau Beach SSSI, Sha Chau and Lung Kwu Chau Marine Park and the proposed Marine Park at Fan Lau), there are a few others inside the assessment area but far away from the HKLR and HKBCF sites, including Lung Kwu Chau, Tree Island & Sha Chau SSSI, Pak Nai SSSI, Mai Po Inner Deep Bay Ramsar Site, Inner Deep Bay SSSI, Tsim Bei Tsui SSSI, Shui Hau in South Lantau, the proposed marine park in Soko Islands, Sham Wan SSSI in south Lamma, and Cape d'Aguilar Marine Reserve in Hong Kong Island (see **Figure 10.1**). As most of these sites are far away and sheltered from the project site by Lantau Island, they would be unlikely to be impacted by HKLR and HKBCF, as indicated by water quality assessment results (sediment plume would be limited to the vicinity of the reclamation sites, and other water quality criteria would be complied, see **Section 9**). The present EcoIA on marine ecology would thus focus on the North Western Water Control Zone and North Western Supplementary Water Control Zone.

10.3.1.18 Given the above considerations, the best approach for establishing an updated and valid ecological baseline for the Project would be to verify the information collected from previous ecological surveys, recent or ongoing studies/research projects as well as to fill any identified gaps in data coverage by the recent field surveys (i.e. **EVS**, **MSS** and HKBCF field survey programme).

10.3.1.19 Information from literature review and field surveys facilitated the identification, prediction and evaluation of ecological impacts potentially arising from the construction and operation of the Project.

10.3.2 Literature Review Methodology

10.3.2.1 Relevant ecological studies were thoroughly reviewed, including those listed in Appendix E of the EIA Study Brief ESB-110/2003. Other relevant sources, including the Terrestrial Biodiversity Survey conducted by HKU, ongoing Biodiversity Survey conducted by AFCD, ongoing academic research and data-gathering efforts (e.g. HK Bird Watching Society, Hong Kong Lepidopterist's Society) were also reviewed. Species groups of concern were identified based on background information on the study areas, field survey results from **EBS**, **EVS**,

MSS of HKLR and ecological surveys of HKBCF, and consultation with relevant government authorities. Desk-top study and field survey results produced a complete picture of the ecology of the assessment area. Major literature more relevant to the present EIA study included:

- "Population Biology of the Indo-Pacific Hump-backed Dolphin in Hong Kong Waters", *Wildlife Monographs 2000 October No. 144: 1-65*;
- "Distribution and abundance of Finless Porpoises in Hong Kong and adjacent waters of China", *Raffles Bulletin of Zoology (Supplement) 2002 No. 10: 43-55*;
- "Monitoring of Marine Mammals in Hong Kong waters – Data Collection: Final Report (10 April 2008 to 31 March)" (AFCD 2009);
- "Monitoring of Chinese White Dolphin (*Sousa chinensis*) in Hong Kong waters – Biopsy Sampling and Population Data Analysis: Final Report" (AFCD 2007);
- "Habitat use by Hong Kong amphibians: with special reference to the ecology and conservation of *Philautus romeri*" (Lau 1998);
- "Avifauna of Hong Kong" (Carey *et al*. 2001);
- "Consultancy Study on Marine Benthic Communities in Hong Kong" (CCPC 2002);
- "Conservation of Horseshoe Crabs in Hong Kong – Final Report (ECF Project 12/2003)", (Shin *et al*. 2007);
- "Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals" (AFCD 2004);
- "Field Guide to Hard Corals of Hong Kong" (Chan *et al*. 2005).
- Annual report and other publications of The Hong Kong Bird Watching Society;
- Memoirs of Hong Kong Natural History Society;
- Porcupine! – newsletter of Department of Ecology & Biodiversity of University of Hong Kong;
- Biodiversity – newsletter of AFCD; and
- Other relevant reports from private sectors or Government.

10.3.2.2 Relevant information contained in the above reports was incorporated into this EcoIA.

10.3.2.3 Other relevant EIA studies included:

- The Feasibility Study of Additional Cross-border Links, Stage 2 (Crosslinks Further Study Stage 2);
- Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study;
- Airport EIA study;
- Agreement No. CE 32/96 Study on Tonggu Waterway;
- EIA-040/2000 Northshore Lantau Development Feasibility Study;
- EIA-042/2000 Tai O Sheltered Boat Anchorage;
- EIA-075/2002 Improvement to Tung Chung Road between Lung Tseng Tau and Cheung Sha;
- EIA-082/2002 Shenzhen Western Corridor;
- EIA-077/2002 Permanent Aviation Fuel Facility for Hong Kong International Airport;
- EIA-081/2002 Construction of Lung Kwu Chau Jetty;

- Proposed Port Development at Northwest Lantau (CT10);
- EIA 090/2003 Tung Chung – Ngong Ping Cable Car Project;
- EIA 100/2004 Extension of Siu Ho Wan Water Treatment Works – Investigation (Metcalf & Eddy Ltd. 2004);
- EIA 106/2005 New Contaminated Mud Marine Disposal Facility at Airport East / East Sha Chau Area;
- EIA 125/2006 Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities; and
- EIA study for Feasibility of Lantau Logistics Park.

10.3.2.4 The validity of the information compiled during the literature review was assessed before it had been adopted into the present EIA study and was verified on-site during the ecological field surveys for the present Project (see below).

10.3.3 Identification of Information Gap

10.3.3.1 Surveys on Chinese White Dolphin have been conducted in Hong Kong waters since 1996 and have also been conducted off North Lantau for various EIA studies recently. The territory-wide AFCD dolphin monitoring programme covers 9 zones in Hong Kong waters including Western and North Lantau waters, with vessel survey transects within each zone (AFCD 2009). Further dolphin surveys were conducted in North Lantau waters during the EIA study for TMCLKL and in West Lantau waters during the EIA study for CT10. The information from these recent studies is sufficient for establishing the baseline conditions of CWD within the assessment area in particular in the vicinity of the Project Site. Field surveys for CWD for the Project are therefore not necessary.

10.3.3.2 While for other aspects on ecology, field surveys for the purpose of verifying and updating the information from literature were proposed. The scope of the field surveys covered habitat, vegetation, terrestrial fauna, intertidal fauna, marine benthic communities and corals. Details of the surveys are given in below sections.

10.3.4 Ecological Field Survey Methodology

9-month Ecological Baseline Survey for HZMB / NLHC (EBS)

10.3.4.1 The Study Area for the EBS (the same as the Study Area of the HZMB Project as shown in Appendix H in the Brief for the Project) covers a large area from Tai Ho to Sham Wat and the southern portion of Airport Island, and the marine waters near North Lantau. The duration of the field surveys is 9 months (September 2003 – May 2004) covering both wet and dry seasons.

10.3.4.2 The field surveys of the EBS covered all marine and terrestrial sites, habitats and species of conservation within the study area (**Figure 10.3**), and included the following items:

- Habitat survey and mapping;
- Vegetation survey with special attention on seagrass beds and mangroves;
- Bird survey;
- Terrestrial invertebrate survey;
- Herpetofauna survey;
- Mammal survey;
- Freshwater fish survey;
- Freshwater invertebrate survey;
- Intertidal epifauna survey;
- Horseshoe crab survey;

- Subtidal benthic infauna survey;
- Coral survey; and
- Chinese White Dolphin study based upon literature.

10.3.4.3 Findings of the EBS were incorporated into the baseline description of the study area in the survey report. Readers are referred to the final survey report for the EBS (**Appendix 10A**) for details of survey methods and data.

Ecological Verification Survey (EVS)

10.3.4.4 When the EIA study for the HKLR resumed in 2008, a large-scale and comprehensive Ecological Verification Survey (**EVS**) was planned, to verify the validity of the existing ecological data previously collected and to update the ecological baseline information before the detailed assessment is performed.

10.3.4.5 The items and survey methods applied in this EVS followed those in the EBS, but the area coverage was shifted to the 500m distance area along the new alignment which mainly follows the airport channel or is located on Airport Island, and would not contact the North Lantau landmass.

10.3.4.6 Terrestrial surveys (see below sections) were conducted in all the land areas within 500m from the mid-2008 HKLR alignment (see **Figure 10.3**), on North Lantau and Airport Island for a 6-month duration covering both wet season and dry season (August 2008 to January 2009).

10.3.4.7 It is noted that the eastern part of the mid-2008 HKLR alignment (the sea viaduct offshore to the eastern coast of Airport Island) was revised in late 2008 to an at-grade road along the airport island shoreline on new reclamation, so as to reduce the visual impact to Tung Chung Town. Under the latest alignment, additional land areas on Airport Island would fall within the 500m assessment area. But these additional land areas are all developed area on the Airport Island, and with a significant portion inside restricted area of Airport. The natural habitats within the current 500m assessment area have already completely covered by the EVS study. Given that, the information from the EVS would be sufficient for the ecological assessment purposes.

10.3.4.8 Habitat and vegetation surveys were conducted within in the 500m area. Surveys covered all habitat types. The survey locations are selected prior to the field survey through aerial photographs and data from the baseline survey. During the surveys, the locations of rare or protected plant species were recorded with their number, and photos were taken. Lists of the plant species recorded in wet and dry seasons in each habitat with relative abundance were provided. Plant species which were not reported in the EBS but are found in the EVS were highlighted. A habitat map of suitable scale was provided.

10.3.4.9 Mammal surveys - Traces, tracks and scats of mammals were searched and recorded. Since most mammals are nocturnal, night surveys were also conducted. All mammals were identified to species level and the abundance was recorded. Lists of the mammal species recorded in wet and dry seasons in each habitat with abundance were provided.

10.3.4.10 Reptile and amphibian surveys in the 500m distance area were conducted by active searching in all habitats, with particular attention given to potential shelters sites and hiding places such as litters, streams and watercourses. Special attention was paid on Scenic Hill on Airport Island where Romer's Tree Frog was previously recorded by AFCD (Chan *et al*. 2005). Frogs and toads were surveyed by auditory as well as visual detection. As most of the amphibian species are more active during night time, night surveys were conducted. All herpetofauna were identified to species level and the abundance was recorded. Lists of the herpetofauna species recorded in wet and dry seasons in each habitat with abundance were provided.

10.3.4.11 Avifauna surveys - Transect count method was used to survey the avifauna present in the 500m distance area. Sampling transects were recorded on map. In addition,

night surveys, with binoculars and powerful search lights, were conducted in order to assess the activity of nocturnal species, e.g., owls, nightjars. All birds were identified to species level and the abundance was recorded. List of the bird species recorded in wet and dry seasons in each habitat with abundance was provided.

10.3.4.12 Dragonfly surveys - Dragonflies were surveyed following the same transects used for bird surveys. Dragonflies were identified with the aid of binoculars, and a telescopic hand net was used to capture specimens for identification in the hand (when necessary). All dragonflies were identified to species level and the abundance was recorded. Lists of the dragonfly species recorded in wet and dry seasons in each habitat with abundance were provided.

10.3.4.13 Butterfly surveys were conducted in tandem with the dragonfly surveys, using similar methodology. Potential microhabitats, e.g., ground and canopy of woodland were searched and sweep with a long-handled (5m) butterfly net. All butterflies were identified to species level and the abundance was recorded. Lists of the butterfly species recorded in wet and dry seasons in each habitat with abundance were provided.

10.3.4.14 Stream surveys - Fish and invertebrates present in streams within the 500m distance area were identified and recorded by direct observation, dip-netting and active sampling. All aquatic fauna were identified to species level as far as possible and abundance recorded. Lists of the aquatic species recorded in wet and dry seasons in each stream with abundance were provided.

10.3.4.15 Intertidal surveys were conducted on both hard (including natural and artificial coastlines) and soft shores along the Airport Channel and on Airport Island, during both wet season and dry season (September 2008 and December 2008). All intertidal surveys were conducted during suitable ebbing tides.

10.3.4.16 Horizontal transects (at least 50m in length) at three tidal levels (High, Middle and Low) were established on each of the landing points of HKLR covering natural and artificial coastlines. There were ten 0.5m x 0.5m quadrats on each transect. The epifauna in each quadrat were identified and their numbers/coverage percentages were recorded. Species and abundance of biota in quadrats were reported. Diversity index, evenness index and other statistical analyses were provided for evaluating and ranking the ecological values.

10.3.4.17 Detailed active search surveys along the shores were also conducted to find out the species present and their occurrence in the survey locations in addition to the transect surveys, so as to produce a comprehensive species lists of the survey areas. Photos of the recorded species were taken where possible.

10.3.4.18 The embayments along and in the vicinity of Airport Channel, namely Sham Wat, San Shek Wan, Sha Lo Wan, Hau Hok Wan, San Tau and Tung Chung Bay, were surveyed.

10.3.4.19 In each site, horizontal transects (at least 50m in length) at three tidal levels (High, Middle and Low) were established. There were ten 0.5m x 0.5m quadrats on each transect. The epifauna and infauna (within the top 5cm sediment) in each quadrat were identified and their numbers/coverage percentages were recorded. One core of 10cm diameter x 20cm depth was also collected within each quadrat. The sediments of the cores was sieved with 2mm mesh-size sieve and the biota inside were identified and counted. Species and abundance of biota in both cores and quadrats were reported. Diversity index, evenness index and other statistical analyses were provided for evaluating and ranking the ecological values.

10.3.4.20 Seagrass surveys and horseshoe crab surveys were also conducted at the above soft shore sites. The sites were thoroughly searched for the seagrasses and horseshoe crabs during suitable ebbing tides. The species, number, sizes of horseshoe crabs and the species, area sizes and coverage percentages of seagrasses were recorded, and the locations of horseshoe crabs and the locations and extents of seagrasses were mapped. Photos of seagrasses and horseshoe crabs found during the surveys were taken.

10.3.4.21 Dive surveys for corals and other hard substrate marine organisms were conducted. As spot dives within and outside the Airport Channel had been previously conducted during the 9-month ecological baseline survey, the verification survey concentrated on shallow coastal waters that are potentially subject to direct loss of marine habitats, including the landing points of HKLR at both natural and artificial coastlines along Airport Channel and on Airport Island, and indirect impacts due to change of water quality and hydrodynamic condition, including the coastlines to the east and to the west of Airport Channel.

10.3.4.22 Semi-quantitative Rapid Ecological Assessment (REA) surveys were conducted at each survey location. The REA survey was performed along 100m underwater transects horizontal to the coastlines. Transects perpendicular to the coastline of 50m to 100m (subject to the underwater visibility) was also performed. The depth and substrate along the perpendicular transects for REA were recorded at 3m intervals, or at smaller intervals if the gradient significantly changes along the transects. The benthic cover, taxon abundance, and ecological attributes of the transects were recorded in a swathe of 2m wide, 1m either side of the transects (subject to the underwater visibility), following the Rapid Ecological Assessment (REA) technique. The exact locations and routes of the REA transects were recorded on site by GPS and map. Video footages and photos along the transects and of the surveyed areas were taken during the dive surveys.

10.3.4.23 The purposes of the REA survey are to quantitatively record the habitat types and ecological values of the area by SCUBA diving and the application of Rapid Ecological Assessment (REA) approach. The REA approach (see **Annex A** in **Appendix 10B** for details) will aim at collecting data on the type of substrate and the abundance of marine organisms in particular the occurrence of corals and the extent of the coral distribution from the coastline, for ranking the ecological values. Other parameters to be recorded during the surveys included site condition (e.g. observations regarding the degree of exposure of the sites to wave action), species list of corals and other marine organisms, coral sizes, coral health status, and translocation feasibility of corals.

10.3.4.24 Marine grab samplings on soft substrate seabed for benthic communities were conducted at 9 stations along the mid-2008 HKLR alignment during both wet season and dry seasons (September 2008 and December 2008). Three grab sample replicates of 0.1m^2 were collected in each of the sampling stations by van Veen Grab (or other sampling devices with equivalent surface area coverage). Collected samples were sieved by 0.5mm mesh-size sieve and then preserved in 5% buffered seawater formalin. Organisms inside the samples were sorted from the sediments by staining with Rose Bengal and then identified to the lowest practicable taxonomic level. Species composition, abundance and biomass were reported. Diversity index, evenness index, Abundance/Biomass Comparison (ABC) plots and other statistical analyses should be provided for evaluating and ranking the ecological values.

HKBCF Ecological Survey

10.3.4.25 HKBCF is a new element for the HZMB after 2008. It would involve large-scale reclamation near the Airport Island, and thus an in-depth marine ecological survey programme was formulated to investigate the proposed reclamation site and its vicinity.

10.3.4.26 Dive surveys for corals and other hard substrate marine organisms were conducted in September 2008. The dive surveys concentrated on shallow coastal waters that would be subject to direct loss of marine habitats or indirect water quality impacts, including both natural and artificial coastlines at the northeast of Airport Island. The methodology used in the present survey followed those adopted in the AFCD territory-wide dive survey conducted in 2001-2002 (AFCD 2004). It consisted of a suite of three standardized “nested” survey methods including spot-check dive reconnaissance dives, Rapid Ecological Assessment (REA) and video transects. In the present study, due to the highly turbid water and the low diversity and coverage of marine fauna, video transect was not performed. The spot-check and REA

methods were used and were found sufficient for establishing the ecological profile of the study area.

10.3.4.27 Spot reconnaissance dives were conducted 17 spot-check dives were conducted and covered: 1) along the coastlines of Northeast Airport Island (8 spots), with focus concentrated on the section opposite to the future BCF reclamation area, ; 2) as well as within the future BCF reclamation area covering the entire proposed reclamation site (9 spots). The locations for spot reconnaissance dives are shown in **Figure 10.3** and **Appendix 10D**. Visual reconnaissance was made of the area of each bounce dive point. The purposes of the spot reconnaissance dives are to verify whether corals (including all hard corals, octocorals and black corals) and other marine organisms with conservation importance are present within the areas potentially subject to direct impacts (e.g. the reclamation area and the fire station seawalls) and indirect impacts (e.g. some sections of the Airport Island coastlines). As the underwater visibility is low in North Lantau waters, during the reconnaissance dives circular path at each dive spot was adopted (a continuous route might be difficult under the very low visibility). Besides the biota, the habitat types present within the areas and their approximate proportions/distributions were also recorded. Underwater photographs were also taken.

10.3.4.28 In accordance with the findings from the spot-check dives, a REA was conducted along the seawall which was found to be the only area with hard bottom substrate habitat within the dive survey study area. Semi-quantitative Rapid Ecological Assessment (REA) survey was conducted at the two major locations, i.e. where the BCF connecting on Airport Island, and the Automatic People Mover location. The REA survey at the two major areas was performed along 100m underwater transects horizontal to the coastlines. Transects perpendicular to the coastline up to 50m in length (limited by the low underwater visibility) were also performed. The depth and substrate along the perpendicular transects for REA were recorded. The benthic cover, taxon abundance, and ecological attributes of the transects were recorded in a swathe of 2m wide, 1m either side of the transects, following the Rapid Ecological Assessment (REA) technique. The REA transect locations are shown in **Figure 10.3**. Video footages and photos were taken during the dive surveys.

10.3.4.29 The purposes of the REA survey are to quantitatively record the habitat types and ecological values of the area by SCUBA diving and the application of Rapid Ecological Assessment (REA) approach. The REA approach aims at collecting data on the type of substrate and the abundance of marine organisms in particular the occurrence of corals and the extent of the coral distribution from the coastline, for ranking the ecological values. Other parameters to be recorded during the surveys included site conditions (e.g. observations regarding the degree of exposure of the sites to wave action), species list of corals and other marine organisms, coral sizes, coral health status, and translocation feasibility of corals.

10.3.4.30 Marine grab samplings for benthic communities were conducted at 9 stations within the BCF reclamation area (see **Figure 10.3**) during both wet season and dry season (September and December 2008). Five grab sample replicates of 0.1m^2 were collected in each of the sampling stations by van Veen Grab. Collected samples were sieved by 0.5mm mesh sieve and then preserved in 5% buffered seawater formalin. Organisms inside the samples were sorted from the sediments by staining with Rose Bengal and then identified to the lowest practicable taxonomic level. Species diversity, abundance and biomass were reported for evaluating and ranking the ecological values.

10.3.4.31 Intertidal surveys for epifauna communities were conducted on both natural and artificial coastlines at the northeast of Airport Island, during both wet season and dry season (August and November 2008).

10.3.4.32 Horizontal transects at three tidal levels (High, Middle and Low) were established on each of the natural and artificial coastlines and cover the landing points of the connecting roads on Airport Island. The locations of the intertidal transects are shown in **Figure 10.3**. There were ten 0.5m x 0.5m quadrats on each transect.

The epifauna in each quadrat were identified and their numbers/coverage percentages were recorded. Species diversity and abundance were reported for evaluating and ranking the ecological values.

10.3.4.33 In addition to the above quantitative surveys, walk-through surveys were also conducted in the survey extent to facilitate the smooth implementation of the ecological survey and to help audit the survey findings. Walk-through survey aimed at to find out the species present and their occurrence and hence facilitate the determination of representative sites for conducting quantitative surveys. Effort spent in walk-through surveys, such as number of surveyors involved and time-spend were recorded.

HKLR Marine Supplementary Survey

10.3.4.34 Intertidal surveys for epifauna communities were conducted at four locations on the southeast shore of Airport Island (**Figure 10.3**), covering both natural and artificial coastlines as well as hard and/or soft (if any) shore habitats, during both wet and dry seasons. The survey frequency of intertidal survey were four (two in dry season and two in wet season, December 2008, February 2009, April 2009 and May 2009), with a view to compensating the relatively short survey period by higher survey efforts. All intertidal surveys were conducted during suitable ebbing tides.

10.3.4.35 In each location, horizontal transects (at least 50m in length) at three tidal levels (High, Middle and Low) were established. There were ten 0.5m x 0.5m quadrats on each transect. For hard shores, the epifauna in each quadrat were identified and their numbers/coverage percentages were recorded. For the soft shores, in addition to the epifauna, the infauna within the top 5cm sediment inside the quadrat as well as from one core (10cm diameter x 20cm depth) collected inside the quadrat were also identified and recorded. Species and abundance of biota in quadrats were reported. Diversity index, evenness index and other statistical analyses were provided for evaluating and ranking the ecological values.

10.3.4.36 In addition to the above quantitative surveys, walk-through surveys were also conducted in the survey extent to facilitate the smooth implementation of the ecological survey and to help audit the survey findings. Undertaking an initial observation along the shore, for example, could find out the species present and their occurrence and hence facilitate the determination of representative sites for conducting more detailed quantitative surveys. A walk-through survey along the transect during or after a quantitative sampling event could also help assess whether the sampling exercise has collected representative data (e.g. the number and type of species encountered) and whether the sampling effort is deemed adequate. Effort spent in such qualitative surveys, such as number of surveyors involved and time spent were recorded.

10.3.4.37 Dive surveys for corals and other hard substrate marine organisms were conducted. The dive surveys focused on shallow coastal waters within the survey extent, i.e. both natural and artificial coastlines at the southeast of Airport Island.

10.3.4.38 Spot reconnaissance dives were conducted along the coastlines of Southeast Airport Island, i.e. within the survey extent. There were eight dive spots within the survey extent. The locations for spot reconnaissance dives are shown in **Figure 10.3**. The purpose of the spot reconnaissance dives is to verify whether corals (including all hard corals, octocorals and black corals) and other marine organisms with conservation importance are present within the areas potentially subject to direct impacts (e.g. the survey extent).

10.3.4.39 Circular paths at each dive spots were adopted during the reconnaissance dives as the underwater visibility is found too low for continuous routes. Besides the biota, the habitat types present within the areas and their approximate proportions/distributions were also recorded. Photos of each spot dive locations, underwater photos, and underwater video footages were taken during the spot dive surveys.

10.3.4.40 In accordance with the findings of the spot dives, semi-quantitative Rapid Ecological Assessment (REA) surveys were conducted in two locations within the

survey extent. The REA surveys were performed along 100m underwater transects horizontal to the coastlines. Transects perpendicular to the coastline of 50m to 100m (subject to the underwater visibility) were also performed. The depth and substrate along the perpendicular transects for REA were recorded at 3m intervals. The benthic cover, taxon abundance and ecological attributes of the transects were recorded in a swathe of 2m wide, 1m either side of the transects, following the REA technique. The exact locations and routes of the REA transects were recorded on site by GPS and map. Photos of each REA locations, underwater video footages and underwater photos along the transects and of the surveyed areas were taken during the REA dive surveys.

10.3.4.41 The purposes of the REA survey are to quantitatively record the habitat types and ecological values of the area by SCUBA diving and the application of REA approach. The REA approach aimed at collecting data on the type of substrate and the abundance of marine organisms in particular the occurrence of corals and the extent of the coral distribution from the coastline, for ranking the ecological values. Other parameters to be recorded during the surveys included site condition (e.g. observations regarding the degree of exposure of the sites to wave action), species list of corals and other marine organisms, coral sizes, coral health status, and translocation feasibility of corals. The conservation status of the recorded biota were provided.

10.3.4.42 Marine grab samplings on soft substrate seabed for benthic communities were conducted at eight stations within the survey extent during both wet season and dry season (December 2008 and May 2009). The survey extent and the indicative sampling locations are shown in **Figure 10.3**. Five grab sample replicas of 0.1m^2 were collected in each of the sampling stations by van Veen Grab (or other sampling devices with equivalent surface area coverage). Collected samples were sieved by 0.5mm mesh-size sieve and then preserved in 5% buffered seawater formalin. Organisms inside the samples were sorted from the sediments by staining with Rose Bengal and then identified to the lowest practicable taxonomic level. Species composition, abundance and biomass were reported. Diversity index, evenness index and Abundance/Biomass Comparison (ABC) plots were provided for evaluating and ranking the ecological values. The conservation status of the recorded biota were provided.

TMCLKL Ecological Survey

10.3.4.43 TMCLKL ecological survey programme covered a 9-month period. Besides the terrestrial surveys conducted in Tuen Mun and Tai Ho (both are outside the current 500m terrestrial assessment area for the present Project), the TMCLKL survey also included marine and intertidal surveys in North Lantau waters which are more relevant to the assessment. The TMCLKL marine and intertidal survey covered dolphin vessel survey (systematic line-transect survey in North Lantau waters), Benthic grab survey, Intertidal flora and fauna survey, and Coral dive survey.

10.3.4.44 Details of the methodology of the ecological surveys for TMCLKL are provided in the separate EIA Report for TMCLKL.

10.4 Baseline Conditions

10.4.1 Terrestrial Ecological Baseline within the EBS Study Area

10.4.1.1 The below **Sections 10.4.1** and **10.4.2** cover fauna and flora in terrestrial habitats including freshwater streams.

Terrestrial Sites of Conservation Importance within the EBS Study Area and the current 500m Assessment Area

10.4.1.2 The original Assessment Area for terrestrial ecological impact assessment of the Project (i.e. the study area for the 9-month **EBS**) is located in North Lantau near the airport, stretching from Sham Wat to Tai Ho Wan. Although this area is located on

the coast of north Lantau, which is not considered as important for tourism as southern Lantau and has been a focus of development since the airport project and Tung Chung development, there are still sites of conservation importance, important habitats and species of conservation importance occurring here.

10.4.1.3 The recognised sites of conservation importance within this original assessment area include (**Figure 10.2**):

- Tai Ho Stream SSSI;
- Pok To Yan and Por Kai Shan SSSI;
- Lantau North Country Park;
- San Chau SSSI;
- Lantau North (Extension) Country Park; and
- San Tau Beach SSSI.

10.4.1.4 Other sites in the original assessment area that have been identified during the EIA as of conservation importance include:

- Bat roost in Tai Ho Wan;
- Pak Mong fung shui wood;
- San Tau fung shui wood;
- Sha Lo Wan fung shui wood; and
- The Scenic Hill on Airport Island (which supports a remnant population of the Romer's Tree Frog).

10.4.1.5 However a larger portion of these sites of conservation importance are now outside the current 500m assessment area and far away from the HKLR footprint. Only three of the above sites of conservation importance still fall within the current 500 m assessment area, i.e. Lantau North (Extension) Country Park; San Tau Beach SSSI and Scenic Hill.

10.4.1.6 Lantau North (Extension) Country Park **(Figure 10.2)** covers an area on the slope of Nei Lak Shan just uphill from Sha Lo Wan and the hill slopes to the south of North Lantau Highway between Tai Ho Wan and Siu Ho Wan. It falls within the study area of the 9-month EBS as well as the current 500m assessment area. In addition to the existing 7,800ha of designated Lantau North and South Country Parks, the Lantau North (Extension) Country Park was proposed in the 1999 Policy Address as a positive means to conserve the natural environment of Lantau, gazetted in 2001, and was designated in 2008.

10.4.1.7 Scenic Hill is a small hill at the southeast end of Airport Island. Romer's Tree Frog is endemic to Hong Kong and is protected under the Wild Animals Protection Ordinance (Karsen *et al*. 1998). Ngong Ping is known to support the largest population of this endemic frog (Lau 1998) and has been designated as a Site of Special Scientific Interest (SSSI) for this reason.

10.4.1.8 Before construction of the airport, Chek Lap Kok was one of the few islands on which Romer's Tree Frog was found in Hong Kong. A translocation programme was implemented as a mitigation measure for the PADS project. Though the translocation programme was successful, it is possible that a remnant population still inhabiting the only remaining natural area on the airport island, i.e. the Scenic Hill.

10.4.1.9 San Tau Beach SSSI is a seagrass site and is described in the sections on intertidal ecology below.

Habitats and Vegetations inside the EBS Study Area

10.4.1.10 The habitats recorded within the study area for the EBS include secondary woodland, plantation woodland, tall shrubland, shrubby grassland, cultivated land,

mangrove and seagrass, salt marsh, stream, wasteland, and developed area (see **Appendix 10A**). The information of terrestrial habitats is given in the sections below, while intertidal habitats such as mangrove & seagrass and salt marsh are discussed under the sections on intertidal ecology.

Table 10-1 Coverage of Different Habitats within the Study Area for the EBS

Habitat Type	Area (ha)	No. of plant species recorded
Secondary Woodland	302.54	217
Plantation Woodland	6.57	125
Tall Shrubland	22.17	185
Shrubby Grassland	191.8	153
Cultivated Land/Orchard	59.9	126
Mangrove and Seagrass	10.57	85
Salt Marsh	1.63	74
Stream/riparian	5.36	N/A
Wasteland	2.64	159
Developed Area	483.9	129

10.4.1.11 A total of 475 plant species were recorded within the study area (**Appendix 10A**). The description of habitats below follows **Appendix 10A** unless otherwise specified.

Secondary Woodland

10.4.1.12 Notable woodland patches can be found at Tai Ho Wan headland and adjacent to Sha Lo Wan San Tsuen. This habitat is extensive and relatively rich in flora with a total of 217 recorded plant species.

10.4.1.13 Major/dominant plant species included trees *Aporosa dioica*, *Bridelia tomentosa*, *Litsea glutinosa*, *Mallotus paniculata*, *Schefflera octophylla* and *Sterculia lanceolata*. Dominant shrub species included *Litsea rotundifolia*, *Ilex asprella* and *Psychotria rubra*. Of the plant species recorded, only the shrub *Pavetta hongkongensis* was protected under the law but this species in considered common (Xing *et al*. 2000).

10.4.1.14 Woodlands within the study area also consisted of fung shui woods at Tung Chung near the villages of San Tau and Sha Lo Wan.

Plantation Woodland

10.4.1.15 Plantation woodland habitats were mainly located either on the hill slopes or near developed areas. The vegetation was dominated by species with either high amenity value or pioneer species and was comprised of *Acacia confusa, Dimocarpus longan, Ficus hirta, Mallotus paniculata, Microcos paniculata* and *Pinus massoniana*. The understorey shrub consisted of *Ilex asprella, Litsea rotundifolia* and *Vitex negundo* var *negundo*, the climbers, *Lygodium japonicum* and *Embelia laeta*. The understorey shrub communities were not particularly diverse. Fung shui woods at Pak Mong, which lies on the boundary of the eastern study area and was found being heavily modified, is categorised under this habitat type. A total of 125 plant species were present in the plantation woodland habitats. *Aquilaria sinensis* is listed under State Protection (Category II) and is considered “Near Threatened” in the China Plant Red Data Book. However, this species is common in Hong Kong (Xing *et al*., 2000).

Tall Shrubland

10.4.1.16 Tall shrubland occurred along the coast of Tung Chung to Sham Wat and was dominant on the hill-slope of the Tai Ho Wan headland. This habitat type was densely populated with a mix of native tree and shrubby plant species.

10.4.1.17 A total of 185 plant species were recorded in this habitat. Species found commonly in this habitat included trees such as *Acronychia pedunculata*, *Cratoxylum cochinchinense*, *Schefflera octophylla*, *Rhus succedanea* and *Mallotus paniculatum, Sapium discolor*; the shrubs *Eurya japonica, Litsea rotundifolia, Melastoma sanguineum* and *Rhaphiolepis indica,* the climbers *Alyxia sinensis, Lygodium japonicum, Cassytha filiformis, Tetracera asiatica* and *Embelia ribes;* as well as the herbs *Dianella ensifolia* and *Dicranopteris pedata.*

10.4.1.18 *Carex tristachya* is a rare sedge (Xing *et al*. 2000) recorded in this habitat in Hau Hok Wan and patches of the orchid *Eulophia graminea* were found near tall shrubland habitats at Hau Hok Wan and Sha Lo Wan. The locally protected *Pavetta hongkongensis* was also recorded in this habitat.

Shrubland-Grassland Mosaic

10.4.1.19 The shrubby grassland is composed of a range of plant species showing various growth forms (from herbaceous ferns to woody tree species) that are patchily distributed on the hill-slopes and mostly located at higher elevations. Generally, this habitat type is open in structure and has a vegetation height of less than 2m. Moreover, it is believed that part of this mosaic may be disturbed frequently by hill-fire as evidenced by the presence of patches of the fire-resistant fern *Dicranopteris pedata*, especially in the areas behind the burial grounds.

10.4.1.20 153 plant species were recorded in this habitat. Trees were not particularly diverse and most common species included *Ficus variolosa*, *Aporosa dioica* and *Cratoxylum cochinchinense.* However, many shrub species were recorded including *Baeckea frutescens*, *Aster baccharoides*, *Breynia fruticosa*, *Melastoma sanguineum* and *Helicteres angustifolia.* Herbs included *Arundinella setosa*, *Eremochloa ciliaris*, *Eulalia* spp., *Grewia biloba*, *Inula cappa*, *Ischaemum rugosum* together with climbers, *Alyxia sinensis*, *Cassytha filiformis*, *Lygodium japonicum*, *Millettia nitida* and *Morinda umbellata.* Plant species in this habitat were similar to those present in the tall shrubland although fewer tree species were recorded. Three protected orchids *Acampe rigida, Arundina chinensis* and *Cleisostoma simondii* were recorded in this habitat. Although all three species are common in Hong Kong (Siu 2000), all members of the orchid family (Orchidaceae) are protected under the Forestry Regulations in Hong Kong.

Cultivated Field / Orchard

10.4.1.21 Cultivated field/orchards include both active, inactive cultivation and orchards. Cultivated fields are mainly scattered among the village areas and mostly distributed along the coast of the study area. These are planted with fruit trees and ornamental plants such as *Litchi chinensis*, *Dimocarpus longan*, *Clausena lansium*, *Citrus* sp., and some widespread herbs including *Lantana camara*, *Solanum torvum* and *Lygodium japonicum*. A total of 126 plant species were present in this habitat although no rare or protected plant species was recorded.

Stream / Riparian

10.4.1.22 Many stream courses in the EBS study area are seasonal, or of very low base flow. These low base-flow streams are considered of lower ecological value than the permanent streams with reliable discharge to support aquatic life year-round.

10.4.1.23 The streams in the study area pass through various vegetated habitats such as woodlands, grassland-shrubland mosaic and cultivated fields. Riparian vegetation is broadly similar to that of the surrounding habitats, comprising secondary woodland and shrubby grassland.

Wasteland

10.4.1.24 Wasteland is mostly found in heavily disturbed or previously developed areas. This habitat type is poorly represented within the EBS study area.

10.4.1.25 In general, the species diversity of this habitat is poor and its structural complexity is simple. The vegetation on wasteland is dominated by weedy herbaceous ruderal plants; such as the common herbs, *Cynodon dactylon*, *Panicum maximum*, *Lygodium japonicum* and the climbers *Mikania micrantha* and *Pueraria lobata.*

Developed Area

10.4.1.26 The developed area refers to urbanised areas including roads, buildings and villages that can be found in Chek Lap Kok, Tung Chung and some scattered in the western part of the study area. This habitat is man-made.

10.4.1.27 The vegetation is predominantly composed of herbs and climbers, and occasionally with some planted or orchard trees such as *Casuarina equisetifolia*, *Bambusa* sp., *Clausena lansium* and *Averrhoa carambola*. Despite some observations of restricted species, the 129 plant species recorded in the developed areas are common and widespread in Hong Kong. No rare or protected plant species was recorded.

Terrestrial Fauna inside the EBS Study Area

Mammals inside the EBS Study Area

10.4.1.28 Only two species of non-flying mammals were recorded in the EBS study area (Table 5.14 in **Appendix 10A**). These were the Indian Muntjac *Muntiacus muntjak* and Brown Musk Shrew *Suncus murinus*. Both are considered locally common (**Appendix 10A**). Sighting of Indian Muntjacs was made within the terrestrial study area of the EBS at tall shrubland at Sham Shek Tsuen in April 2004. Unidentified insectivorous bats were observed at Tai Ho Wan, Sham Wat and San Shek Wan during night surveys in February, April and May 2004 (*ibid*.).

10.4.1.29 Diversity of medium to large non-flying mammals on Lantau is low. Three species of non-flying mammal, i.e. the Chinese Ferret Badger *Melogale moschata*, Wild Boar *Sus scrofa* and Indian Muntjac were recorded on Lantau Island using camera traps (Shek *et al*. 2007). All are present in low abundance on Lantau (*ibid*.). Chinese Ferret Badger and Indian Muntjac are protected under the Wild Animals Protection Ordinance.

10.4.1.30 A number of rodents, including Sikkim Rat *Rattus sikkimensis*, *R*. *rattus flavipectus*, Norway Rat *R*. *norvegicus* and *Bandicota indica* were recorded at Chek Lap Kok by Chandrasekar-rao (1994). *Rattus r. flavipectus* was recorded at the back of the Tung Chung mangal, near cultivated land in July and August 2002 during the field surveys for the EIA of Tung Chung Cable Car Project (Mott 2003). Several burrows of the species were present in adjacent bunds at the backshore and in adjacent abandoned cultivated land.

10.4.1.31 A Least Horseshoe Bat *Rhinolophus pusillus* roost was found near Pak Mong within the Terrestrial Study Area (Ades 1999). Four bat species were reported in Tung Chung (Lin 2001). These included Leschenault's Rousette Bat *Rousettus leschenaulti*, Rufous Horseshoe Bat *Rhinolophus rouxi*, Lesser Bamboo Bat *Tylonycteris pachypus* and *Hipposideros armiger* (*ibid*.). The Lesser Bamboo Bat was first discovered in Hong Kong in 1996 (Ades 1999). Just above the intertidal zone along the east shore of Tai Ho Bay a cave probably excavated for mineral exploration and subsequently abandoned has been colonised by bats (Mott 1998). The cave is used as a day-time roost by at least three species of insectivorous bats. These were the Fulvous Leaf-nosed Bat *Hipposideros pomona* (approx. 100 individuals), Least's Horseshoe Bat (1 male) and Rufous Horseshoe Bat (1 individual). The mine was a nursery site for Fulvous Leaf-nosed Bat. The 20 females caught were each carrying a single young (approx. 2-3 week old). This species is rare in Hong Kong. The cave was probably also used as a winter hibernaculum.

10.4.1.32 Two species of non-cave dwelling bats were recorded in Tai Ho and nearby areas by AFCD (Shek and Chan 2006). These were Japanese Pipistrelle *Pipistrellus abramus* and Brown Noctule *Nyctalus noctula*. Japanese Pipistrelle is very common and Brown Noctule is common in Hong Kong (*ibid*.). All bats are protected locally under the Wild Animals Protection Ordinance.

Birds inside the EBS Study Area

10.4.1.33 A total of 55 bird species was reported in the **EBS** Study Area by Hong Kong Bird Watching Society between 1993 and 1998 (Carey *et al*. 1998, 1999, 2001, 2002). This included a number of rare/uncommon species (e.g., Crested Kingfisher *Ceryle lugubris*) (Carey *et al*. 2001) and species protected by regional/international regulation/convention (e.g., Pacific Reef Egret *Egretta sacra*, Black Kite *Milvus lineatus*, White-bellied Sea Eagle *Haliaeetus leucogaster*, Osprey *Pandion haliaetus*) (Zheng and Wang 1998). These bird species are inhabitants of terrestrial habitats (e.g., Black Baza *Aviceda leucophotes*, Peregrine Falcon *Falco peregrinus*), e.g., woodland and shrubland, and coastal habitats (e.g., Pacific Reef Egret, White-bellied Sea Eagle, Osprey).

10.4.1.34 A total of 75 species was recorded in Tai Ho Wan during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study" (Mott 1998). Inter-tidal mudflat in Tai Ho Wan provides feeding habitat for a number of bird species (e.g., ardeids, kingfishers, terns, Osprey), but abundance was not high (*ibid*.).

10.4.1.35 A total of 118 bird species were recorded in the EBS study area (**Appendix 10A**). Most of the recorded species are common and widespread in Hong Kong, and 32 species were considered of conservation interest according to Fellowes *et al*. (2002) (Table 5.13 in **Appendix 10A**). This included bird species inhabiting coastal and terrestrial habitats. Locations of the sighting of these species are mapped in Figure 13a of **Appendix 10A**.

10.4.1.36 Bird abundance in secondary woodland, tall shrubland, shrubland-grassland mosaic and cultivated/agricultural land in the EBS study area were ranked very high. Bird abundance in wasteland and developed area were ranked high, while plantation habitat ranked low (Tables 7.1 to 7.8 in **Appendix 10A**).

10.4.1.37 The Project is basically a marine project, while terrestrial habitats to be affected by this Project are mainly developed areas on Airport Island. Avifauna mainly foraging in coastal habitats would be more relevant to the Project. Bird species of conservation importance and foraging in coastal habitats included Little Grebe *Tachybaptus ruficollis*, Grey Heron *Ardea cinerea*, Chinese Pond Heron, Cattle Egret *Bubulcus ibis*, Striated Heron *Butorides striatus*, Swinhoe's Egret *Egretta eulophotes*, Great Egret *E. albus*, Little Egret, Intermediate Egret *E. intermedia*, Pacific Reef Egret, Black-crowned Night Heron, Grey-tailed Tattler *Heteroscelus brevipes*, Black-winged Stilt *Himantopus himantopus*, Wood Sandpiper *Tringa glareola*, Brown Fish Owl *Ketupa zeylonenis*, White-bellied Sea Eagle, Black Kite, White-throated Kingfisher *Halcyon smyrnensis* and Black-capped Kingfisher *H. pileata*. Remarkably high bird abundance in coastal habitats was only recorded at Tung Chung Bay, when about 700 Little Egrets and 773 Cattle Egrets were observed on 24 September 2003 (Fig. 9 in **Appendix 10A**).

10.4.1.38 No ardeid nesting colony or nesting of White-bellied Sea Eagle was recorded within the EBS study area.

10.4.1.39 Black Kite, White-bellied Sea Eagle, Osprey and Brown Fish Owl are Class 2 Protected Animals of PRC and listed in Appendix 2 of CITES (Zheng and Wang 1998). Black Kite is common and widespread in Hong Kong (Carey *et al*. 2001), and occurs in many types of habitats. Black Kites usually soar above and take food from the sea surface. No regular Black Kite roost has been reported in the study area, and the only roost on Lantau Island is found in Tai O (Carey 1996). Brown Fish Owl is a rare resident, and only recorded from a few localities. It usually feeds in undisturbed and unpolluted lowland streams and tidal creeks (Carey *et al*. 2001).

Waters at the mouth of Tai Ho Stream probably provide feeding habitat for this species. Brown Fish Owls were only recorded at Tai Ho during the EBS.

10.4.1.40 Osprey and White-bellied Sea Eagle are mainly maritime (Carey *et al*. 2001). Both are uncommon in Hong Kong. Most records of Osprey come from Inner Deep Bay (*ibid*.). White-bellied Sea Eagle was reported nesting at Pa Tau Kwu near Penny's Bay (Scott Wilson 2000), but not within the Study Area. The estimated local nesting population of this species is about 10 pairs (Carey *et al*. 2001). The home range of White-bellied Sea Eagle is estimated to be 100 km^2, which is one-tenth of total area of Hong Kong (Mooney 1986b in Marchant and Higgins (1993)).

Reptiles inside the EBS Study Area

10.4.1.41 Fourteen species of reptiles were recorded in the EBS study area (Table 5.17 in **Appendix 10A**). Uncommon/rare species included Blue-tailed Skink *Eumeces quadrilineatus*, Four-clawed Gecko *Gehyra mutilata*, Tokay Gecko *Gekko gecko*, Chinese Cobra *Naja naja* and Taiwan Kukri *Oligodon formosanus*. Locations of the sightings of these species were shown in Figure 13a of **Appendix 10A**.

10.4.1.42 Tokay Gecko is locally rare and is Class 2 Protected Animal of China (Zhao 1998). It is mainly found in thick bush and forest (Karsen *et al*. 1998). Chinese Cobra can be found in many types of habitats throughout Hong Kong, and is listed in Appendix 2 of CITES (Zhao 1998). Taiwan Kukri is uncommon and can be found in many types of habitats (Karsen *et al*. 1998).

10.4.1.43 Abundance of herpetofauna (reptiles and amphibians) was ranked high in secondary woodland, tall shrubland, shrubland-grassland mosaic and developed area, medium in wasteland and cultivated/agricultural land of the EBS study area (Tables 7.1 to 7.8 in **Appendix 10A**).

10.4.1.44 During the EIA study of the Tung Chung – Ngong Ping Cable Car Project, Buff-striped Keelback was recorded at Tung Chung (Mott 2003). This species is common and widespread in Hong Kong (Karsen *et al*. 1998). Buff-striped Keelback mainly occur in low altitude wetlands (*ibid*.). Mangrove Water Snake *Enhydris bennettii* was recorded at the mangroves near Hau Wong Temple at Tung Chung during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study" (Mott 1998). This species was first recorded in Hong Kong in 1954, and is mainly a muddy coastal habitat species (Karsen *et al*. 1998) and threatened by destruction of habitats and pollution (Zhao 1998).

10.4.1.45 Reptiles observed near Tung Chung Valley area included Buff-striped Keelback *Amphiesma stolata*, Large-spotted Cat Snake *Boiga multimaculata* , King Cobra *Ophiophagus hannah* and Greater Green Snake *Ophedrys major* (Ridley 2001). Buff-striped Keelback and Greater Green Snake are common in Hong Kong and occur in many types of habitats (Karsen *et al*. 1998). Large-spotted Cat Snake is rather uncommon, widespread throughout Hong Kong and primarily occurs in shrubland and woodland (*ibid*.). King Cobra is a very uncommon snake in Hong Kong that occurs in many types of habitats (*ibid*.). It is listed in Appendix 2 of CITES (Zhao 1998). Chinese Cobra was recorded at Shek Mun Kap during the EIA Study of Tung Chung Road Improvement (Mouchel 2002).

Amphibians inside the EBS Study Area

10.4.1.46 Seven species of amphibian were recorded within in the EBS study area (**Appendix 10A**). Lesser Spiny Frog was the only species of conservation concern according to Fellowes *et al*. (2002), and individuals were found in streams at two locations within in the EBS study area (Figure 13a of **Appendix 10A**). This species is the most common of the Hong Kong hill stream frogs (Karsen *et al*. 1998). Abundance throughout its distribution range may have declined (Fellowes *et al*. 2002). The other amphibian species recorded within the terrestrial study area during the EBS are all common and widespread in Hong Kong.

10.4.1.47 Gunther's Frog *Rana guentheri* and Three-striped Grass Frog *R*. *microdactyla* were recorded at abandoned cultivated land in Tai Ho Wan during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility

Study" (Mott 1998). Both are common and widespread in Hong Kong (Lau and Dudgeon 1999).

10.4.1.48 Ten amphibian species were reported from the EBS study area by Lau and Dudgeon (1999). These were Asian Common Toad *Bufo melanostictus*, Gunther's Frog, Paddy Frog *Rana limnocharis*, Three-striped Grass Frog *R*. *macrodactyla*, Chinese Bullfrog *R*. *rugulosa*, Romer's Tree Frog *Philautus romeri*, Brown Tree Frog *Polypedates megacephalus*, Asiatic Painted Frog *Kaloula pulchra*, Ornate Pigmy Frog *Microhyla ornata* and Marbled Pigmy Frog *M*. *pulchra*. All except Chinese Bullfrog are common and widespread in Hong Kong (Lau and Dudgeon 1999). Chinese Bullfrog is a Class 2 Protected Animal of China (Zhao 1998). Romer's Tree Frog is an endemic species protected under the Wild Animals Protection Ordinance.

10.4.1.49 Short-legged Toad *Megophrys brachykolos* was recorded at Tung Chung Stream during the EIA Study of Tung Chung Road Improvement (Mouchel 2002b). This species is considered endemic to Hong Kong (Karsen *et al*. 1998). Short-legged Toad is mainly found in forested mountain stream (*ibid*.). A locally common species Three-striped Grass Frog was reported near Sham Wat stream (Ridley 2001). This species is mainly found in wet abandoned cultivated land (Karsen *et al*. 1998).

10.4.1.50 Romer's Tree Frog was not recorded during the **EBS** study. However, several individuals and tadpoles were reported from Scenic Hill in the summer of 2004 by AFCD (Chan *et al*. 2005b).

Butterflies inside the EBS Study Area

10.4.1.51 Ninety species of butterfly were recorded within the EBS study area (Table 5.16 in **Appendix 10A**). Most are common and widespread in Hong Kong (**Appendix 10A**). Six species are considered of conservation concern according to Fellowes *et al*. (2002). These were Common Albatross *Appias albina*, Burmese Bush Blue *Arhopala bimana*, Small Grass Yellow *Eurema brigitta*, Danaid Eggfly *Hypolimnas misippus*, White Dragontail *Lamproptera curius* and Falcate Oak Blue *Mahathala ameria*. Locations of the sighting of these species are mapped on Figure 13a of **Appendix 10A**. Apart from Danaid Eggfly (found in shrubby-grassland in Scenic Hill), all were recorded in North Lantau and away from the HKLR alignment.

10.4.1.52 Abundance of butterfly was ranked very high in secondary woodland, tall shrubland, shrubland-grassland mosaic, cultivated/agricultural land and developed area, high in wasteland (Tables 7.1 to 7.8 in **Appendix 10A**).

10.4.1.53 60 species of butterfly were recorded at Tung Chung during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study" (Mott 1998). This included 13 uncommon and five rare species. Uncommon species included Yellow Pansy *Junonia hierta*, Blue Pansy *J*. *orithya*, Plain Tiger *Danaus chrysippus*, Common Cerulean *Jamides celeno*, Quaker *Neopithecops zalmora*, Albocaerulean *Udara albocaerules*, Yellow Orange Tip *Ixias pyrene*, Common Jay *Graphium doson*, Swallowtail *Papilio xuthus*, Common Birdwing *Troides helena*, Bush Hopper *Ampittia dioscorides*, Tree Flitter *Hyarotis adrastus* and Yellow Band Dart *Potanthus parva*. Rare species included Red Lacewing *Cethosia biblis*, Forget-me-not *Catochrysops strabo*, Painted Jezebel *Delias hyparete*, Common Brownie *Miletus chinensis* and Common Pierrot *Castalius rosimon*.

10.4.1.54 Tree Flitter, Swallowtail, Common Jay, Bush Hopper, Plain Tiger, Yellow Band Dart, Lesser Band Dart, Common Pierrot and Yellow Orange Tip are found in abandoned cultivated lands (Bascombe *et al*. 1999, Yiu 2004). Red Lacewing, Yellow Pansy, Blue Pansy, Painted Jezebel, Common Birdwing, Albocaerulean, Quaker, Common Brownie and Common Cerulean are found in forest (Yiu 2004). Forget-me-not is found in low shrub and secondary growth (Bascombe *et al*. 1999).

10.4.1.55 A total of 40 species of butterfly were recorded at Tai Ho Wan during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study" (Mott 1998). Forest in Tai Ho Wan provided habitats for four uncommon species, which included Baron *Euthalia aconthea*, Striped Blue Crow

Euploea mulciber, Common Birdwing *Troides helena* and Painted Jezebel *Delias hyparete*.

Dragonflies inside the EBS Study Area

10.4.1.56 Twenty-four species of dragonfly were recorded in the EBS study area (**Appendix 10A**). All are common and widespread in Hong Kong. Dragonfly species considered of local concern by Fellowes *et al*. (2002) included Elegant Clubtail *Leptogomphus elegans* (recorded at Tai Ho Wan) and Sapphire Flutterer *Rhyothemis triangularis* (Tung Chung Bay). These two species were also recorded near the terrestrial study area in a previous EIA study for Tung Chung Road improvement (Mouchel 2002b). Elegant Clubtail mainly occurs in wooded streams while Sapphire Flutterer is usually found in weedy ponds (Wilson 2004).

10.4.1.57 Dragonfly abundance is ranked high in secondary woodland and shrubland-grassland mosaic, medium in tall shrubland, wasteland and developed area, low in cultivated/agricultural land in the EBS study area (Tables 7.1 to 7.8 in **Appendix 10A**).

10.4.1.58 19 species of dragonfly were recorded at Tung Chung during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study" (Mott 1998). Three species of dragonfly were recorded at Tung Chung by Wilson (1997). These included Chinese Greenwing *Neurobasis chinensis*, Fiery Emperor *Anax immaculifrons*, and Small Clubtail *Stylogomphus chunliuae*. Chinese Greenwing and Fiery Emperor are common in Hong Kong (Wilson 2004). Small Clubtail is uncommon in Hong Kong (*ibid*.). This species inhabits streams with steep gradient and boulder substrate.

10.4.1.59 A total of 15 species of dragonfly were recorded in streams and agricultural lands in Tai Ho Wan during the field surveys for "Remaining Development in Tung Chung and Tai Ho Comprehensive Feasibility Study" (Mott 1998). Two uncommon species of damselfly were recorded at abandoned cultivated lands in Ngau Kwu Long (*ibid*.). These were Milky Midget *Agriocnemis lacteola* and Chinese Mountain Damsel *Calicnemia sinensis*. Milky Midget is found in abandoned cultivated lands, while Chinese Mountain Damsel inhabits small forested spate streams in low altitude (Wilson 2004).

Stream Fishes inside the EBS Study Area

10.4.1.60 Approximately 160 species of freshwater fish have been recorded in Hong Kong (Lee *et al*. 2004). The first comprehensive listing of species present in Hong Kong was the checklist produced by Chong and Dudgeon (1992) which provides details of 96 indigenous fish species, including information on distribution and conservation status. A brief review of local freshwater fish ecology is provided in Dudgeon and Corlett (1994). Lee *et al*. (2004) in "Freshwater Fish in Hong Kong" provides information on identification of common species and the distribution and conservation status of the 160 predominantly freshwater fish species recorded locally.

10.4.1.61 Lowland freshwater streams are considered one of the most endangered habitats in Hong Kong. The freshwater streams present on north Lantau are generally unaffected by pollution and support comparatively diverse aquatic communities (Chong and Dudgeon, 1992; EPD, 2000; Mouchel, 2002b).

10.4.1.62 Freshwater fish have been relatively well-studied in the north Lantau area. Chong and Dudgeon (1992) reported that the Tai Ho (46 species recorded between 1980-1991) and Tung Chung (23 species recorded between 1980-1991) streams rank first and second in terms of species-richness of all streams in Hong Kong. The locally rare Ayu *Plecoglossus altivilis* was first recorded in Hong Kong from the Tai Ho stream (Chong and Dudgeon, 1992). The catadromous Giant Mottled Eel *Anguilla marmorata* has also been recorded in Tai Ho stream (Chong and Dudgeon, 1992). Both species are listed in the China Red Data Book of Endangered Animals. Owing to the high diversity of fish, the Tai Ho stream has been designated an SSSI.

10.4.1.63 67 fish species were recorded during the EBS field surveys. Details are presented in the final EBS report (**Appendix 10A**). Survey results confirmed that the Tai Ho, Tung Chung and Sham Wat streams support high fish diversity and species of conservation interest. It should be noted, however, that only the estuaries of these three streams fall within the study area for the **EBS**, while the stream courses themselves are located outside the study area for the **EBS**.

10.4.1.64 Fish species of conservation concern recorded in the streams include the *Acrossocheilus beijiangensis* (in Tung Chung Stream), *Anguilia marmorata* (in Sham Wat Stream and Tai Ho Stream), *Channa asiatica* (in Pak Mong Stream, Sha Lo Stream, Sham Wat Stream, Tai Ho Stream and Tung Chung Stream), *Oryzias curvinotus* (in Tung Chung Stream), *Plecoglossus altivelis* (in Tai Ho Stream), *Takifugu ocellatus* (in Pak Mong Stream, San Tau Stream, Sham Wat Stream, Tai Ho Stream and Tung Chung Stream). Among these, *Acrossocheilus beijiangensis*, *Anguilia marmorata* and *Oryzias curvinotus* are of global concern and the remaining two species are considered locally/regionally restricted.

10.4.1.65 During the May 2004 survey, the Ayu *Plecoglossus altivelis* was recorded in the Tai Ho Stream. Declining populations of this species were reported locally, regionally and globally. This species is considered to be of immediate regional conservation concern (Fellowes *et al*., 2002) and only recorded once during the course of the surveys.

10.4.1.66 The Giant Mottled eel *Anguilla marmorata* was recorded in Sham Wat and Tai Ho during the surveys conducted in December 2003 and May 2004. The population of *Anguilla marmorata* was reported to be in marked decline locally and considered a species threatened globally by Fellowes *et al*. (2002) but is not included in the IUCN World Conservation Union Redlist. This species is also listed in the China Red Data Book.

Stream Invertebrates inside the EBS Study Area

10.4.1.67 The streams of Hong Kong are known to support a diverse group of freshwater macroinvertebrates some which are endemics (e.g. certain odonates and water beetles). The streams on north Lantau are generally unaffected by pollution inputs and support comparatively diverse aquatic communities (Chong and Dudgeon 1992; EPD 2000; Mouchel 2002b). The recently published China Water Beetle Trilogy (Jach and Ji 1995, 1998, 2003) reported that some of the water beetles in Hong Kong are probably endemic as they have not yet been recorded in other parts of Mainland China. These include *Sinonychus lantau* (Elmidae) from Ngau Kwu Long near to Tai Ho. Wilson (1995) and Mouchel (2002b) also reported the presence of several endemic odonates on Lantau and their larval stages are completed in uncontaminated freshwater. A species of sesarminae crab, *Sesarma (Holometopus) tangi* Rathbun was also recorded in Tai Ho stream (Lee & Leung 1999). This species of crab has a very limited distribution in Hong Kong. Tai Ho Stream is one of the two local sites of occurrence for this species, the other being Mai Po.

10.4.1.68 A total of twelve freshwater macroinvertebrate families/suborders consisting of 83 individuals were recorded during the EBS macroinvertebrate stream surveys conducted between September 2003 and January 2004 (**Appendix 10A**). The number of macrofauna species recorded in each stream was generally low except in the stream at San Shek Wan (**Appendix 10A**). The generally low species richness was probably caused by the lower water flow during the dry season.

10.4.1.69 It was found that the water levels in stream courses with significant flows in wet season became much lower in dry season, while many of the courses with low water flows in wet season completely dried out during the dry season. This seasonal variation, however, is typical of streams in Hong Kong (Dudgeon and Corlett, 1994).

10.4.1.70 In order to determine the relative quality of each stream course, a BMWP (Biological Monitoring Working Party) biotic index was calculated for each stream. The BMWP biotic index for Pak Mong, Hau Hok Wan, Sha Lo Wan and San Shek

Wan are 8, 0, 2 and 34, respectively. The biotic index indicated that there were large variations in the habitat quality of the streams within the study area. This, however, could be a reflection of stream flow variability and the percentage of taxa that does not have a score rather than pollution/disturbance.

10.4.2 Terrestrial Ecological Baseline within the 500m Assessment Area

Terrestrial Sites of Conservation Importance within the 500m Assessment Area

10.4.2.1 A larger portion of the sites of conservation importance listed in Section 10.4.1 is now outside the current 500m assessment area and far away from the HKLR footprint. Only three of the above sites of conservation importance still fall within the current 500 m assessment area, i.e. Lantau North (Extension) Country Park; San Tau Beach SSSI and Scenic Hill.

- Lantau North (Extension) Country Park;
- San Tau Beach SSSI; and
- The Scenic Hill on Airport Island (which supports a remnant population of the Romer's Tree Frog).

10.4.2.2 Lantau North (Extension) Country Park **(Figure 10.2)** covers an area on the slope of Nei Lak Shan just uphill from Sha Lo Wan and the hill slopes to the south of North Lantau Highway between Tai Ho Wan and Siu Ho Wan. It falls within the study area of the 9-month EBS as well as the current 500m assessment area. In addition to the existing 7,800ha of designated Lantau North and South Country Parks, the Lantau North (Extension) Country Park was proposed in the 1999 Policy Address as a positive means to conserve the natural environment of Lantau, gazetted in 2001, and was designated in 2008.

10.4.2.3 Scenic Hill is a small hill at the southeast end of Airport Island. Romer's Tree Frog is endemic to Hong Kong and is protected under the Wild Animals Protected Ordinance (Karsen *et al*. 1998). Ngong Ping is known to support the largest population of this endemic frog (Lau 1998) and has been designated as a Site of Special Scientific Interest (SSSI) for this reason.

10.4.2.4 Before construction of the airport, Chek Lap Kok was one of the few islands on which Romer's Tree Frog was found in Hong Kong. A translocation programme was implemented as a mitigation measure for the PADS project. Though the translocation programme was successful, it is possible that a remnant population still inhabiting the only remaining natural area on the airport island, i.e. the Scenic Hill.

10.4.2.5 San Tau Beach SSSI is a seagrass site and is described in the sections on intertidal ecology below.

Vegetation and Habitats within the 500m Assessment Area

10.4.2.6 The coastal areas between inner Tung Chung Bay and San Tau, and the southeast end of Airport Island including Scenic Hill, were surveyed during the EIA study for Tung Chung Cable Car project (Mott 2003). Habitats identified included Developed Area on Airport Island; Grassland on Scenic Hill; Plantation; Woodland; and Tall Shrub.

10.4.2.7 The vast expanse of terrestrial habitats (1,087 ha) between Siu Ho to Sham Wat, covering Tai Ho, Tung Chung, San Tau, Sha Lo Wan, San Shek Wan, Airport Island and Scenic Hill, were surveyed between September 2003 to May 2004 in the **EBS**. Habitats recorded included developed area (e.g. North Lantau Highway, Airport Island), wasteland, shrubby grassland and woodland.

10.4.2.8 A large portion of the current 500m Terrestrial Assessment Area (about 1600 ha) is currently sea area (about 1,100 ha) (**Figures 10.4a-c & 10.5 & 10.6**). Terrestrial habitats within the elongated 500m assessment area are located in the middle to eastern parts on Airport Island and along the North Lantau shore from San Tau to

Sha Lo Wan. Habitats recorded in previous studies were reviewed and renamed in the **EVS** study. As it was found during the field surveys, and from the review of aerial photos of the last few years and the habitat maps prepared by those previous studies, the land use within the 500m Assessment Area was similar with that in the time of the previous studies, with minor changes in the boundaries at certain locations. For example, some grassland habitat at Scenic Hill has been replaced by the Angle Station of Tung Chung Cable Car. But these changes were minor and did not significantly change the ecological profiles of the area. Other than the Cable Car project which has small footprints on non-developed areas, there was no major development implemented within the 500m assessment area in the last few years. The information provided by the previous studies such as **EBS** should therefore still be valid in general.

10.4.2.9 A total of 14 habitat types were identified in the current 500m assessment area. Terrestrial habitats recorded included woodland, shrubland, grassland, stream/channel, plantation, and developed area (**Figures 10.4a-c & 10.5 & 10.6**). Among these habitats, developed area on Airport Island is the predominant habitat type (over 350 ha), while tall shrubland also contribute a significant proportion (42.7 ha). Other habitat types (Grassland/shrubland, Secondary woodland and Plantation etc.) with a much lower area size.

Table 10-2 Coverage of Different Habitats within the 500m Assessment Area

Habitat Type	Area (ha)	No. of plant species recorded
Active Dry Agriculture	0.05	NA
Associated Mangrove	0.80	20
Developed Area	About 350	111
Grassland	0.40	19
Grassland/ Shrubland	15.22	96
Mangrove	0.14	18
Plantation	15.37	67
Mudflat	0.14	NA
Seasonally Wet Grassland	0.64	85
Secondary Woodland	17.73	90
Shrubland	10.50	Included by grassland/shrubland
Stream	1.35	50
Tall Shrubland	42.70	123
Young Woodland	3.84	49

10.4.2.10 A total of 307 plant species were identified within the current 500m assessment area. Tall shrubland, secondary woodland, grassland/shrubland and developed area support higher plant species diversities, with 123, 90, 96 and 111 plant species respectively, than other coastal and riparian habitats.

10.4.2.11 Low numbers (3-5 individuals) of the tree *Pavetta hongkongensis* were identified in tall shrubland close to Hau Hok Wan. This species is protected under the Forestry Regulations (Cap. 96A) but it is a common tree species found in tall shrubland and young woodland in Hong Kong (Xing *et al*. 2000).

10.4.2.12 The insectivorous herb *Drosera indica* was identified on the rock surface of a stream at Hau Hok Wan. Approximately 40 individuals of *D. indica* were identified in both dry and wet season surveys. This herbaceous plant is identified as a very rare plant only found in Tung Chung (Xing *et al*. 2000) but receives no protection by law

in Hong Kong (South China Institute of Botany & AFCD 2003). It has been listed as "Least Concern" in China.

10.4.2.13 Around six individuals of orchid *Eulophia graminea* were identified within the stone crevices along a stream at Hau Hok Wan. This orchid species is a restricted terrestrial herb found in the grassland and highly disturbed areas (Siu 2000, Xing *et al*. 2000). All wild native orchid species are protected under the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) and the Forestry Regulations (Cap. 96A) in Hong Kong. It is also classified as a restricted species by Siu (2000).

10.4.2.14 Several tree specimens and seedlings of *Aquilaria sinensis* were identified along the footpath near the tall shrubland from Hau Hok Wan to Sha Lo Wan and within the secondary woodland of the Scenic Hill in Chek Lap Kok Island. Due to potential threats of habitat destruction and over-exploitation in China, this tree species is regarded as "Near Threatened" in the China Plant Red Data Book and the Illustrations of Rare & Endangered Plants in Guangdong Province. It is listed as a Category II nationally protected species in China (South China Institute of Botany & AFCD 2003). This species is, however, common in lowland forest and Fung Shui woodlands (Xing *et al*. 2000) and currently is protected under the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586).

10.4.2.15 Numerous individuals of tree *Thespesia populnea* were identified along the coastal and associated mangrove habitats of the Study Area. This is a tree species restricted to coastal habitats (Xing et al. 2000) and is regarded as a rare associate mangrove species (present in only nine of 43 mangrove stands) in a territory-wide mangrove study by Tam and Wong (1997). However, T. populnea has no protection by law in Hong Kong.

10.4.2.16 An individual of shrub/small tree *Drosera viscosa* was recorded near the tall shrubland close to the coastline at Sha Lo Wan. This is regarded as a rare species only found in Ham Tin and Tung Chung (Xing *et al.* 2000), but it is not protected by law in Hong Kong.

10.4.2.17 Two seagrass species, *Halophila* sp. and *Zostera japonica* were recorded along the mangrove fringe within the San Tau Beach SSSI. The seagrass bed at San Tau mudflat and mangrove stands is regarded to be of high conservation value and its locality is designated as San Tau Beach SSSI for better protection by law (South China Institute of Botany & AFCD 2003). In addition, all established seagrass beds are considered to be an important habitat under the Environmental Impact Assessment Ordinances and any potential developmental disturbances and/or impacts should be avoided or minimized (Kwok *et al*. 2005).

10.4.2.18 Three natural habitats are of particular concerns, i.e. the young woodland in Sha Lo Wan headland, on which the viaduct will span over, the grassland/shrubland habitat on Scenic Hill where direct impact from the latest alignment is anticipated, and the secondary woodland on Scenic Hill, where remnant population of Romer's Tree Frog was recorded previously and is potentially subject to direct impacts under some earlier alignment options.

10.4.2.19 The headland at Sha Lo Wan is young woodland habitat. Under natural succession, this young woodland has evolved from tall shrubland by developing a denser and more complex canopy coverage and structure. The young woodland is dominated by the trees *Sterculia lanceolata*, *Microcos paniculata*, *Ardisia quinquegona*, *Myrsine seguinii*, *Schefflera heptaphylla* and *Garcinia oblongifolia*, with the understorey containing shrubs such as *Psychotria asiatica*, *Desmos chinensis*, *Ardisia crenata*, *Ilex asprella*, *Ilex pubescens* and seedlings of tree species including *Daphniphyllum calycinum*, *Archidendron clypearia* and *Archidendron lucidum*.

10.4.2.20 The majority of the grassland/shrubland habitat within the 500m Assessment Area is on North Lantau, and typically dominated by grasses *Panicum maximum*, *Imperata koenigii*, *Ischaemum* spp., *Rhynchelytrum repens* and *Neyraudia reynaudiana*, herbs *Bidens alba*, *Eupatorium catarium*, *Mimosa pudica*, *Aster*

baccharoides, *Inula cappa*, isolated shrubs *Melastoma candidum*, *Rhaphiolepis indica*, *Rhodomyrtus tomentosa*, *Ilex asprella*, *Osbeckia chinensis*, *Clerodendrum fortunatum*, *Baeckea frutescens*, *Breynia fruticosa* and *Eurya chinensis* and trees *Zanthoxylum avicennae*, *Litsea rotundifolia* var. *oblongifolia*, *Schefflera heptaphylla*, *Aporusa dioica*, *Ficus hirta*, *Ficus variolosa* and *Itea chinensis*. The grassland/shrubland habitat on North Lantau is adjacent with other natural habitats, and might undergo further succession in time. This habitat type is also found on the western and southeast of Scenic Hill on Airport Island. Scenic Hill however is isolated from other natural habitat and surrounded by developed areas and sea area. The secondary woodland in Scenic Hill is typical of other woodlands in Hong Kong. It is dominated by *Sterculia lanceolata*, *Schefflera heptaphylla*, *Celtis sinensis*, *Tetradium glabrifolium* and *Microcos paniculata* as the overstorey (8 – 10 m high). Its understorey is dominated by common and widespread shade-tolerant species including shrubs and small tree species such as *Psychotria asiatica*, *Litsea rotundifolia* var. *oblongifolia*, *Melicope pteleifolia*, *Sarcandra glabra*, *Bredelia tomentosa*, *Zanthoxylum avicennae* and *Uvaria macrophylla*. Seedlings of the trees *Archidendron clypearia* and *Aquilaria sinensis* were found occasionally in the understorey.

10.4.2.21 Besides the above, there were also intertidal habitats (including artificial seawall, natural shore, mangrove and intertidal mudflat), marine waters, and other terrestrial habitats (agricultural land) recorded within the 500m boundary or inside Tai Ho area. These habitats would be covered in the later sections on intertidal ecology, marine ecology, and Tai Ho area.

Terrestrial Fauna within the 500m Assessment Area

10.4.2.22 The surveyed terrestrial habitats within the 500m Assessment Area were urbanised/disturbed (including artificial coastlines), stream/channel, woodland, grassland, and shrubland. The recorded fauna were typical of disturbance tolerant, due to the high disturbance level within the Assessment Area. More than 60% of the terrestrial habitats within the 500m Assessment Area are Developed Area, which is under high level of human disturbance. Grassland/shrubland made up 4.55% of total area of terrestrial habitats. Fauna diversity in this type of habitat is generally low (Dudgeon and Corlett 1994, 2004). Plantations of exotic species made up only 4.59% of total area of terrestrial habitats. This type of habitat, particularly young ones, generally supports low fauna diversity (Dudgeon and Corlett 1994, 2004). Woodland and tall shrubland exist as small isolated patches in the Assessment Area, and mainly support disturbance tolerant species or habitat generalists.

Birds within the 500m Assessment Area

10.4.2.23 A total of 77 species was reported from Chek Lap Kok airport (Carey *et al*. 1998, 1999, 2002). This high species richness was at least partially attributed to the fact that birds are more visible at the airport, but does not indicate the ecological importance of the Chek Lap Kok airport as a bird habitat. A total of 136 bird species was recorded in the Kai Tak Airport (Melville 1979), but it was concluded that most of the bird species were grounded by adverse weather, and would leave once their condition recovered. The former Kai Tak Airport provided little food for birds (*ibid*.). The situation on Chek Lap Kok airport is likely to be similar.

10.4.2.24 Use of inter-tidal mudflats near San Tau by ardeids (e.g., Reef Egret, Little Egret) was reported in the EIA study of the Tung Chung – Ngong Ping Cable Car Project (Mott 2003).

10.4.2.25 A total of 61 bird species was recorded during the **EVS** study. Of these 61 species, 14 are listed by Fellowes *et al*. (2002) as species of conservation concern; 10 of the 14 species of conservation concern are also wetland dependant species, and were observed on the shoreline of northern Lantau and the artificial seawall of Chek Lap Kok. These species included Grey Heron, Great Egret, Little Egret, Pacific Reef Egret, Straited Heron, Black-crowned Night Heron, Little Ringed Plover, Whimbrel, and Grey-tailed Tattler. Birds utilizing coastal habitats should be of higher concern

in the present Project as the majority of terrestrial habitats to be affected are the coastal areas along the Airport Channel and Airport eastern shore.

10.4.2.26 Apart from Pacific Reef Egret, all are common and widespread in Hong Kong (Carey *et al.* 2001). Bird abundance and species richness were low in all surveyed habitats. The low diversity in developed area, and artificial coastline was related to the high human disturbance and low food abundance. Grassland and plantations of exotic species generally support low diversity of bird (Kwok and Corlett 2000, Kwok and Dahmer 2002), due to low food abundance and simple habitat structure. Woodland and shrubland exist as small isolated patches, and support bird species basically similar to those in surrounding habitats (developed area, grassland).

10.4.2.27 Bird species that are locally rare or regional/global protected were considered of conservation concern. Among the water-dependent birds, only Pacific Reef Egret *Egretta garzetta* is Class 2 Protected Animals of PRC (Zheng and Wang 1998). Pacific Reef Egret is mainly found in rocky coastlines of widespread localities (Carey *et al.* 2001).

Mammals within the 500m Assessment Area

10.4.2.28 During the EIA study of the Tung Chung – Ngong Ping Cable Car Project, Indian Muntjac was observed in tall coastal shrub/ woodland off the coastal path near Hau Hok Wan in May 2002, and in woodland of the San Tau Valley and Ngau Au Area in early October 2002 (Mott 2003). Scats of Ferret Badger or civet were found near San Tau Valley (*ibid*.). Indian Muntjacs were recorded in tall shrubland of Sha Lo Wan in September 2003 and April 2004 during the EBS study. The common rat *Rattus norvegicus* was observed around San Tau village during the course of the survey during the field surveys for the EIA of Tung Chung Cable Car Project (Mott 2003).

10.4.2.29 Only three species of mammal were recorded during the **EVS** study. A Red Muntjac *Muntiacus muntjac* was seen in the village section of San Tau stream. In addition, footprints of Muntjac deer, presumably Red Muntjac, were observed in the soft sand at the beach close to the mouth of a stream at San Tau. Red Muntjac (as Indian Muntjac) is listed as being of Potential Regional Concern following Fellowes *et al*. (2002) and is protected under the Wild Animals Protection Ordinance (WAPO). This small deer is widespread in Hong Kong (Shek and Chan 2006).

10.4.2.30 The skull of a Eurasian Wild Pig *Sus scrofa* was found on the beach at Sha Lo Wan. This species has a widespread distribution in Hong Kong (Shek and Chan 2006). The third mammal is unconfirmed rat species (*Rattus* sp.) near San Tau and Hau Hok Wan.

10.4.2.31 Four species of non-cave dwelling bats were recorded in San Tau and nearby areas by AFCD (Shek and Chan 2006). These were Japanese Pipistrelle *Pipistrellus abramus*, Short-nosed Fruit Bat *Cynopterus sphinx*, Lesser Yellow Bat *Scoptophilus kuhlii* and Whiskered Myotis *Myotis muricola*. Both Japanese Pipistrelle and Short-nosed Fruit Bat are very common in Hong Kong. Lesser Yellow Bat is uncommon while Whiskered Myotis is rare in Hong Kong. Yellow House Bat often roosts in the attics of houses, but it also roosts under the modified fronds of palm trees next to the Short-nosed Fruit Bat, holes in walls or even in an abandoned bird nest (Lin *et al*. 2005 in Shek and Chan 2006). Whiskered Myotis is reported to roost in the central curled leaves of banana trees, and occasionally in caves in Thailand (Lekagul and McNeely 1988 in Shek and Chan 2006).

Reptiles within the 500m Assessment Area

10.4.2.32 Seven species of reptiles, all common and widespread in Hong Kong (Karsen et al. 1998) and not of conservation concern, were seen across wet and dry season surveys of the **EVS** (**Appendix 10B**). Two species of gecko, Chinese Gecko *Gekko chinensis* and Bowring's Gecko *Hemidactylus bowringii*, were recorded in villages, particularly the abandoned village houses on Scenic Hill. Three species of skink (Chinese Skink *Eumeces chinensis*, Long-tailed Skink *Mabuya longicaudata* and Reeves' Smooth Skink *Scincella reevesii*) were recorded primarily on woodland/shrubland edges. Juvenile Long-tailed Skinks were also common

amongst the leaf-litter of the abandoned village on Scenic Hill. Changeable Lizard *Calotes versicolor* was seen in waste ground on the edge of Sha Lo Wan. There was also one exotic species of terrapin, Red-eared Slider *Trachemys scripta*. No snakes were seen during any of the surveys.

10.4.2.33 During the EIA study of the Tung Chung – Ngong Ping Cable Car Project, Long-tailed Skink *Mabuya longicaudata* and Copperhead Racer *Elaphe radiata* were recorded in San Tau (Mott 2003). Both are common and widespread in Hong Kong (Karsen *et al*. 1998). Long-tailed Skink and Copperhead Racer occur in many types of habitats (*ibid*.).

10.4.2.34 Checkered Keelback *Xenochrophis piscator* was recorded at mangroves near San Tau (Mott 1998). This species is common and widespread in lowland wetlands in Hong Kong (Karsen *et al*. 1998).

10.4.2.35 Two species of snakes were reported from the Airport island (Chan *et al*. 2006a). These were Large-spotted Cat Sanke *Boiga multomaculata* and Chinese Cobra *Naja atra*. Both are common and widespread in Hong Kong. Chinese Cobra is considered to be of Potential Regional Concern (Fellowes *et al*. 2002). This species occurs in various types of habitats, including woodlands, shrublands, grasslands and mangroves. The Airport island is mostly developed and of high level of disturbance and is not considered optimal habitat of Chinese Cobra.

10.4.2.36 Chinese Gecko *Gekko chinensis* and Bowring's Gecko *Hemidactylus bowringii* were reported from the Airport island and San Tau respectively (Chan *et al*. 2006b). Both species are very common in Hong Kong.

Amphibians within the 500m Assessment Area

10.4.2.37 Four species of amphibians were recorded during the EVS in the 500m Assessment Area (**Appendix 10B**), Chinese Bullfrog *Hoplobatrachus chinensis*, Lesser Spiny Frog *Paa exilispinosa*, Asian Common Toad *Bufo melanostictus* and Asian Painted Frog *Kaloula pulchra*. Chinese Bullfrog is a Class II Protected Animal in China and is considered to be of Potential Regional Concern in Hong Kong owing to depletion of wild populations for the food trade (Fellowes *et al*. 2002, Chan *et al*. 2005a). An adult Chinese Bullfrog was seen in a drain at Scenic Hill. The species has previously been recorded on Chek Lap Kok (Chan *et al*. 2005a).

10.4.2.38 Tadpoles of Lesser Spiny Frog were observed in the streams between San Tau and Hau Hok Wan. This species is regarded as Vulnerable by IUCN Redlist (2009) and is considered to be of Global Concern (Fellowes *et al*. 2002), although it is widely distributed and common in suitable habitat in Hong Kong (Chan et al. 2005a). The remaining two species are common and widespread in Hong Kong (Karsen *et al*. 1998, Chan *et al*. 2005a).

10.4.2.39 Romer's Tree Frog was not recorded during the **EBS** study or the **EVS** study. The endemic Romer's Tree Frog was discovered on Lamma Island in 1952 (Lau and Dudgeon 1999). The other locations with records of this species included Chek Lap Kok, Lantau and Po Toi (Karsen *et al*. 1998). This species is protected under the Wild Animals Protection Ordinance, Cap. 170. The habitat characteristics of Romer's Tree Frog were studied in details by Lau (1998). Romer's Tree Frog lives on forest floor and breed in shaded, slow-flowing or stagnant waters including man-made structure. The diet of this species consists of small forest litter invertebrates (Lau 1998). Ngong Ping is known to support the largest population of this endemic frog (*ibid*.) and has been designated as a Site of Special Scientific Interest (SSSI). Given its small size, predation pressure from larger amphibians and limited mobility, Romer's Tree Frog is very sensitive to habitat fragmentation.

10.4.2.40 Prior to the construction of Chek Lap Kok International Airport, populations of Romer's Tree Frog on Chek Lap Kok were collected, captive bred and translocated to localities with suitable local habitats (Lau 1998) as a mitigation measure for the PADS project. Breeding of translocated populations was monitored between 1994 and 1997 (*ibid*.). Regular breeding was recorded at half of the translocated sites (*ibid*.).

10.4.2.41 While it was believed that the population on Chek Lap Kok would be exterminated by the construction of the new airport, a single specimen was caught at the abandoned village on the south side of the former island in July 2000 (Lynch 2001). The presence of old water tubs and pitchers maintain pools of rain water, which provide breeding habitats for Romer's Tree Frog. This enabled survival of a small population.

10.4.2.42 Indeed Romer's Tree Frog has demonstrated a high adaptability elsewhere in Hong Kong. For example at Lamma Island a population was found in a patch of grassland receiving seepage flow from an adjacent engineered slope (Halcrow China Ltd. 2002). A number of tadpoles of Romer's Tree Frog were also found in seasonal streams at Ngong Ping (Arup 2002). In addition, this species can also breed in artificial breeding sites (e.g., pots) (Lau 1998).

10.4.2.43 Besides the **EBS** study and the **EVS** study, night survey conducted for Cable Car EIA study at Scenic Hill aimed at verifying Lynch's finding also failed to find any evidence of Romer's Tree Frog (Mott 2003). The general environment and topography of Scenic Hill have not changed significantly since the discovery of the frog in 2000. Breeding habitat of Romer's Tree Frog is also present on Scenic Hill (e.g., streams, old water tubs and pitchers). Tadpoles of this species were seen earlier in 2008 as part of the on-going monitoring by AFCD (**Appendix 10B**). Therefore it is reasonable to adopt a precautionary approach assuming that some individuals still survive in the area. This makes Scenic Hill the only location on Airport Island supporting Romer's Tree Frogs that are descended from the original Chek Lap Kok population.

10.4.2.44 Some amphibian species were recorded in the Airport island by AFCD (Chan *et al*. 2005b). These included Asian Common Toad *Bufo melanostictus*, Short-legged Toad *Xenophrys brachykolos*, Asiatic Painted Frog *Kaloula pulchra*, Butler's Pygmy Frog *Microhyla butleri*, Paddy Frog *Fejervarya limnocharis*, Chinese Bullfrog *Hoplobatrachus chinensis*, Three-striped Grass Frog *Rana macrodactyla* and Brown Tree Frog *Polypedates megacephalus*. All are common and widespread in Hong Kong. Chinese Bullfrog is a Class 2 Protected Animal of PRC. Short-legged Toad is potentially endemic to Hong Kong, and is considered of "Potential Global Concern (Fellowes *et al*. 2002).

Dragonflies within the 500m Assessment Area

10.4.2.45 A common damselfly species Marsh Dancer *Onychargia atrocyana* was reported in Sha Lo Wan (Wilson 2004). This species occurs in wet abandoned cultivated lands (*ibid*.).

10.4.2.46 The dragonfly species, Small Hooktail *Melliogomphus moluamis*, which is considered globally threatened by Fellowes *et al*. (2002) was recorded at San Tau during the EBS (**Appendix 10A**). Very little is known about the habitat requirements of this species (Wilson 2004).

10.4.2.47 Only seven dragonfly species were recorded during the **EVS** study, none of which are considered to be of conservation concern. By far the most numerous and widespread species recorded was the Wandering Glider *Pantala flavescens*, with many hundreds seen across the site over all habitats. This is the most common species in Hong Kong (Wilson 2004). Other than Wandering Glider, all other species were recorded only outside the proposed HKLR alignment, within the limits of stream and/or irrigation ditches across the 500m assessment area. Both abundance and species richness of dragonfly were low in all habitats within the Assessment Area. The low diversity of dragonfly within the Assessment Area was related to the paucity of natural freshwater habitats.

Butterflies within the 500m Assessment Area

10.4.2.48 Danaid Eggfly *Hypolimnas misippus*, considered of conservation concern according to Fellowes *et al*. (2002), was found in shrubby-grassland in Scenic Hill during the EBS study.

10.4.2.49 A total of 58 butterfly species was recorded during the **EVS** study. Most species occur in shrubland (32) with 24 species recorded in woodland and 15 species recorded from village habitats. Few records of butterflies were made from the intertidal habitats (i.e. soft shore, hard shore and mangrove), as would be expected from the paucity of suitable food plants in this habitat. Common Mormon *Papilio polytes* was the most widespread species, occurring in various habitat types. This species is very common and widespread in Hong Kong (Lo & Hui 2005). Among the species recorded, only White Dragontail *Lamproptera curius* recorded at a stream in San Tau stream is considered to be of conservation concern (Local Concern in Fellowes *et al*. 2002).

10.4.2.50 The hillside along the coastline from Tung Chung to Tai O is a recommended butterfly watching route by the Lepidopterist's Society (Young and Yiu 2002). Rare species such as Hainan Palm Dart *Telicota besta* and Common Awl *Hasora badra* are reported from this trail (*ibid*.).

10.4.2.51 Two locations within the Study Area – San Tau and Sha Lo Wan – have been identified as important sites for butterflies in Hong Kong (Young and Yiu 2002).

10.4.2.52 A total of 89 species of butterfly have been recorded in San Tau (Yiu 2004). Uncommon/rare butterfly species reported in this location include Golden Birdwing *Troides aeacus*, White Dragontail *Lamproptera curius*, Plain Cupid *Chilades pandava*, Falcate Oak Blue *Mahathala ameria*, Red Lacewing, White-edged Blue Baron *Euthalia phemius* (*ibid*.). Important butterfly habitats identified in San Tau include ravine woodland, *fung shui* forest and orchard (*ibid*.).

10.4.2.53 A total of 81 species of butterfly have been recorded in Sha Lo Wan (Yiu 2004). Uncommon/rare butterfly species reported in this location included Swallowtail, Red Lacewing, Yellow Orange Tip, Cornelian *Deudorix epijarbus*, Silver Streak Blue *Iraota timoleon*, Dark Blue Tiger *Tirumala septentrions* (*ibid*.). Important butterfly habitats in Sha Lo Wan include *fung shui* forest and abandoned cultivated land (*ibid*.).

Stream Fish within the 500m Assessment Area

10.4.2.54 Several species of conservation interest were recorded in streams within the 500m assessment area, including Beijiang Thick-lipped Barb *Acrossocheilus beijiangensis*, Dark-margined Flagtail *Kuhlia marginata*, Rice Fish *Oryzias curvinotus*, the Indo-Pacific Tropical Sand Goby *Favonigobius reichei*.

10.4.2.55 Beijiang Thick-lipped Barb is a rare species and only appears in several locations including streams on Lantau Island (Lee *et al.* 2004) and it is also considered to be of Global Concern (Fellowes *et al*. 2002). One individual was observed in the midstream section of a stream near San Tau (i.e. ST9).

10.4.2.56 Dark-margined Flagtail *Kuhlia marginata* was observed at the same stream. This species was regarded as locally endangered in a recent EIA Study Report (DSD 2005). It is regarded to be of Regional Concern by Fellowes *et al*. (2002), but its status was not evaluated by Lee *et al*. (2004) or AFCD (2009). Since freshwater streams are important nursery habitats for this catadromous species (Oka & Tachihara 2008), ST9 is considered to have potential to be a nursery habitat for this species.

10.4.2.57 Rice Fish *Oryzias curvinotus* was found at three stream sites and is a species considered to be of Global Concern (Fellowes *et al*. 2002) which is uncommon in the wild in Hong Kong (Lee et al. 2004). Although it is generally considered to be a freshwater species, it can inhabit brackish environments (Froses & Pauly 2008) and a large population was seen in the mangrove area of Tung Chung Bay (**Appendix 10B**). a small population of Rice Fish was observed in the lower reaches of ST9, and only single individuals of this species were seen in the lower sections of the other two stream sites near Hau Hok Wan (HH3 and HH5).

10.4.2.58 Predaceous Chub *Parazacco spilurus* is common and widespread in Hong Kong (Lee et al. 2004), but is regarded as a vulnerable species in Mainland China (Yue & Chan 1998, CSIS 2008).

10.4.2.59 Populations of over 100 individuals of this species were seen in the middle sections of ST9 and SL3. The Indo-Pacific Tropical Sand Goby Favonigobius reichei, which is regarded as "Lower Risk/ Near Threatened" by IUCN (2009), was found in the lower sections of several streams surveyed. Whilst it is regarded globally as Near Threatened, this species is common and widespread in the intertidal area in Hong Kong (Lee et al. 2004, Nip 2005).

Stream Invertebrates within the 500m Assessment Area

10.4.2.60 The Sesarmine Crab species Chiromantes sereni was found in the lower sections of HH3 and SL3. This species was first recorded in Hong Kong by Soh (1978) and is reported to be endemic (Kwok & Tang 2005). Although its conservation status is not fully understood, it was only found at four sites in a recent territory-wide Sesarmine Crab survey (Kwok & Tang 2005).

10.4.2.61 *Somanniathelphusa zanklon*, another endemic crab species, was also found in the Current Study. Although this species has been found to be quite abundant in Lantau and other places in Hong Kong (DSD 2002, EPD 2007), it is regarded as an endangered species by IUCN due to its restricted distribution (IUCN Redlist 2009). Two juveniles of this species were recorded in ST12. This small stream has potential to provide a nursery habitat for this endangered species.

10.4.2.62 Greasyback Shrimp *Metapenaeus ensis* juveniles were recorded in the lower section of the streams ST9 and SL3. Shrimps belonging to the genus Metapenaeus are commercially important and were extensively cultured in the Gei Wai of Mai Po in the past. They are common in mangrove and estuarine areas in Hong Kong (Leung 1999, Vance 1999). Due to over-exploitation, all four *Metapenaeus* species found in Hong Kong (including *M. ensis*) are considered to be Vulnerable in China (CSIS 2008). Shallow estuarine areas in Hong Kong have the potential to provide nursery habitats for these species.

10.4.3 Marine and Intertidal Ecological Baseline

Marine Recognized Sites of Conservation Importance and important habitats

10.4.3.1 Recognised Sites of Conservation Importance at intertidal zone are divided into two groups, i.e. those within the North Western and North Western Supplementary WCZs, and those within the marine ecological assessment area for the EIA Study.

Within the North Western and North Western Supplementary Water Control Zones

10.4.3.2 There are several Recognised Sites of Conservation Importance and important habitats located Within the North Western Water Control Zone:

- Site of Special Scientific Interest (SSSI) at San Tau Beach;
- Horseshoe crab nursery sites at Sham Wat, Hau Hok Wan, San Tau, Tung Chung Bay, Tai Ho Wan;
- Tai Ho Stream SSSI;
- Seagrass site at Yam O;
- Artificial reefs;
- Sha Chau and Lung Kwu Chau Marine Park;
- The proposed Marine Park at Fan Lau; and
- Marine waters in North and West Lantau waters as dolphin habitats (in particular dolphin hotspots).

Within the Marine Ecological Assessment Area of the EIA Study

10.4.3.3 There are further Recognised Sites of Conservation Importance and important habitats located at intertidal and subtidal zones within the marine ecological assessment area as follows:

- The proposed Marine Park at Soko Islands;
- Horseshoe crab nursery site at Shui Hau: Shui Hau, which is the third identified horseshoe crab nursery sites in Hong Kong (Chiu & Morton 1999);
- Pak Nai SSSI: Pak Nai SSSI was designated in 1980 for its function as roost site for gulls and terns in the Deep Bay area;
- Seagrass beds and Horseshoe crab nursery site in Pak Nai: Pak Nai is one of the three confirmed horseshoe crab nursery site (Chiu and Morton 1999) and also harbours the largest seagrass beds in Hong Kong (Fong 1998);
- Mai Po and Inner Deep Bay Ramsar Site;
- Inner Deep Bay SSSI; and
- Tsim Bei Tsui SSSI.

10.4.3.4 The coastal areas of the southeast shore of Airport Island, southward to the Marine Cargo Terminal, are zoned as "Coastal Protection Area" (CPA) in the outline zoning plan for Chek Lap Kok.

10.4.3.5 In addition to the above recognised sites, another SSSI, i.e. The Lung Kwu Chau, Tree Island and Sha Chau SSSI, designated as Site of Special Scientific Interest on 20 September 1979, is also located within the study area. Pak Chau (Tree Island), a small island located closed to the western boundary of Sha Chau and Lung Kwu Chau Marine Park, is an important night-time roosting site for wintering Cormorants *Phalacrocorax carbo* in Hong Kong. This SSSI, however, is not included in the present assessment as the Lung Kwu Chau, Tree Island and Sha Chau SSSI only covers the land areas of the islands within the Marine Park.

San Tau Beach SSSI

10.4.3.6 Tung Chung Bay is the largest lowland and river mouth habitat on North Lantau, as well as within the marine ecological assessment area except inner Deep Bay, and has extensive mudflats. San Tau Beach SSSI, designated in 1994, is a shallow sheltering beach of about 2.7 ha with fine sand and silt at the west coast of Tung Chung Wan. San Tau harbours the largest seagrass area on Lantau. Two species of seagrasses, *Zostera japonica* and *Halophila ovalis*, were recorded at San Tau Beach. San Tau is the only site located in western waters among the three known sites in Hong Kong where *Zostera japonica* is found. This species of seagrass was previously thought to be limited to the temperate regions, and is thus of special interest to plant biogeography. In the site, there are also trees of the mangrove species *Bruguiera gymnorrhiza*, which was previously thought to be rare but is now considered locally uncommon. Besides seagrass beds, it is also one of the three recognized horseshoe crab nursery sites Hong Kong (Huang *et al*. 1999; Chiu and Morton 1999, Shin et al. 2007).

Horseshoe Crabs and Horseshoe Crab Nursery Sites at Sham Wat, Hau Hok Wan, San Tau, Tung Chung Bay, Tai Ho Wan.

10.4.3.7 Horseshoe crabs are an ancient and taxonomically isolated group (class Merostomata, sub-class Xiphosura) related to spiders, ticks and mites. Though not presently protected under local law, Horseshoe crabs have been identified as a species of conservation importance in Hong Kong. Three species have been reported in HKSAR waters: *Tachypleus tridentatus*, *T. gigas* and *Carcinoscorpius rotundicauda* (Chiu & Morton 1999). These represent all species known from the South China Sea, and three of four species known worldwide. All three species appear to be undergoing rapid population declines and are thought to be under severe pressure in the South China Sea, including Hong Kong waters, due to habitat loss, pollution and over exploitation (Huang 1997; Chiu and Morton 1999, 2003; Chiu 2003; Morton and Lee 2003). Information on abundance of these species is limited, but Liang and Zhou (1987) note that in surveys in Beibu Bay, Guangxi/Guangdong, *T. tridentatus* made up 90% of the catch and the other two species together made up only 10%.

10.4.3.8 In an extensive study of the distribution of horseshoe crabs in Hong Kong conducted between March 1995 and June 1998 *Tachypleus gigas* was not recorded and its local status is uncertain (Chiu and Morton 1999.) It is likely that only two species of horseshoe crab (*T. tridentatus* and *C. rotundicauda*) are currently widely distributed in Hong Kong as no recent records of *T. gigas* are available (Chiu and Morton 1999; Mouchel 2002c). Liao et al. (2001) also did not record *T. gigas* in their extensive surveys (September 1994 to June 1998) of the South China Sea (from Hainan to Xiamen). All three species of Indo-Pacific horseshoe crabs appear to be in population decline and are thought to be under severe pressure in the South China Sea, including HKSAR waters, due to habitat loss and overexploitation (Huang 1997). The most critical habitat is the sandy shore and sandy backshore where adult horseshoe crabs mate and lay eggs. Horseshoe crabs have been identified as species of conservation importance in the HKSAR, and regarded as Vulnerable by CSIS (2008).

10.4.3.9 Horseshoe crabs, most commonly *T. tridentatus*, have been recorded in the HKSAR at Tap Shek Kok, Sha Chau, Tai Po and Peng Chau, though there are no recent records from any of these sites (Huang 1997). *C. rotundicauda* was recorded in 1997 from Ma Wan Chung, Lantau, at a site that would be lost to development of the Tung Chung New Town (*ibid*.). The other areas where horseshoe crabs have been recorded in the HKSAR are on the shores of Outer Deep Bay and the waters around Black Point-Tap Shek Kok.

10.4.3.10 Horseshoe crabs are currently more often found in western waters of Hong Kong, though they were once thrived on many beaches in Hong Kong including Tolo Harbour (Huang 1997; Huang *et al*. 1999).

10.4.3.11 During the Crosslinks 2 study, horseshoe crabs were reported to have been recorded from trawl surveys at Tap Shek Kok, and beaches at Lung Kwu Sheung Tan and Lung Kwu Tan were thought once to be breeding grounds for horseshoe crabs, based upon information from the residents in Lung Kwu Tan (Mouchel 1999). It was also reported that spawning of horseshoe crabs was seen in Lung Kwu Sheung Tan many years ago (Huang *et al*. 1999).

10.4.3.12 Confirmed nursery sites for horseshoe crabs in recent years included Pak Nai, San Tau and Shui Hau (Huang *et al*. 1999), together with Tai Ho Wan (Fong 1999). Some other beaches on Lantau, including Tai O, Yi O, Sham Wat Wan, Sha Lo Wan and Tung Chung, are considered of high possibility due to the records that adult horseshoe crabs were frequently fished offshore (Huang *et al*. 1999).

10.4.3.13 At a territory-wide study, three locations, i.e. Pak Nai in Deep Bay, San Tau near Tung Chung, and Shui Hau at south Lantau, are identified as important horseshoe crab nursery sites, all of which are located at western waters (Chiu & Morton 1999). San Tau is identified as one of the key ecological issues for the present study.

10.4.3.14 Two species of horseshoe crab, *Tachypleus gigas* and *Tachypleus tridentatus*, have been recorded from trawl surveys at Tap Shek Kok just south of Lung Kwu Tan, and the beaches at Lung Kwu Sheung Tan and Lung Kwu Tan have been identified as potential breeding sites for *T. gigas* (ERL 1993, ERM 1996). Juvenile horseshoe crabs are seen by fishermen in the intertidal zone from Sheung Pak Nai to Ngau Hom Shek, but adults are seldom seen.

10.4.3.15 In Deep Bay the preferred habitat was identified as sandy to muddy intertidal zones, which appear to provide habitats for mating and egg laying, and for juveniles. Currently, Ha Pak Nai in Deep Bay, together with San Tau near Tung Chung and Shui Hau in South Lantau, are regarded as nursery sites for horseshoe crabs (Chiu & Morton 1999).

10.4.3.16 *T. tridentatus* and *C. rotundicauda* have been recorded at Tai Ho Wan, Tung Chung Wan, San Tau and Sha Lo Wan and Sham Wat (Huang 1997; Chiu and Morton 1999; Fong 1999; Mouchel 2000 2002c; Mott 2003). Specimens of horseshoe crabs were also collected in north Lantau waters (ERM 1997; Chiu and Morton 1999).

Tai Ho Stream SSSI

10.4.3.17 The Tai Ho Stream SSSI is about 5ha in area and comprises two main components: Tai Ho Stream and the inner part of Tai Ho Wan. "Tai Ho Stream" includes several tributaries that lie to the south and east of Tai Ho Wan, passing Tin Liu, Tai Ho San Tsuen, and merging just below Ngau Kwu Long, and entering Tai Ho Wan at its southern end. Tai Ho Stream is one of the most ecologically valuable fresh water streams in Hong Kong. Chong and Dudgeon (1992) recorded the salmonid fish Ayu ("sweetfish") *Plecoglossus altivelis* at Tai Ho Stream, the first record and the only site of occurrence of this species for Hong Kong or Guangdong (Dudgeon 1993). This species requires unobstructed passage between salt and fresh water to breed. The high water quality and natural state of Tai Ho Stream are likely very important to this species.

10.4.3.18 The importance of Tai Ho Stream to Hong Kong's freshwater fish fauna, and the linkages to other ecologically important intertidal habitats in Tai Ho Wan, qualify Tai Ho Stream as a habitat of high ecological value. Conservation and prevention of damage to the stream channel and riparian zone is essential. The Tai Ho Stream and part of its estuarine zone were designated as an SSSI in 1999 in recognition of the ecological importance of the stream and its fish fauna.

Seagrass site at Yam O

10.4.3.19 Seagrasses were recorded in Yam O (Sunny Bay) during a territory-wide seagrass survey conducted by AFCD (Kwok *et al*. 2004). About 0.75 ha of *Halophila ovalis* was found at this location and made it a new seagrass locality (*ibid*). *H. minor* was also reported in this site (Yip and Lai 2006).

Artificial Reefs

10.4.3.20 Artificial Reefs were deployed near the northeast corner of Airport Island within Marine Exclusion Zone 3 and at Sha Chau and Lung Kwu Chau Marine Park. Both ARs were deployed in 2000, with a footprint of 1,200 m^2 (3,600 m^3 in terms of volume) in the Marine Exclusion Zone, and a footprint of 3,660 m^2 (3,600 m^3 in terms of volume) in the Marine Park.

Sha Chau and Lung Kwu Chau Marine Park

10.4.3.21 North Lantau waters also contain Sha Chau and Lung Kwu Chau Marine Park which was designated for the conservation of Chinese White Dolphin (**Figure 10.1**). Sha Chau and Lung Kwu Chau Marine Park, a marine area of 12 km2 (1,200 hectares), lies adjacent to the Urmston Road shipping channel. It is the only marine park in Hong Kong western waters. The Marine Park was designated on 22 November 1996 with the primary objective of protecting Chinese White Dolphin and its habitat. Some human activities are controlled in the Marine Park in order to provide a safe haven for CWD. Bottom trawling is prohibited, and speed limits are placed on vessel traffic to decrease the risk of collisions. The boundary is demarcated by yellow light buoys deployed at the corners of the marine park. The landward boundary follows the high water mark along the coastline of the islands. The marine environment of Sha Chau and Lung Kwu Chau Marine Park is greatly influenced by the Pearl River freshwater run-off, with high organic loading and sediment loading. Marine organisms found in this region are adapted to a low salinity and high turbidity marine environment. Sha Chau and Lung Kwu Chau Marine Park has rich fisheries resources. Fishes of the Engrulidae, Scieanidae and Clupeidae families are important food for Chinese White Dolphin. It therefore provides an important feeding ground for Chinese White Dolphin.

Proposed Marine Park at Fan Lau

10.4.3.22 The waters off the southwest coast of Lantau (i.e. Fan Lau) is considered a proposed Marine Park for the protection of cetaceans (**Figure 10.1**). A feasibility study was completed in 1999 (Tsang & Milicich 1999). One of the marine

ecological resources in this area is the cetaceans, in particular Chinese White Dolphin which are abundant in West Lantau waters.

10.4.3.23 West Lantau and North Lantau waters which are the most important dolphin habitats in Hong Kong. Chinese White Dolphin is present commonly year-round in the waters north and west of Lantau, and are found only seasonally or rarely in other places of Hong Kong.

Other recognized sites of conservation importance/ important habitats

10.4.3.24 The proposed Marine Park at Soko Islands was also proposed for the protection of cetaceans.

10.4.3.25 Horseshoe crab nursery site at Shui Hau: Shui Hau, which is the third identified horseshoe crab nursery sites in Hong Kong (Chiu & Morton 1999).

10.4.3.26 Pak Nai SSSI was designated in 1980 for its function as roost site for gulls and terns in the Deep Bay area (Anon. 1995).

10.4.3.27 Seagrass beds and Horseshoe crab nursery site in Pak Nai: Pak Nai is one of the three confirmed horseshoe crab nursery site (Chiu and Morton 1999) and also harbours the largest seagrass beds in Hong Kong (Fong 1998).

10.4.3.28 Mai Po and Inner Deep Bay Ramsar Site is the only Ramsar Site in Hong Kong and important for several thousands of waterbirds during winter.

10.4.3.29 Inner Deep Bay SSSI is designated in 1986. It covers 2,300 ha of intertidal mudflats and mangroves at the inner most part of inner Deep Bay, between Hong Kong and Shenzhen.

10.4.3.30 Tsim Bei Tsui SSSI is also located in inner Deep Bay, but covers a much smaller area of 2.1 ha. It is a mature mangrove community at a seafront location just below Tsim Bei Tsui Police Post. Designated in 1985, it was at that time considered the only known habitat in Hong Kong for the snail *Ellobium polita*.

Intertidal Ecological Baseline for the North Western Water Control Zone

10.4.3.31 Similar with the terrestrial habitats, intertidal habitats relevant to the ecological impact assessment are located in two main areas, i.e. the North Lantau coastlines near the Airport Channel and the shores on Airport Island. These two areas are separated by Airport Channel which is a 200m wide sea channel separating the New Town from the Airport Island and giving each a distinct waterfront.

10.4.3.32 The North Lantau coastlines near the Airport Channel are mainly natural intertidal habitats, including undisturbed rocky shores and intertidal sandflats/mudflats, while all the original coastlines in Tung Chung New Town (the eastern end of the present project's study area) have been lost to reclamation.

10.4.3.33 The coastlines of Airport Island are predominately artificial seawalls, but the northeast and southeast shores of Airport Island contain some remnant shores of the original Chek Lap Kok Island. All the other original coastlines of Chek Lap Kok have been lost during reclamation for the Airport.

Artificial Seawalls

10.4.3.34 The dominant intertidal habitat type within the 500m distance of the HKLR alignment was sloping boulder-form artificial seawall.

10.4.3.35 All the coastlines on the southern shore of Airport Island (along the Airport Channel), and some sections in the southeastern shore (e.g. the most southern end) and northeast shore (e.g. the marine cargo terminal) of Airport Island are artificial shores. The artificial coastlines on Airport Island, at least 10km meters in total, are seawalls of reclamation for the Airport. The age, design, homogeneity, orientation and lack of habitat niches of the seawall are, however, likely to limit faunal numbers and diversity here.

10.4.3.36 The intertidal habitats on the artificial seawalls of Airport Island were studied during the field survey programme for the **EVS** (see **Appendix 10B**). The number of species and the diversity and evenness indices of artificial seawalls were in general slightly lower than other natural rocky shores inside the 500m assessment area. Sessile organisms such as Purplish Bifurcate Mussel, Rock Oyster and Striped Barnacle were the dominant species of all these sites. Other abundant species observed were Bearded Ark Shell, Limpets, *Nerita yoldii* and Periwinkles. The dominant species found are common and widespread in Hong Kong rocky shores (Williams 2003, Lai *et al*. 2006). None of the species recorded are considered to be rare or of conservation importance.

10.4.3.37 The sloping seawalls in the Northeast of Airport Island, where direct impacts on intertidal zone from the HKBCF reclamation are anticipated, were also surveyed during the HKBCF ecological survey programme. The artificial seawalls were colonised by intertidal fauna, but the abundance and diversity were low. The species recorded were all common in Hong Kong, including Acorn Barnacle *Tetraclita squamosa*, Rock oyster *Saccostrea cucullata*, False limpet *Siphonaria japonica*, Limpet *Patelloida pygmaea* & *P. saccharina*, and Nerite snails. No fauna of special conservation interest was found.

Rocky Shores

10.4.3.38 The remaining intertidal habitats within the 500m assessment area of the HKLR, except those inside embayments as explained in the next section, are rocky shores including 1) remnant rocky shores along the southeast coast and a small section at the northeast end of Airport Island, and 2) undisturbed natural rocky shores on North Lantau coastlines from Tung Chung Bay to Sham Wat.

10.4.3.39 Rocky shores are not rare in Hong Kong, and are not characterised by high productivity, species richness or diversity as are intertidal mudflats. Various studies of the coastal areas of Northern Lantau have revealed that the intertidal fauna and flora present in rocky shore habitat are typical of other locations in Hong Kong

10.4.3.40 During the intertidal survey for the **EBS** between September 2003 to May 2004, all recorded species on hard intertidal shore are common and widespread in Hong Kong, such as rock oyster *Saccostrea cucullata* and littorinid gastropod *Littoraria articulata*.

10.4.3.41 Their survey results revealed that only common intertidal species such as freshwater nerite (*Clithon cf. faba*), top shell (*Monodonta labio*), nerite (*Nerita spp.*), rock oyster (*Saccostrea cucullata*), the littorinid gastropod (*Littoraria articulata and Nodilittorina radiata*), common whelk (*Thais clavigera*), and acorn barnacle (*Balanus* sp.) were recorded on the rocky shores. In addition, a few small shore crabs (*Hemigrapsus sanguineus*) and one hermit crab were seen on pebbles or rocky bottom. All hard-bottom intertidal species recorded are common and characteristic of intertidal habitats throughout Hong Kong. These results were consistent with the findings from other previous literatures.

10.4.3.42 The undisturbed natural coastlines on North Lantau would not be impacted by the Project. Three natural rocky shores, including those on the western and eastern sides of Sha Lo Wan headland, and near the Sha Lo Wan Pier, were surveyed during the **EVS** study. A total of 54 species was recorded in the hard shore habitats (including natural rocky shore on North Lantau and artificial seawalls on Airport Island). None of the recorded species are listed as being of conservation importance (IUCN 2009, CSIS 2009). During the quantitative survey, 45 species were recorded. The number of species and the diversity and evenness indices of natural rocky shores were in general slightly higher than those of the two artificial hard shores.

10.4.3.43 The remnant coastlines at the southeast shore of Airport Island, which are originated from the old Chek Lap Kok Island, were surveyed during the Marine Supplementary Survey (**MSS**) for the HKLR. Four locations were investigated following the same hard shore methodology applied in the **EVS** and the HKBCF survey programme. Although not being completely converted to artificial coastlines,

these coastlines have been subject to disturbance and modification of various extents, including the elimination of backshores and conversion to seawalls, and thus should not be considered as natural coastlines. It was also isolated from other natural shores. Only 26 taxa were recorded from both quantitative and wall-through survey during wet and dry seasons. All the species found are common and widespread intertidal fauna in Hong Kong. The abundance of the intertidal fauna was generally low, especially in areas with isolated sandy substrates.

Intertidal Sandflats/Mudflats

10.4.3.44 The intertidal habitats from Tung Chung Bay to Sham Wat are characterized by mudflats/sandflats, seagrass beds and mangroves.

10.4.3.45 Intertidal mudflats, together with the mangroves and seagrasses, were found to be the most ecologically important intertidal habitats for the present EIA. Ecological functions provided by these communities include energy cycling, coastal stabilisation, and habitat for wildlife such as coastal birds and horseshoe crabs. Tung Chung Bay is the largest embayment on North Lantau, and has extensive mudflats. Mudflats are important not only because they provide a habitat to infauna which are in turn the prey items of many waterfowls, but also they are the suitable substrate for the colonization of mangroves and seagrasses, both are important habitat types in Hong Kong. The seagrass beds are also an important nursery and feeding ground of horseshoe crabs. The structures of the mudflat habitat would be diversified by the colonizing vegetation. A large variety of microhabitat types may contribute to a diverse intertidal fauna. The high species richness of crabs in Mai Po, where 32 species of crabs were recorded, was also attributed to the large variety of microhabitats there (Lee & Leung 1999).

10.4.3.46 Important species such as horseshoe crabs and seagrasses are present within certain intertidal sandflats/mudflats in the study area (ERM 2001; Mouchel, 2000, 2002b; Tam and Wong, 2000; Mott, 2003).

10.4.3.47 During the **EBS** study, soft shores were surveyed, and quantitative transect survey were performed in selected locations including Tung Chung Bay. All the species recorded were typical soft shore intertidal fauna and can be found in similar habitats throughout Hong Kong. Mud snails (Cerithidea diadjariensis) were common representatives on the sandflats of Tung Chung Bay.

10.4.3.48 In the **EVS** study, six soft shore locations (Sham Wat (SW), Sha Lo Wan (SLW), Hau Hok Wan (HHW), Tung Chung Bay (TCB), San Tau (ST) and San Shek Wan (SSW)) along the northern coast of Lantau (The locations of these soft shore locations are shown in **Appendix 10B**) were surveyed to cover wet and dry seasons.

10.4.3.49 A total of 155 species from several faunal groups, including echinoderms (sea cucumber), arthropods (shrimp, crab and horseshoe crab), molluscs (bivalve, gastropod and tusk shell), annelids (segmented worm), sipunculids (peanut worm), nemerteans (ribbon worm), cnidarians (sea anemone) and poriferans (sponge), were recorded from these soft shore sites. Of these six sites, the highest species number was recorded at San Tau and Tung Chung Bay (76), and the lowest number was recorded at Sham Wat (57). Species numbers recorded at San Shek Wan, Sha Lo Wan and Hau Hok Wan were 69, 72 and 75, respectively.

10.4.3.50 During the transect and quadrat surveys, a total of 26,627 individuals belonging to 104 species were recorded, including a single horseshoe crab individual. A total of 1,019 individuals belonging to 56 fauna species were found in the core samples. Findings of quantitative surveys are summarized in the table below.

Table 10-3 Species number, numerical abundance, Pielou's evenness index (J') and Shannon diversity index (H', Log e) recorded at soft shore sites

	SW	SSW	SLW	HHW	ST	TCB
Epifauna						
Number of Species	29	42	44	49	55	50
Abundance	1259	4147	5079	3899	4222	8021
J'	0.46	0.49	0.47	0.53	0.55	0.43
H' (Log $_e$)	1.56	1.82	1.79	2.07	2.20	1.67
Infauna						
Number of Species	12	20	17	18	19	24
Abundance	164	265	83	56	115	336
J'	0.45	0.52	0.74	0.86	0.81	0.48
H' (Log $_e$)	1.11	1.56	2.10	2.47	2.38	1.51

10.4.3.51 Most species found during these surveys are common and widespread in Hong Kong. Six species considered of international or regional (China) conservation importance were recorded (**Table 10-4**), details of which are given in the following paragraphs.

Table 10-4 Species of international or regional conservation importance found in soft shore habitats

Species	SW	SSW	SLW	HHW	ST	TCB
Indo-Pacific Tropical Sand Goby *Favonigobius reichei*	+	+	+	+	+	+
Snowy Puffer *Takifugu niphobles*				+	+	
Predaceous Chub *Parazacco spilurus*		+				
Sea Cucumber *Holothuria leucospilota*	+					
Horseshoe Crab *Tachypleus tridentatus*	+				+	+
Greasyback Shrimp *Metapenaeus ensis*	+		+	+	+	

10.4.3.52 The Indo-Pacific Tropical Sand Goby *Favonigobius reichei*, which has been regarded as "Lower Risk/Near Threatened" by IUCN (2009), was found to be very common at all the study sites. Although it is regarded globally as Lower Risk/Near Threatened, this species is common and widespread in intertidal areas in Hong Kong (Lee *et al*. 2004, Nip 2005).

10.4.3.53 Another fish species observed, Snowy Puffer *Takifugu niphobles*, is regarded as "Data Deficient" by IUCN (2009). This fish is, however, considered to be common in Hong Kong (Nip 2005, AFCD 2009b).

10.4.3.54 Two Predaceous Chub *Parazacco spilurus* were observed in a freshwater creek running across the shore in SSW. This species is considered to be Vulnerable in Mainland China (Yue & Chen 1998, CSIS 2008). This is primarily a freshwater species, however, and is not known to tolerate saline conditions; its presence on the surveys probably resulted from upstream populations having been washed into the lower reaches of the stream.

10.4.3.55 The Horseshoe Crab *Tachypleus tridentatus* was recorded at two of the soft shore sites, TCB and ST. Two records from TCB included a juvenile (max. width of prosoma = 40mm) and one dead subadult (max. width of prosoma = 150mm). The single crab at ST was one tiny juvenile (max. width of prosoma = 5mm). This Horseshoe Crab species is regarded as Vulnerable by CSIS (2008).

10.4.3.56 The Sea Cucumber *Holothuria leucospilota* was found on the shore of SW. This species is usually found in the low tide/subtidal zone of boulder shores (Morton & Morton 1983) and the soft shore at SW is not optimal habitat for this species. It is the most common holothuroid in Hong Kong (Lai *et al*. 2006) but is regarded as Endangered in Mainland China due to over-exploitation (CSIS 2008).

10.4.3.57 Although *Metapenaeus* spp. are common in mangrove and estuarine areas in Hong Kong (Leung 1999, Vance 1999), all four species found in Hong Kong (including *M. ensis*) are considered to be Vulnerable in Mainland China due to over-exploitation (CSIS 2009). In the Current Study, individuals of *M. ensis* were found in SW, SLW, HHW and ST.

10.4.3.58 All of the species recorded were typical soft shore intertidal fauna and can be found in similar habitats throughout Hong Kong. Mud snails (*Cerithidea diadjariensis*) were common representatives on the sand-flats of Tung Chung Bay. Survey results obtained at Tai Ho Wan also revealed that the mud snail (*C. diadjariensis*) was dominant. Common species including acorn barnacle (*Balanus* sp.), small shore crab (*Hemigrapsus sanguineus*) and the nerite (*Nerita polita*) were abundant on hard surfaces such as rocks and boulders present on the soft shores of the entire coastal study area. Species abundance was similar in wet and dry seasons. Besides the sandflats/mudflats, there are some patchy sandy beaches on the southeast shore of Airport Island. These patcthy sandy beaches are of very low abundance of intertidal fauna as recorded during the MSS, and no infauna was recorded in the sediment in these sandy beaches (see **Appendix 10C**).

10.4.3.59 Tai Ho Wan is located in the estuarine area and harbours intertidal mudflats and mangroves. It has been partly cut off from the sea by the construction of the North Lantau Highway. A culvert at the western end of the bay maintains tidal exchange within the bay. The southern end of the bay is dominated by mangroves and extensive mudflats where Tai Ho Stream enters the bay. Mudflats of this size are uncommon outside Deep Bay area and are becoming more and more scarce in the territory.

10.4.3.60 The intertidal habitats inside the embayment at Tai Ho Wan are dominated by intertidal mudflats, with patches of seagrass beds and mangroves along the coastline.

10.4.3.61 Intertidal mudflats, together with the mangroves and seagrasses, were ecologically important intertidal habitats. Ecological functions provided by these communities include energy cycling, coastal stabilisation, and habitat for wildlife such as coastal birds. Tai Ho Wan has extensive mudflats. Mudflats are important not only because they provide a habitat to infauna which are in turn the prey items of many waterfowls, but also they are the suitable substrate for the colonization of mangroves and seagrasses, both are important habitat types in Hong Kong. The seagrass beds are also an important nursery and feeding ground of horseshoe crabs (Fong 1999). AFCD recorded 20 *C. rotundicauda* individuals at Tai Ho Wan December 2003 (**Appendix 10A**). The structures of the mudflat habitat would be diversified by the colonizing vegetation. A large variety of microhabitat types may contribute to a diverse intertidal fauna. The high species richness of crabs in Mai Po, where 32 species of crabs were recorded, was also attributed to the large variety of microhabitats there (Lee & Leung 1999).

10.4.3.62 Tai Ho Wan provides an ecological linkage between marine habitats and freshwater habitats (Tai Ho Stream) of conservation importance. It is a movement corridor for anadromous and catadromous fishes moving between streams and the sea. The bay also provides additional habitat for the marine vagrant fish species recorded in Tai Ho Stream.

10.4.3.63 The Tai Ho area is notable for the fact that the hydrological system of streams, estuary and bay remains intact and little modified by human activity. Horseshoe crabs are known to prefer undisturbed beaches (Botton *et al*. 1998 in Chiu and Morton 1999). Chong and Dudgeon (1992) attributed the exceptional fish fauna they recorded in Tai Ho Stream to the relatively unaltered condition of the area. Tai Ho provides an example of a well-interlinked ecological landscape, dominated

by sheltered bay, wetlands, woodlands and streams, that support a high diversity of plant and animal communities.

Mangrove Habitats

10.4.3.64 Mangrove communities are under threat from urbanisation and reclamation, and because many stands have been destroyed in Hong Kong they are considered to be a conservation priority (Tam and Wong, 2000). There is a large body of data on the mangal and seagrass habitats present in the **EBS** study area (e.g., Mouchel 2000; Tam and Wong 2000).

10.4.3.65 During the EBS study, mangroves in San Tau to Tung Chung Bay were surveyed. The Tung Chung and San Tau mangrove habitats have also been well studied previously (Tam and Wong 2000; Mott 2003). The mangrove habitat at San Tau is considered to be of particular ecological importance because of its size and seagrass beds. This habitat is dominated by the mangroves *Aeigceras corniculatum*, *Kandelia candel* and *Bruguiera gymnorrhiza* (which was previously thought to be rare but is now considered locally uncommon). Other mangroves *Avicennia marina* and *Acanthus ilicifolius* are also well represented.

10.4.3.66 During the **EVS**, mangrove was identified within the San Tau Beach SSSI, while two patches of associated mangrove were found along the coastlines of Tin Sam (just to the north of San Tau) and Hau Hok Wan. The mangrove habitat is dominated by a number of mangrove species, especially *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera gymnorrhiza*, *Kandelia obovata* and *Acanthus ilicifolius*. The associated mangrove habitats are dominated by herb *Limonium sinense*, shrubs *Clerodendrum inerme*, *Suaeda australis*, *Scaevola sericea* and *Pandanus tectorius* and trees *Cerbera manghas*, *Hibiscus tiliaceus* and *Thespesia populnea*.

10.4.3.67 There are also mangroves in Tai Ho Wan and Sham Wat. Mangroves in Sham Wat were also surveyed during the EBS, and different from the mangrove stands in Tung Chung Bay or Tai Ho, there were only small areas of mangroves fringing the eastern and western shores of Sham Wat, and no species of special concern were recorded.

10.4.3.68 Tam and Wong (1997) surveyed the main mangrove stand in Tai Ho Wan. They found this 1.86 ha stand to be the third largest mangrove on Lantau, after Tung Chung and San Tau. The Tai Ho Bay mangroves harboured all of Hong Kong's mangrove species except *Lumnitzera racemosa* and the extremely restricted *Heritiera littoralis* (*ibid*.). Tai Ho Wan also had the densest mangrove stand encountered in the study.

10.4.3.69 During the **EBS**, the number of floral species recorded in Tai Ho was fairly high. There were six true mangrove species including *Lumnitzera racemosa, Kandelia candel, Bruguiera gymnorrhiza, Avicennia marina, Aegiceras corniculatum* and *Acanthus ilicifolius*. In addition to these true mangrove species, a number of mangal-associated flora, such as *Limonium sinense, Clerodendrum inerme* and *Acrostichum aureum* were also recorded. Other common species recorded within the coastal or mangrove communities included *Zoysia sinica, Suaeda maritime* and *Vitex rotundifolia*.

10.4.3.70 During a field visit in 2005, it was verified that the mudflat in Tai Ho Wan consisted of isolated patches of mangrove stands at the estuary of Tai Ho Stream and some inlet. 13 mangrove and mangrove associate species were recorded.

Seagrass Beds

10.4.3.71 North Lantau harbours a few locations of seagrasses including Tung Chung Bay, San Tau, Tai Ho Wan and Yam O. Tung Chung Bay is the largest lowland and river mouth habitat on North Lantau, and has an extensive mudflat. San Tau, at the northwest of Tung Chung Bay mudflat, harbours the largest seagrass area on Lantau. Two species of seagrasses, *Zostera japonica* and *Halophila ovalis*

(previously described as *H. ovata*), were recorded in San Tau Beach, and an area of 2.7 ha was designated a SSSI in 1994.

10.4.3.72 Both *Zostera japonica* and *Halophila ovalis* (previously described as *H. ovata*) are considered rare locally (Xing *et al*, 2000). *Zostera japonica* and *Halophila ovata* are usually found co-habiting the seaward margins of mangrove stands (AFCD 2003). San Tau is the only site in western waters among the five known sites in Hong Kong where *Zostera japonica* can be found (i.e. Lai Chi Wo, So Lo Pun, Siu Tan, Sheung Sze Wan and San Tau, see Kwok *et al*. 2005). *Zostera japonica* was previously thought to be limited to the temperate regions and is thus of special interest to plant biogeography.

10.4.3.73 *Halophila ovalis* is also considered to be of special scientific interest because it is one of the few marine flowering plants in Hong Kong (AFCD 2003). Apart from San Tau, *Halophila ovalis* (described as *Halophila ovata*) has been previously recorded in Tai Tam Bay, Ho Chung, Hoi Ha Wan, Wu Shek Kok and Lai Chi Wo (AFCD 2003). More localities for this species have been found in a territory-wide search of seagrass sites in Hong Kong, including Ham Tin, Kai Kuk Shue Ha, Nam Chung, Nim Shue Wan, Sheung Sze Wan, Siu Tan, To Kwa Peng, Tsam Chuk Wan and Yam O (Kwok *et al*. 2004).

10.4.3.74 These two seagrass species at San Tau were surveyed during some previous studies and was found that much of the seagrass beds lied outside the SSSI (Mott 1998).

10.4.3.75 During the **EBS** study, the field surveys for seagrass beds were undertaken between 2003-2004. Field survey results confirmed that the seagrass bed at San Tau Beach SSSI still supported the two seagrass species, *Halophila ovalis* (described as *H. ovata* in the **EBS** study) and *Zostera japonica.* (**Appendix 10A**).

10.4.3.76 It should be noted that the seagrass bed at San Tau has been subject to impacts associated with the reclamation works for the airport at Chek Lap Kok. The seagrass has, however, recovered since the works were completed.

10.4.3.77 During the field survey for TMCLKL in July 2008, however, no seagrass beds were found on the mudflat in Tung Chung Bay (Maunsell 2009). During the **EVS** study, a third species of seagrass, *Halophila minor*, was recorded in San Tau. *Halophila minor* was also previously recorded at Sunny Bay (previously called Yam O) in North Lantau (Yip & Lai 2006).

10.4.3.78 Patches of the seagrass *Halophila beccarii* were also recorded in Tai Ho Wan (Wu and Lee 1998, Fong 1998) and at the stream mouth within Tai Ho Stream SSSI (Mott 1998; Mouchel 2000). *H. beccarii* is widespread along the coast of various Southeast Asian countries (Hodgkiss and Morton 1978). *H. beccarii* was first recorded in Hong Kong at Tsim Bei Tsui in Deep Bay (*ibid*.). Besides Tsim Bei Tsui and Tai Ho, other sites where this species of seagrass was recorded included Starling Inlet (Wong 1998), Black Point (Xing *et al.* 2000), Sheung Pak Nai, Sha Kong Tsuen and Nam Chung Yeung Uk. (Kwok et al. 2005, with the largest *H. beccarii* bed in Ha Pak Nai (Fong 1999).). This seagrass species is considered locally rare (Xing *et al.* 2000). The seagrass beds are also an important nursery and feeding ground of horseshoe crabs. During the April 2004 survey, the seagrass *Halophila beccarii* habitat was found during low tide at Tai Ho Wan and supported more than 20 colonies each approximately 30cm X 30 cm in area. During the field survey for TMCLKL, however, no seagrass beds were found on the mudflat in Tai Ho Wan (Maunsell 2009). The Tai Ho seagrass beds are of importance due to the presence of a locally restricted seagrass species and also it is a horseshoe crab nursery site while horseshoe crabs are threatened by habitat loss in Hong Kong.

Horseshoe Crab

10.4.3.79 Horseshoe crabs are considered of conservation importance in Hong Kong. Three species have been reported in HKSAR waters: *Tachypleus tridentatus, T. gigas* and *Carcinoscorpius rotundicauda* (Chiu & Morton 1999). These represent all species known from the South China Sea, and three of four species known worldwide. All

three species appear to be undergoing rapid population declines and are thought to be under severe pressure in the South China Sea, including Hong Kong waters, due to habitat loss, pollution and over exploitation (Huang 1997; Chiu and Morton 1999).

10.4.3.80 In an extensive study of the distribution of horseshoe crabs in Hong Kong conducted between March 1995 and June 1998, *Tachypleus gigas* was not recorded and its local status is uncertain (Chiu and Morton 1999.) It is likely that only two species of horseshoe crab (*T. tridentatus* and *C. rotundicauda*) are currently widely distributed in Hong Kong as no recent records of *T. gigas* are available (Chiu and Morton 1999; Mouchel 2002c).

10.4.3.81 Horseshoe crabs are currently more often found in western waters of Hong Kong, though they were once thrived on many beaches in Hong Kong including Tolo Harbour (Huang 1997; Huang *et al.* 1999). Conformed nursery sites for horseshoe crabs in recent years included Pak Nai, San Tau and Shui Hau (Huang *et al.* 1999), together with Tai Ho Wan (Fong 1999). Some other beaches on Lantau, including Tai O, Yi O, Sham Wat Wan, Sha Lo Wan and Tung Chung, are considered of high possibility due to the records that adult horseshoe crabs were frequently fished offshore (Huang *et al.* 1999). At a territory-wide study, three locations, i.e. Pak Nai in Deep Bay, San Tau near Tung Chung, and Shui Hau at south Lantau, are identified as important horseshoe crab nursery sites, all of which are located at western waters (Chiu & Morton 1999).

10.4.3.82 Horseshoe crabs are known to be sparsely distributed along the coastline of Lantau Island and most survey effort of the **EBS** was expended at bays within the study area where suitable microhabitats were present (typically well-aerated sediment substrates near to seagrass beds; substratum adjacent to streams). These areas included Hau Hok Wan, Pak Mong, San Shek Wan, San Tau, Sha Lo Wan, Sham Wat, Tai Ho Wan and Tung Chung Bay. Several embayments with confirmed records of horseshoe crab juveniles including Tai Ho Wan, San Tau, Hau Hok Wan, Sha Lo Wan, and Sham Wat were considered as ecological sensitive receivers in the present EcoIA (see **Figures 10.1 & 10.2**).

10.4.3.83 During the field surveys of the **EBS**, horseshoe crab juveniles were recorded in Tai Ho Wan and Pak Mong (fourteen live and three molts of *Carcinoscorpius rotundicauda*), San Tau (10 *Tachypleus tridentatus* and 1 *Carcinoscorpius rotundicauda*), Tung Chung Bay (26 *Tachypleus tridentatus*), Hau Hok Wan (Two *T. tridentatus* and one *C. rotundicauda*), and Sham Wat (one live and three molts of *Tachypleus tridentatus*). During the **EVS** study, Horseshoe Crab *Tachypleus tridentatus* was recorded at two of the soft shore sites, Tung Chung Bay and San Tau. Two records from Tung Chung Bay included a juvenile (max. width of prosoma = 40mm) and one dead subadult (max. width of prosoma = 150mm). The single crab at San Tau was one tiny juvenile (max. width of prosoma = 5mm). Besides seagrass beds, it is also one of the three recognized horseshoe crab nursery sites Hong Kong (Huang *et al*. 1999 ;Chiu and Morton 1999). During the TMCLKL study, two *Tachypleus tridentatus* and three *Carcinoscorpius rotundicauda* were recorded at San Tau in July 2008. In addition, two *Carcinoscorpius rotundicauda* were recorded at Tung Chung Bay.

Subtidal Ecological Baseline for the North Western Water Control Zone

Marine waters

10.4.3.84 The assessment area for marine ecology in the present EIA covers a large sketch of sea areas including 7 water control zones. As the areas outside North Lantau waters are far away and sheltered from the project site by Lantau Island, they would be unlikely to be impacted by the project. The present EcoIA would thus focus on North Lantau waters.

10.4.3.85 The HKLR alignment goes through the waters in Hong Kong western boundaries while the proposed reclamation site for HKLR is adjacent to the southeast shore of Airport Island and that for HKBCF is located near the Northeast corner of Airport Island, and are all surrounded by North Lantau waters. Water depths off the North

Lantau reclamation range up to 20m, with the deepest waters in the swift tidal channel of Urmston Road. Water depths in the area just off the NLH are shallower, generally less than 5 m.

10.4.3.86 North Lantau waters also receive effluent from the Urmston Road, Pillar Point and Siu Ho Wan marine discharge outfalls as well as numerous small-scale outfalls. Quantities of effluent from all three major outfalls are predicted to rise continuously (Smith-Evans and Dawes 1996, Maunsell 1997).

10.4.3.87 The North Lantau waters between Tuen Mun and Airport Island are a spawning/nursery grounds for fish and shrimp (ERM 1998). The North and West Lantau waters are important habitats for Chinese White Dolphin in Hong Kong (detailed in below sections on Chinese White Dolphin).

Chinese White Dolphin

10.4.3.88 There are sixteen recorded cetacean species from Hong Kong waters (Jefferson and Hung 2007). And recently in March 2009, a humpback whale was reported in Hong Kong. This made the number of recorded cetacean to seventeen species. Only two of these recorded species, the Chinese White Dolphin (CWD in short form, also commonly known as Indo-Pacific humpback dolphin, *Sousa chinensis*) and Finless porpoise (*Neophocaena phocaenoides*) are resident. Chinese White Dolphin is present in the coastal and inshore waters throughout the Indo-pacific, from Australia and China in the east to South Africa in the west (Jefferson and Karczmarski 2001). Off the coast of south China, at least seven separate populations were identified from Guangxi up to the mouth of the Yangtze River, and all coincide with the presence of river mouths (Jefferson and Hung 2004).

10.4.3.89 One population of Chinese White Dolphin lives in the estuary of the Pearl River, where they inhabit waters of the Hong Kong SAR, Macau SAR and Guangdong Province of the People's Republic of China (Zhou *et al*. 1995; Jefferson and Hung 2004). In Hong Kong, Chinese White Dolphin is also concentrated in the more estuarine-influenced waters, i.e. all the waters of western Hong Kong. They are present commonly year-round in the waters north and west of Lantau, and also occur seasonally or in small numbers to the south and east of Lantau Island, as well as in southern Deep Bay and to the west of Lamma Island (Jefferson 2000, Jefferson & Hung 2004). They are not present in the waters to the east of Lamma Island, except for occasional wanderings.

10.4.3.90 From September 1995 through November 1998, the Hong Kong Airport Authority and the Agriculture, Fisheries and Conservation Department (the then AFD) funded several studies on the biology of the population of Chinese White Dolphin in Hong Kong waters. The results of these early studies indicated that the dolphin population shared with mainland China (Pearl River Estuary) and probably Macao, was much larger than originally estimated, and was probably viable in the long term if appropriate conservation measures were taken (Jefferson 1998, 2000).

10.4.3.91 Chinese White Dolphin is also present in the rest of the Pearl River Estuary outside (to the west) of Hong Kong. Before systematic surveys for the Tonggu Waterway study began in late 1997, there were only sporadic and opportunistic records of CWD from Mainland waters of the Pearl River Estuary (Yang and Chen 1996). From the Tonggu systematic surveys as well as additional systematic surveys conducted in 1999-2000, it has been confirmed that the distribution of Chinese White Dolphin extends throughout the entire Pearl River Estuary from Hu Men in the north to Guishan Dao and Dong'ao Dao in the south (Jefferson & Hung 2004).

10.4.3.92 Through investigation on CWD individual movements and ranging patterns (Hung 2000; Hung & Jefferson 2004), it is confirmed that many identified CWD had ranges that spanned across the Hong Kong/Mainland boundary. A single population of CWD is therefore involved in Hong Kong and Pearl River Estuary, and the population size has been estimated using line-transect methods to be about 1300 – 1500 individuals, with roughly 200 individuals using Hong Kong waters on a regular basis (AFCD 2007).

10.4.3.93 There appears to be seasonal shifts of CWD occurrence with the extent of river influence, moving farther south and east from the Pearl River in the wet season, and farther into the estuary proper in the dry season (Jefferson 2000).

10.4.3.94 Calving seasonality was determined by computing an estimated birth date for each neonate and fetus in the sample, based on the average length at birth, along with fetal and early neonatal growth rates from the literature (Jefferson 2005). Breeding appears to occur throughout the entire year, but there is a peak in the occurrence of births between the months of March and August (Jefferson 2005).

10.4.3.95 Western and Northern Lantau waters are the most important range of the Chinese White Dolphin in SAR waters. This has been concluded from systematic boat surveys for *Sousa chinensis* in Hong Kong waters since 1996 (AFCD 2008). Several hotspots were consistently used by CWD since 2002, including the waters around Lung Kwu Chau, near Black Point, around the Brothers Islands, and the entire stretch of West Lantau waters from Tai O Peninsula to Fan Lau. These hotspots can be considered as the prime dolphin habitats in recent years in Hong Kong. The coast of West Lantau area is of particularly high dolphin density (with densities even higher than in the North Lantau area and around the Sha Chau and Lung Kwu Chau Marine Park), and there are also frequent sightings of young calves in this area.

10.4.3.96 West Lantau waters are currently the most important area in Hong Kong for dolphin conservation as the highest encounter rate of CWD as well as juveniles and calves were recorded in that area. A quantitative grid analysis was developed and has been applied to AFCD long-term monitoring programme to examine fine-scale habitat use by CWD (Hung 2008). According to the results from the long-term AFCD marine mammal monitoring surveys (AFCD 2009), dolphin usage was the highest west of Lantau Island, where most grids (each of 1 km^2) had moderate to high dolphin densities. Densities of CWD engaged in feeding and socializing activities, as well as densities of mother-calf pairs, were particularly high in West Lantau and east of Lung Kwu Chau, indicating the importance of these sites. Chinese White Dolphin frequently uses the whole stretch of the West Lantau waters between Fan Lau to Sham Wat, and some of the sightings of juvenile CWD were even beyond Sham Wat. This finding has been further supported by an additional AFCD land-based dolphin survey in 2004-2005 on the shore between Tai O to Sham Wat, specifically for facilitating the assessment of HZMB on CWD in the West Lantau waters (AFCD 2005).

10.4.3.97 There are also frequent sightings of young calves and juveniles in the coast of West Lantau area (**Figures 10.9 & 10.10 & 10.11**). Most of the sightings of calves and unspotted juveniles in the 2008-2009 monitoring programme were made in the coastal waters of West Lantau (between Tai O to Fan Lau), following by the waters near Lung Kwu Chau, while only a few other sightings were made in waters around the Brothers Islands (only two sightings during 2008-2009, see AFCD 2009) and Soko Islands. To locate the important habitats for nursing activities, the data on unspotted calves and unspotted juveniles from 2002-08 were processed. It was found that both the mean DPSE of unspotted calves and that of unspotted juveniles in West Lantau were much higher those in other areas in Lantau (*ibid*). With the high occurrence of young animals found along the stretch of coastal waters in West Lantau, West Lantau can be considered important nursing area for Chinese White Dolphin in Hong Kong during 2002-08. In view of the importance of this area for CWD, a marine park has been proposed at the coastal waters near Fan Lau.

10.4.3.98 Besides West Lantau waters, the waters around Lung Kwu Chau are also a dolphin hotspot in Hong Kong, and having high densities of unspotted calves. Also in North Lantau waters, Sha Chau and Lung Kwu Chau Marine Park, a marine area of 12 km^2, was designated in November 1996 with the primary objective of protecting *S. chinensis* and its habitat. Two set of artificial reefs were also deployed by government at the marine park and the northeast corner of Airport Island to enhance the food resources for CWD (**Figure 10.1**). The waters offshore the North Lantau Expressway between the Airport Island and Tai Ho Wan are an area of relatively lower dolphin density, compared to other areas in North Lantau (Jefferson

2000) (**Figures 10.8**). Examination of individual range use through photo-ID technique revealed that most CWD had very specific preferences for sites within their home ranges, which acted as core area(s) receiving greater intensity of use (Hung 2008). Several core areas used intensively by many individuals of CWD were identified, including the Sha Chau and Lung Kwu Chau Marine Park, the Brothers Islands, and the stretch of waters from Tai O and Fan Lau in West Lantau (*ibid*). These core areas were considered important habitats for Hong Kong CWD. Among the 62 individuals having higher sighting frequency (over 15 times), the Brothers Islands were the core area for 22 individuals (the second highest number). Furthermore, 12 out of these 22 individuals had exclusive core area use in the Brothers Islands. This implies that many individuals that used the Brothers Islands as their core areas strongly relied on this area with very intensive use (AFCD 2009). On the other hand, the photo-identification works in 2008-09 found an increase of individuals expanding their range use from Northwest Lantau to West Lantau areas or vice versa.

10.4.3.99 Vessel dolphin surveys were conducted for the EIA study on Liquefied Natural Gas receiving terminal in Northwest Lantau waters and Deep Bay between July 2005 and May 2006. 109 sightings of Chinese White Dolphin were recorded in West Lantau waters, 79 in Southwest Lantau waters, 62 in Northwest Lantau waters, while only 25 sightings were made in Deep Bay. In Northwest Lantau waters, the encounter rate in autumn and winter are higher than those in spring and summer.

10.4.3.100 A systematic Chinese White Dolphin line-transect survey in the Pearl River Estuary and Hong Kong waters (covering all of Hong Kong's waters and Pearl River Estuary from Hu Men in the north to Aizhou Dao (隘洲島) in the southeast and Sanzao Dao (三灶島) in the southwest) was conducted between February 2006 to January 2007 for the study on "Proposed Port Development at Northwest Lantau". It covered the entire known range of the Chinese White Dolphin population in the Pearl River Estuary, and the waters at the exit of Modaomen(磨刀門), in order to calculate abundance and density in a 12-month period. In Hong Kong waters of the Pearl River Estuary, individuals of Chinese White Dolphin were frequently sighted along the narrow strip of coastal waters west of Lantau waters. Most sightings were made near Tai O Peninsula (大澳半島), Kai Kung Shan (雞公山), Peaked Hill (雞翼角) and Fan Lau (分流). The frequency of dolphin occurrence was slightly higher along the inshore transect lines than the offshore ones. The dense distribution of dolphin sightings throughout West Lantau was in accordance with results from AFCD's long-term monitoring studies.

10.4.3.101 18 systematic line-transect dolphin vessel surveys were conducted from July 2008 to March 2009 for TMCLKL study. The survey area covered the central portion of North Lantau waters between Pillar Point and Brothers Islands. 30 groups of CWD numbering 100 individuals were sighted, with most sightings (22 sightings) made in the western section of Northeast Lantau survey area (the transect covering the Brothers Islands), while another eight sightings were made in the eastern section of Northwest Lantau survey area.

10.4.3.102 The waters to the east of Airport Island and the waters to the west of Airport Island were the potential areas for locating HKBCF during the early stage of the HKBCF EIA study. To facilitate the ranking of the options, a desk-top study on the dolphin use of both areas was conducted. Both the potential HKBCF locations at the eastern and western Airport were covered by dolphin vessel survey transect adopted for AFCD regular annual dolphin monitoring programme. The dolphin monitoring data thus provided relevant information for assessing the dolphin use in these two locations. Dolphin sightings in North and West Lantau waters during 2002-2008 were reviewed. Positions of on-effort sightings of Chinese White Dolphin from 2002-08 were retrieved from the long-term sighting database and then plotted onto 1 km^2 grids in the waters around Lantau Island. It was found that during the 2,857 dolphin groups (or 11,189 individuals) sighted during vessel and helicopter surveys in North and West Lantau waters between year 2002 and 2008, only a few dolphin sightings overlapped with the potential location to the east of Airport, while more sightings overlapped with the potential location to the west of

Airport. Moreover, for the section of transect to the south of the options, only a handful of sightings were made to the south of the eastern Airport option (the waters immediately to the east of Airport), while CWD were frequently sighted immediately south of the western Airport option. Furthermore, for the coastal waters, dolphin sightings were densely distributed along the coastal waters from Shum Wat to Tai O, while there are very limited sightings on Tung Chung coastlines except the waters around the Brothers Islands and Sham Shui Kok. For seasonal pattern, dolphin sightings were only recorded in the eastern Airport option during autumn months, while the sightings were made during all four seasons in the western Airport option though fewer sightings were made in spring months. The overall abundance of Chinese White Dolphin at several survey areas was estimated by Jefferson (2007), using line-transect analysis with vessel survey data collected during 2004-06. It was found that the area with highest dolphin density was the West Lantau waters, with exceptionally high densities in all four seasons of 159-219 individuals/100 km^2. Moreover, dolphin density at Northwest Lantau was quite high with 52-107 individuals/100 km^2, and the one at Northeast Lantau was relatively low with 6-34 individuals/100 km^2 (Jefferson 2007). Since dolphin densities were much higher in West and Northwest Lantau than in Northeast Lantau among all four seasons, it appeared that dolphin usage at the western Airport option (which lies in between the Northwest Lantau and West Lantau survey areas) should be much higher than the one at the eastern Airport option (which lies in between the Northwest Lantau and Northeast Lantau survey areas).

10.4.3.103 Ranging patterns of 54 individuals of CWD re-sighted 10-123 times since 1995 and with their ranges spanning the Northeast, Northwest and West Lantau survey areas were examined. Of these 54 individuals, 49 of them (90.7%) had their ranges overlapped with the western Airport option, and 37 individuals (68.5%) had their ranges overlapped with the eastern Airport option. The eastern Airport option is thus preferred and has become the present proposed HKBCF.

10.4.3.104 Although the HKBCF lies within the range of dolphin activities and sightings, few sightings were made in the HKBCF reclamation site. Based upon the data from the AFCD dolphin surveys between 2002 and 2008, the mean SPSE values per grid of all 356 grids around Lantau Island was 4.1 ± 6.12, while the mean DPSE values per grid was 16.0 ± 25.77. A total of four grids in Northeast Lantau survey area overlapped with the HKBCF reclamation, and the mean SPSE and DPSE values among these four grids were 2.8 and 10.9 respectively, which were both below the overall means of all grids around Lantau.

10.4.3.105 For the HKLR, its reclamation along the southeast shore of Airport Island and the part of viaduct inside the Airport Channel are within areas with no dolphin sighting records. The waters to the east of Airport Island and offshore Tung Chung are rarely used by the Chinese White Dolphin. Even though a transect line (i.e. the westernmost transect line in Northeast Lantau) run through the area of HKBCF site extending toward Tung Chung, it is found from the desk-top study that only two dolphin sightings were made in this area (between Tung Chung and Airport eastern shore) from 2002-08.

10.4.3.106 The sections of viaduct between Sham Wat to the HKSAR boundary are (i.e. the HKLR marine section open sea part in the below impact assessment) in waters of various levels of dolphin densities, ranging from 0.1-20.0 DPSE to 61.0 – 80.0 DPSE. Only a section of viaduct offshore to Tai O Peninsula gets close to a grid cell with higher DPSE value (61.0-80.0 DPSE) at its northeast corner and this grid cell is the only one with relatively high dolphin density among all grid cells along the HKLR alignment.

10.4.3.107 In the vicinity of the proposed HKBCF reclamation site, the records of calves and juveniles were low in comparison with Lung Kwu Chau and West Lantau. During 2002-08, only two sightings of unspotted juveniles were made within the HKBCF reclamation footprint, while none for unspotted calves (**Figures 10.9 & 10.10**). During the 2008-2009 dolphin monitoring programme, no sighting of calves or unspotted juvenile was made inside or near the HKBCF reclamation footprint

(**Figure 10.11**). The nearest sightings of calves and unspotted juveniles were made in the waters around the Brothers Islands,

10.4.3.108 For the HKLR alignment, as mentioned in above sections that its reclamation and viaduct inside the Airport Channel are not within dolphin habitats (areas with no dolphin sighting including adult and juvenile). During 2002-08, though only two sightings of unspotted calves were made on the HKLR alignment open sea part, there were over 11 sightings of unspotted juveniles along this section of alignment (**Figures 10.9 & 10.10**). There are three unspotted calves and unspotted juvenile sightings lie on or are very close to the HKLR alignment between Sham Wat to Tai O Peninsula during 2008-09 (**Figure 10.11**).

10.4.3.109 There was no frequent feeding activity of Chinese White Dolphin in the HKBCF reclamation site. During 2008-2009, no record of dolphin feeding behaviours was made in the site and its vicinity. While for HKLR, one feeding activity record and four socializing activity records were made on or close to its alignment offshore to Sham Wat.

10.4.3.110 It is noted that the waters around Brothers Islands (to the east of the HKBCF reclamation site) are considered as one of the dolphin hotspots in recent years. Although the HKBCF reclamation is located outside the waters around Brothers Islands with higher dolphin density (between 20.1- 60.0 DPSE, see **Figure 10.8**), this location is still near the dolphin hotspot. The HKBCF site option desk-top study also revealed that more dolphin groups were sighted near the northeast corner of the airport (north of the HKBCF site) and near the Brothers Islands. The HKBCF location is to the west of the hotspot and immediately adjacent to the existing Airport artificial seawall, where the dolphin density is much lower. The DPSE values in the majority of the reclamation site range from 0.1-20.0 DPSE only (see **Figure 10.8**), with only a small fraction inside the area with relatively higher dolphin density (20.1-40.0 DPSE). The habitat use of this area by dolphin is relatively low when compared with other dolphin hotspots in North Lantau.

10.4.3.111 The ecological values of marine waters in western Hong Kong could largely relate to the habitat use of Chinese White Dolphin which is the most significant species of conservation importance in this habitat, and would vary in accordance with the levels of usage by CWD. The West Lantau waters and the waters near Lung Kwu Chau would be of high ecological value due to the high dolphin density and the functions as dolphin nursery grounds. Other dolphin hotspots such as the Brothers Islands would be of moderate to high ecological value. Areas without dolphin sightings or of very limited dolphin use such as Airport Channel and the waters immediately to the east of Airport Island would be of low ecological value. But under some certain circumstances, the ecological value of low dolphin usage areas would escalate to low to moderate if they are adjacent to high use areas (such as Northeast Airport where is close to the Brothers Islands), or even to moderate if they are on potential corridors between high use areas (such as the waters to the west of Airport Island).

Finless Porpoise

10.4.3.112 Within Hong Kong Finless Porpoises occur in the waters to the south and east of Lantau Island, but have never been sighted north or west of Lantau. In addition, they occur in Hong Kong's eastern waters, south of Lamma Island, Hong Kong Island, and in the Po Toi, Ninepins, Sai Kung, and Mirs Bay areas (Parsons *et al.* 1995; Jefferson & Braulik 1999; Jefferson *et al.* 2002a).

10.4.3.113 The total size of the local Finless Porpoise population is not known, but based on line transect analyses, there are estimated to be between 55 (the low season in autumn) and 152 (the peak season in spring) porpoises in Hong Kong's waters in different seasons, and up to 217 finless porpoises occur in the area of Hong Kong plus Mainland waters immediately to the southwest that have been surveyed (Jefferson *et al.* 2002a). The minimum estimate of the population size is thus about 220 porpoises, although the true size of the population is likely to be much larger.

Breeding is strongly seasonal, and although some may be born at other times of year, most calves are born from October to January (Jefferson *et al.* 2002b).

10.4.3.114 Nothing is known of ranging patterns for individual finless porpoises, as individual specimens cannot be identified at sea, and no tagging or marking studies have been done. Feeding habits are known only from examination of stomachs of dead, stranded specimens (Barros *et al.* 2002). Porpoise prey includes many different species of fish, several types of cephalopods and at least one kind of shrimp. Porpoises prey on reef-associated organisms, but these are not primary constituents of the Finless Porpoise diet. Although field observation is currently lacking, there is some indication from stomach contents that porpoises may also feed in association with fishing vessels.

10.4.3.115 Finless porpoises do not occur in North Lantau waters, and within Hong Kong waters, finless porpoise are widely distributed in the southern and eastern waters (Jefferson *et al.* 2002a). There was also no porpoise recorded within the proposed HKBCF reclamation area and its vicinity or the HKLR alignment during the AFCD regular marine mammal monitoring as well as the land-based cetacean survey mentioned above.

Soft substrate seabed

10.4.3.116 Seabed sediments in North Lantau waters display a range of types: those in deeper and swifter-moving waters such as Urmston Road are dominated by coarse material, while those in areas with slower-moving currents are dominated by mud, silt and clay (Greiner Maunsell 1991). This variety of benthic substrates was found to foster a diversity of burrowing infauna in grab samples conducted in 1990 (Greiner Maunsell 1991).

Benthos

10.4.3.117 There is no known macrofauna species of conservation interest in Hong Kong, other than the cephalochordate *Branchiostoma belcheri*. The species is regarded as living fossil link in the evolution of marine invertebrates to vertebrates and is, therefore, considered a potentially important species. The species, however, is typically recorded in the eastern waters of Hong Kong (CCPC 2002) and recently to the south of Cheung Chau (Mouchel, 2003). No species of conservation importance were recorded in the Western waters stratum.

10.4.3.118 Parts of the seabed off North Lantau (beyond the project footprint of the present project) have been used as marine borrow and spoil dumping sites. Contaminated spoil is dumped at the East Sha Chau dumping grounds, where benthic grab samples indicate a fauna low in species diversity, and highly variable due to natural and human disturbance (ERM 1996). More recent monitoring results in the mud pits also revealed similar conditions in the benthic and demersal communities (Mouchel 2002a).

10.4.3.119 Surveys of benthic fauna had been conducted off North Lantau for various studies. In a territory-wide benthic survey commissioned by AFCD (CCPC 2002), up-to-date information on the subtidal benthic communities, with respect to spatial distribution, abundance, and species composition, was collected at 120 sampling stations over the territorial waters of Hong Kong which was divided into 5 strata (regions). One of the strata, Western waters with 29 sampling stations, covers Urmston Road, Deep Bay and North Lantau, and is more relevant with the works areas of the Project. Station 18 is more relevant with the Project as this station is located in the vicinity of the Project footprint (**Figure 10.7**).

10.4.3.120 Station 18 is located in to the north of Airport Northeast corner. The water depth of Station 18 is 8m, and in summer the mean Total Organic Matter TOM was 3.64%, lower than the average in Hong Kong (6.04%). The species richness index (*d*) was 5.62, the species, individual and biomass density were 38 species, 1,444 individuals, and 1,347.68 g/m^2 respectively. The diversity index, H', was 1.52 and evenness, J, was 0.42. Common species in the group of stations covering Station

18 included annelids of *Mediomastus* sp., *Aglaophamus distranchis* and *Apionsoma trichocephalus*.

10.4.3.121 In winter, the mean TOM in Station 18 was 4.39%, lower than the average in Hong Kong (5.45%). A species richness (*d*) of 8.06 was recorded and the density of species, abundance and biomass were 52, 1,120 individual/m^2 and 263.38 g/m^2 respectively. *H'* was 2.14 and *J* was 0.54. Common species in the group of stations covering Station 18 included annelids of *Prionospio ehlersi*, *Mediomastus* sp., *Apionsoma trichocephalus, Aglaophamus distranchis* and *Neoxenophthalmus obscurus*.

10.4.3.122 Species richness, diversity and evenness indices are inter-related. A diversity index integrates two components: the total number of species and the distribution of individuals among species, into a single number (*H'*). H' is usually high (e.g. >3 or 4) in environmentally undisturbed benthic communities, and low (e.g. <1) in highly disturbed communities (Gray 1989). Values for richness, diversity, and evenness would be high, with *d*>10, *H'*>3 and *J* (evenness) >0.8 for a diverse community structure. In benthic habitats where organic matter is concentrated or dissolved oxygen is low, such values are low, with *d*<5, *H'*<2, and *J*<0.5. Results in above paragraphs show that Station 18 is of moderate species richness, low diversity, and low evenness in both summer and winter seasons. No species of conservation importance was recorded. The only known benthic macrofauna species of conservation interest in Hong Kong, the cephalochordate *Branchiostoma belcheri* was not found in this station. This area is therefore not of special conservation importance in terms of benthic communities.

10.4.3.123 The diversity and abundance of benthic infauna in North Lantau display a high level spatial variation. Among the four CCPC sampling stations around Airport Island (i.e. Station 18 at the northeast Airport Island described above, Station 19 at the Northwest of Airport Island, Station 20 to the east of Airport Island at Brothers Islands, and Station 21 to the west of Airport Island, the density of benthos in summer varied from 218 no./m^2 (Station 20) to 1,444 no./m^2 (Station 18), and the biomass varied from 11.52 g/m^2 (Station 21) to 1,347.68 g/m^2 (Station 18). During winter, similar spatial variations are observed, with the density of benthos varied from 36 no./m^2 (Station 20) to 1,120 no./m^2 (Station 18), and the biomass varied from 15.12 g/m^2 (Station 19) to 263.38 g/m^2 (Station 18).

Table 10-5 The number of species, density and biomass of benthic infauna from four CCPC benthic stations near Airport

Station	Summer			Winter		
	No. of species (0.5m^2)	No. of Individual (m^2)	Wet weight (g/m^2)	No. of species (0.5m^2)	No. of Individual (m^2)	Wet weight (g/m^2)
18	38	1444	1347.68	52	1120	263.38
19	41	650	77.80	54	664	15.12
20	27	218	38.58	13	36	18.38
21	38	460	11.52	37	296	38.62

10.4.3.124 Grab sampling were conducted at 15 sampling stations in North Lantau inshore waters at both wet and dry seasons during the **EBS** study. 15 sampling stations were sampled from three zones, i.e. HKS (to the west of Airport Island), NLHC (within Airport Channel) and THW (to the east of Airport Island). In the wet season, species abundance and diversity was higher outside (32.6 individuals and 4.2 taxa grab-1) than inside Airport Channel (9.2 individuals and 2.4 taxa grab-1). In the dry season, conversely, species abundance and diversity was higher inside (46.2 individuals and 9.8 taxa grab-1) than outside (23 individuals and 5.6 taxa grab-1) Airport Channel (**Appendix 10A**). The marine benthic macrofauna was comprised

of a high diversity of polychaete species, in which *Sigambra hanaokai* was the dominant species in the wet season, while *Eunice indica* and *Prionospio* sp. dominated in the dry season. Species diversity of other taxa (mainly crustaceans, echinoderms and molluscs) and the overall biomass were, however, low, which is typical in the North-western waters of Hong Kong (ERM 2000; CPCC 2002; Mouchel 2002). All the species recorded occur frequently in Hong Kong and no rare species were observed (CPCC 2002). The biotic index of ~ 2 – 3 and the dominant species recorded implies the community is slightly disturbed.

10.4.3.125 During wet season, the recorded benthic species number in THW Area was 23 taxa including annelid (with the dominant families of Spionidae, Pilargiidae, Poecilochaetidae, and Capitellidae) and crustacean (with the most abundant group of amphipod Corophiidae), the individual number was 163, the density of benthos was 32.6 individual/grab (or 326 individual/m^2), and the biomass was 0.76 g/grab (or 7.6 g/m^2)

10.4.3.126 In dry season (winter), the recorded benthic species number in THW Area was 28 taxa also including annelid (with the dominant families of Spionidae and Capitellidae) and crustacean (with the most abundant group of amphipod Corophiidae), the individual number was 115, the density of benthos was 23.0 individual/grab (or 230 individual/m^2), and the biomass was 0.54 g/grab (or 5.4 g/m^2)

10.4.3.127 Infauna diversity to the east of Airport Channel was relatively low (H' at THW = 0.97) compared to other areas in Hong Kong. The impoverished assemblages present is likely due to the proximity of Pearl River Estuary (estuarine areas are often less diverse owing to their highly dynamic physical and chemical nature) and possibly due to the predominantly silt-clay composition of the seabed that tends not to support high diversity (Shin 1998; Mouchel 2002b; CCPC 2002).

10.4.3.128 The major conclusion from other previous work in the North-western waters as summarised in Mouchel (2002b) was that benthic macrofauna present are impoverished and relatively similar throughout the North-western waters and are representative of the general study area.

10.4.3.129 Marine grab samplings of **EVS** study were conducted for benthic communities in soft substrate seabed at 9 stations along the mid 2008 HKLR alignment during both wet season and dry seasons (September 2008 and December 2008). The mid-2008 HKLR alignment and the sampling locations are shown in **Figure 10.3** and Figure A1.1.3 in **Appendix 10B**. Three grab sample replicates of 0.1m^2 were collected at each of the sampling stations by van Veen-type Grab and collected samples were sieved using a 0.5mm mesh-size sieve and then preserved in 70% ethanol. Organisms inside the samples were sorted from the sediments by staining with Rose Bengal and then identified to the lowest practicable taxonomic level. Species composition, abundance and biomass were reported and statistical analyses (Diversity index, evenness index and Abundance/Biomass Comparison (ABC) plots), were provided for evaluation and ranking of ecological values.

10.4.3.130 A total of 985 macro-faunal specimens, comprising 90 species from 59 families in 9 phyla (Annelida, Arthropoda, Branchiopoda, Chordata, Cnidaria, Echinodermata, Mollusca, Nemertea and Platyhelminthes), were recorded in the wet season. In the dry season, a total of 383 macro-faunal specimens comprising 58 species from 44 families in 6 phyla (Annelida, Arthropoda, Coelenterata, Echinodermata, Mollusca and Nemertea) were recorded. Only 28 species were found in both seasons. Polychaetes (Annelida) were collected at all stations and represented the highest species richness and abundance in both seasons.

10.4.3.131 The bivalves *Donax* sp. and *Theora lata* and the brittle star *Macrophiothrix longipeda* were the commonest species recorded in the wet season, whilst the polychaetes *Notomastus latericens* and *Euclymene* sp. and the pea crab *Xenophthalmus* sp. were the most abundant species recorded in the dry season. Detailed data are presented in **Appendix 10B**.

10.4.3.132 Species abundance and richness were higher in the wet season than in the dry season (using two-way ANOVA, $p < 0.001$), except in Station 7 where the species abundance and richness remained constant. The overall patterns were, however, similar in both seasons: higher in open waters (Stations 1-3, 8 & 9) and declining gradually towards the Airport Channel. In the wet season, Stations 2 and 3 possessed the highest species abundance and Station 1 had the highest species richness. The lowest species richness and abundance occurred in Station 7. In the dry season, the species abundance and richness were highest in Stations 2 and 3 and were lowest in Stations 5 and 6.

10.4.3.133 The Pielou's Index was similar between seasons and stations (wet season: 0.75 – 0.93, dry season: 0.79 – 0.99). The Shannon-Wiener Diversity Index was slightly higher in the wet season than in the dry season, but the variation between stations is slight (wet season 2.68 – 3.37, dry season: 1.84 – 2.57).

10.4.3.134 The overall biomass was higher in the dry season than in the wet season (using two-way ANOVA, $p < 0.05$). The values in both seasons were, however, variable between stations and no general patterns could be deduced. Total biomass in the wet season was 30.94 g and was mainly due to the relatively high mass of molluscs (22.1 g) and arthropods (5.5 g). Juveniles (~1 – 5 mm length) of bivalves and gastropods were recorded. Total biomass in the dry season was 131.53 g and was mainly due to the relatively high mass of molluscs (67.92 g), echinoderms (40.77 g) and arthropods (20.77 g). The biomass of other taxa in both seasons was low because of their small sizes and/or low abundance. Detailed biomass data are presented in **Appendix 10B**.

10.4.3.135 The W statistics for the 9 stations during the wet season were all positive and generally similar (0.225 – 0.411), although Station 7 possessed the lowest value of 0.11 and Station 9 had the highest value of 0.556. The W-statistics for the 9 stations during the dry season were also positive and the values were higher than those recorded in the wet season (0.264 – 0.739).

10.4.3.136 In both wet and dry seasons, none of the species are mentioned in the IUCN Red List (IUCN 2009). One species is listed in the China Species Red List (CSIS 2008): the Greasyback Shrimp *Metapenaeus ensis* is listed as Vulnerable due to over-exploitation in China. This species indeed is commercially important in many Asian countries (Leung *et al*. 2004). In Hong Kong, *Metapenaeus ensis* is a common fisheries species, and is also one of the major species cultured in the tidal shrimp ponds "Gei Wais" in Mai Po, and commonly known as "Gei Wai Shrimp" in the local market.

10.4.3.137 The marine benthic macrofauna in North Lantau was composed of a high diversity of polychaete species and a low diversity of other taxa, which is characteristic in the North-western waters of Hong Kong (ERM 2000; Shin, 2002; Mouchel, 2002). There was, however, a distinct spatial and temporal pattern, suggesting the benthic macrofauna are sensitive as a biological indicator to reflect changes in environmental conditions (Shin, 2002).

10.4.3.138 Spatially, species abundance and richness were higher outside than inside the Airport Channel. The large error bars indicate that species abundance and richness varied considerably within sites.

10.4.3.139 Temporally, species abundance, richness and diversity (Shannon-Wiener Diversity Index) were higher in the wet season than in the dry season. The small individual sizes observed and the low biomass recorded in the wet season may suggest that the majority of the benthic macrofauna recruit during this time period. The decrease in species abundance and richness in the dry season is possibly an indication of post-recruitment mortality of the benthic macrofauna. The similarity in the Pielou's Evenness between seasons and stations indicates the species evenness was constant over time alike among the 9 stations.

10.4.3.140 Infauna diversity in the North Lantau waters is relatively low when compared to other areas in Hong Kong. The impoverished assemblages present is likely due to the proximity of the Pearl River Estuary, leading to low salinity and possibly due to

the predominantly silt-clay composition of the seabed which does not lend itself to supporting high diversity (Shin 1998). All the species recorded occur frequently in Hong Kong and no rare species were observed (Shin 2002).

10.4.3.141 The benthic communities in the waters offshore to the southeast coast of Airport Island were also investigated in the **MSS** study. From the 8 sampling stations, a total of 917 organisms from 83 taxa were identified from the dry season survey. The most diverse group was polychaetes (46 species). In terms of number of individuals, 43% of collected organisms were polychaetes, followed by crustaceans (35%).

10.4.3.142 During the dry season benthic survey under the **MSS** study, 345 organisms were identified from the sediment samples collected. In wet season, 58%, 15%, 12%, 8% and 7% of organisms collected were polychaetes, molluscs, crustaceans, echinoderms and other phyla, respectively. The total biomass was 130.87 g, in which 52%, 27%, 15% and 6% of total biomass were accounted by echinoderms, molluscs, crustaceans and other phyla, respectively.

10.4.3.143 The benthic communities inside the footprints of HKBCF reclamation (the waters offshore to the northeast coast of Airport Island) were also investigated in the HKBCF survey programme. 559 organisms from 80 taxa (210 individuals weighted 264.28g and 349 individuals weighted 179.73g from dry season survey) were collected from 9 sampling stations within the HKBCF reclamation area. Detailed results are presented in **Appendix 10D**. No species of special conservation importance was found. The results are basically similar with those from the grab sampling surveys of **EVS** and **MSS**.

10.4.3.144 During the TMCLKL study, benthic samplings were conducted at 8 stations along the alignment in October 2008 and February 2009. 917 individuals from 50 families comprising 8 different phyla. The total recorded biomass was 58.0 g due to the high mass of molluscs, echinodermata, annelida and arthropoda. The infauna density was 382 individuals/m^2, and the average biomass was 24.2g/m^2. The dry seasons survey collected 1,579 individuals from 50 families comprising 7 different phyla. The total recorded biomass was 73.1g. The density was 658 individuals/m^2 and the average biomass was 30.46 g/m^2.

10.4.3.145 The soft substrate seabed of the vast Hong Kong western waters also provides a habitat for adult horseshoe crab. Though the available habitats are abundant, but the density of the adult horseshoe crabs is not high as this species is not a regular fishing catch. Adult horseshoe crabs are only occasionally collected during bottom trawling.

Hard substrate seabed

Corals

10.4.3.146 Recent information on coral ecology in North Lantau waters is provided by several studies as well as field survey programmes including the **EBS**, **EVS**, **MSS**, and the HKBCF.

10.4.3.147 Hard corals are protected in Hong Kong by the Protection of Endangered Species of Animals and Plants Ordinance (Cap 586) which includes the protection of all stony (hard) corals. Established coral communities of any size are regarded as important habitat types in Hong Kong as defined in Annex 8 of EIAO-TM.

10.4.3.148 Corals in Hong Kong exhibit strong gradients in distribution, species diversity and abundance. Hard corals are more vulnerable to water quality such as salinity and suspended solid and prefer clear oceanic water, and their geographical distribution in Hong Kong is affected by the salinity of the water. Hard coral coverage and diversity decrease from east to west, toward the influence of the Pearl River (Scott 1984). The estuarine environment of the western Hong Kong waters was thought unsuitable for the existence of scleractinians (reef-building corals)(Scott 1984). A later study demonstrated that water quality, particularly elevated freshwater and suspended sediment levels which are characteristic of estuarine environment,

prevent substantial hard coral growth (Hodgson and Yau 1997). The vertical distribution of hermatypic corals is largely controlled by the requirements of their photosynthesising zooxanthellae which require strong light and hence shallower water, whereas many of the soft corals that do not possess symbiotic algae can survive at greater depths (Morton and Morton 1983; Morton 1994).

10.4.3.149 The North Lantau waters are within the estuarine western waters. In contrast to the oceanic eastern waters, the abundance and diversity of corals are low in western Hong Kong waters (in particular North-western waters which are closer to Pearl River Estuary). North Lantau waters are thus characterized by domination of gorgonian and soft corals. Soft corals, sea pens and gorgonian corals (sea fans) were reported to be present throughout the North-western waters (Mouchel 2002b, 2004).

10.4.3.150 AFCD commissioned intensive underwater surveys in 2001-2002 to survey corals at 240 sites covering about 70 km of coastline in territorial waters (AFCD 2004). Hard corals were found in western waters of Hong Kong, but in southern Lantau waters (Tong Fuk, Soko Islands) and eastern (Cheung Chau, Hei Ling Chau) Lantau waters, and only sparse colonies or low-coverage communities, composed of extremely tolerant and hardy species were found.

10.4.3.151 The coverage of corals in this region is very low (less than 5%, and usually < 1%, the lowest compared with other regions in Hong Kong). The “near-total or complete absence” of reef-building hard corals was considered attributable to the high turbidity and low salinity.

10.4.3.152 A dive survey targeting on corals was conducted along the coastline from Sham Wat to Kei Tau Kok (to the east of Tung Chung near Tai Ho) during the EBS. No hermatypic hard coral was found at any of the 27 dive sites. Although ahermatypic corals were recorded, but they were concentrated in sites to the west of the airport island. The only widespread and common coral recorded in the survey was one species of gorgonians *Echinomuricea* sp. which was found both to the east and to the west of the airport island, but not inside the Airport Channel. The species composition at the dive sites near the HKLR reclamation for the at-grade road (the southeast coast of Airport Island, Dive site 22 and 23) consisted of gorgonian soft corals and ahermatypic corals, and their coverage were found all below 5% (**Appendix 10A**). The gorgonian soft corals near Airport Island suffered high levels of partial mortality. The findings are consistent with that recorded in western water during the AFCD study.

10.4.3.153 A dive survey was conducted at the artificial seawalls near MTR depot at Siu Ho during the LLP EIA study. The survey site is basically facing to the Brothers in North Lantau waters. It is to the east of the outlet of Tai Ho Wan. Freshwater input from Tai Ho Stream is discharged into the nearby waters through this only outlet of Tai Ho Wan with the open sea.

10.4.3.154 It was found from the LLP dive survey that the topography of the subtidal habitats within the proposed LLP site is generally flat. The coastline is all sloping boulder artificial seawall.

10.4.3.155 The horizontal transect covered the seawall adjacent to the MTR depot. Along the transect the seabed composition was all boulders. The boulders on the seawalls were also heavily covered by fine sediment.

10.4.3.156 Though no alive or dead hard corals, colonies of gorgonian were found on the boulders of the artificial seawalls. They were all of small sizes (less than 10 cm in length) and scattered on the boulders, resulting in a low coverage (<1%). Partially mortality was also observed in many colonies, which indicated that these gorgonians were under stress. Other marine fauna species found during the survey included Fan Shell, Green Mussel, and Oyster, and they were common and of no special conservation importance in Hong Kong. The results from the present dive survey were basically consistent with those from the EBS dive survey, in particular the coral composition and coverage.

10.4.3.157 Dive surveys were conducted at seven dive survey sites (with DS1 near Sham Wat, DS2 at the western shore of Sha Lo Wan headland, 3 sites DS3, DS4, DS5 inside the Airport Channel, DS6 on the southeast shore of Airport Island, and DS7 on Tung Chung New Town) in 2008 during the **EVS** study. The results revealed that no coral was found within the Channel while the diversity and abundance of hard and soft corals outside the Airport channel were low. Most hard substrates were dominated by barnacles, mussels and rock oysters. At the western shore of Sha Lo Wan headland, i.e. DS2, the subtidal hard substrate extends less than 10m from the shore.

10.4.3.158 Only one genus of ahermatypic cup coral *Balanophyllia* (Dendrophylliidae) and one genus of octocoral, *Echinomuricea* sp. (Plexauridae) were recorded from two (DS1 and DS2) and four (DS1, DS2, DS6 and DS7) of the seven survey sites, respectively. Both the hard and soft corals were only present outside the Airport Channel. No coral was found within the Channel (i.e. DS3, DS4 and DS5).

10.4.3.159 No other taxa of high conservation interest were recorded in the seven survey sites. Full details of substrate type and fauna recorded are shown in **Appendix 10B**.

10.4.3.160 Compared with the **EBS** study, the spot dive in 2003 generated similar qualitative data as the **EVS** study. In the **EBS** study, the ahermatypic cup coral *Balanophyllia* sp. was only recorded outside the Airport Channel at site SD5 (DS1 in the **EVS** study), SD9 (DS2 in the **EVS** study) and SD22 (DS6 in the **EVS** study). In the **EVS** study, this cup coral was also recorded in DS1 and DS2 but not in DS6, which is probably due to the very low abundance and patchy distribution of the coral within same area. For the octocoral *Echinomuricea* sp., the results in the **EVS** study agree with the finding in the **EBS** study.

10.4.3.161 In Hong Kong context, the low salinity and murky water at the western Hong Kong limit the development of hard coral to few thriving species such as *ahermatypic* cup corals, *Oulastrea crispata*, *Plesiastrea versipora* and selected *Favia* species. At north and northwest Lantau, only *Oulastrea crispata* and *ahermatypic* cup corals have been reported. The low diversity and low abundance of corals in the present survey is typical for the western Hong Kong waters.

10.4.3.162 During the **MSS** study, 8 locations along the southeast shore of Airport Island were investigated by spot dive and two of them were further surveyed with REA technique. In the HKBCF survey programme, dive surveys were conducted at 7 locations along the northeast shore of Airport Island and 9 locations within the HKBCF reclamation site, with two shore locations where direct impacts are anticipated further studied by REA technique.

10.4.3.163 Only 2 out of the 8 dive locations in the **MSS** study had records of gorgonian coral *Echinomuricea* sp., and both sites (D1 and D8) are sloping boulder seawalls. The percentage cover of the gorgonian recorded was less than 1% and the gorgonians were of fair condition. The seabed within the HKBCF reclamation site was quite homogeneous, of all muddy seabeds, lacking the hard bottom substrate required for coral colonization and thus was not a habitat for corals. The sediment was very fine and no demersal fauna was sighted. As no hard substrate in these locations, no coral (both hard and soft) was found in the seabed within the reclamation site. The only hard bottom substrate in the area was the artificial seawalls which laid along the Airport Island shoreline, to the west of the HKBCF reclamation site. No hermatypic hard corals were found, but sparsely distributed small-sized gorgonian colonies (*Echinomuricea* sp.) were found at all seawall bounce dive points. The existing artificial sloping seawalls is comprised of both vertical (at Marine Cargo Terminal and Sky Pier) and sloping seawalls (Fire station and to the south of MCT). The vertical seawalls had no hard corals and very little soft corals, but with more common epifauna such as rock oysters. The seawall surveyed by REA was sloping boulder form. To further investigate the epifauna fauna on the seawall which was the only hard bottom substrate habitat in the area, two sections of 100m seawall was surveyed by REA in a horizontal transect pattern. The slope of the sloping artificial seawall maintained the gradient (about 45 degree gradient) in the subtidal zone and extended till it met the seabed. The boulders of the sloping seawalls

were all irregular in shape and the largest ones were close to 1m in size. On the boulders of the sloping seawalls, there was no hermatypic hard coral, but a low coverage percentage of small-sized gorgonian colonies (*Echinomuricea* sp.) which is common in Hong Kong western waters and not of special conservation importance. Furthermore, partially mortality was observed on some branches of the gorgonian colonies, demonstrating the poor conditions of the gorgonians. Very low coverage of ahermatypic cup corals *Balanophyllia* sp. was found at the Northern REA transect at the Fire Station sloping seawall. Other epifauna on the boulders were mainly sessile bivalves including Green mussel *Perna viridis* and Oyster *Ostrea* sp., and predatory snail *Thais* sp. except the boulders at the seawalls, the seabed in the area was almost solely muddy substrate. Other fauna recorded on both the muddy seabed and the boulders of the seawall were also of low conservation importance including green mussels and oysters.

10.4.3.164 The hard substrate seabed along North Lantau coastlines were also surveyed during the dive survey of TMCLKL study. Low coverage of populations of soft coral *Guaiagorgia* sp. (< 10%) and ahermatypic coral *Paracyathus rotundatus* (< 5%) were found along the seawalls. Partial mortality (about 20%) of the population of *Guaiagorgia* sp. was recorded during the REA survey at this coastline. Other organisms recorded were common in Hong Kong, such as sponges, barnacles, oysters, coralline algae. No taxa of high conservation interest were recorded. It is expected that the salinity in the HKBCF site is diluted by the flow from Pearl River as in other locations in North Lantau waters, and it might explain the absence of hard corals in the HKBCF site. This might also explain the similarity in the results from the present study and those from EVS and MSS in which many dive sites near Tung Chung Bay which is the outlet of Tung Chung River and Wong Lung Hang Stream.

10.4.3.165 Basically, the marine communities showed no particular trend within the several study areas of different surveys in terms of diversity and abundance. The northeast and southeast coastlines of Airport Island are exposed to the open sea and no hermatypic coral coverage was found there. These results matched the results from the EBS during 2003-04. From the information presented in the previous sections, it is clear that the hard substrate subtidal habitats in the area can be considered as of low ecological value due to the absence of hermatypic coral, the low coverage and the small sizes of gorgonian and ahermatypic corals, and their poor conditions (with partial mortality on the branches of gorgonians).

Artificial Reefs

10.4.3.166 Artificial Reefs were deployed near the northeast corner of Airport Island within Marine Exclusion Zone 3 and at Sha Chau and Lung Kwu Chau Marine Park. Both ARs were deployed in 2000, with a footprint of 1,200 m^2 (3,600 m^3 in terms of volume) in the Marine Exclusion Zone, and a footprint of 3,660 m^2 (3,600 m^3 in terms of volume) in the Marine Park. The artificial reef units in the Marine Exclusion Zone comprised Ferro-cement vessels (build-up river barge) and natural materials (quarry rock), while the units in the Marine Park comprised Ferro-cement vessels (river barge) and concrete-coated materials (Steel Container). Primarily postulated as feeding stations for Chinese White Dolphin, these artificial reefs also help to enhance habitat quality and marine resources. As both sites are restricted, for either fishing or marine traffic, the undisturbed environment should facilitate a better development of the reef community and enhancement functions. The enhancement functions of artificial reefs deployed in Eastern waters were demonstrated by monitoring surveys, and it was recorded that juvenile fish were found to have settled after artificial reef vessels were deployed (Wilson 2003). While the ARs in the Marine Park is quite distant (approximately 7 km from HKBCF), the ARs in Marine Exclusion Zone is the nearest marine ecological sensitive receiver and is approximately 300m from the HKBCF reclamation and 1.5km from HKLR reclamation.

10.4.4 Evaluation of Ecological Importance of Habitats

10.4.4.1 The ecological importance of different parts of the assessment areas are evaluated based primarily on the criteria set forth in Table 2, Annex 8 of the EIAO-TM:

- naturalness;
- size;
- diversity;
- rarity;
- re-creatability;
- fragmentation;
- ecological linkage;
- potential value;
- nursery/breeding ground;
- age; and
- abundance/richness of wildlife.

Table 10-6a Ecological value of different habitats along HKLR and HKBCF

Criteria	Terrestrial			
	Woodland	Shrubland	Plantation	Agricultural
Naturalness	Semi-natural	Semi- natural	Artificial	Artificial
Size	About 22 ha	About 67 ha	23.5 ha	About 0.05 ha
Diversity	Moderate	Moderate	Moderate	Low
Rarity	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong
Re-creatability	Creatable through planting	Creatable through planting	Creatable through planting	Readily creatable
Fragmentation	Unfragmented, except the woodland in Scenic Hill.	Unfragmented, except the shrubland in Scenic Hill..	Unfragmented.	Fragmented to a certain extent by paths and houses.
Ecological linkage	Generally linked with adjacent natural habitats except the woodland in Scenic Hill.	Generally linked with adjacent natural habitats except the shrubland in Scenic Hill.	No significant linkage	Generally linked with adjacent natural habitats
Potential value	Low. Already a natural habitat.	Low.	Low.	Low
Nursery/breeding ground	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed
Age	N/A	N/A	N/A	N/A
Abundance/Richness of wildlife	Moderate	Moderate	Low	Low
Overall Ecological value	High for Scenic Hill; Moderate –high for other woodlands Low-moderate for young woodland	Moderate-high for tall shrubland and shrubland; moderate for grassland /shrubland; low for grassland/shrubland on Scenic Hill	Low-moderate	Low-moderate

Table 10-6b Ecological value of different habitats along HKLR and HKBCF

Criteria	Terrestrial		
	Grassland/Seasonally wet grassland	Developed area	Streams
Naturalness	Natural.	Artificial	Basically natural.
Size	About 1 ha	Over 300 ha	NA
Diversity	Low	Low	Moderate
Rarity	Common habitat in Hong Kong	Common and abundant in Hong Kong	Common habitat in Hong Kong
Re-creatability	Re-creatable.	Re-creatable.	Difficult to re-create.
Fragmentation	Unfragmented.	Unfragmented.	Unfragmented.
Ecological linkage	Generally linked with adjacent natural habitats	No significant linkage	Linked with open sea
Potential value	Low.	Low.	Low. Already a natural and undisturbed habitat.
Nursery/breeding ground	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed, but some marine species might use estuarine areas as nursery grounds.
Age	N/A	N/A	N/A
Abundance/Richness of wildlife	Low	Low	Low to moderate
Overall Ecological value	Low	Low	Ranging from low to Moderate-high

Table 10-6c Ecological value of different habitats along HKLR and HKBCF

Criteria	Intertidal			
	Hard shore - Rocky shore	Sandy beach/ sandflat/ mudflat (including seagrass beds)	Mangroves	Hard shore - Artificial seawalls
Naturalness	Basically natural.	Basically natural.	Basically natural.	Artificial
Size	About 6km	NA	0.94 ha within the 500m assessment area	About 5.5km
Diversity	Low	Low for sandy beaches; Low to moderate for San Shek Wan, and Moderate for other soft shores	Low	Low
Rarity	Common habitat in Hong Kong	Common in Hong Kong for sandy beach; For the soft shores, limited in Hong Kong, with records of seagrasses and horseshoe crabs.	Common habitat in Hong Kong waters.	Common habitat in Hong Kong
Re-creatability	Not re-creatable.	Re-creatable for sandy beach; Difficult to recreate for sandflat/mudflats.	Creatable through planting	Readily creatable
Fragmentation	Unfragmented.	Unfragmented.	Unfragmented.	Unfragmented.
Ecological linkage	Generally linked with the open sea.	Generally linked with the open sea and/or mangroves.	Generally linked with sandflats/mudflats and the open sea.	Generally linked with the open sea.
Potential value	Low.	Low for sandy beaches;	Low. Already a natural habitat.	Low

Criteria	Intertidal			
	Hard shore - Rocky shore	Sandy beach/ sandflat/ mudflat (including seagrass beds)	Mangroves	Hard shore - Artificial seawalls
		Moderate for other soft shores which are currently disturbed by the clam harvesting activities		
Nursery/breeding ground	No special nursery/breeding ground function observed	Sandflat/mudflats provide horseshoe crab nursery ground	Breeding/nursery ground for marine species.	No special nursery/breeding ground function observed
Age	N/A	N/A	N/A	N/A
Abundance/Richness of wildlife	Generally low – moderate; low in the remnant rocky shore on Airport Island	Low for sandy beach; Moderate for other soft shores	Low to moderate	Low
Overall Ecological value	Low – moderate for rocky shore on North Lantau; Low for remnant rocky shore on Airport Island	Low to moderate for San Shek Wan; Moderate to High for Sham Wat, Sha Lo Wan, Hau Hok Wan, San Tau, Tung Chung Beach and Tai Ho	Moderate	Low

Table 10-6d Ecological value of different habitats along HKLR and HKBCF

Criteria	Marine waters			
	To the west of Airport Island	Airport Channel	Near eastern shore of Airport Island	Northeast Airport Island
Naturalness	Natural	Natural	Natural	Natural
Size	NA	NA	NA	NA
Diversity	Low	Low	Low	Low
Rarity	Common habitat in Hong Kong waters. Dolphin habitat.	Common habitat in Hong Kong waters. No dolphin records.	Common habitat in Hong Kong waters. No dolphin records	Common habitat in Hong Kong waters. Dolphin habitat.
Re-creatability	Not re-creatable.	Not re-creatable.	Not re-creatable.	Not re-creatable.
Fragmentation	Unfragmented.	Unfragmented.	Unfragmented.	Unfragmented.
Ecological linkage	Potentially a corridor for dolphin movement between Sha Chau and Lung Kwu Chau Marine Park and West Lantau waters	Generally linked with the open sea. Connect to soft shore habitats along the channel	Not functionally linked to any high value habitats (e.g. mudflat) in close proximity.	Potentially a corridor for dolphin movement between the Sha Chau and Lung Kwu Chau Marine Park and the Brothers Islands
Potential value	Low. Already a natural habitat. Development of coral colonies constrained by water quality	Low. Already a natural habitat. Development of coral colonies constrained by water quality	Low. Already a natural habitat. Development of coral colonies constrained by water quality	Low. Already a natural habitat. Development of coral colonies constrained by water quality
Nursery/breeding ground	Potential breeding/nursery ground for marine species.	Potential breeding/nursery ground for marine species.	Potential breeding/nursery ground for marine species.	Potential breeding/nursery ground for marine species.
Age	N/A	N/A	N/A	N/A
Abundance/Richness of wildlife	Low to Moderate	Low	Low	Low to Moderate
Overall Ecological value	Moderate-high	Low	Low	Moderate

Table 10-6e Ecological value of different habitats along HKLR and HKBCF

Criteria	Hard substrate seabed	Artificial reefs in Northeast Airport	Soft substrate seabed
Naturalness	Partially natural, and partially artificial.	Artificial	Basically natural.
Size	NA	1,200 m^2	NA
Diversity	Low Colonised by low coverage of common gorgonians and ahermatypic corals	Moderate	Low
Rarity	Common habitat in Hong Kong waters.	Deployed in at least 8 locations within Hong Kong waters.	Common habitat in Hong Kong waters.
Re-creatability	Re-creatable.	Re-creatable.	Not re-creatable.
Fragmentation	Unfragmented.	Unfragmented.	Unfragmented.
Ecological linkage	Generally linked with the open sea.	Generally linked with the open sea.	Generally linked with the open sea.
Potential value	Low. Development of coral colonies constrained by estuarine environment	Moderate.	Low. Limited by the mobile nature of the sediment. Already a natural habitat.
Nursery/breeding ground	Breeding/nursery ground for marine species.	Breeding/nursery ground for marine species.	Breeding/nursery ground for marine species.
Age	N/A	Deployed in 2000	N/A
Abundance/Richness of wildlife	Low	Moderate	Low
Overall Ecological value	Low-moderate	Moderate	Low

Table 10-6f Ecological value of recognised sites of marine conservation importance within North Western and North Western Supplementary WCZs

Criteria	Sha Chau and Lung Kwu Chau Marine Park	Proposed Marine Park at Fan Lau	San Tau Beach SSSI	Tai Ho Stream SSSI
Naturalness	Natural	Natural	Basically Natural	Basically Natural l
Size	1,200 ha	N/A	2.7 ha	5 ha
Diversity	Moderate	Moderate	Moderate	High
Rarity	One of the two most important sea areas for CWD in Hong Kong	One of the two most important sea areas for CWD in Hong Kong	San Tau harbours the largest seagrass area on Lantau; one of the three recognized horseshoe crab nursery sites Hong Kong.	Support the greatest diversity of fresh water and brackish-water fish in Hong Kong.
Re-creatability	Not re-creatable.	Not re-creatable.	Not re-creatable.	Not re-creatable.
Fragmentation	Unfragmented.	Unfragmented.	Unfragmented.	Unfragmented.
Ecological linkage	Generally linked with the open sea	Generally linked with the open sea.	Connect to soft shore habitats along the channel	Generally linked with the open sea.
Potential value	Low. Already a natural habitat.	Low. Already a natural habitat.	Low. Already a natural habitat.	Low. Already a natural habitat.
Nursery/breeding ground	Nursery ground for CWD.	Nursery ground for CWD..	Nursery ground for horseshoe crab	Nursery ground for horseshoe crab
Age	N/A	N/A	N/A	N/A
Abundance/Richness of wildlife	High for CWD	High for CWD	Moderate	High
Overall Ecological value	High	High	High	High

10.4.4.2 Based upon the evaluation, discussions are concentrated on the habitats that are simultaneously more important to the species/habitats of conservation importance and relevant to the Project.

10.4.4.3 West Lantau and North Lantau waters which are the most important dolphin habitats in Hong Kong. The CWD are present commonly year-round in the waters north and west of Lantau, and are found only seasonally or rarely in other places of Hong Kong.

10.4.4.4 In accordance with Table 3, Annex 8 of the EIAO-TM, the ecological value of species was assessed in terms of:

- Protection status;
- Species distribution; and
- Rarity.

10.4.4.5 12 floral species of conservation interest have been identified. Eight species were identified in both **EBS** and **EVS** studies, while sedge *Carex tristachya* and orchid *Arundina chinensis* were not recorded in the **EVS**. These two species were previously recorded in tall shrubland and shrubby grassland. Among them, three species of seagrasses are considered relevant to the impact assessment as they colonise intertidal zone and potentially subject to water quality impacts.

10.4.4.6 A total of 51 faunal species of conservation interest or restricted range, based on Fellowes *et al*. (2002), IUCN redlist, China Redlist, and Hong Kong legislations, have been recorded during the **EBS** and **EVS**. Among them, a total of 22 fauna species of conservation concern is considered relevant to the impact assessment of this Project, as they were recorded in habitats potentially subject to direct or indirect impacts from the HKLR and HKBCF, including marine mammal, wetland dependent birds, terrestrial fauna recorded in Scenic Hill, soft shore intertidal fauna.

10.4.4.7 This project would only affect limited area of terrestrial habitats within the terrestrial study area. In addition, terrestrial habitats would be affected are mainly disturbed/developed areas, which are of low ecological importance. Most terrestrial fauna of conservation concern were recorded at locations distant from the proposed alignment. Therefore not all the 51 fauna species utilize the habitats relevant to the Project. Only 22 species are considered relevant to the impact assessment.

10.4.4.8 The proposed alignment would span over coastal waters. Therefore, fauna relevant to the impact assessment for the Project are those foraging in coastal habitats, in particular avifauna. This included 9 water dependent bird species.

10.4.4.9 Romer's Tree Frog, though not recorded during the **EBS** or the **EVS**, was reported by AFCD in Scenic Hill (Chan *et al*. 2005b). The proposed alignment would encroach part of the Scenic Hill and potentially disturb the nearby habitats of this endemic frog species. This species is protected under the Wild Animals Protection Ordinance (Cap. 170) and considered of potential global concern. This species is therefore also put into the list of species of conservation concern.

10.4.4.10 Chinese White Dolphin is a Class I protected species in the Mainland. In the SAR, it is protected from capture or direct harm under the Wild Animals Protection Ordinance. The degree of threat to the global population is also ranked as Near Threatened by IUCN World Conservation Union.

10.4.4.11 Of the fauna species of conservation concern within the Assessment Area reported from literature reviews and field surveys, only Pacific Reef Egret mainly forages in coastal habitats. The artificial coastline of Airport Island is not considered to be important habitat of Pacific Reef Egret, due to the deep water and poor food base. More important habitat is present in the inter-tidal mudflats.

10.4.4.12 Though not presently protected under local law, Horseshoe crabs have recently been identified as a species of conservation importance in Hong Kong.

10.4.4.13 Established coral communities of any size are regarded as important habitat types in Hong Kong as defined in Annex 8 of EIAO-TM.

10.4.4.14 The list and evaluation of the floral and faunal species of conservation interest recorded within the Assessment Area, according to the TM-EIAO, are given in **Tables 10-7** and **10-8**. Relevant species are in bold form.

Table 10-7 Evaluation of floral species of conservation concern within the Assessment Area

Species	Protection status/China Red Data Book	Locations/Habitats recorded	EBS	EVS	Rarity	Relevant to the assessment
Dwarf Eel Grass *Zostera japonica*		San Tau Beach SSSI	✓	✓	Locally Rare (Hu *et al.* 2003)	Potentially subject to water impacts
Halophila minor		San Tau Beach SSSI		✓	Not previously recorded at San Tau. Locally Rare (Hu *et al.* 2003)	Potentially subject to water impacts
Halophila ovalis		San Tau Beach SSSI	✓		Locally Rare (Xing *et al.* 2000)	Potentially subject to water impacts
Hong Kong Pavetta *Pavetta hongkongensis*	Cap. 96	Tall Shrubland	✓	✓	Common (Xing *et al.* 2000)	No, on North Lantau
Indian Sundew *Drosera indica*		Stream (HHW)	✓	✓	Rare (Xing *et al.* 2000)	No, on North Lantau
Pale Purple Eulophia *Eulophia graminea*	Cap. 586; Cap. 96	Stone crevices in Stream (HHW)	✓	✓	Restricted (Siu 2000)	No, on North Lantau
Incense Tree *Aquilaria sinensis*	Cap. 586; Cap. 96;Near Threatened**; Class II Protected*	Tall Shrubland, Secondary woodland	✓	✓	Common (Xing *et al.* 2000)	No, on North Lantau
Portia Tree *Thespesia populnea*		Coastline, Mangrove associate.	✓	✓	Limited range; coastal areas (Xing *et al.* 2000)	No, on North Lantau
Clammy Hop Seed *Dodonaea viscosa*		Coastal habitat (SLW)	✓	✓	Rare (Xing *et al.* 2000)	No, on North Lantau
Carex tristachya,		Tall Shrubland (HHW)	✓		Very rare (Xing *et al.* 2000)	No, on North Lantau
White-green sedge (*Carex leucochlora*)		Not in present study			Very rare (Xing *et al.* 2000)	No, on North Lantau and not recorded in EBS and EVS
Bamboo Orchid *Arundina chinensis*	Cap. 586; Cap. 96	Shrubby grassland	✓		Very Common (Siu 2000); Common (AFCD 2001)	No, on North Lantau

* Species relevant to impact assessment are bolded.

Table 10-8 Evaluation of fauna species of conservation concern within the Assessment Area (Species relevant to impact assessment are bolded.)

Species	Species of Conservation Interest*	Protection status**/China Red Data Book***	Locations/Habitats recorded	EBS	EVS	Rarity****	Relevant to assessment
Mammals							
Chinese White Dolphin (Indo-pacific Humpback Dolphin) *Sousa chinensis*	-	WAPO; Cap. 586; CITES App. 1; China Class I protected; IUCN Redlist (Near Threatened)	Mostly in waters north and west of Lantau, Seasonally in waters south and east of Lantau	#	#	Locally found in western waters, especially the North and West Lantau waters; some 103-193 individuals inhabit Hong Kong waters in various time of the year.	Yes. Habitat loss and potential water impacts
Red Muntjac *Muntiacus muntjac*	PRC	WAPO	Scrubland, Streams	✓	✓	Widespread (Shek 2004)	No, on North Lantau
Birds							

Species	Species of Conservation Interest*	Protection status**/China Red Data Book***	Locations/Habitats recorded	EBS	EVS	Rarity****	Relevant to assessment
Little Grebe *Tachybaptus ruficollis*	LC	-	Open water	✓		Locally common	No, not recorded in the EVS
Grey Heron *Ardea cinerea* w	PRC	-	Soft Shore; Hard shore		✓	Abundant winter visitor	Yes. Waterbirds,
Great Egret *Egretta alba* w	PRC (RC)	-	Soft Shore; Hard shore		✓	Common to abundant resident	Yes. Waterbirds,
Little Egret *Egretta garzetta* w	PRC (RC)	-	Soft Shore; Hard shore		✓	Abundant resident	Yes. Waterbirds,
Pacific Reef Egret *Egretta sacra* w	(LC)	Class II Protected* Rare***	Hard Shore		✓	Locally uncommon resident	Yes. Waterbirds,
Cattle Egret *Bubulcus ibis*	(LC)	-	Soft Shore	✓		Uncommon to common resident	No, on North Lantau
Chinese Pond Heron *Ardeola bacchus*	(LC)	-	Hard Shore	✓		Common resident	No, on North Lantau
Striated Heron *Butorides striatus* w	(LC)	-	Intertidal; Streams		✓	Uncommon in summer, scare in winter	Yes. Waterbirds,
Black-crowned Night Heron *Nycticorax nycticorax* w	(LC)	-	Intertidal; Streams		✓	Common to abundant resident	Yes. Waterbirds,
Black Kite *Milvus migrans*	(RC)	Class II Protected*	Overhead		✓	Abundant winter visitor and resident	No,
Peregrine Falcon *Falco peregrinus*	LC	-	Overhead	✓		Scare resident and winter visitor	No, not recorded in the EVS.
Black-winged Stilt *Himantopus himantopus*	RC	-	Soft Shore	✓		Common to uncommon winter visitor	No, not recorded in the EVS.
Little Ringed Plover *Charadrius dubius* w	(LC)	-	Soft Shore		✓	Locally common winter visitor, scarce breeding.	Yes. Waterbirds,
Whimbrel *Numenius phaeopus* w	LC	-	Soft Shore		✓	Common passage migrant	Yes. Waterbirds,
Grey-tailed Tattler *Heteroscelus brevipes* w	LC	-	Soft Shore		✓	Passage migrant	Yes. Waterbirds,
Eurasian Woodcock *Scolopax rusticola*	LC	-	Secondary Woodland	✓		Scare winter visitor	No, not recorded in the EVS.
Collared Scops Owl *Otus bakkamoena*	-	Class II Protected*	Tall Shrubland		✓	Common and widespread resident	No, on North Lantau
Pacific Swift *Apus pacificus*	(LC)	-	Overhead	✓		Common spring migrant, localized summer visitor, scarce and irregular in autumn and winter	No, not recorded in the EVS.
White-throated Kingfisher *Halcyon smyrnensis*	(LC)	-	Soft Shore, Hard Shore	✓		Resident, locally common in autumn and winter	No, not recorded in the EVS.
Emerald Dove *Chalcophaps indica*	-	Near Threatened**; Vulnerable***	Tall Shrubland		✓	Scarce but widespread resident	No, on North Lantau
Hwamei *Garrulax canorus*	-	Near Threatened**	Shrubland		✓	Common and widespread resident	No, on North Lantau
Blyth's Leaf Warbler *Phylloscopus reguloides*	LC	-	Shrubland		✓	Scarce winter visitor	No, on North Lantau
Common Rosefinch	LC	-	Village/farmland		✓	Rare winter visitor	No, on North

Species	Species of Conservation Interest*	Protection status**/China Red Data Book***	Locations/Habitats recorded	EBS	EVS	Rarity****	Relevant to assessment
Carpodacus erythrinus							Lantau
Red-billed Starling *Sturnus sericeus*	GC	-	Coastal habitat, secondary woodland		✓	Abundant but localized winter visitor	No, on North Lantau
White-shouldered Starling *Sturnus sinensis*	(LC)	-	Village/farmland		✓	Common passage migrant, scare and localized breeding summer visitor and winter visitor	No, on North Lantau
Black-naped Oriole *Oriolus chinensis*	LC	-	Plantation		✓	Scarce autumn migrant and irregular breeder	No, on North Lantau
Brown Fish Owl			Tai Ho Stream			Rare	No, at Tai Ho on North Lantau
Reptiles							
Tokay Gecko *Gekko gecko*	RC	-	San Tau Village	✓		Rare (Karsen *et al.* 1998)	No, on North Lantau
Amphibians							
Chinese Bullfrog *Hoplobatrachus chinensis*	PRC	IUCN Least Concern Class II Protected*	Scenic Hill – concrete drainage system		✓	Fairly common and widespread in NT and Lantau (Chan *et al.* 2005)	Yes, at Scenic Hill
Lesser Spiny Frog *Paa exilispinosa*	GC	IUCN Vulnerable	Streams	✓	✓	Common & Widespread in protected areas (Chan *et al.* 2005).	No, on North Lantau
Romer's Tree Frog *Philautus romeri*	PGC	IUCN Endangered	Literature review and AFCD (Pers. comm.)			Endemic to Hong Kong. Locally Common in protected areas (Chan *et al.* 2005)	Yes, at Scenic Hill
Fish							
Beijiang Thick-lipped Barb *Acrossocheilus beijiangensis*	GC	-	Stream (ST9)		✓	Rare (Lee *et al.* 2004)	No, on North Lantau
Indo-Pacific Tropical Sand Goby *Favonigobius reichei*	-	IUCN Lower Risk/Near Threatened	Estuaries of Streams (ST9, HH5, SL3)		✓	Common and widespread (Lee *et al.* 2004, Nip 2005)	Potentially subject to water impacts
Dark-margined Flagtail *Kuhlia marginata*	RC	-	Stream (ST9)		✓	Status unknown (Lee *et al.* 2004)	No, on North Lantau
Rice Fish *Oryzias curvinotus*	GC	-	Stream (ST9, HH3, HH5)		✓	Uncommon (Lee *et al.* 2004)	No, on North Lantau
Predaceous Chub *Parazacco spilurus*	-	Vulnerable***	Stream (ST9, SL3)		✓	Common and widespread (Lee *et al.* 2004)	Potentially subject to water impacts
Snowy Puffer *Takifugu niphobles*	-	IUCN "Data Deficient"	Soft Shore (San Tau)		✓	Considered to be common in Hong Kong (AFCD 2008).	Potentially subject to water impacts
Takifugu ocellatus	LC	-	Stream (ST9)	✓		-	No, on North Lantau
Butterflies							
White Dragontail *Lamproptera curius*	LC	-	Stream At San Tau (ST9))		✓	Limited Distribution (Lo 2005)	No, on North Lantau
Common Albatross *Appias albina*	LC	-	Cultivated field at San Tau	✓		Rare (Lo 2005)	No, on North Lantau

Species	Species of Conservation Interest*	Protection status**/China Red Data Book***	Locations/Habitats recorded	EBS	EVS	Rarity****	Relevant to assessment
Danaid Eggfly *Hypolimnas misippus*	LC	-	Shrubland at Scenic Hill	✓		Uncommon (Lo 2005)	Yes, at Scenic Hill
Crustaceans							
Sesarmine Crab *Chiromantes sereni*	-	-	Stream (HH3, SL3)		✓	Endemic. Only known from four sites(Kwok & Tang 2005)	No, on North Lantau
Greasyback Shrimp *Metapenaeus ensis*	-	Vulnerable***	Stream (ST9, SL3)		✓	Found on sandy-mud or muddy bottoms. Major species cultivated at Mai Po Marshes Nature Reserve (AFCD 2004)	Potentially subject to water impacts
Freshwater Crab *Somanniathelphusa zanklon*	-	IUCN Endangered	Stream (SL12)		✓	Locally abundant in Lantau (DSD 2002, EPD 2007),	No, on North Lantau
Horseshoe Crabs							
Tachypleus tridentatus	-	Vulnerable***	San Tau, Hau Hok Wan, Sham Wat, Tung Chung Bay,	✓	✓	Declining in range due to water pollution/ loss of nursery grounds (Morton & Lee 2003)	Yes. Potentially subject to water impacts
Carcinoscorpius rotundicauda	-	Vulnerable***	San Tau, Hau Hok Wan, Tai Ho Wan. (Tung Chung Bay from TMCLKL survey),	✓		Declining in range due to water pollution/ loss of nursery grounds (Morton & Lee 2003)	Yes. Potentially subject to water impacts
Echinoderm							
Sea cucumber *Holothuria leucospilota*	-	Endangered	Sham Wat		✓	Endangered in CSIS 2008 due to over-exploitation.	Yes. Potentially subject to water impacts
Coral							
Echinomuricea sp.			Sham Wat to San Shek Wan; east of Chek Lap Kok; Northeast and southeast shores of Airport Island	✓	✓	Common in Hong Kong Waters (AFCD 2004)	Yes. Direct impacts and potentially subject to water impacts
Balanophyllia sp.,	-	Cap 586	Sham Wat to San Shek Wan (e.g. DS1 and DS2); east of Chek Lap Kok; Northeast shore of Airport Island	✓	✓	Common in Hong Kong Waters (AFCD 2004)	Yes. Direct impacts and potentially subject to water impacts

* Fellowes *et al*. 2002.

** All birds are protected under WAPO

*** Zeng and Wang 1998.

**** Rarity for birds follows Carey *et al*. 2001

Not covered by the field survey programmes

10.5 Assessment Methodology

10.5.1 Identification of Impacts

10.5.1.1 Ecological impact assessment aimed at to protect, maintain and rehabilitate the natural environment.

10.5.1.2 The ecological impact assessment included:

- identification and quantification of any direct/indirect and on-site/off-site ecological impacts to foraging areas, breeding grounds, reduced survival of adult or juvenile wildlife;
- identification of parameters (e.g. water quality parameters) including any potential toxic contaminants released from the dredged sediment;
- evaluation of the identified impacts, caused by the construction and operation of the Project, such as habitat loss, water quality deterioration, underwater noise, bioaccumulation, marine collision, chemical spillage and disturbance;
- recommendations for mitigation measures; and
- review of the need for monitoring and to propose a monitoring and audit programme if needed.

10.5.1.3 The ecological impact assessment followed the criteria and guidelines for evaluating and assessing ecological impact as stated in Annexes 8 and 16 of the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM).

10.5.1.4 Potential aquatic and terrestrial and marine ecological impacts arising from the Project, including construction phase and operation phase, would be identified. Predicted impacts would be quantified as far as possible and evaluated with reference to the criteria in Annexes 8 and 16 of the EIAO-TM. Where significant negative impacts are predicted, based upon the priority of “avoid, minimize, and compensate”, the strategy followed the approaches as: the feasibility of modifications to the design, consideration of alternate sites or options, special controls on construction methods and schedule, or compensatory habitat creation or enhancement. The acceptability of residual impacts following mitigation was assessed. Finally, the assessment evaluated the need for ecological monitoring and audit, and prescribed in detail any required EM&A programme in accord with the Study Brief.

10.5.2 Criteria to Evaluate Impacts

10.5.2.1 The significance of ecological impacts was evaluated based primarily on the criteria set forth in Table 1, Annex 8 of the EIAO-TM:

- habitat quality;
- species affected;
- size/abundance of habitats/organisms affected;
- duration of impacts;
- reversibility of impacts; and
- magnitude of environmental changes.

10.5.2.2 The determination of the above first 3 items, namely "habitat quality", "species affected" and "size/abundance of habitats/organisms affected", made reference to the baseline conditions. "Duration of impacts" and "reversibility of impacts" are closely related to the nature of the impacts. Usually construction disturbance such as noise is regarded as a short-term impact. Temporary occupation of natural habitats can be reversible. In contrast, the occupation of space by the development itself is a permanent and irreversible impact. "Magnitude of environmental change" is determined by the scale of the projects, i.e. the extent of the works area and/or

the degree of changes of the ambient environment. The abundance and/or distribution of the same kind of habitat in Hong Kong, or individuals of the same species, is also considered.

10.5.2.3 Impacts are generally ranked as "minor", "moderate" or "severe", although in a few cases a ranking of "insignificant" (less than "minor") may be given. The ranking of a given impact varies, based on the criteria listed above. Wherever possible, significance of impacts is quantified to allow ready appreciation of relative significance. Quantification is straight forward for certain types of impact, particularly habitat loss (usually measured in hectares).

10.5.2.4 Quantification of levels of ecological impact requires the application of professional judgement and value judgements, as noted in paragraph 5.3.1, Annex 16 of the EIAO-TM. Such judgements are often not amenable to quantification.

10.5.2.5 Nearby projects, especially any associated works of the HZMB portion outside the HKSAR boundary, are assessed for potential cumulative impacts with the present project. The study team liaised with Mainland and Macao authorities, consultants of relevant feasibility studies, relevant departments/offices, and private and public organisations to address interfacing issues and cumulative environmental impacts.

10.5.3 Identification of Sensitive Receivers

10.5.3.1 Sensitive receivers of impacts are defined for this report as 1) species of conservation importance whose local, regional, or global populations would be expected to show the effects of reduced survivorship or productivity caused by the project. This implies that project-induced losses are predicted to exceed the range of fluctuation attributable to natural population variation; and 2) important habitats identified during the ecological baseline study to be within the study area, and have the potential to be affected indirectly by the project, for example, through deterioration of water quality. Such impact would normally be evaluated by the predicted magnitude of changes, e.g. extent of increase in suspended solids or other contaminants at the sensitive receivers.

10.5.4 Recommendation of Mitigation Measures

10.5.4.1 Impacts are assessed in the absence of mitigation. Efforts are made to identify feasible and practicable mitigation measures to reduce the severity of any significant negative impacts to acceptable levels. For the purposes of this EIA, "Significant" is used to refer to impacts requiring mitigation and is applied to "moderate" and "severe" impacts, while "minor" and "insignificant" impacts do not require mitigation. Where significant negative impacts are predicted from the Project, mitigation responses are developed to “Avoid, Minimize and Compensate” for impacts in that order of priority. As stipulated in EIAO-TM, the study team, in consultation with the client, resolved impacts by first determining the feasibility to avoid impacts (modifications to project design, consideration of alternate sites or alignments). The second priority was to minimise impacts (refining the bridge design or alignment, special controls on construction methods and schedule). The third priority was to design measures to compensate for impacts (compensatory habitat creation or enhancement). Mitigation measures are provided in the ecological assessment to address the potential impacts identified. These measures are described in terms of their scope, programme, feasibility and financial implications during the construction and operation of the project. The acceptability of residual impacts following mitigation is assessed. Finally, the assessment evaluates the need for ecological monitoring and audit, and prescribes in detail any required EM&A programme in accord with the Study Brief.

10.5.4.2 Finally, the assessment concludes whether the mitigation measures envisaged could bring secondary impacts of the project and control them to within acceptable bounds. The acceptability of the overall residual ecological impacts is determined. Besides adverse impacts, potential benefits of the Project are also considered in the EIA.

10.6 Impact Identification and Evaluation

10.6.1 Description of the Project

10.6.1.1 The present Project (HKLR and HKBCF) has gone through different stages including conceptual planning, feasibility study and option selection, under various studies. During those studies, the environmental feasibility and acceptability have been thoroughly investigated and assessed.

10.6.1.2 In the mid 1990's, the Crosslinks study investigated the needs and potential options of cross border links, mainly in western Hong Kong. A bridge connecting the eastern and western sides of Pearl River Estuary was considered.

10.6.1.3 In the early 2000's, the Hong Kong-Zhuhai-Macao Bridge was proposed. A Preliminary Environmental Study for HZMB was conducted (Scott 2002).

10.6.1.4 The PER verified that the environmentally optimal landing point of the bridge would be at Northwest Lantau. After reaching the proposed landing point at Northwest Lantau, the HZMB would connect to North Lantau Highway in both the interim and the long term. In 2007, it is agreed that separated boundary crossing facilities would be established for the three areas. A second PER for the Hong Kong Boundary Crossing Facilities (HKBCF) was conducted to formulate the form and location of the HKBCF (Arup 2008).

10.6.1.5 In 2008, the current alignment of the HZMB with the HKBCF and the integrated TMCLKL was derived. The present assessment is based upon this latest alignment and form of the HZMB-HKBCF-TMCLKL complex.

10.6.1.6 The connection point between the HZMB Main Section and the HZMB HKLR would be on the western HKSAR boundary. The proposed connection point lies on the HKSAR boundary about 4 km west of Sham Wat and 3 km north of Tai O pier.

10.6.1.7 From the connection point, HKLR (previously referred as the HZMB Hong Kong Section) alignment will run eastward through the open sea of western Hong Kong waters, and go into Airport Channel. Inside the Airport Channel, the alignment will span over the headland at Sha Lo Wan and get close to the headland at Hau Hok Wan so as to avoid getting close to the touch down zone of southern runway and the Government Flying Service (GFS) headquarters, but will not actually land on either headland. The supporting piers in this section are still located in subtidal zone as other piers in the open sea. After passing the GFS headquarters near Hau Hok Wan, the alignment will cross the Airport Channel and the actual landing point of the alignment would be on the seawall at the southern shore of Airport Island.

10.6.1.8 After landing on Airport Island, the HKLR will comprise several sections of different forms. HKLR will run in viaduct form, first alongside the Airport Island artificial seawall, and then on Airport Island developed area, until it reaches Scenic Hill at the southeast end of Airport Island. HKLR will go through Scenic Hill in tunnel form, and then change into at-grade road on a new reclamation area along the southeast shore of Airport Island.

10.6.1.9 At the end of this at-grade road, HKLR will connect to the HKBCF, which is formed entirely on a new reclamation near the northeast Airport Island.

10.6.1.10 TMCLKL provides road connection between HKBCF to Tuen Mun and Tai Ho. Its reclamation will be immediately adjacent to the HKBCF. The details of TMCLKL are provided in a separated EIA study.

10.6.1.11 In assessing the ecological impacts of HKLR and HKBCF, three major components need to be addressed (see **Section 3**):

1) The section from Hong Kong-Zhuhai connection point to the landing point in Hong Kong SAR on Airport Island, i.e. the marine section of HKLR, which could be further divided into two parts (open sea part and airport channel part);

2) The section from the landing point at Airport Island, through the tunnel in Scenic Hill and at-grade road on reclamation land, and connect HKBCF, i.e. the land and reclamation section of HKLR; and

3) The HKBCF reclamation.

10.6.1.12 HKLR and the first phase of HKBCF would be constructed from 2010-2015 while the remaining of HKBCF would be completed in 2016.

10.6.2 General Environmental Impacts

10.6.2.1 There are some marine recognised sites of conservation importance and important habitats inside the marine ecological impact assessment area but far away from the Project Site, including Shui Hau in South Lantau, the proposed marine park in Soko Islands, Sham Wan SSSI in south Lamma, and Cape d'Aguilar Marine Reserve in Hong Kong Island (see **Figure 10.1**). These sites due to the vast distance are not likely to be affected, directly or indirectly, by the present Project. For the recognized sites of conservation importance identified within the North West Water Control Zone, including Sha Chau and Lung Kwu Chau Marine Park, San Tau Beach SSSI and Tai Ho Stream SSSI, there will be no direct impact, and the water quality model concluded that there will be no impact to these sites of conservation importance. The construction sediment plume is confined within the Tung Chung Bay and all water quality parameters in these sites are well within the WQO. Details of the water quality results are presented under the water quality impact sections.

10.6.2.2 HKLR and HKBCF are not expected to cause direct impacts to Finless Porpoises. This is because porpoises do not occur in the North Lantau waters where the Project is located. Thus, the Project does not potentially impact Finless Porpoise.

10.6.2.3 The primary global threats to populations of Chinese White Dolphin are considered to be entanglement in anti-shark nets, fishing nets including gillnets and pair trawls, and vessel collisions (IUCN Redlist 2009 at www.redlist.org). Contamination by organochlorine compounds and mercury are also thought to threaten dolphins and porpoises in South China coastal waters (IUCN Redlist 2009). With respect to these threats, the Project would have no effect on the risks associated with entanglement in fishing gear or anti-shark nets. The threats of vessel collision and contamination are addressed under construction phase impacts below.

10.6.3 Construction Phase – Direct Impacts

10.6.3.1 Construction phase direct impacts would include the following:

- Habitat losses in the subtidal and intertidal zones in project footprint and works areas; and
- Terrestrial habitat loss in project footprint and works areas.

HKLR Marine Section – Open Sea part

Marine Habitat Loss (Soft substrate seabed and marine waters loss during construction)

10.6.3.2 The open sea part of the marine section of HKLR refers to the viaduct from HKSAR boundary to immediately to the west of Sha Lo Wan headland. This section of viaduct is completely on open sea area and about 5.6km in length. No terrestrial habitat will be affected. Furthermore, the nearest pier to Sha Lo Wan headland would be at least 30m from the shore. Therefore no direct impact on intertidal habitat or coral communities on shallow subtidal hard substrate will be resulted from the open sea part of HKLR (The EVS dive survey confirmed that at the western shore of Sha Lo Wan headland, i.e. DS2 in EVS study, the subtidal hard substrate extends less than 10m from the shore.)

10.6.3.3 The marine section HKLR will be a viaduct supported by piers. Some physical loss of marine habitat (seabed and water column) will result from construction works at each location where piers are installed to support the bridge deck. The HKLR

marine section would be around 7.6 km in length (5.6 km in the open sea from HKSAR boundary to Sha Lo Wan, and about 2 km within the Airport Channel from Sha Lo Wan to the actual landing point on Airport Island). If the 50m pier spacing is adopted in the open sea part and 100m spacing is adopted in the Airport Channel part as shown in engineering layout (see **Section 4**), the number of pier sites would be about 112 in the open sea and about 20 in the channel. At each pier site two piers would be constructed side-by-side, each supporting 3 lanes of bridge deck (half of the highway).

10.6.3.4 At each pier site two sets of 4 piles (each of 2m diameter) would be bored through the seabed sediment to reach a solid (rock) substrate. Atop each set of 4 piles a concrete pilecap will be constructed (most of pilecaps would be near the water surface, except a few inside the Airport Channel which would be beneath seabed surface to maintain the vessel traffic) to support the bridge pier. The size of each pilecap would be approximately 8m x 12m.

10.6.3.5 Taking a conservative approach, the footprint of the pilecap would be assumed a seabed loss in this assessment. The seabed area to be lost at each pier site (for both open sea and inside the Airport Channel) would be 8 x 12 x 2 = 192 m^2 (about 200 m^2). The total seabed loss due to the project footprint in the open sea part of the marine section of HKLR would be 112piers x 200 m^2 = 22,400 m^2, i.e. 2.24 ha or less than 3 ha. The 50m pier spacing in the open sea part represents the most conservative scenario: The required number of piers in the open sea part declines as spacing increases from 50m. While standard engineering practice specifies bridge pier spacing at 50m, wider spacing would probably be specified for this Project in an effort to reduce the number of piers and the resulting environmental impacts.

10.6.3.6 This estimation of seabed and water column loss due to project footprint is conservative because all sets of pilecaps are assumed to occupy 200 m^2 of seabed. In reality, all pilecaps in the open sea would be near the sea surface for reasons of marine navigation safety, while the pilecaps inside Airport Channel would be beneath seabed to avoid influences on the sea current flow. In that event the total seabed loss occupied by the pier would be the total cross-sectional area of the 8 piles protruding from the seabed (8 piles x 3.14 m^2 = 25.12 m^2). In such cases the actual seabed loss from project footprint of 25.12 m^2 would be around 12.5 % of the assumed 200 m^2. However, we adopt the most conservative approach, assuming that the seabed beneath/above the pilecap is lost in all cases.

10.6.3.7 In addition to the loss of the seabed and water column due to the project footprint (these losses will become permanent habitat loss after completion of construction), works areas in each pier site will cause additional temporary loss of seabed and water column habitat.

10.6.3.8 To provide access for construction equipment and labour each pier construction site would include an area of works area which could be considered as temporary marine habitat loss: (i) 5m from the outer perimeter of the paired pilecaps as a disturbance perimeter for coffer dam construction and silt curtain deployment; and (ii) the 4m gap between the two pilecaps. Thus the size of each pier construction site would be (5+12+4+12+5 = 38m) x (5+8+5 = 18m) = 684 m^2 (about 700m^2). Of this pier-site total area, the area of temporary habitat loss would be 700 – 200 = 500 m^2. The HKLR marine section open sea part temporary marine habitat loss would be 112 pier sites x 500 m^2 = 56,000 m^2, or 5.6 ha.

10.6.3.9 This 5.6 ha of marine habitat would not be disturbed at the same time. Piers would be constructed in sequence. The viaduct of the open sea part will be constructed portion by portion (totally in three portions). Each portion comprises about 35 continuous pier sites, and the construction of these portions would not overlap. Thus the maximum number of pier sites simultaneously under construction would be 35 in the open sea. Presuming the worst-case, in which the maximum number of work fronts is under construction and all other piers have been completed, the habitat loss during this construction period is estimated in **Table 10-9.** It would be (700 x 35) + (200 x 77) = 24,500 + 15,400 = 39,900 m^2 (about 4 ha) for open sea.

In other words, the maximum temporary seabed loss at any given time would be 500 m^2 x 35 = 17,500 m^2, or about 1.8 ha. But even this is a conservative estimate because this optimum works schedule is unlikely to occur (Due to other environmental considerations such as water quality protection, the minimum distance between two pilecap construction sites would be 180 m.).

Table 10-9 Calculation of worst-case habitat loss during construction

Location	Habitat	Area (m^2/ha)		Total Affected Area
		Under construction / works areas	Completed	
HKLR Marine section				
Open Sea	Soft substrate seabed and marine waters	700 m^2 x 35 = 24,500	200 m^2 x 77 = 15,400	39,900 m^2 (about 4 ha)
Airport Channel	Soft substrate seabed and marine waters	700 m^2 x 10 = 7,000	200 m^2 x 10 = 2,000	9,000 m^2 (about 0.9 ha)
HKLR Land and reclamation section				
Airport Island	Developed area	Less than 1 ha	Less than 1 ha	1 ha
Scenic Hill	Grassland/ shrubland	2 ha	1 ha	3 ha
Southern shore of Airport Island	Artificial seawalls	Less than 1.5 km	200 x 25 = 5,000 or 200m in length	Maximum 1.5 km
Southeast shore of Airport Island	Remnant rocky shores	NA	2 km	2 km
Southeast reclamation	hard substrate seabed	NA	2 km	2 km
	Soft substrate seabed and marine waters	10 ha	27 ha [1]	37 ha
HKBCF				
Existing Fire Station	Artificial seawall and hard substrate seabed	NA	Less than 150m sloping seawalls and less than 100m vertical seawalls	250m
Northeast Airport Island	Soft substrate seabed and marine waters	26 ha	138 ha [2]	164 ha

Notes : 1. For the HKLR reclamation, the land area to the copeline is about 23 ha. The seabed loss is estimated to be about 27 ha (for the footprint area to the bottom of the seawall where it intersects the seabed).

2. For the HKBCF reclamation, the land area to the copeline is about 130 ha. The seabed loss is estimated to be about 138 ha (for the footprint area to the bottom of the seawall where it intersects the seabed).

10.6.3.10 This section would have small area of soft substrate seabed and marine waters loss (less than 3 ha of loss due to the footprint, and at any given time would not exceed 4 ha). The results from the various studies and sampling indicated that the ecological values of the benthic communities on soft substrate seabeds at different parts of the North Lantau waters are similar, at low value. Although the marine

waters to the west of Airport Island are of moderate to high ecological value due to the relatively closer distance to the dolphin hotspot in West Lantau waters. The marine habitat loss from the marine section open sea part of HKLR is of small area and is scattered, thus the impact is considered as **minor**.

HKLR Marine Section – Airport Channel part

Marine Habitat Loss (Soft substrate seabed and marine waters loss during construction)

10.6.3.11 The Airport Channel part of the marine section of HKLR refers to the section of viaduct from the western shore of Sha Lo Wan Headland, via the Airport Channel, to the landing point of HKLR on Airport Island. Although the alignment of this part of HKLR would span over and get close to the two headlands at Sha Lo Wan and Hau Hok Wan, none of the piers would encroach onto the headlands or other terrestrial habitats, and thus there would be no terrestrial habitat loss for this section of viaduct. Similarly the alignment also crosses some intertidal habitats, such as the natural rocky shores on the headlands at Sha Lo Wan, but piers would not be constructed at the intertidal zones and there would be no direct impacts on intertidal habitats. The EBS and EVS dive survey also confirmed that there is no hard or soft coral inside the airport channel. Therefore no direct impact on coral communities on subtidal hard substrate seabed will be resulted from the Airport Channel part of HKLR.

10.6.3.12 As described in the above sections, the Airport Channel part would be about 2 km within the Airport Channel from Sha Lo Wan to the actual landing point on Airport Island. A 100m spacing is adopted in the Airport Channel part as shown in engineering layout (see **Section 4**). The number of pier sites would be about 20 in the channel.

10.6.3.13 The design of the piers at Airport Channel would be similar with those in the open sea, so the seabed area to be lost at each pier site inside the Airport Channel would also be about 200 m^2. The total permanent seabed loss in the Airport Channel of HKLR would be 20 piers x 200 m^2 = 4,000 m^2, i.e. 0.4 ha.

10.6.3.14 In addition to the permanent loss of the seabed and water column, works areas in each pier site will cause temporary loss of seabed and water column habitat.

10.6.3.15 The temporary seabed loss in HKLR marine section Airport Channel part would be 20 pier sites x 500 m^2 = 10,000 m^2, or approximately 1 ha.

10.6.3.16 This 1 ha of seabed would not be disturbed at the same time. Piers would be constructed in sequence. The viaduct of the Airport Channel part will be constructed portion by portion (totally in two portions). Each portion comprises less than 10 continuous pier sites, and the construction of these portions would not overlap. Thus the maximum number of pier sites simultaneously under construction would be 10 inside the Airport Channel. Presuming the worst-case, in which the maximum number of work fronts is under construction and all other piers have been completed, the habitat loss during this construction period is estimated in **Table 10-8.** It would be (700 x 10) + (200 x 10) = 7,000 + 2,000 = 9,000 m^2 (about 0.9 ha) for Airport Channel. In other words, the maximum temporary seabed loss at any given time would be 500 m^2 x 10 = 5,000 m^2, or about 0.5 ha. But even this is a conservative estimate because this optimum works schedule is unlikely to occur. Due to other environmental considerations (such as water quality protection), the minimum distance between two pilecap construction sites would be 180 m.

10.6.3.17 This section would have small area of soft substrate seabed and marine waters loss (about 0.4 ha of permanent loss, and at any given time would not exceed 0.9 ha). The soft substrate seabeds at different parts of the North Lantau waters are at low ecological value. And the marine waters inside Airport Channel are not used by CWD, and thus of low ecological value. The marine habitat loss from the marine section Airport Channel part of HKLR is thus considered a **low impact**.

HKLR Land and Reclamation Section

10.6.3.18 The HKLR Land and Reclamation section would cause habitat loss in terrestrial, intertidal and subtidal zone, as it involves different forms in areas of different nature.

Terrestrial Habitat loss (Loss of Developed Area and Grassland/Shrubland during construction)

10.6.3.19 The majority of the HKLR and the entire HKBCF would be on newly reclaimed area or piers in sea areas. The only exceptions are a section of viaduct and a tunnel portal on Airport Island, and thus would cause a small scale loss of terrestrial habitat. On Airport Island, the alignment of HKLR would first run along the seawall by viaduct, go through the southeast part of Airport Island in viaduct and tunnel form, and then go through a new reclamation area as at-grade road. Only two types of existing terrestrial habitats, i.e. developed areas (between the seawall and Scenic Hill) as well as the grassland/shrubland habitat on the lower reach of the south-western slope of Scenic Hill will be affected by the alignment.

10.6.3.20 The section of HKLR going through the developed area will be in viaduct form. Less than 1 ha of developed area within the project works boundaries would be affected by the construction of about 6 viaduct piers and/or maintenance access. The works areas would be subject to temporary habitat losses and the pier footprint would be a permanent habitat loss after completion. While the developed areas are of low ecological value and the affected area size is very small, the impacts on this habitat are considered **insignificant** in terms of ecology and do not require mitigation.

10.6.3.21 The viaduct will connect to a tunnel going through Scenic Hill with one portal at the southwest slope of Scenic Hill. The other portal of the tunnel will be on the new reclamation land and thus the location of this southwest portal will be the only existing terrestrial habitat to be affected by the tunnel. The portal location is currently a grassland/shrubland habitat which is of low ecological value. The affected area is outside the woodlands at northern Scenic Hill with Romer's Tree Frog records and considered of high ecological value. The terrestrial habitat to be lost would be grassland/shrubland habitat and the size of the loss would be about 1 ha. Both abundance and species richness of terrestrial flora and fauna in grassland/shrubland habitat on Scenic Hill, which is isolated from other natural habitats on North Lantau, surrounded by highly disturbed areas, and recently partially disturbed by the construction of the Cable Car angle station, are low. The site for the portal was currently covered by vegetations dominated by common grasses such as *Panicum maximum* and isolated common shrubs such as *Melastoma candidum*.

10.6.3.22 In addition to the permanent loss of the terrestrial habitats, works areas in the tunnel portal will cause temporary loss of another 2ha of grassland/shrubland habitats. The impact area is small and these works area will be reinstated by planting or hydroseeding during the operation phase. Grassland/shrubland is not the important habitat for fauna of conservation concern listed in **Table 10-7**. Due to the very small area size and the low ecological importance of the habitat affected, the impacts for both footprint and works areas are considered **minor**. Mitigation measure is not required.

10.6.3.23 There are records of remnant population of Romer's Tree Frog by AFCD in the secondary woodlands on the northern slope of Scenic Hill (Chan *et al*. 2005b). These secondary woodlands will not be encroached by the construction works. Most of the Romer's Tree Frogs on Chek Lap Kok have already been collected during the rescue programme for the Airport project. The remnant population on Scenic Hill may be low. And this remnant population, which has withstand the construction work of the Airport (scale much larger than this Project), also indicate Romer's Tree Frog is disturbance tolerant to certain extent. There was also a record of Chinese Bullfrog in Scenic Hill during the EVS study, but the grassland/shrubland to be encroached was not their habitats.

10.6.3.24 Apart from Scenic Hill, no other identified terrestrial site/ terrestrial habitat of conservation importance (e.g. woodlands) is in the vicinity of the Project. Those terrestrial sites/habitats are all on North Lantau and not going to be impacted by HKLR or HKBCF due to the physical separation of Airport Channel (a 250 m channel). There also would not be any encroachment on any terrestrial recognised sites of conservation importance (i.e. Lantau North (Extension) Country Park) which is also on North Lantau.

10.6.3.25 Most fauna species listed in **Table 10-7** mainly utilise terrestrial habitats. As there will be no loss of terrestrial habitats of higher ecological values (such as streams or woodlands), these fauna will not be adversely affected by loss of habitats.

Intertidal Habitat Loss (Loss of Artificial Seawalls, Disturbed/Remnant Rocky Shores and patchy sandy beaches during Construction)

10.6.3.26 After landing, HKLR alignment will go along the artificial seawall on the southern shore of Airport Island in viaduct form, and would directly affect limited areas in the intertidal zone. The main impact area would be a length of the constructed seawall on the Airport Island's southern shore (of 1.5 km) on which about 25 bridge piers would be constructed. Artificial seawalls on Airport Island are a man-made habitat and were all constructed in the mid 1990's (approximately 15 years of age) during the development of the new airport. For this 1.5 km section, the seawall to be permanently lost would be 25 piers x 200 m^2 = 5,000 m^2, or 0.5 ha. In terms of length, the loss would be 25 x 8 m = 200m.

10.6.3.27 The intertidal zone along the southeast shore of Airport Island will be lost due to a new reclamation to accommodate the at-grade road of HKLR. This section of shoreline (total 2km in length) comprises artificial seawalls (about 500 m), and remnant rocky shore (about 1,500 m), and a few patchy sandy beaches.

10.6.3.28 The remnant rocky shores along the southeast shore of Airport Island are all the remnant of the original Chek Lap Kok Island shore before the airport development. Though not completely converted into artificial shores, these shores have been disturbed and modified to various extents at different locations. Artificial seawalls and rocky shores (both natural rocky shores on North Lantau and remnant rocky shores on Airport Island) within the assessment area are all of low ecological value as indicated by the results from the various field surveys (i.e. EVS, MSS and HKBCF field survey programme), in particular for the seawalls near the Marine Cargo Terminal which are vertical and constantly disturbed by logistics operations. The remnant rocky shores on Airport Island is of even lower value than the natural rocky shores on North Lantau, as the number of species recorded there is much lower (approximately half the number of recorded in North Lantau side). The patchy sandy beaches were of very low abundance of intertidal fauna as recorded during the **MSS**, and no infauna was recorded in the sediment in these sandy beaches (see **Appendix 10C**).

10.6.3.29 For the southern shore, in addition to the permanent loss of the artificial seawalls, works areas in each pier site will cause temporary loss of artificial seawalls. These works areas will only cause limited temporary impacts on areas of low ecological value. However there would be no temporary loss in the southeast shore (with both artificial seawalls and remnant disturbed rocky shores) as all the losses due to reclamation are permanent.

10.6.3.30 During the EVS study, 9 species of water dependent bird of conservation concern were recorded. Among the nine species, Pacific Reef Egret is of higher conservation status, while Great Egret and Little Egret were recorded on artificial seawalls of Airport Island which will be impacted by the Project, and are more relevant with this impact (other species of wetland dependent birds were recorded on North Lantau side and would not be impacted).

10.6.3.31 The artificial coastline within the Project Area is not considered an important habitat for Pacific Reef Egret, Great Egret and Little Egret. The slopes of the existing artificial seawall are steep, with little area of shallow water for these waterbirds to

feed. In addition, the boulder substratum of the artificial seawall may only provide a poor food base. Inter-tidal mudflat and natural rocky shores on North Lantau shore is actually more important foraging habitat of these species. In addition, there will be an increase in length of artificial coastline in the Project Area during operation stage, which can be utilised by these waterbirds, and constitute an increase in foraging habitat of fauna utilise coastal area (a potential positive effect). Therefore, the loss of foraging habitat of waterbirds will only be temporary.

10.6.3.32 **Insignificant impact** on the intertidal habitat would be expected on the southern shore of Airport Island because the entire works area consists of constructed seawall, as well as artificial seawalls on southeast shore, while **minor impact** on the remnant and disturbed rocky shores (together with the patchy sandy beaches) on the southeast coastlines are anticipated. As new artificial seawalls will be created in the new reclamation, intertidal habitats will be provided after the Project. No further mitigation is required for the loss of the low value intertidal habitat.

Subtidal Habitat Loss (Loss of Soft Substrate Benthic Habitat, Hard Substrate Coral Communities and Marine Waters during Construction)

10.6.3.33 The sea area (27 ha) immediate offshore to the southeast coastline of Airport Island will be lost from a reclamation to accommodate the northeast portal of the HKLR tunnel and the at-grade road. The sea areas to be lost mainly include soft substrate seabed and a strip of hard substrate subtidal area (less than 2km) along the coastline (the subtidal zone of the Airport Island coastline). The soft substrate seabed in this area was also investigated by grab sampling survey during the EVS and MSS. The results indicated that the ecological value of the soft substrate seabed is also low. Results of the dive survey of the MSS revealed that only low coverage (<1%) of common gorgonian corals *Echinomuricea* sp. colonised in scattered locations (*Echinomuricea* sp. was only recorded in 2 out of the 8 dive survey locations along this coastline) along the subtidal hard substrate in this area. The ecological value of the coral communities along this shore was ranked as low (**Appendix 10C**).

10.6.3.34 Similar subtidal hard substrate habitats are abundant along the coastlines of North Lantau, and dive surveys from EBS and other studies such as LLP EIA study confirmed that the gorgonian corals *Echinomuricea* sp. were widespread in the North Lantau coastlines. And more hard substrate habitats would be provided by new artificial seawalls at the future HKBCF and HKLR reclamation (after the total reclamation, there will be an increase of at least 4km of artificial seawalls). New hard substrate habitat will be provided for the colonization of gorgonians. Corals could naturally colonise in a fairly short period if hard substrate surface are provided. The Penny's Bay reclamation provided new artificial seawalls for about 5 years and coral colonisation has been reported during the monitoring programme.

10.6.3.35 As described in previous sections, the inshore waters along the southeast shore of Airport Island are not used by dolphin. There has been no sighting record of adult or juvenile in this area.

10.6.3.36 Besides the loss within the footprint of the marine structures, there are also some losses around the boundary of the reclamation. Silt curtains around the reclamation sites will be established during the construction phase. The area enclosed by silt curtains would be not available for marine organisms during construction phase, and thus are considered a temporary habitat loss. Though silt curtains for reclamation sites will be established in 5m from the seaward boundary of the reclamation footprint, it is anticipated that working vessels might occasionally need to operate close to the silt curtains and the disturbance level would be high near the silt curtains. To take a conservative approach, the 50m distance from the footprint would be assumed as temporary loss of habitats, cover an area of the perimeters (~2km) times the width of 50m distance, approximately 2,000m x 50m = 100,000 m^2, i.e. 10 ha.

10.6.3.37 Given the above, the ecological impacts caused by HKLR reclamation are ranked as **minor impact**. With this increase of habitats for the common gorgonians

impacted, the impact would be acceptable. No mitigation is required, but a pre-construction dive survey for corals will be provided as additional enhancement measure (see **Section 10.7.8**).

HKBCF

Intertidal Habitat loss (Loss of Artificial Seawall during Construction)

10.6.3.38 The majority of the northeast shore of Airport Island is artificial seawalls, with only a small section of remnant rocky shore at the most northern end. Artificial seawalls and remnant rocky shores at the northeast Airport Island are all of low ecological value as indicated by the results from the HKBCF field survey, in particular for the vertical seawalls near the Marine Cargo Terminal which are vertical and constantly disturbed by logistics operations, as well as the vertical seawall to the north of the existing fire station. The remnant rocky shore at the northern end was also previously disturbed by modification.

10.6.3.39 An "Automatic People Mover" (APM) will be constructed at the northwest part of the HKBCF reclamation. This APM will be a tunnel and its alignment starts from the HKBCF western shore, goes through the waters between the HKBCF and Airport Island, crosses the berth of the existing Fire Station, and then connects road systems on Airport Island.

10.6.3.40 The construction of APM would encroach the berth of the fire station, which is currently a sloping seawall and less than 150m in length. Though the APM is in tunnel form, cut and cover construction method will be required and thus direct encroachment on this seawall is anticipated. This seawall was surveyed for intertidal fauna by quantitative transect method during the HKBCF survey programme (Northern transect in the HKBCF survey, see **Appendix 10D**). The diversity and abundance of intertidal fauna recorded in this location were low, and no species of conservation importance was found. The ecological value was ranked as low.

10.6.3.41 A new fire station will be constructed at the northern end of the vertical seawall just to the north of the existing fire station. A small section of artificial seawall (less than 100m vertical seawall) at this new fire station location will be lost due to the construction.

10.6.3.42 Artificial seawalls on Airport Island were all constructed in the mid 1990's during the development of the new airport. Given the low ecological value of these artificial seawalls, the impact of intertidal habitat loss from HKBCF is ranked as **insignificant**. The remnant rocky shore at the northern end will not be encroached by the HKBCF project.

Subtidal Habitat loss (Loss of Soft Substrate Benthic Habitat, Hard Substrate Coral Communities and Marine Waters during Construction)

10.6.3.43 The majority of the HKBCF would be on newly reclaimed area which would be adjacent to urbanised areas. The land reclamation is 130 ha to the copeline. The sea area (138 ha, the footprint area to the bottom of the seawall where it intersects the seabed) near the northeast Airport Island will be reclaimed for the HKBCF. The sea area to be lost is soft substrate seabed. The soft substrate seabed in this area was investigated by grab sampling survey during the HKBCF survey. The results indicated that the seabed is of low value.

10.6.3.44 The encroachment of the sloping seawall and the loss of vertical seawall mentioned in above paragraphs also cause impacts on subtidal hard substrate habitats (i.e. the subtidal part of the seawalls). Results of the dive survey of the HKBCF field survey (see **Appendix 10D**) revealed that low coverage of common gorgonian corals *Echinomuricea* sp and common ahermatypic corals *Balanophyllia* sp. (both common in western Hong Kong waters) colonised the subtidal hard substrate in this area. Dive surveys from **EBS** and other studies such as LLP EIA study confirmed that the affected gorgonian corals *Echinomuricea* sp. were widespread in the North Lantau coastlines and *Balanophyllia* sp. was also recorded in both to the east and

to the west of Airport Island during **EBS** and **EVS** studies. These were the only coral species recorded, and the subtidal hard substrate habitat was ranked as low ecological value.

10.6.3.45 The proposed reclamation site was thus not of unique importance for marine benthos and corals. No hermatypic corals or other marine benthic infauna or epifauna of conservation importance were recorded inside or in the vicinity of the proposed reclamation site as shown by the HKBCF survey and other studies. Only low coverage of common gorgonian corals and ahermatypic corals would be affected. Though the proposed reclamation site is potentially used by adult horseshoe crabs, similar habitats (soft substrate seabed) are abundant throughout the North Lantau waters and thus the loss of this area should not constitute a major impact. The impact from the physical loss of marine habitat caused by the Project would be **minor** in terms of the conservation for marine benthos, corals and horseshoe crabs. No mitigation is required, but a pre-construction dive survey for corals will be provided as additional enhancement measure (see **Section 10.7.8**).

10.6.3.46 Besides habitats for benthos, the sea areas to be occupied are also habitat for Chinese White Dolphin.

10.6.3.47 The temporary habitat loss for HKBCF reclamation would be an area of the perimeters (~5.2km) times the width of 50m distance, approximately 5,200m x 50m = 260,000 m^2, i.e. 26 ha.

10.6.3.48 Marine waters loss would reduce the habitat size for CWD. As illustrated in the above sections on baseline conditions, at the earlier stage of the HKBCF study, the waters to the east of Airport Island and the waters to the west of Airport Island were both the potential areas for locating HKBCF. The pros and cons of the two options were thoroughly studied, and the current proposed HKBCF location is considered a preferred option in terms of dolphin conservation. Although within the range of activities, the waters within the HKBCF footprint are not frequently used by the Chinese White Dolphin and thus not important for CWD (the majority of the HKBCF reclamation footprint falls within the waters near the eastern shore of Airport Island, i.e. of low ecological value, while only its northeast part falls within the waters of moderate ecological value at Northeast Airport Island, which ecological value for dolphin has been elevated due to one of the dolphin hotspot, the Brothers Islands, is located to the east of the reclamation. The HKBCF site option desk-top study revealed that more dolphin groups were sighted near the northeast corner of the airport (north of the HKBCF site) and near the Brothers Islands). This impact (dolphin habitat loss) therefore would not be severe. The marine waters habitat in the HKBCF locations is thus ranked as **moderate for dolphin**. Given the low usage of this area by CWD, physical loss of habitat therefore should not be a critical issue for CWD. But taking into account the reclamation size and relatively close to the Brothers Islands, this impact is therefore considered **moderate impact for dolphin**, mitigation measure is recommended.

Seabed Physical Disturbance

10.6.3.49 The areas of temporary marine habitat loss quantified above would not be occupied by the bridge structure after completion of construction. However, at these locations the seabed would be disturbed during construction and this could adversely affect benthic fauna.

10.6.3.50 Benthic communities are resilient to seabed disturbances. Whilst dredging destroys or degrades benthic habitats, recovery of benthos within several years, even months, after substrate disturbance is evident from many studies. Sampling station from previous marine borrow area (e.g. Station 24), showed relatively high species richness, numbers of individuals and biomass in the study commissioned by AFCD (CCPC 2002). This recovery is attributed to the rapid recolonisation of the disturbed area by nearby dominant and/or opportunistic benthic species. Because benthic communities are capable of quickly recovering after physical disturbance, this potential impact is considered insignificant in the present Project.

Off-site Works Areas

10.6.3.51 There would be off-site works areas for the present Project. These off-site works areas are all located in existing developed areas or existing/previous works areas for other projects. The disturbed nature of these sites limits their ecological value, and the operation of these works areas is not anticipated a significant ecological impact.

10.6.4 Construction Phase – Indirect Impacts

10.6.4.1 Construction phase indirect impacts would include the following:

- Disturbance of protected areas including country parks and SSSIs;
- Disturbance of wildlife;
- Degradation of marine water quality and associated habitats including seagrass beds and mangroves; and
- Degradation of terrestrial habitats.

Water Quality

10.6.4.2 The major potential water quality impacts that may arise during the construction phase of the Project include:

- Seawall dredging and filling;
- Reclamation filling behind seawall;
- Pier site dredging;
- Construction site runoff; and
- Wastewater from construction activities.

10.6.4.3 Besides these, sewage from workforce and accidental spillage of works site chemicals might also potentially cause water quality impact but would be, if any, in a much smaller scale.

10.6.4.4 In the modelling for the water quality impact assessment, the Year 2010 is considered a baseline year. The tidal flow simulations have been chosen to represent the worst case scenarios during both the constructional and operation phases of the project. As the project works will last over some years, several interim construction stages were considered beside the final operation phase (see **Section 9.8.3.4**), including:

- Year 2011 Construction Scenario 1: when the construction of the HKBCF and HKLR has begun and the potential sediment loss rates from dredging and filling were at their maximum.
- Year 2012, Construction Scenario 2: when the construction of the TMCLKL, HKBCF and HKLR would be well under way and would have had the potential to modify tidal currents.
- Year 2013, Construction Scenario 3: when the construction of the TMCLKL, HKBCF and HKLR would be near completion and would have had the potential to modify tidal currents.
- Year 2026: The Completed Scenario: It is anticipated that the TMCLKL+HKBCF and HKLR will be completed in 2016. In order to assess long term operational impacts, the target year of 2026 has been selected to allow for completion of all other expected reclamations. This scenario includes the completed TMCLKL+HKBCF+HKLR reclamations and associated bridges, the HKLR and HZMB bridges and HZMB artificial islands. This scenario also considers the completion year of 2026 for all committed projects, such as Road P1, the increased water depths in the Kwai Tsing Container Basin and

associated fairways, the LLP completed reclamations (72ha and 40ha), and the completed Tung Chung East and West Reclamations.

10.6.4.5 As the Year 2011 is the peak period for dredging and filling, to take a more conservative approach, the constructional phase water quality impact on marine ecology will consider this scenario. The present assessment will also focus on the two nearest marine ecological sensitive receivers to the Project, i.e. Artificial reefs in Northeast Airport (= WSR41) and San Tau Beach SSSI (=WSR 27). In addition, the dolphin hotspot in Brothers Islands (= WSR 49) would also be considered. If these three nearest locations are not affected by water quality impact, then it is assumed that other marine ecological sensitive receivers more distant to the Project will not be affected.

10.6.4.6 During construction phase, this project would involve dredging (for seawall foundation, reclamation and pier construction) and filling (see **Section 4** for details on construction methodology). Large-scale dredging and filling works both are potential sources of suspended solids and thus the potential to cause associated water quality deterioration such as reduction in dissolved oxygen.

10.6.4.7 Both the HKBCF and HKLR reclamation sites would be divided into several portions. Where possible, the seawall formation for each portion would be completed (optimally with small marine access of 100m only) before any dredging and filling activities commence. Full depth silt curtain will also be used to surround the access. The seawall thus formed would be a very effective means to reduce the dispersion of the sediment during the dredging and filling processes. The reclamation sequence (with completed seawall, silt curtain and marine access) is illustrated in **Sections 4 and 9**. As demonstrated in most other reclamation projects such as Penny's Bay, by this approach (the seawalls to be constructed prior to the dredging and filling works), reclamation would cause limited water quality impacts. In this manner, the occasion with higher potential of sediment release would be the dredging and filling of the seawall, which are of much smaller scale when compared with the reclamations.

10.6.4.8 Where the reclamation dredging and filling activities cannot be deferred until the seawalls are completed due to programme constraints, the dredging and filling of reclamation will be scheduled to be carried out at the areas where the leading edge of the formed seawall is about 200m as far as practicable. The provision of leading edge of seawall for the reclamation dredging and filling activities could effectively reduce the dispersion of the sediment and prevent any significant deterioration of water quality. This is expected to reduce the potential sediment loss from the reclamation dredging and filling by at least 45% (see **Section 9.8.4.17**). Barges would unload materials within the seawall, along the seawall, or within silt curtains.

10.6.4.9 In addition, closed-grab dredging and silt curtain for the dredging and filling would also be used. The measures would effectively prevent any significant deterioration of water quality. The use of a layer of stand (floating) type silt curtains surrounding each reclamation site (while taking into account the need for marine access), combined with a cage-type silt curtain around each grab dredger to be used (referred as the (1+1) silt curtain system), has been recommended and modelled. This (1+1) silt curtain system is expected to reduce the overall potential sediment loss to the surrounding water columns by 72% in the 2011 scenario year (with the maximal potential sediment loss rates from dredging and filling, see **Section 9.10.1.8** and **Table 9.16b**).

10.6.4.10 If closed-grab dredging and silt curtain around dredging sites are used, the associated water quality impacts would be localised, and would effectively reduce the sediment release. The potential for sediment resuspension is predicted to be low. The Artificial Reef at NE Airport (WSR 41) is very closed to (about 300m from the HKBCF and about 1km from the TMCLKL) and downstream (during flooding tide) of the project site. If without mitigation, this WSR would be subject to exceedances of the calculated WQO in terms of the predicted maximum depth average SS elevations (see **Section 9, Table 9.19**). After the implementation of mitigation measure, WQO exceedances are reduced but still present (see **Section**

9, Table 9.20). Hence, mitigation measures for the Artificial Reef at NE Airport (WSR 41) are required (see below sections on mitigation measures).

10.6.4.11 It was found from the water modelling results that even under an unmitigated conditions, the sediment plumes generally remain around the East Tung Chung Bay near the project site, although during the flooding time of the spring cycle, the plumes from HKLR could pass the Tung Chung Channel (underneath the North Lantau Highway) and reach Ma Wan Chung at low concentrations (<10 mg/L), but not reaching the San Tau Beach SSSI (WSR 27)(see **Section 9.10.1.4**). This situation is, again, very rare and the plumes only last for around 2 hour if it does occur. For other key marine ecology sensitive area around the project area, no WQO exceedances are predicted under both unmitigated and mitigated conditions for Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c) or Airport Channel (WSR 27, 29 and 30)(see **Section 9.10.1.5 & 9.10.1.12**). Without mitigation, the predicted maximum depth average SS elevations, at south of Tai Mo To (WSR49) would exceed the WQO in dry season (see **Section 9, Table 9.19**). With the mitigation measures, exceedences in WQO at Tai Mo To (WSR WSR 49) (i.e. the predicted maximum percentage of time to exceed respective WQO) are small and only of very short time. Given the short transient time of exceedence, adverse impact on this sensitive receiver is not anticipated (see **Section 9, Table 9.20**). Details of the water quality assessment are given in the **Section 9.10**. In view of the above, the impacts on suspended solids could be controlled to acceptable level. Apart from the reclamation, construction of piers for the marine viaducts is required in this project and these activities are the potential sources of water quality impacts.

10.6.4.12 The HKLR alignment will pass through natural seabed where limited dredging and bored piling would be required for construction of piers. There would be about 112 pier sites in the open sea to the west of Airport Island and another 20 inside the Airport Channel. But piers would be constructed in sequence rather than all at the same time. The viaduct will be constructed portion by portion (totally in three portions in the open sea part and two portions in the Airport Channel part). Each portion comprises about 35 and 10 continuous pier sites in the open sea and in the Airport Channel respectively, and the construction of the portions within one part would not overlap. Thus the maximum number of pier sites simultaneously under construction would be 35 in the open sea and 10 inside the Airport Channel. The water quality impact is thus controlled. Furthermore, the pier locations would be enclosed by cofferdams and silt curtains, and the minimum distance between two pilecap construction sites would be maintained to 180 m.

10.6.4.13 Western Hong Kong waters are characterized by high background levels of suspended solids due to the proximity to the Pearl River estuary. Trawling and sediment disposal are common in western waters and both activities disturb the seabed sediment and cause increased SS levels. Wildlife in western waters including CWD and horseshoe crabs are all well adapted to a high SS environment and are not expected to be impacted by the SS increase caused by the Project. Water quality impact on CWD has been discussed in Section 9.10.8.

10.6.4.14 Artificial Reefs - The artificial reefs near the northeast corner of Airport Island within the Marine Exclusion Area is the nearest marine ecological sensitive receiver to the HKBCF reclamation (**Figures 10.1** & **10.13**). These reefs are outside the HKBCF footprint and thus would not be directly impacted, but they are potentially subject to water quality impact from the reclamation. The seawalls would be constructed prior to the filling where possible and mitigation measures will be implemented accordingly during the seawall construction. After the implementation of mitigation measures, WQO exceedances are reduced and predicted for, in maximum, 12% of the time (wet season for the mid-depth), while the exceedances for depth average are 0% of the time in dry season and 4% of the time in wet season (see **Section 9, Table 9.20**). The potential of the artificial reefs influenced by the works, however, is still high even with the mitigation measures in place given the close distance. Impact is ranked as **moderate**. Mitigation is recommended for the artificial reefs.

10.6.4.15 Soft shores (mudflats, seagrass beds, mangroves, horseshoe crab nursery sites) – The soft shores along North Lantau shore in Airport Channel are important habitats. Degradation of marine water quality due to dredging and filling and associated impacts might potentially affect marine fauna inside these soft shores. They are just second to the ARs in terms of the distance to HKLR and HKBCF construction sites, and are on higher potential risk of being affected by the sedimentation.

10.6.4.16 However, the water quality assessment results indicate that if the above recommended mitigation measures such as silt curtains are provided, the increased concentrations of suspended solids caused by the dredging and filling works at all the water sensitive receivers, including those nearest to the reclamation such as Tung Chung Bay (represented by San Tau Beach SSSI, WSR 27) would be within the statutory requirements of 30% (the increases in maximum SS at WSR 27 would be 0.1 mg/L (see **Section 9, Table 9.20**), lower than assessment criteria). This increase has included the contributions of other concurrent projects that would have a bearing on the water quality during the construction phase of the Project (the worst case scenario, see cumulative impacts in below sections). Tung Chung Bay (represented by WSR 27 San Tau Beach SSSI which is at the mouth of Tung Chung Bay) is the nearest soft shore habitat for the project. As Tung Chung Bay would not be subject to adverse water quality from the Project, other embayments along the north Lantau shore, such as Tai Ho Wan, would not be affected by the SS from the Project construction.

10.6.4.17 Resuspended seabed sediment from dredging might also settle on nearby subtidal and intertidal habitats, including the mudflats along Airport Channel where horseshoe crabs and seagrass beds were recorded. Sediment resuspension will be controlled by the use of closed-grab dredgers, cofferdams surrounding works areas, and bored piling. The resulting water quality impacts would be highly localised. The number of work fronts would be much smaller than if all construction works were to be conducted at the same time. Use of these construction methods and protective measures would minimize impacts from suspended solids and/or dissolved oxygen. Given the mitigation measures implemented during the dredging works, it is unlikely that impacts would be significant in an environment where baseline SS levels are high. Any impacts on intertidal fauna such as horseshoe crabs and coastal birds which feed on intertidal fauna such as Pacific Reef Egret on the intertidal mudflats along the Airport Channel would be **minor**.

10.6.4.18 Many factors can affect the survival of seagrasses and often these are interlinked. Two most crucial are: the change of sediments, and the availability of light. Both sedimentation and erosion could impact seagrasses. Deposition of sediment on leaf blades can affect the absorption of light. In extreme cases, Sedimentation could result in partial or complete burial of seagrasses. Though seagrasses can help control of erosion, they also subject to erosion if the currents exceed some certain speed. Erosion could affect the physical stability of the seagrasses. Severe erosion can result in healthy plants being dislodged and washed ashore, and even the reduction of the size of their habitats. The availability of light is mostly determined by the dynamics of sediments. An increase in suspended solid level is usually accompanied in both the cases of sedimentation and erosion. This can increase turbidity in the water column and in turn lead to less light reaching the seagrass leaves which results in a decrease in photosynthetic activity and an increase in stress on the plant.

10.6.4.19 Seagrass beds in San Tau was studied during the 90's as part of the PADS mitigation plan. At that time, reclamation works for the airport at Chek Lap Kok was being conducted in the vicinity of San Tau. In that study, sedimentation is considered as one of the most important threat to seagrass. Correlative studies revealed that sedimentation is probably a strong stress on the San Tau seagrass. It is supported by data on potential and actual sedimentation rates estimated, respectively, by sediment traps and measurements of superficial sediment on leaf blades. Sedimentation rate measured by sediment traps ranged between 2.89 to 14.52 mg/cm/day (or 28.9-145.2 g/m^2/day)(SWIMS 1994).

10.6.4.20 200 g/m^2/day is adopted as the criteria for sediment deposition rate for hard corals in previous EIA studies (Binnie 1996, Meinhardt 2007, Mouchel 2002) Seagrasses are often found in the low to middle intertidal area, especially where the sediments are silty or sandy (Kwok *et al*. 2005). It should also be noted that the seagrass bed at San Tau has been subject to impacts associated with the reclamation works for the airport at Chek Lap Kok. The seagrass has, however, recovered since the works were completed. Seagrasses are therefore expected to be less sensitive to and more tolerant of suspended solids and sediment deposition than are hard corals, which prefer oceanic waters. For this reason, the threshold values adopted for hard corals (i.e. sediment deposition rate of 200 g /m^2/day) may also be applicable to seagrasses. There are water quality mitigation measures to control the SS level and the sedimentation rate in the construction sites to meet the sedimentation rate. As mentioned above, the increased concentrations of suspended solids caused by the dredging and filling operation at San Tau Beach SSSI (WSR 27) would be 0.1 mg/L, lower than assessment criteria (see **Table 9.20**). Furthermore, the daily deposition rate in San Tau Beach SSSI (WSR 27) would be below 10 g/m^2/day (6.8 during dry season and 8.0 during wet season) even under the unmitigated conditions (see sections and tables for mitigated sediment plumes under Year 2011 Scenario in **Section 9.10.1.14**). If with mitigation in place, the daily deposition rate would be below 1.0 g/m^2/day under all scenarios (with or without concurrent project in different years) (see **Section 9**). This is much lower than the criteria of 200 g /m^2/day and the impact on seagrasses could be controlled. As San Tau Beach is the nearest soft shores to the reclamation sites, all other soft shores sites along the Airport Channel would not be significantly impacted by sedimentation. Other soft shores such as Tai Ho and Tung Chung Bay and mangrove habitats, as well as other aquatic organisms, mainly those recorded on soft shores such as *Metapenaeus ensis* will not be significantly affected by water quality impact as they were all at North Lantau shore and farther from the major reclamation site than San Tau Beach.

10.6.4.21 Recognised sites of conservation importance – the potential water quality impact at recognised sites of conservation importance within the North Western and North Western Supplementary WCZs (i.e. San Tau Beach SSSI, Tai Ho Stream SSSI, Sha Chau and Lung Kwu Chau Marine Park, and the proposed Marine Park at Fan Lau) is also a concern. As the San Tau Beach SSSI, which is much closer to the Project Site, would not be affected by the SS or the sedimentation impact as illustrated in above sections, the other recognised sites would not be affected due to the longer distance. Similarly, ,the mudflats in Deep Bay including those in Mai Po, Tsim Bei Tsui and Pak Nai would not be affected by water quality or would not have changes in the local erosion and sedimentation patterns.

10.6.4.22 Marine Mammals – Generally, degradation of water quality due to increases in suspended solids or decreased dissolved oxygen are not considered to be the major issue of concern for marine mammals, which do not obtain oxygen from the water and would not have the risk of gill blockage by high level of suspended particles as fish might encounter. Dolphins and porpoises, that use echolocation as well as vision to navigate and find food, are even less susceptible to sedimentation effects than are other marine mammals that filter prey from the water. However, significant alteration of physical water characteristics may influence prey and therefore affect the animals indirectly. Resuspension of seabed sediment or filling materials might also settle on nearby subtidal and intertidal habitats and indirectly affect their prey.

10.6.4.23 The HKBCF and HKLR reclamation sites are not frequently used by Chinese White Dolphin (**Figure 10.8**). Some of the areas to be dredged (inside Airport Channel and the area on southeast Airport Island) are even not used by Chinese White Dolphin (**Figure 10.8**). Physical separation of dredging works from areas used by Dolphin will further reduce risks of sedimentation impacts. If closed-grab dredging and silt curtains are used, the associated water quality impacts would be localised and would not affect Chinese White Dolphin. The distribution of sediment plumes was compared with the distribution of dolphin density DPSE (see **Figure 10.12**), it was found that the predicted maximum plumes would not reach the Brothers

Islands (a recently identified key dolphin habitat, represented by WSR49). The predicted SS level would be controlled below the WQO, and no impacts are anticipated with the mitigation measures (i.e. sit curtain) implemented. The silt curtain system encloses the entire project sites, the SS elevation band at around 500m of the site are largely reduced to <30 mg/L. SS at this level would not adversely affect CWD which is air-breathing and navigate by echo-sounding, and establishing a SS mixing zone for CWD is not considered as being warranted. Discussion on the water quality impacts on CWD had been presented in **Section 9.10.8**. It is expected that the impacts from suspended solids in the present Project could be controlled to **minor to moderate** after implementing all good site practices.

10.6.4.24 The maximum potential instant DO depletion has been estimated using the estimated maximum potential increase in suspended solids. Among the ecological sensitive sites (WSR 10 – Sha Chau and Lung Kwu Chau Marine Park, WSR 27 – San Tau Beach SSSI, WSR 41 – Artificial Reef in northeast airport, and WSR 49 – the Brothers Island), the predicted highest depth-averaged SS elevation (29.9 mg/L in 2011 unmitigated scenario) is at the artificial reef at the NE airport (WSR 41) and with this level of SS elevation, the potential maximal DO depletion is only 0.4 mg/L which is well within the natural background fluctuation of the area (see **Section 9.10.7.3**).

10.6.4.25 The effects of sewage on wild cetaceans remain largely unknown (Johnston *et al*., 1996). However, it is known that sewage can introduce pathogenic bacteria (such as *Salmonella* sp. and *Vibrio cholera*) and viruses, which in turn can cause diseases such as hepatitis. Sewage-borne bacteria have been found in tissues of Chinese White Dolphin stranded in Hong Kong (Parsons and Jefferson 2000). However, it cannot be confirmed if these bacteria were taken-up while the animals were alive or post-mortem. The Project has low potential to cause increased sewage discharge, therefore this potential impact is **insignificant**. The potential water quality impacts due to site runoff, sewage from workforce and wastewater from various construction activities, and accidental spillage would be controlled through the implementation of suitable mitigation measures, including temporary drainage system, chemical toilets, etc (See sections on **Mitigation of Water Quality Impacts**).

10.6.4.26 Redistribution of environmental contaminants (especially heavy metals and organochlorines), and increased exposure of small cetaceans to pollutants, can have damaging effects on dolphins and porpoises. The impacts from redistribution of environmental contaminants into the water column are discussed under **Bioaccumulation** below.

Chemical Spillage

10.6.4.27 There is an increased risk of small-scale oil or chemical (construction works solvent) spills from vessels due to the increased number of vessels working in the area. Because of the small volumes of such materials involved, this risk is considered **insignificant**.

Surface runoff

10.6.4.28 Potential impacts to aquatic habitats and associated fauna from sedimentation due to surface runoff may arise during the construction phase. Elevated suspended solids levels caused by site runoff could increase the suspended solid load in the water bodies, and could decrease dissolved oxygen levels. This may affect the survivorship of aquatic fauna, e.g., larvae of amphibian and dragonfly, or intertidal fauna. The result could be a temporary reduction in abundance of aquatic or intertidal life. However as there was only limited land-based construction works on Airport Island which lacks of aquatic habitats of ecological value, and intertidal habitats of high ecological value are all located on North Lantau shore (separated from the Airport by the Airport Channel), the potential impact from runoff to aquatic or intertidal communities would be **insignificant**.

Bioaccumulation

10.6.4.29 Resuspension of seabed sediment might potentially incur the release of toxic substances, if any, into the seawater. If toxic substances are present in the seawater, bio-accumulation might occur through the food chains and impact marine fauna, particularly those on higher trophic levels such as dolphins. Bioaccumulation is a concern for top predators such as cetaceans, but other marine organisms such as horseshoe crabs and corals are much less susceptible to this impact. High levels of environmental contaminants including heavy metals (e.g. mercury and cadmium), organochlorines (e.g. DDTs, PCBs and HCHs) and organotins (TBTs) have been found in the blubber, liver and kidney of stranded CWD and porpoises (Jefferson 2000; Jefferson et al. 2006; Minh et al. 1999; Parsons 1999). A few compounds from several classes were considered to be of particular concern when dealing with Chinese White Dolphin in the Pearl River Estuary. These include:

- DDTs and Polychlorinated Biphenyls (PCBs) among the organochlorines;
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Arsenic (As) and mercury (Hg) among the metals; and
- Total BTs (including Tributylin (TBT), Dibutylin (DBT) and Monbutylin (MBT)) among the butyltins (see Parsons 2004).

10.6.4.30 A risk assessment conducted for the ecological monitoring programme of Contaminated Mud Pit IV (Mouchel 2002a) examined the content of heavy metals, PAH, PCB, organochlorines, and TBT in trawling catches from the mud pit area and two reference sites, one near Sha Chau and Lung Kwu Chau Marine Park and the other to the southwest of Airport Island. The assessment concluded that only three contaminants showed potential risks for CWD. Two of them, TBT and MBT (a breakdown product of TBT), are only marginally in excess on a risk index (RQ, Risk quotient) and thus the risk to dolphin health could be considered to be low or negligible. While for the third contaminant, arsenic, there was no significant difference in arsenic concentration in fish at the reference sites versus those at the mud pits. Arsenic is regularly encountered at elevated concentrations in the North Lantau area due to the naturally occurring arsenic-rich mineral deposits. This indicates that the mud pits are not a source of contamination.

10.6.4.31 Ecological risk assessment for marine mammals was also conducted during the EIA study for new mud pits at the South Brothers, to determine whether contaminated mud disposal operations at South Brothers are predicted to pose any risk to CWD. The operation of mud pit facilities includes sequentially dredging of the original seabed sediment within the pits, followed by backfilling with contaminated mud and capping with uncontaminated mud. The nature of these works are similar with the works for reclamation in the Project, except the backfilling materials in the HKBCF and HKLR reclamation will be all uncontaminated materials.

10.6.4.32 Impacts associated with the backfilling are of concern as the pollutants in the contaminated mud might potentially be released into the environment and intaken by marine organisms. Pathways of contaminant release to sensitive receivers (ie CWD) include ingestion of contaminated sediment, ingestion of dissolved and suspended contaminants in water, and ingestion of organisms with contaminant residues. The contaminants examined included PAHs, PCBs, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver, and Zinc. It was found that for almost all examined contaminants, the potential risk of exposure would be very similar with the background, only Silver was identified as of potential concern in relation to the diet of Chinese White Dolphin from coastal waters near Hong Kong.

10.6.4.33 The above risk assessment indicates that inputs of bio-accumulable contaminants into the environment were insignificant even near pits for disposal of contaminated mud, both capped or in operation. As the backfilling in the present Project would only involve uncontaminated materials, the risk from the present Project would be much lower than the above two cases.

10.6.4.34 The locations of the reclamation sites of the present Project will be largely natural seabed where contaminated materials due to anthropogenic causes are not anticipated. However, biological screening results for the samples from HKBCF showing exceedance of the LCELs indicated that some of them should be disposed of under requirements (e.g. at the confined mud pit). According to **Section 9.10.5**, dredged Mf sediment would be re-used in reclamation on-site. Mitigation measures for the re-use of those sediments will be provided (detailed in **Section 9**) and thus the release of any contaminants could be controlled. The alignment of the HKLR will not pass through contaminated materials, but rather will cross natural seabed where limited dredging and bored piling will be required for construction of piers. The pier works sites will be surrounded by silt curtains. The number of work fronts would be controlled and would be much smaller than if all construction works were to be undertaken at the same time.

10.6.4.35 During the water quality assessment, elutriation tests were conducted for sediment samples for the present Project, for the purpose of water quality assessment of the extent of contaminant release when dredging activities take place, with the results given in **Section 9.10.6**. The testing parameters included heavy metals (cadmium, chromium, copper, mercury, nickel, lead, zinc and silver), metalloid (arsenic) and organic micro-pollutants (PCB, PAHs and TBT), chlorinated pesticides and nutrients including TKN, NO3-N, NO2-N, NH4-N, PO4-P and total phosphorus. In general, no exceedance of the assessment criteria for all heavy metals and PAH was found. The concentrations of PCBs and TBT were all below the corresponding detection limits and assessment criteria. It is therefore anticipated that the potential impact associated with the release of PAHs, PCBs and TBT from sediments during dredging and filling is insignificant. However, exceedances are observed for Metalloid (i.e As), and the ammonia nitrogen, total phosphorus and total reactive phosphorus are also concern. After the estimation of dilution, however, it was found that under the worst-case condition (no mitigation measure, and assuming the highest concentration values obtained from elutriate testing as the source concentrations), at the nearest water quality sensitive receiver WSR 46 near Tai Mo To (WSR 41 the artificial reef at NE airport is excluded as there will be reprovision for it), the estimated highest concentrations of As at WSR 46 is well within the water quality criteria of 25 μg/L, while the diluted concentration of ammonia is still within the WQO of 0.021mg/L. The diluted concentrations of the phosphorus are very close to the background levels. Since silt curtains need to be used in the seawall dredging and filling activities, release of pollutants from the dredging/filling sites should be minimal, and concentrations of pollutants are not likely to be elevated (see **Section 9.10.6**).

10.6.4.36 Pore water tests were also conducted for the sediment samples. The parameters of Cd, Cr, Cu, Ni, Pb, Ag, Zn, As, PCBs, TBT and chlorinated pesticides in pore water are all below the corresponding reporting limits and the assessment criteria for release of contaminants during dredging and filling. Only one sample exceed the EU limit of 0.2 μg/L for PAH. Nevertheless, given the long distance (> 200m) to the nearest sensitive receivers (WSR 41) and the dilution factor (greater than 10), adverse water quality impact is not anticipated (see **Section 9.10.6**).

10.6.4.37 It is clear in the above worst case estimations, based upon the assumptions that the suspended sediments from the projects would be moderately contaminated up to the threshold of UCELs and could immediately desorbed/dissolved from the solid phase into solution, the predicted maximum increases in the sediment borne contaminants will be well within the criteria for the protection of marine life. The potential impacts from the release of the above contaminants would thus be insignificant. Furthermore, the locations for the dredging required for reclamation will be protected by silt curtains. Silt curtain is a proven measure to effectively control sediment re-suspension. The concerned contaminants, if any, would therefore be controlled to be redistributed into the water column, and would not be made more available for uptake by CWD or their prey. It is thus reasonable to predict that bioaccumulation impacts would not be significantly increased by the Project. Thus **insignificant** bioaccumulation impacts from the construction of HKBCF & HKLR are predicted for Chinese White Dolphin populations.

Terrestrial disturbance (Noise, dust and visual disturbance)

10.6.4.38 Noise, dust and visual disturbance will be generated during construction stage, potentially affecting the distribution and behaviour of fauna of the adjacent terrestrial habitats, but will only affect areas adjacent to the Project Area. Areas adjacent to the Project Area included only developed areas on Airport Island, Scenic Hill and the two headlands on North Lantau near Sha Lo Wan and Hau Hok Wan.

10.6.4.39 The background noise on Airport Island is high. Construction noise will be short-term, intermittent, and lower in volume when compared with aircraft noise. The ecological value of the site for the SkyCity Golf Course on Airport Island was investigated during the EIA study and was considered low in terms of terrestrial ecology, as the land is man-made and reclaimed in the early 1990s (Bhanja Cheung 2005). It is likely that the ecological value of the remaining parts of the airport as habitat for terrestrial fauna would also be low. In addition, measures are implemented in airport to reduce wildlife abundance, especially birds and their prey (e.g., amphibians), to reduce the potential hazards of birdstrike. Terrestrial fauna diversity in the airport is thus very low, due to the low vegetation cover, high disturbance level and absence of aquatic habitats. Disturbance to terrestrial fauna at woodland in Scenic Hill due to construction noise would be limited as the tunnel construction works would not involve disturbing methods such as blasting or cut-and-cover.

10.6.4.40 There would be no construction work on the headlands at Sha Lo Wan (where the HKLR alignment spans overhead) and Hau Hok Wan (where the HKLR alignment gets close to, which is also part of the Lantau North (Extension) Country Park. The noise generated from bored piling at the nearby pier construction sites in the Airport Channel would be much less than if percussive piling were to be used. Terrestrial fauna on the headlands at Sha Lo Wan and Hau Hok Wan may be disturbed by noise generated during the construction of the section of bridge deck overhead. As precast method would be used, the disturbance would be short-term and localised.

10.6.4.41 Lantau North (Extension) Country Park is only less than 50m from its nearest point (the headland of Sha Lo Wan Pier) to the HKLR alignment. But noisy construction method such as percussive piling would not be used and precast method will be applied, the disturbance impact to this recognised site of conservation importance is not significant

10.6.4.42 Except the tall shrubland on Sha Lo Wan headland, other terrestrial habitats of higher ecological value on North Lantau (e.g., woodland) are away from the Project Area. It is anticipated that noise, dust or visual disturbance from the Project Area will not have significant impact over this distance. The terrestrial fauna in North Lantau of conservation concern listed in **Table 10-7** would not be affected. The sizes of these terrestrial habitats are small. The impact will be localised and short-term. In addition, abundance of fauna is low. Due to the small area affected and the short duration of disturbance, the potential ecological impact is considered as **insignificant**.

Marine Noise

10.6.4.43 In the present Project, cetaceans are the major concern related to marine noise, while other marine organisms in the marine study area such as horseshoe crabs are not considered subject to noise impacts.

10.6.4.44 Small cetaceans are acoustically sensitive, and sound is important to their survival. Noise pollution adversely affects marine mammals, such as Chinese White Dolphin, which rely on sound as a primary means of exploration and communication (Most of them rely on echo-location method to navigate and detect prey). During project design, two types of work activities that are known to be most disturbing for cetaceans were excluded, i.e. underwater blasting and percussive piling (see below), to minimize the potential noise impacts on cetaceans, in particular on the Chinese White Dolphin. Noise from other construction activities (e.g. bored piling, marine traffic and dredging) might still be a source of impacts.

10.6.4.45 The National Research Council (2003) classified industrial noise related to marine mammal conservation. There are six major types of underwater noise:

1) Blasting,
2) Pile driving,
3) Industrial machinery,
4) Dredging,
5) Power plant, and
6) Power-generating windmills.

10.6.4.46 Noise from the above sources can cause adverse impacts to dolphins from the mildest short-term behavioural disturbance, threshold shifts, auditory masking, physiological stress, to acoustic trauma, long-term displacement from preferred habitat, or even injury or death in the most serious cases (see Richardson *et al*. 1995; National Research Council 2003; Wartzok *et al*. 2003).

10.6.4.47 Although, in some cases, dolphins may adjust the characteristics of their emitted sounds to accommodate foreign noise sources (Geraci & St. Aubin 1987; Wartzok *et al*. 2003). In other cases, they may habituate, sensitize, or become tolerant of introduced noise. Therefore, caution must be exercised in the present Project, in which noise over long periods of time may be produced.

10.6.4.48 Blasting, which produces a shock wave similar to but much stronger than percussive piling and represents the most serious threat among the six industrial sources listed above, will not be required in the Project and will not be discussed further.

10.6.4.49 Piles could be divided into two main categories, i.e. driven piles and bored piles. Driven piles (or referred as impact piling) are considered to be displacement piles. In the process of driving the pile into the ground, soil is moved radically as the pile shaft enters the ground. Bored piles are generally considered to be non-displacement piles but replacement piles. A void is formed by boring or excavation before piles is produced. Piles can be produced by casting concrete in the void. In unstable ground, temporary support from casing would be required (Abebe & Smith 1999).

10.6.4.50 The noise from pile driving displays high peaks associated with each hammer blow. In the case of bored piling equipment, much of the noise emanates from the engine providing the power, and it is possible to reduce the steady noise level by improving the soundproofing qualities of the engine enclosure (Fleming *et al*. 2008). During bored piling, metal case for the piles will be pushed into seabed sediment by machines rather than driven by hammers. But some of the noise associated with the driving and extraction of temporary casings would still be produced.

10.6.4.51 Percussive piling is an impact piling in which piling by sinking or driving a pile by direct or indirect hammering or other percussive means, and generates noise of greatest concern relative to cetaceans in Hong Kong. For the proposed Project piles will be bored rather than driven, therefore percussive piling impacts will not be discussed further.

10.6.4.52 Bored piling is considered “usually a lot less disturbing than hammer piling” (EPT 2003). Bored piling would produce much lower levels of noise than percussive piling, and this method is recommended by governing authorities and construction companies when quieter construction method is required. When comparing bored piles and impact-driven piles, bored piles “would minimise noise and vibration impacts” (TIDC 2007). In the present Project, bored piling will be conducted at all HKLR pier sites, including both the open sea part and the Airport Channel part under the Marine section. The bored piling works in pier sites within Airport Channel would not be a concern for CWD as the channel is not utilized by them. As described in the above sections on habitat loss, the viaduct of the open sea part will be constructed portion by portion (totally in three portions). Each portion

comprises about 35 continuous pier sites, and the construction of these portions will not overlap. Thus the maximum number of pier sites simultaneously under construction would be 35 in the open sea. Among these 35 pier sites within one portion, the bored piling works will not be conducted at all pier sites at the same time. The bored piling works will be scheduled to conduct in a limited number of sites at any given time (The maximum number of sites with bored piling works at the same time would be 17 or lower, and the number is also limited by the availability of the equipment, as pier construction will also be conducted in some pier sites inside Airport Channel).

10.6.4.53 Sheet piling is also a replacement piling method, but it is the metal sheet piles instead of steel metal casing to be put into sediment. The magnitude of noise should be similar with bored piling as the machines used are similar, but the noise level could be lower as sheet piles are usually not for supporting purposes and are not necessary to reach solid rock layer.

10.6.4.54 Industrial machinery and dredging noises are the most common types of noise from marine construction in Hong Kong. Dolphins and porpoises use mostly high-frequency sounds (>5 kHz) for communication and echolocation, while the vast majority of noise associated with development and construction activities is low-frequency (< 5 kHz). Low-frequency noise is generally not considered to be a serious problem for small cetaceans (Geraci & St. Aubin 1987; Richardson *et al*. 1995).

10.6.4.55 Since the completion of the AFRF, it has been found that noise from vessels offloading fuel at the facility is barely detectable above the ambient noise at distances exceeding about 500 m (Würsig & Greene 2002). This result may imply that the general construction works for the present Project, including vessel traffic (Vessel noise is also covered in the Marine Traffic section below), would not constitute a significant noise impact to the vicinity.

10.6.4.56 There are cases in which construction noise may be a problem for dolphins, such as when high-frequency components are present (e.g. certain types of equipment that use high-speed engines), when a source of noise is relatively loud and continuous for long periods of time (e.g. oil-drilling or dredging operations), and when the noise is impulsive and emits shock waves (e.g. with pile-driving or blasting). As explained in previous sections that percussive piling and blasting would not be required. Mitigation measures for high-speed engines would be proposed (see **Section 9**).

10.6.4.57 Very little is known about the effects of dredging on cetaceans in general. The few studies that have been done dealt with large whales. Richardson *et al*. (1990) conducted sound playback experiments with bowhead whales (*Balaena mysticetus*) in the Arctic, and used sounds recorded from active dredgers. The whales showed some behavioural responses, changing their vocalization patterns, feeding, and diving behaviour when the noise corresponded to that of dredgers at about 3-11 km distance.

10.6.4.58 In general, dolphins utilize more on the high frequency sound, and make them less vulnerable to the effects of dredgers, which generally produce very low frequency sounds (less than a few kHz - see Greene 1987). Also, stationary dredgers appear to have less effect than more transitory sound sources (Richardson & Würsig 1997). The only small toothed whale for which there is some quantitative data on reaction to dredgers is the beluga whale (*Delphinapterus leucas*). In general, the reactions of belugas to dredgers were of a low level, and whales tended to occur well within the ensonified areas, suggesting that they did not find the noise to be highly disturbing (Richardson & Würsig 1997). Similarly, Thomas *et al.* (1990) conducted studies of the behavioural responses of captive belugas to record playbacks of oil drilling operations (which in some ways are similar to those of dredging operations). They found no discernable behavioural responses, and also found no evidence of stress from examination of blood catecholamines.

10.6.4.59 The dolphins appeared to be attracted to the disturbance of the sea bottom such as trawling (perhaps this makes prey more accessible for them). CWD activities

associated with trawlers have been reported in the AFCD annual dolphin monitoring programme. This is probably indicative that the level of disturbance and noise is minor. The level of seabed disturbance and noise caused by dredging would be similar or even smaller than that from trawling as it is stationary. Furthermore, in the present Project all dredging works would be conducted within silt curtains, the noise level would be reduced and it also avoids the chances of a dolphin being struck by equipment or vessels involved in the operations.

10.6.4.60 As the other five industrial activities (i.e. blasting, pile driving, industrial machinery, power plant and power-generating windmills) would not be conducted in the present project, they are not of concern and will not be discussed further.

10.6.4.61 Further to the above 6 types of marine noise, vessel noise is well-known as a potential disturbance factor for dolphins, although it is mainly the smaller, faster-moving boats with outboard engines that are considered most disturbing (Richardson *et al*. 1995; Richardson & Würsig 1997). Dolphins mainly use sounds that are well above the frequencies produced by most large vessels used in shipping and marine construction activities. Based on available experience in Hong Kong SAR, these types of vessels are not thought to be a significant source of acoustic disturbance.

10.6.4.62 Bored piles would minimise noise and vibration impacts when compared with traditional impact-driven piles (TIDC 2007). Construction of HKLR and HKBCF phase 1 would be completed prior to 2015 and remaining of HKBCF in about 2016. The number of work fronts would thus be smaller than if all construction works were to be undertaken at the same time. The viaduct of the open sea part will be constructed portion by portion (totally in three portions), which construction would not overlap. Within each portion, bored piling will be scheduled to conduct in only several sites at any given time. Only minor noise impacts are identified from the construction works for the present Project. However, there is still a small possibility that noise would be transmitted from the onboard equipment (e.g. air-compressor) and during the installation of temporary casings into the sea. The level of noise from this source would be much lower than those from percussive piling and might be similar with marine industrial activities. To take a precautionary approach, however, the noise impact is ranked as **Moderate**, and mitigation measure is proposed to reduce this impact. Furthermore, there will be an underwater noise monitoring for the bored piling works during the construction phase to verify the predictions of the assessment.

Marine Traffic

10.6.4.63 Although vessel noise is not thought to be a major source of acoustic disturbance to cetaceans, dolphins may need to change their diving and surfacing patterns to avoid being hit by large vessels (the skippers of which generally do not know or care that there are dolphins in their path). This may result in behavioural disturbance in areas of very busy shipping, ferry lanes, or regions with active marine construction.

10.6.4.64 CWD and porpoises have been injured and/or killed by vessel collisions in Hong Kong (Parsons & Jefferson 2000). Boat traffic is intensive in Hong Kong for trading and transportation between Hong Kong and China. The Urmston Road shipping channel is situated at the area of highest density of Chinese White Dolphin in Hong Kong (Hung 2008). Some CWD may get hit by high-speed vessels and become seriously injured or killed. From the photo-ID results, a few identified individual CWD showed permanent injury marks on their bodies and fins caused by propellers. Further evidence from several stranded CWD presented wounds consistent with blunt traumatic injury, probably caused by impacts from vessel bows or hulls during boat collisions (Jefferson 2000; Parsons and Jefferson 2000). Of CWD and porpoises stranded in Hong Kong, 10% showed evidence of probable or definite vessel collisions (Parsons & Jefferson 2000), and at least 2.1% of individual CWD in the photo-ID catalogue show evidence of propeller cuts (Jefferson 2004). This indicates that vessel collision is a significant cause of death for local cetaceans. Though the actual collisions have not been observed, it is considered that high

speed vessels such as out-board engine speed boat would be the prime source of collision risk. Since most of the vessels that will be involved in the construction of the HKLR and HKBCF construction will be slow-moving working barges and vessels, this issue is not likely to be critical.

10.6.4.65 Increased vessel traffic through the Northwest Lantau area would likely affect Chinese White Dolphin. However, since most of the vessels that will be involved in the HZMB construction will be larger, slow-moving vessels (which generally involve low-frequency sound, to which dolphins are less sensitive), this issue is not likely to be critical.

10.6.4.66 The increase in vessel movements in the area during construction is also of concern, and if the number of movements is very high it could cause some avoidance of the area by CWD. However, the proposed reclamation area is not adjacent to the Urmston Road channel which is known very busy and noisy in Hong Kong's western waters (Würsig & Greene 2002), the potential for this situation seems quite low.

10.6.4.67 Since the proposed reclamation areas are not used frequently by the CWD, and most of the vessels that will be involved in the construction will be larger, slow-moving vessels which would be of low hazardous level in terms of both collision risk and disturbance, the impact from marine traffic on the dolphin is thus ranked as **minor to moderate,** mitigation measures would be needed. Some precautions would also be taken such as to locate the HKBCF reclamation access opening at the far side from the dolphin hotspot of Brothers Islands, so as to minimise the disturbance from the reclamation-associated marine traffic.

Entanglement and entrapment

10.6.4.68 There will be double-layer silt curtains to be installed surrounding the areas for seawall dredging and filling. The silt curtains would be in the form of a fabric sheet rather than a net, and thus should not pose any net entanglement risk to the CWD. The opening for vessel access would be small and thus the chance that CWD accidentally enter the waters surrounded by silt curtains would be very low. Furthermore, a construction dolphin watching plan will be included in the EM&A programme. The plan would also include regular inspection of the curtains, scanning of the waters surrounded by the curtains, and an action plan in case CWD are found within the waters surrounded by the silt curtains. This impact is ranked as **insignificant**.

Disturbance on marine borrow areas and dredged/excavated material disposal sites

10.6.4.69 The dredging would also cause secondary impacts on the dredged/excavated material disposal sites, while the backfilling would require a large quantity of sand and would have implication on marine borrow areas. These disposal and sand dredging activities would follow the current practices, guidelines, and requirements.

Cumulative Impacts from Construction Phase impacts

10.6.4.70 In accordance with Section 4.3.3 (b) of EIA-TM, the assessment should examine the cumulative environmental effects if there may be interactions between the environmental impacts of the projects which might affect the sum total of its environmental impacts. In the present project, no interactions between the construction phase impacts, which would affect the sum total of all ecological impacts, are identified.

10.6.4.71 Construction phase impacts are summarised in **Table 10-10** below.

Table 10-10 Construction Stage Impacts

Impact	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Terrestrial habitat loss (Project footprint)	NA	Tunnel Portal	NA	Grassland/shrubland habitat	Low	Common flora and fauna species	About 1ha	Turn into permanent loss after completion	Irreversible	Small	Minor	No
	NA	Viaduct columns	NA	Developed areas	Low	Disturbance tolerant fauna	About 1 ha	Turn into permanent loss after completion	Irreversible	Small	Insignificant	No
Intertidal habitat loss(Project footprint)	NA	Viaduct columns, reclamation	APM, Reprovision of fire station	Existing artificial seawall	Low	Common species of intertidal fauna and Waterbirds utilising coastal areas e.g. Pacific Reef Egret	200m (or 0.5ha) for viaduct; about 500m for reclamation, 250m for APM	Turn into permanent loss after completion	Irreversible	Small	Insignificant	No, But more seawall would be provided after reclamation
	NA	Reclamation	NA	Disturbed/Remnant rocky shores on Airport Island	Low	Common species of intertidal fauna	1,500m of remnant rocky shore	Turn into permanent loss after completion	Irreversible	Medium	Minor	No, But more seawall would be provided after reclamation
Seabed loss and loss of dolphin habitat above the seabed (Project footprint)	NA	Reclamation	APM, Reprovision of fire station	Shallow subtidal hard substrate seabed	Low to moderate	Gorgonians and ahermatypic corals	Approximately 2km (due to HKLR and HKBCF)	Turn into permanent loss after completion	Irreversible	Small to Medium	Minor for gorgonians and ahermatypic corals;	No, more hard substrate seabed would be provided after reclamation, but a pre-construction dive survey for corals will be provided as additional enhancement.
	Viaduct piers	Reclamation	Reclamation	Subtidal soft substrate seabed	Low	Benthic communities	<3ha for HKLR viaduct, 27 ha for HKLR reclamation and 138 ha for HKBCF reclamation	Turn into permanent loss after completion	Irreversible	Medium	Minor	No
	Viaduct piers in open sea	NA	NA	Marine waters west of Airport Island	Moderate to High	Chinese White Dolphin	< 3 ha	Turn into permanent loss after completion	Irreversible	Small	Minor	No.

Impact	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Seabed loss and loss of dolphin habitat above the seabed (Project footprint)	Viaduct piers in Airport Channel	NA	NA	Marine waters in Airport Channel	Low	Marine fauna	< 1 ha	Turn into permanent loss after completion	Irreversible	Small	Minor	No
	NA	Reclamation	NA	Marine waters to the east of Airport Island	Low	Marine fauna	27 h	Turn into permanent loss after completion	Irreversible	Medium	Minor	No
	NA	NA	Reclamation	Marine waters near Northeast Airport Island	Moderate	Chinese White Dolphin	138 ha	Turn into permanent loss after completion	Irreversible	Medium	Moderate	Mitigation during the operation phase
Terrestrial Temporary habitat loss (works areas)	NA	Works area for construction of viaduct column; maintenance access and tunnel portal	Modification of existing road system on Airport Island	Grassland/shrubland habitat and Developed areas	Low for developed area and grassland/ shrubland	Common flora and fauna species Disturbance tolerant fauna	About 2ha for HKL; more for HKBCF	Temporary	Reversible	Small	Minor	No, but the disturbed habitats should be reinstated after construction
Intertidal Temporary habitat loss (works areas)	NA	Works area for viaduct column on artificial seawalls	Works area for APM and fire station	Existing artificial seawall	Low	Common fauna species	About 1.5km	Temporary	Reversible	Small	Insignificant	No
Temporary Soft Substrate seabed loss (works areas) and seabed disturbance	Pier construction sites	Works areas for reclamation	Works areas for reclamation	Subtidal soft substrate marine habitat	Low	Common intertidal fauna species	About 6.6ha for HKLR viaduct; 10ha for HKLR reclamation; 26ha for HKBCF reclamation	Temporary	Reversible	Small	Minor	No, benthos able to self-recolonisation
Temporary marine waters loss (works areas)	Pier construction sites	Works areas for reclamation	Works areas for reclamation	Marine waters	Ranging from moderate-high to low in different locations	Chinese White Dolphin	About 6.6ha for HKLR viaduct; 10ha for HKLR reclamation; 26ha for HKBCF reclamation	Temporary	Reversible	Small	Minor	No.
Temporary land disturbance	Off-site works areas	Off-site works areas	Off-site works areas	Fauna on developed area and existing construction sites	Low	Disturbance-tolerant species	Low	Temporary	Reversible	Small	Insignificant	No

Impact	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Marine water quality (e.g. Sedimentation and Resuspension during dredging; Decreased D.O., Dumping, spilling)	Reclamation Resuspension during dredging Decreased D.O., Dumping, spilling, and leakage of chemicals from vessels or equipment			Marine and coastal fauna in the nearby waters	Low to High for dolphin; Low for gorgonians and benthos	Chinese White Dolphin Gorgonians Marine benthos	Low to High for dolphin Low for gorgonians and benthos	Temporary	Reversible	Medium	Minor for gorgonians and benthos; minor to Moderate for CWD (with water quality mitigation in place)	There would be water quality mitigation measures
				Softshore habitats	Moderate for mudflat; High for juvenile horseshoe crab; High for seagrasses	Estuarine species, including horseshoe crab juveniles, seagrasses, and mangroves	Small for mangroves and seagrass beds; extensive for mudflat	Temporary	Reversible	Small	Minor	No, but there would be water quality mitigation measures
				Artificial reefs	Moderate	Epifauna and fish	3,600 m^3	Temporary	Reversible	Large given the close distance	Moderate	Re-provision of ARs of same volume
				Sha Chau and Lung Kwu Chau Marine Park	High	Chinese White Dolphin; coral communities	1,200 ha	Temporary	Reversible	Small given the vast distance	Insignificant	No.
				San Tau Beach SSSI	High	Estuarine species, including horseshoe crab juveniles, seagrasses, and mangroves	2.7 ha	Temporary	Reversible	Small given the vast distance	Insignificant	No.
				Tai Ho Stream SSSI	High	Estuarine species, including horseshoe crab juveniles, seagrasses, and mangroves	5 ha	Temporary	Reversible	Small given the vast distance	Insignificant	No.
				Proposed Marine Park at Fan Lau	High	Chinese White Dolphin	N/A	Temporary	Reversible	Small given the vast distance	Insignificant	No.
Bioaccumulation	Redistribution of contaminants during dredging	Redistribution of contaminants during dredging	Redistribution of contaminants during dredging	Nearby waters	Low to High	Chinese White Dolphin	Low to High	Long term	Irreversible	Insignificant	Insignificant	No, but there would be silt curtain to control sediment re-suspension, thereby minimizing availability for uptake by dolphins or their prey species

Impact	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Terrestrial noise, dust and visual disturbance	Works equipment and human activities	NA	NA	Wildlife species on adjacent habitats, including urbanised/disturbed and grassland	Terrestrial habitats affected are of low ecological importance	Disturbance tolerant fauna	Low	Temporary	Reversible	Small	Insignificant	Good Site Practices.
Sedimentation from land-based works areas	NA	Construction of the tunnels in Scenic Hill and access roads	NA	Nearby natural habitats (woodland with Romer's Tree Frog records)	Low	Amphibians,	Very low	Temporary	Reversible	Small	Insignificant	Good Site Practices.
Marine noise	Dredging, and Works Vessels	Dredging, and Works Vessels	Dredging, and Works Vessels	Nearby waters	Low to High	Chinese White Dolphin	Low to High	Temporary	Reversible	Medium	Moderate	Acoustic decoupling Dolphin Exclusion Zone or Dolphin Watching Plan,
	Bored piling		Sheet piling	Nearby waters	Low to High	Chinese White Dolphin	Low to High	Temporary	Reversible	Medium	Minor to Moderate	Yes, use of quiet vibratory piler, to avoid drilling onto rock surface of bored pile during May and June; dolphin exclusion zone.
Marine traffic during construction	Vessel traffic associated with construction	Vessel traffic associated with construction	Vessel traffic associated with construction	Nearby waters	Low to High	Chinese White Dolphin	Low to High	Temporary	Reversible	Small	Minor to moderate	Yes to set up regular routes for vessels to avoid dolphin hotspots; vessel speed limits; training for vessel captains
Entanglement and entrapment	Silt curtain	Silt curtain	Silt curtain	Nearby waters	Low to High	Chinese White Dolphin	Low to High	Temporary	Reversible	Small	Insignificant	Dolphin watching plan during construction phase

10.6.5 Operation phase – Direct Impacts

Permanent habitat loss

10.6.5.1 After the construction of the Project, the temporary works areas will be restored by the contractor (for terrestrial habitats) or self-restored (for intertidal habitats and subtidal habitats), but the habitats occupied by the Project footprint would be permanently lost. The sizes of the permanent habitat losses have been calculated in the above sections for construction phase, i.e.

1) Less than 1ha developed area for HKLR;
2) About 1 ha grassland/shrubland habitat for HKLR;
3) 700m (200m on southern shore and 500m on southeast shore) artificial seawalls for HKLR;
4) 1500m remnant rocky shores for HKLR;
5) Less than 250m seawall lost for HKBCF;
6) About 2km hard substrate seabed for HKLR;
7) Less than 250m hard substrate seabed for HKBCF;
8) Less than 3ha of sea area (including soft substrate seabed and water column) in HKLR marine pier sites;
9) 27 ha of sea area (including soft substrate seabed and water column) in HKLR reclamation; and
10) 138 ha of sea area (including soft substrate seabed and water column) in HKBCF reclamation.

10.6.5.2 The severity of these habitat loss impacts have been discussed, and it is concluded that only the 138 ha sea area loss is considered a moderate impact and mitigation is required. The mitigation for this impact will be detailed in the sections on mitigation measures below.

Carrying Capacity

10.6.5.3 The major food items of CWD would be estuarine fish. The fish production in the sea areas to be lost would be an indication of the food supply for CWD. Port Survey conducted AFCD provides information of the fishing production in different areas in Hong Kong waters. In accordance with the results from Port Survey 2006, the sea area to be lost from the reclamations of the Project are not of high fishing production. The fishing production in these areas ranged from very low to moderate, when considering the fishing production distribution in Hong Kong. The project footprint also would not encroach any area of fish fry production or fisheries species spawning/nursery ground. There would not be any impact on the sustainability of the fish resources, i.e. the food supply to CWD, in North Lantau waters. It is not anticipated that the carrying capacity of the North Lantau waters for CWD would be affected.

Terrestrial and Intertidal Habitat Fragmentation

10.6.5.4 The Project Area is mainly located in marine environment, and therefore would not cause significant fragmentation of terrestrial habitats.

10.6.5.5 The HKLR will span over sea and span over the headlands at Sha Lo Wan. Therefore these viaducts will not cause fragmentation of natural habitats on these headlands. Flight behaviour of birds in relationship to bridges was studied during the EIA study of Shenzhen Western Corridor, and it was found that birds can fly across bridges, either above or below the deck (Appendix 9C in Arup 2002). The bridge would not be an obstacle to birds.

10.6.5.6 The impact from habitat fragmentation on Airport Island is insignificant as the alignment would go through the edge of the only affected natural habitats (grassland/shrubland on Scenic Hill) in tunnel form, rather than split them into different parts. The ecological value of the grassland/shrubland on Scenic Hill is low. The HKLR will not pass by the woodland of higher ecological value. The impact of habitat fragmentation to terrestrial fauna is ranked as **insignificant**.

Marine Habitat Fragmentation

10.6.5.7 Another consideration is whether a series of bridge piers would restrict the movement of CWD. Some Chinese White Dolphin individuals might use both the North Lantau and West Lantau areas (such as the year-round resident NL123, and the seasonal resident NL188, see AFCD 2009) and HKLR will be located in between these two areas. Though this alignment would have less magnitude of impacts to CWD than if the alignment were to pass directly through the high dolphin density areas, if the CWD restrict their movements because of the bridge, then this would be a significant impact, as it will affect their foraging efficiency and ability to socialize and find mates. The concern on the present Project would be on whether the space between any two bridge piers (minimal distance of 50m) would constitute a restriction for CWD movement or discourage them to pass through this space. Besides the presence of the bridge piers, it is also needed to consider if the shade of the viaduct (approximately 50m above water surface) on sea surface would affect CWD and make them avoid swimming underneath the bridge structure. However, there is no record that the existence of a bridge structure has any impact on dolphins. Furthermore the 50m pier spacing assumed in the habitat loss assessment is the minimal distance and is a conservative assumption. The actual pier spacing would be increased where possible during the detailed design stage. For a viaduct structure (i.e. elevated trestle bridge form) as HKLR, the optimal span-length (i.e. spacings between columns) is often in the range of 50m to 60m from structural points of view. Nevertheless, a larger span-length (i.e. wider column spacings) up to approximately 75m is structurally feasible, so as to enhance performance as regards ecology and water quality. For this reason, it is recommended that 75m should be adopted as the typical span-length for the portion of HKLR in the waters west of the Airport Island (where larger column spacings will be particularly beneficial not only to ecology and water quality, but also from the point of view of Pearl River Delta water flow). Hence, the typical spans for the portion of HKLR in the western waters will indeed be 75m, even though for conservatism, the assessment on ecology and water quality will show that it will be acceptable even if the spans are 50m.

10.6.5.8 Examples of bridge structures outside Hong Kong also provided evidences on the possible fragmentation impact on dolphins. The Kessock Bridge in Scotland crosses a tidal channel (Kessock Channel) connecting two inlets of the sea (Beauly Firth and Inner Moray Firth). The Inner Moray firth is a core part of the range of one of the resident populations of bottlenose dolphins occurring in UK waters (Wong 2006). Though the tidal channel is just less than 1 km wide with a maximum water depth of approximately 15m, since the opening of the bridge in 1982, the dolphins have continued to move in and out of their feeding area in the Kessock Channel on a daily basis. Groups of dolphins were seen swimming under the bridge within 30m of the concrete bridge supports. Normal activities such as swimming, playing, breaching, and feeding close to the Kessock Bridge are observed and photographed (*ibid*).

10.6.5.9 Xiamen waters lie in the estuarine area of Jiulong River and are inhabited by a population of CWD. The abundance of CWD in Xiamen is about 60 individuals in 2000 (Liu and Huang, 2000). CWD is widely distributed all around Xiamen waters of 700 km^2. They use mostly waters of Xiamen Harbour and Tongan Bay, which are the core areas of Xiamen CWD nature reserve. Haicang Bridge, spanning 6km over, is the second bridge to connect the Mainland and Xiamen Island. Haicang Bridge lies in the middle of the Xiamen Harbour core area of the dolphin nature reserve. During the construction of Haicang Bridge, CWD could

pass the bridge as indicated by vessel surveys. During the operation phase, CWD were found to occur in the waters around Haicang Bridge very often (both sides of the bridge) according to the vessel surveys conducted from June 2003 to May 2004 (Liu pers. comm.). Especially, with the removal of mariculture in the inner Xiamen Harbour in 2002, water quality improved in this area, and more and more occurrences were recorded in the inner part to Haicang Bridge (Liu and Luo, 2004). It can be concluded that the construction of Haicang Bridge has no effects on the habitat use by CWD. CWD can pass the bridge and reach the northern (inner) part of the harbour waters.

10.6.5.10 Therefore, bridge structure is not predicted to cause a significant impact on cetacean movements or distribution. The dolphin monitoring programme for the HKBCF and HKLR will also cover the movement ranges of individual CWD, so as to verify the validity of the current assessment.

10.6.5.11 There is also a concern on whether reclamation would block the travel corridor of CWD. The study on individual movement range of CWD revealed that some individuals would utilize a larger size of sea area, which may cover different dolphin hotspots such as Sha Chau, the West Lantau waters, or the Brothers Islands. If large-scale reclamation is built in between these dolphin hotspots, the travel of the individual dolphins which are used to move between these hotspots might be blocked, subject to the sizes of the reclamations and the locations with reference to their travel paths. For the present Project, the alignment of the HKLR and the location of the HKBCF are carefully selected taking into account of our knowledge on CDW ecology. A detailed study to review the dolphin density distribution and individual movement ranges was conducted to support the selection process (Details on the study and option selection see **Section 10.4.3.101-103** and **Section 10.7.1**). The location of HKBCF reclamation is to the east of the airport island in an area not highly utilised by the CWD and away from the waters between the Sha Chau/Lung Kwu Chau area and the area around the Brothers Islands/Sham Shui Kok (i.e. a potential CWD travelling corridor), and this impact would not be significant.

10.6.5.12 The embayment along airport channel, including Tung Chung Bay, Hau Hok Wan and Sha Lo Wan are either confirmed, or considered of high potential, as horseshoe crab nursery sites. As explained in the sections above, all these intertidal sites would not be directly impacted or disturbed by the pier construction. On the other hand, there would be some temporary and permanent subtidal habitat loss on adult horseshoe crabs. As all soft substrate seabed of the vast Hong Kong western waters provides a habitat for adult horseshoe crab, the loss of soft substrate seabed from the Project would only affect a small fraction of their available habitat, and the density of the adult horseshoe crabs is not high as this species is only occasionally collected by trawlers. The impact of the habitat loss for adult horseshoe crabs would be **insignificant**. The temporary occupation of the space in Airport Channel by the pier construction sites, however, might have an additional indirect effect on horseshoe crabs besides habitat loss, as the Airport Channel provides the access for adult horseshoe crabs to those nursery sites to spawn. If the channel is blocked, the horseshoe crab might not be able to utilize the nursery sites.

10.6.5.13 This impact, however, is considered insignificant as the pier sites inside Airport Channel would only occupy a small proportion of the channel scattered along the bridge alignment. The piers inside the Airport Channel would be all located in deeper subtidal zone, and thus would not obstruct the access of adult horseshoe crabs to the intertidal nursery sites along airport Channel, and therefore would not cause fragmentation effects on them. The channel would not be blocked. Construction works would be conducted at these sites in turn rather than at the same time. Furthermore, the eastern opening of the channel would not be affected. Given the relative size of the horseshoe crabs and the space remained available during construction stage, there is no indication that the access of horseshoe crabs to the nursery sites would be impacted.

10.6.6 Operation Phase – Indirect Impacts

Hydrodynamic Regime and Water Quality

10.6.6.1 For HKLR, because the marine viaduct of it will be a raised structure that will only slightly affect water flow, the bridge should not have any significant effect on the hydrodynamic regime of the Pearl River Estuary in general. Erosion and sedimentation might however result from changes of the hydrodynamic regime in North-western Lantau, especially in the Airport Channel. The presence of the bridge piers in Airport Channel might also change the hydrodynamic conditions of the coastal bays and thus affect the erosion and sedimentation patterns of the mudflats and seagrass beds. The 138 ha HKBCF reclamation and 27 ha HKLR reclamation sites might cause some changes on the hydrodynamic regime in its vicinity in response to the physical presence of the reclamations, which were assessed in the water quality assessment. The hydrodynamic regime of the Pearl River Estuary as a whole, however, is not likely to be significantly affected by the Project as the reclamation size is relatively not large when compared with the entire estuary. The existence of the reclamation should not have any significant effect on the hydrodynamic regime of the Pearl River Estuary. The water quality of the area should not be significantly affected once construction is completed.

10.6.6.2 After the HKLR and the two phases of HKBCF finished in 2016, and with the Tung Chung East and West Reclamation in place, will give the worst scenario of the operation phase. For the flow through the Airport Channel. In wet season, the residual, peak flood and ebb flow are shown to reduce by 41.3%, 12.5% and 1.9% respectively, while in dry season, the residual, peak flood and ebb flow increase by 50.2%, 59.3% and 5.6% respectively (see **Section 9.9.2.7** and **Table 9.17)**. Implementation of the projects, therefore, are predicted to result in increased flows in the sea channel in both directions in the dry season and in general, the proposed developments cause more westward flow through the Airport Channel, both of which could improve the flushing of East Tung Chung Bay but with reduced flows in the wet season. The predicted increased tidal flows in the sea channel following construction of the TM-CLKL+HKBCF+HKLR project could have some impact on the stability of the seabed in the sea channel with some erosion of any soft marine deposits present. However, it is considered that any erosion would be relatively small and would take many years to develop.

10.6.6.3 There would be changes in salinity in the Airport Channel. According to **Section 9.9.3.8**, the maximum decrease in salinity of around 10%, or around 3 ppt, occurs at bottom layer of WSR 27 (San Tau Beach SSSI) in wet season. The decrease may be due to a reduction in oceanic flow into the airport channel in wet season. Nevertheless, the change in salinity is still within the WQO criteria of not causing the natural ambient salinity to change by more than 10%. There are several soft shore sites along the Airport Channel which are of moderate to high ecological value. These soft shores are all sandflats/mudflats at estuarine areas of streams/rivers. Under an estuarine environment, the salinity in the water would be affected by both the seawater and the freshwater input from the streams/rivers. When the tide is flooding, seawater will dominate the estuaries and the salinity will increase. However when the tide is ebbing, the freshwater influence will be more prominent and the salinity will drop. The salinity inside estuaries thus fluctuates in a wide range everyday. The range of the fluctuation would also change everyday following the tidal cycle, with the seawater influences more prominent in spring tides and less significant in neap tides. In a review of the water quality in Deep Bay (WWF-HK 2004), which is based upon the water quality monitoring data collected by EPD (EPD 2004), it was found that the salinities in Deep Bay could range between 0.3 to 23.6 ppt. Estuarine organisms are well-adopted to this kind of changes in salinity (i.e. euryhaline, able to adapt for a wide range of salinities). The predicted change of salinity (around 3ppt) would be small when compared with the regular salinity changes.

10.6.6.4 In the Airport Sea Channel (WSR28), it is found that the average speed decreases by about 10% (from about 10 cm/s to 9 cm/s) in the wet season, but increases slightly by about 3% (from about 8.9 cm/s to 9.2 cm/s) (see **Section 9.9.2.3**). At the eastern entrance to the channel, the average speed increases

from around 4.8 cm/s to 6 cm/s in dry season and from 6.4 cm/s to 6.7 cm/s in wet season. In general, the induced change incurrent speed around the proposed development is at most up to 10 – 20% or a few cm/s and no extensive stagnant area is observed (see **Section 9.9.2.3**). As mentioned above, the induced changes in the tidal speeds are only up to a few cm/s and, therefore, it is not expected that such changes will cause significant differences in the deposition and erosion of sediments from the case without the new developments.

10.6.6.5 Hydrodynamic and sequential water quality impacts on important habitats such as Artificial reefs in the Marine Exclusion Zone 3 and the Brothers, and recognised sites of conservation importance (i.e. San Tau Beach SSSI, Tai Ho Stream SSSI, Sha Chau and Lung Kwu Chau Marine Park and the proposed marine park at Fan Lau), caused by the reclamation site are also a concern in ecological assessment. Hydrodynamic modelling results indicate that there is no significant change in the velocity vector in the open water. In both the wet and dry season, the peak flood and ebb flow at Artificial reefs in the Marine Exclusion Zone 3 (WSR41) located north of the HKBCF reclamation, were found to reduce by about 2.3% and 1.7% respectively, while the residual flows were reduced by about 4.5% (see **Section 9.9.2.6**). In terms of flow velocities, the average speed north of the Airport Island decreases by 11% (from 43 cm/s to 39 cm/s) in wet season and 3% (from 37 cm/s to 36 cm/s) in dry season (see **Section 9.9.2.3**). It is therefore anticipated that the environment in these areas can be maintained.

10.6.6.6 At the dolphin habitat of the Brothers Islands (WSR49 Tai Mo To) located to the north-east of the HKBCF, major water quality parameters, including salinity, DO, SS, BOD5 and E. coli, all would comply with the WQO. The speed increases by about 3% (from 40 cm/s to 41 cm/s) in the wet season and by 13% (from 32 cm/s 36 cm/s) in the dry season (see **Section 9.9.2.3**). These changes though relatively high in terms of percentage, are still low in terms of the changes of value. San Tau Beach SSSI, as illustrated in above sections, would not affected by water quality impact during operation phase. The remaining recognised sites of conservation importance, as they are more distant to the Project Site than San Tau Beach SSSI, the artificial reefs and the Brothers, they would not be affected by water quality impact neither.

10.6.6.7 Levels of Dissolved oxygen (DO) do not significantly change as a result of the implementation of the project. All results for both the scenarios with and without projects in 2026 show that the DO levels will comply with the DO criteria (depth average >=4 mg/L, bottom level >=2 mg/L). As a result, it can be concluded that the implementation of the project will not significantly affect DO levels and no sensitive receivers, including marine ecological and fisheries, will not be affected by the implementation of the project. The impact of the Project on water quality in these areas would therefore be acceptable. Detailed assessment results are given in **Section 9**.

Erosion and Sedimentation patterns

10.6.6.8 Soft shores on North Lantau – the local erosion and sedimentation patterns in San Tau, in particular the mudflats, during the construction phase is also a concern. The predicted annual sedimentation rate at San Tau Beach SSSI (WSR27) in Scenario 2026 would be 1,607 g/m^2, or 2.14mm. The difference with the "without project" baseline is a reduction of only 18 g/m^2 in each year, or a reduction of 0.02mm each year (see **Section 9.9.3.15**). This is a very minor change, especially for estuarine areas where the sedimentation rate fluctuates throughout the year with the changes in flow volumes of the streams/rivers. In the EM&A programme for the Project, a mudflat monitoring is included and the sedimentation rate will be one of the parameters to be monitored. (see **Section 10.9**).

10.6.6.9 Deep Bay – Regarding the local erosion and sedimentation patterns in Deep Bay during the construction phase, in particular the mudflats, it is unlikely to be affected given the distance from the Project Sites.

Water Quality (Surface Runoff from Bridge and Reclamation)

10.6.6.10 As stated in **Section 9.11.2**, no significant impacts are predicted for the operational stage. Notwithstanding, as a precautionary measures roadside gullies to trap silt and grit prior to discharging the stormwater into the marine environment. The sumps will be maintained and cleaned at regular intervals. The impact is ranked as **insignificant**.

Operation Disturbance

Noise

10.6.6.11 No negative impacts on the CWD and porpoises from the human activities (e.g. land traffic flows) are foreseen during the operation of the HKLR and HKBCF as they are mainly land-based activities.

10.6.6.12 For the HKLR, it is possible that the noise from traffic flows will be transmitted from the bridge to the waters. If this noise is of significant level, it might constitute a noise impact. The transmission of noise would be subject to various factors, including the types of vehicles, the types of the tyres, and the materials and forms of the bridge road surfaces, etc.

10.6.6.13 Noise will be generated during the operation stage (e.g., traffic, operation of machines). It is anticipated that noise from the proposed project will only affect adjacent areas. The HKBCF will be away from any terrestrial natural habitat. Only a small proportion of the HKLR would be close to natural habitats in the headlands on the west and east of Sha Lo Wan and the woodland habitats at Scenic Hill. As the bridge would only span over or get close to these headlands and the bridge deck may screen out some of the traffic noise, noise level to terrestrial fauna beneath the bridge deck is predicted to be low. Hence the impact to terrestrial fauna due to traffic noise is considered **insignificant**. The section encroaching Scenic Hill is a tunnel, hence impact from operation phase noise to terrestrial fauna of adjacent habitats is predicted to be **insignificant**. It is also anticipated that noise from the proposed project will not impose significant impact to terrestrial fauna on habitats on North Lantau (e.g., those inhabiting tall shrubland in Sha Lo Wan), due to the higher elevation of the viaduct, or on other natural habitats in North Lantau (such as Fung Shui Woods in Sha Lo Wan and San Tau), due to the long distance (approximately 700 m) between these habitats and the Project Area. The impact to terrestrial fauna, including all the fauna of conservation concern listed in **Table 10-7**, from this source is considered **insignificant**.

Light pollution

10.6.6.14 Observations from other parts of the world showed that birds may be confused by lighting during bad weather (e.g., mist, rain) (e.g. Merriam 1885, Culver 1915, Brooks 1951, Bagg 1965) and killed by collisions with man-made structures (e.g., windows, towers) (e.g., Brewster 1886, Carpenter and Lovell 1963, Peterson 1963, Savage 1965, Swales 1965). But bridges were not among the structures causing bird kills. A precautionary approach on lighting was taken for the Shenzhen Western Corridor because part of the bridge was cable-stayed and the bridge site was near Inner Deep Bay, a site of high bird abundance (ARUP 2002). The HKLR and HKBCF differ from Shenzhen Western Corridor in having no cable-stayed section and being located distant from any location with high bird abundance. A lighting design similar to other local or overseas bridges would not cause increased bird mortality due to collision with the bridge.

10.6.6.15 Other nocturnal animals (such as Brown Fish Owl in Tai Ho) are recorded far away from both the HKLR and HKBCF, and would not be affected by lighting of the Project.

Shading Effect

10.6.6.16 The HKLR viaduct will span over the Sha Lo Wan headland. The headland at Sha Lo Wan is young woodland habitat and of low-moderate ecological value. The intertidal and subtidal zones at the shores of the headland did not harbour light-sensitive habitats such as stony coral communities or seagrass beds. The

EIA study for Shenzhen Western Corridor demonstrated that shading by a bridge on mudflat (which is of higher ecological value than the young woodland) would not cause adverse impact on wildlife utilize the habitats beneath the bridge deck.

10.6.6.17 A computer model was run to demonstrate graphically the location of the bridge shadow on the mudflat at hourly intervals during an entire day in January, April, July, and September. The objective was to determine whether any portion of the beneath habitats (i.e. mudflat and seabed in Shenzhen Western Corridor EIA study) would be shaded during all hours of the day. This would not occur because the Shenzhen Western Corridor is on a southeast-northwest bearing. The sun rises on the east side of the bridge and sets on the west side, thereby lighting both sides of the bridge at different times of the day.

10.6.6.18 The model outputs demonstrated that the SWC bridge shadow would affect areas directly beneath the bridge for periods ranging from 4 to 5 hours per day, but no area beneath the bridge would be shaded at all times during any day in any season of the year. In our case, the HKLR alignment is on a southwest–northeast bearing. Though diagonal with the bearing of SWC, the HKLR is still have a certain angle with the east-west direction and the sun would rise on the east side of the bridge and sets on the west side, thereby lighting both sides of the bridge at different times of the day. Furthermore, because of the height of the bridge deck above the headland, either direct or indirect light would reach all portions of the headland during all hours of every day. Because the only light-sensitive organisms beneath the bridge are young woodland vegetation, and because no area beneath the bridge would be shaded at all times, we conclude that potential shading impacts are not a conservation concern for this project.

Physical Barrier

10.6.6.19 The Project Area is neither located near any known localities of high bird abundance, nor on the daily flight pathway of large number of birds. Birds fly at altitudes of around 3,700 m over Hong Kong during migration (Melville 1980), and the buildings in the Project Area will not become physical barriers of migrating birds.

10.6.6.20 The Project Area will be similar to the Kwai Tsing Container Terminal during operation phase. The No. 4 Container Terminal started to operate in mid 1970's, and more container terminals (No. 6, 7, 8) were built between Tsing Yi Island and Stonecutters Island in 1980's and 1990's.

10.6.6.21 Stonecutters Island (now a peninsula) is located near the Kwai Tsing Container Terminals. A big winter roost of Black Kite in Hong Kong is located at Stonecutters Peninsula (Carey et al. 2001). This roost has been used at least since 1930 (Hutson 1930). There were more than 700 Black Kites roosting on Stonecutters in winter 2004-05 (HKBWS, unpublished data). Nesting of Black Kites was also recorded on Stonecutters (Carey et al. 2001). There is no evidence that use of Stonecutters as roosting or nesting site is hampered by the presence of the Container Terminals.

10.6.6.22 The existence of a Black Kite winter roost on Stonecutters showed that the operation of the proposed project will not introduce physical barriers to flying birds, and will not affect habitat use by birds in nearby areas. Actually, the high rising structures in the Project Area are visible and can be avoided by flying birds, as in the study of behaviour of birds flying past bridges in Hong Kong and Macau (Arup 2002). Birds either ascend or descend, and fly above or below bridges. The potential impact on birds from this source is considered **Insignificant**.

10.6.6.23 The viaduct of HKLR, similar with HKBCF, is neither located near any known localities of high bird abundance, nor on the daily flight pathway of large number of birds. The deck of the viaduct will be about 50m from surface. Shenzhen Western Corridor EIA study has demonstrated that birds could either fly over or fly beneath bridge deck.

10.6.6.24 There would be some temporary and permanent subtidal habitat loss on adult horseshoe crabs. The temporary occupation of the space in Airport Channel by

the pier construction sites, however, might have an additional indirect effect on horseshoe crabs besides habitat loss, as the Airport Channel provides the access for adult horseshoe crabs to those nursery sites to spawn. If the channel is blocked, the horseshoe crab might not be able to utilize the nursery sites. The pile caps for the piers inside Airport Channel would be beneath the seabed. Only the pile would occupy the seabed. As the sizes of the piles are limited (2m diameter each), the access for horseshoe crab should not be affected.

Air Pollution

10.6.6.25 Air quality during the operation was also assessed in this EIA study. The assessment results indicated that the air quality in all Air Quality Sensitive Receivers in Sha Lo Wan on North Lantau will meet the assessment criteria. The nearest one i.e. A93 is located at the headland between Sha Lo Wan and Hau Hok Wan, and is less than 100m from the HKLR alignment. As these nearer Air Quality Sensitive Receivers would not be impacted, the ecological sites such as Sha Lo Wan fung shui wood and San Tau fung shui wood (considered as important for butterflies) and fauna such as birds inhabiting the natural habitats on North Lantau and butterflies which were recorded in abundance between Sha Lo Wan and San Tau would not be impacted neither.

Chemical Spillage

10.6.6.26 There is a possibility of a traffic accident on the bridge involving a vehicle carrying hazardous chemicals, if vehicles with dangerous goods are allowed to enter the future HZMB, which would then be spilled into the water. This could affect dolphin habitats, in spite of the dilution of spilled chemicals by the marine waters. The potential for impacts from such an event would be related to the toxicity of the chemicals involved. Dolphins can detect and avoid oil under some circumstances (see Smith *et al*. 1983). They do not necessarily avoid oiled areas, however (see Smultea and Würsig 1995). Cetacean skin is vulnerable to damage from oil, and contact can cause skin injury. While ingestion of petroleum products is not generally a problem for dolphins, inhalation of concentrated petroleum vapours can prove fatal. At lower concentrations, inhalation can cause inflammation, hemmorhage, or lung congestion, and in some cases even hallucination, convulsion, and death (Geraci & St. Aubin 1987; Geraci 1990). Large-scale spills of petroleum products can have affect dolphins and small whales. This impact is however sporadic in occurrence, and therefore ranked as minor. But mitigation is recommended under precautionary approach. A contingency plan to deal with such accidents will be formulated by the future management company and agreed by relevant government departments and authorities.

Marine Traffic

10.6.6.27 No negative impacts on the CWD from the marine traffic flows are foreseen during the operation of the bridge. And some positive effects are anticipated, which are detailed in **Section 10.7**.

Cumulative Impacts from Operation –Phase impacts

10.6.6.28 In accordance with Section 4.3.3 (b) of EIA-TM, the assessment should examine the cumulative environmental effects if there may be interactions between the environmental impacts of the projects which might affect the sum total of its environmental impacts. In the present project, no interactions between the operation phase impacts, which would affect the sum total of all ecological impacts, are identified.

10.6.6.29 Operation phase impacts are summarised in **Table 10-11** below.

Table 10-11 Operation Stage Impacts

Activity	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Permanent habitat loss	NA	Viaduct; tunnel portal	NA	Terrestrial habitat: developed area and grassland/shrubland	Low for developed area and grassland/ shrubland	Common flora and fauna	1ha of grassland/ shrubland; 1ha of developed area	Permanent	Irreversible	Low	Minor for grassland/ shrubland; insignificant for developed area	No
	NA	Viaduct; Reclamation	Reclamation; APM	Intertidal habitat	Low	Common species of intertidal fauna	950m of artificial seawalls; 1,500m of remnant rocky shore with patchy sandy beaches	Permanent	Irreversible	Moderate	Minor for remnant rocky shore with patchy sandy beaches; insignificant for artificial seawalls	No, but new hard shore will be provided by seawalls.
	Pier sites;	Reclamation	Reclamation	Seabed (Hard substrate and soft substrate)	Low for benthos; low to moderate for corals	Common infauna species; common gorgonian corals and ahermatypic corals	2,250m for hard substrate seabed, 168 ha for soft substrate seabed	Permanent	Irreversible	Moderate for HKLR; high for HKBCF	Minor	No, but new hard substrate seabed will be provided by seawalls; also a package of enhancement plan; additional artificial reefs.
	Pier sites;	Reclamation	Reclamation	Marine waters	For CWD, ranging from moderate to high in open sea to low in airport channel	Chinese White Dolphin	168 ha	Permanent	Irreversible	Moderate for HKLR; high for HKBCF	Minor for HKLR; Moderate for HKBCF	Setting up a marine park.
Terrestrial and intertidal fragmentation	Viaduct	NA	NA	Mobile terrestrial fauna and fauna utilized intertidal zone	Low	Terrestrial and intertidal species	Low	Long term	Irreversible	Insignificant	Insignificant	No
Marine fragmentation/ blockage of travel corridor	Viaduct	NA	Reclamation	Marine organism	Low to High	Chinese White Dolphin	Low to High	Long term	Irreversible	Insignificant	Insignificant	No But the dolphin monitoring programme will cover the individual movement range which could verify the assessment.

Activity	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Change of hydrodynamic regime and water quality	Piers	Reclamation	Reclamation	North Lantau waters	Low to High	Chinese White Dolphin	For dolphin, low in the waters to the east of Airport, but high in West Lantau waters	Permanent	Irreversible	Insignificant	Insignificant	No
				Intertidal soft shore habitats	Moderate for mangroves; High for mudflat	Horseshoe crab Seagrass Estuarine species	Small for mangroves; extensive for mudflat Both horseshoe crab and seagrass are NOT abundant in Tai Ho Wan.	Permanent	Irreversible	Insignificant	Insignificant	No
				Sha Chau and Lung Kwu Chau Marine Park	High	Chinese White Dolphin; coral communities	1,200 ha	Permanent	Irreversible	Insignificant	Insignificant	No.
				San Tau Beach SSSI	High	Estuarine species, including horseshoe crab juveniles, seagrasses, and mangroves	2.7 ha	Permanent	Irreversible	Insignificant	Insignificant	No.
				Tai Ho Stream SSSI	High	Estuarine species, including horseshoe crab juveniles, seagrasses, and mangroves	5 ha	Permanent	Irreversible	Insignificant	Insignificant	No.
				Proposed Marine Park at Fan Lau	High	Chinese White Dolphin	N/A	Permanent	Irreversible	Insignificant	Insignificant	No.
Surface runoff	Road surface	Reclamation	Reclamation	North Lantau waters	Low to High	Chinese White Dolphin, marine organisms	For dolphin, low in the vicinity of HKBCF, but high in HKLR open sea part	Transitory	Irreversible	Low	Insignificant	No. Silt-grease traps in bridge and HKBCF

Activity	Source			Receiver	Nature of Impacts						Severity	Mitigation Required
	HKLR marine section	HKLR land and reclamation section	HKBCF		Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Terrestrial Noise	Terrestrial traffic	Terrestrial traffic	Terrestrial traffic	Nearby terrestrial fauna	Mainly affect areas adjacent to Project Area, which are of low quality	Mainly disturbance tolerant species	Low	Permanent	Reversible	Low	Insignificant	No
Light Pollution	Lightings at night	Lightings at night	Lightings at night	Nocturnal birds	Mainly affect areas adjacent to Project Area, which are of low quality	Mainly disturbance tolerant species	Low	Permanent	Reversible	Low	Insignificant	No
Shading effect	Bridge deck	NA	NA	Young woodland in Sha Lo Wan headland	Low to moderate	Common vegetation species	Small	Permanent	Irreversible	Low	Insignificant	No
Physical Barrier	Bridge deck	The reclamation area itself	High rising structures in the Project Area The reclamation area itself	Flying birds Horseshoe crabs	NA	All bird species occur near the Project Area Horseshoe crabs	Low	Permanent	Irreversible	Low	Insignificant	No
Air pollution	Vehicles	Vehicles	Vehicles	Natural habitats	Low to High	Inhabiting fauna, such as birds and butterflies	Low to High	Permanent	Reversible	Small	Insignificant	No
Chemical Spillage	Dangerous goods	Dangerous goods	Dangerous goods	North Lantau waters	Low to High	Chinese White Dolphin, marine organisms	For dolphin, low in the vicinity of HKBCF, but high in HKLR open sea part	Transitory	Reversible	Small	Insignificant	Spillage response plan Silt-grease traps in bridge and HKBCF

NA = not applicable

10.6.7 Overall Cumulative Impacts with other developments

10.6.7.1 As stipulated in Section 4.3.3 of EIAO-TM, the assessment and evaluation of cumulative environmental effects are applied in three circumstances:

- the impacts arising from the project are predicted to extend beyond the boundaries of the project or over a long period of time;
- there may be interactions between the environmental impacts of the project, affecting the sum total of its environmental impacts; or
- there may be interactions between the environmental impacts of the project and those of other developments, and this could result in accumulation of impacts, which would affect the total effect.

10.6.7.2 The potential interactions between the construction and operational phase impacts of the HKLR and HKBCF were examined in previous sections. This section examines whether there might be interactions between the environmental impacts of the Project and those of other developments whose construction or operation phases would overlap with the HKLR and HKBCF, thereby resulting in cumulative impacts whose effects would exceed in severity those of the various projects taken individually. **Sections 1.7** and **1.8** have listed out all the concurrent projects during the construction and the operation phases of HKLR and HKBCF respectively, and provided descriptions of these projects. Nearby projects that would have potential cumulative marine ecological impacts during the construction and the operation phases of HKLR and HKBCF are summarised in **Table 10-12** below.

Table 10-12 Concurrent Projects with Implications on Marine Ecology

Proposed Development	Nature of the projects	Impacts to be Considered		Marine habitat loss	Schedule
		Construction	Operation		
Tonggu Channel	in the southeast region of the Pearl River Estuary, connecting the Urmston Road to the north and the Lantau Channel to the south		✓ (annual maintenance dredging)	The alignment of the channel is outside Hong Kong. The construction phase of this project has been completed (Re 1.7.6.2) though there might be some water quality impacts arising from maintenance dredging (Re 1.8.1 and Table 1-2)	
Kwai Tsing Container Basin Dredging	involves the deepening of the existing seabed to facilitate safe navigation of new generation of ultra large containerships to KCTC	✓	✓	No, but an area of about 415 ha will be dredged.	commence construction in 2010 and for completion in 2013.
New Contaminated Mud Disposal Facilities at South of Brothers / East of Sha Chau	to accommodate contaminated sediment	✓		No, but about 270 ha of seabed will be dredged.	Though the timing of the new pits at South of Brothers is not yet decided, to plan for the worst scenario on water quality impact assessment, it would be

Proposed Development	Nature of the projects	Impacts to be Considered		Marine habitat loss	Schedule
		Construction	Operation		
					considered as concurrent with the construction of the HKLR and HKBCF
Existing Mud Disposal Facilities at North of Brothers and East of Sha Chau (Existing East Sha Chau Confined Marine Sediment Disposal Area)	the existing mud disposal facilities at East Sha Chau are currently in use	✓	✓	No, but about 101 ha of seabed will be dredged.	Existing facilities
Existing Mud Disposal Facilities at North of Brothers and East of Sha Chau (Suspended North Brothers Open Sea Sediment Disposal Area to be re-opened).	the North Brothers' is scheduled to be re-opened (date not yet confirmed)		✓	No, but about 290 ha of seabed will be dredged.	Existing suspended facilities
Proposed Lantau Logistics Park (LLP)	at Siu Ho Wan	✓	✓	72 ha	2010-2012
Possible LLP Extension	possible Logistics Park extension or other compatible uses		✓	40 ha	no confirmed implementation programme
Future Tung Chung East and West Development	New Town Extension and the Possible Theme Park Recreational Uses		✓	110 ha and 50 ha	commence by either end 2015 or early 2016 and the construction would be completed beyond 2017
Tuen Mun-Chek Lap Kok Link	a dual-two-lane carriageway about 9km long connecting Tuen Mun Western Bypass in the north and with the proposed HKBCF and North Lantau in the south.	✓	✓	About 47 ha	Commence in 2010, for completion in 2016

Proposed Development	Nature of the projects	Impacts to be Considered		Marine habitat loss	Schedule
		Construction	Operation		
Road P1, Sham Shui Kok to Sunny Bay	one of the possible road projects in the Revised Concept Plan for Lantau	✓	✓	About 9.5 ha	Completed by 2026
Hong Kong Zhuhai Macao Main Bridge (HZMB)	constructed concurrently with the HKLR and HKBCF	✓	✓	Beyond the HKSAR boundary, the HZMB Main Section would also cause marine habitat loss, in particular 80 ha for two artificial islands near HKSAR boundary and less than 10 ha for the marine piers (about 356 piers, and assuming those piers are of similar sizes as Hong Kong piers, i.e. 200 m^2). Other major marine habitat losses include the Zhuhai BCF and the Macao BCF, which would be located close to the western shore of Pearl River Estuary where the dolphin sightings are much less frequent. According to the EIA Report of the HZMB (Mainland Section), the marine habitat loss is considered insignificant (approx. 0.4% loss of habitat) in compare with the Mainland waters in the Pearl River Delta. Outside Hong Kong	Commence in 2010, for completion in 2014

Water Quality

10.6.7.3 These concurrent projects all involve dredging and/or filling works, and would have the potential to produce cumulative construction phase water quality impact if their constructions are conducted at the same time. Water quality parameters such as suspended solid level in ecological sensitive receivers, e.g. dolphin hotspots might be deteriorated.

10.6.7.4 Besides the temporary water quality impact during the construction, these projects might have implications on the hydrological regime in the North Lantau area if they involve large-scale reclamations. This might in turn produce cumulative operation phase water quality impact on ecological sensitive receivers, e.g. San Tau Beach SSSI.

10.6.7.5 The above nearby concurrent projects, are included in the water quality modelling and assessed for potential cumulative impacts, both construction and operation phases, with the present project in the water quality assessment. The results indicate that the water quality parameters, in particular the increased concentrations of suspended solids caused by the dredging and filling operation would be within the statutory requirements of 30% with the recommended mitigation measures in place. This includes the contributions of other concurrent projects that would have a bearing on the water quality during the construction phase of HKBCF and HKLR, including but not limited to future Tung Chung East and West Development, LLP, the contaminated mud pits, etc. Details of the water quality assessment results and the compliance with WQO are presented in **Section 9**.

10.6.7.6 The sediment plumes from the TMCLKL+HKBCF+HKLR are generally confined to within the sheltered East Tung Chung Bay and do not merge with sediment plumes from the other concurrent projects. The plumes could, however, under certain tidal conditions, slightly mix with the plumes from the (unmitigated) LLP.

The predicted cumulative maximum SS elevation, however, is still low although it will infrequently exceed the WQO. It is expected that the LLP will have extensive mitigation measures in place to avoid cumulative impacts with other projects and, thus, it is not expected that the plume would merge during actual construction.

Chinese White Dolphin

A) Marine Noise

10.6.7.7 If those concurrent projects involve noisy construction methods such as percussive piling to be conducted at different areas in North Lantau, there might be cumulative construction phase acoustic disturbance to CWD, i.e. disturbance of various projects affecting different parts of the dolphin range at the same time. But the majority of the concurrent projects are either dredging projects such as mud pits, or reclamation projects such as LLP. Both types of projects would mainly apply dredging and filling works. Piling works will be required in bridge construction and are needed in TM-CLKL and HZMB Main Section, and the potential of produce noise impact is higher in piling works. But like the present Project, only bored piling method, which is much less noisy than the percussive piling, will be applied in these two projects.

10.6.7.8 The potential of cumulative marine noise impacts from simultaneously bored piling works would be low as noise impacts are localised and transient in nature, unless the sources lie adjacent to each other. Marine bored piling will also be applied in the HZMB Main Bridge, and the construction period would overlap with that of HKLR. As the HKLR will connect to the artificial island beyond the HKSAR boundary, and the two artificial islands for the tunnel underneath Tonggu Waterway is 6.7km apart, there is sufficient separation between the bored piling activities for the two projects. The bored piling works in Mainland waters would be conducted far away from HKSAR boundary. Similarly, the bored piling works for TMCLKL will be conducted in the waters between Tuen Mun and Northeast Airport, and no marine piling works for HKLR will be conducted to the east of Airport (the bored piling works for HKLR will be conducted in Airport Channel and to the west of Airport). The bored piling works for TMCLKL would be conducted far away from HKLR. Furthermore, similar mitigation measures for marine noise impact, including decoupling of noisy equipment on vessels and establishment of dolphin exclusion zone, will be applied in TMCLKL. The potential of cumulative noise impact would be limited.

B) Disturbance/Collision from Marine Traffic

10.6.7.9 The potential of a cumulative marine traffic disturbance or collision risk due to the work-related vessel traffic flow during construction phase is also considered. The potential of an escalation in collision risk would be low as the working vessels in other projects, like in the present Project, would be mainly large-sized and slower vessels (It is considered that the high-speed outboard engine boats pose higher risk on collision). The cumulative marine traffic disturbance is possible if the locations of concurrent projects are close with each other. However, it is anticipated that similar measures on mitigating marine traffic disturbance on CWD, such as speed limits and regular routes, will be applied in other Projects including TMCLKL. The magnitude of any cumulative marine traffic disturbance impact would be low.

C) Blockage of Dolphin Traveling Corridors

10.6.7.10 There is also a concern on the possible blockage of dolphin travelling corridors by construction and operation of concurrent projects. The potential of this impact would be higher in reclamation sites in which sea areas will be replaced by reclamation lands and not available for CWD to pass through, but would be much lower in bridge construction projects in which only the pier sites would be contained and the remaining sea areas are still available for travelling to both

vessels and marine life, and would not even exist in tunnel construction project using Tunnel Boring Machine (i.e. TMCLKL) or mud pit projects involving no marine structure. Among the concurrent projects listed in **Table 10-12** above, the reclamation projects are all adjacent to existing shores/landmass (e.g. LLP and Future Tung Chung development), rather than in the sea areas in between dolphin hotspots. Currently the Sha Chau, the West Lantau waters, and the Brothers Islands are known dolphin hotspots in Northwest Hong Kong waters. Sea areas in between these hotspots might be the travel corridors of CWD if they need to travel from one hotspot to others. But these reclamations are not located in between any dolphin hotspots.

D) CWD Habitat Loss

10.6.7.11 Besides the cumulative water quality impacts, there would be cumulative marine habitat loss from some of these projects. The marine habitat loss from the present Project is estimated to be about 168 ha, including the 3ha for HKLR marine bridge piers, 27 ha of HKLR reclamation and 138 ha of HKBCF reclamation. The mud pit projects would not cause permanent marine habitat loss. Marine habitat loss due to TMCLKL is estimated to be about 47 ha (with 21 ha at the northern reclamation in Tuen Mun shore; 25.4 ha adjacent to HKBCF; and about 0.2 ha for viaduct). Other marine habitat loss (272 ha) includes the two development phases of LLP (112 ha), and the Future Tung Chung East and West Development (110 ha from the east development and 50 ha from the west development). The total marine habitat loss from other concurrent projects would count up to about 319 ha (47 ha from TMCLKL + 272 ha from others)a. If it is assumed that all of these projects with reclamation occurring in North Lantau will actually proceed to construction, a cumulative marine habitat loss from these projects is possible as these projects are all located in the Western Hong Kong waters. The different concurrent projects' contribution towards the issue of permanent loss of dolphin habitat however would not be the same. Quite a significant portion of the loss is not in key dolphin habitats, such as the future Tung Chung East and West Development which is adjacent to the existing Tung Chung town. For the coastal waters, there are very limited dolphin sightings on Tung Chung coastlines except the waters around Sham Shui Kok (see **Section 10.4.3.102** above). Similarly, the LLP extension is also located in coastal waters near Tung Chung town and limitedly used by CWD. Therefore the area size of the cumulative loss of habitats regularly used by CWD would be much smaller than 319 ha.

10.6.7.12 Beyond the HKSAR boundary, the HZMB Main Section would also cause marine habitat loss, in particular 80 ha for two artificial islands near HKSAR boundary and less than 10 ha for the marine piers (about 356 piers, and assuming those piers are of similar sizes as Hong Kong piers, i.e. 200 m^2). Other major marine habitat losses include the Zhuhai BCF and the Macao BCF, which would be located close to the western shore of Pearl River Estuary where the dolphin sightings are much less frequent.

10.6.7.13 Having so many projects being constructed in parallel in the same area is unusual in Hong Kong. Given that the affected area is part of the dolphin habitat, efforts to lessen the cumulative impacts will be required.

10.6.7.14 The HKBCF reclamation is the main contributor towards the cumulative permanent loss of CWD habitat (Different from the future Tung Chung East and West Development or the LLP extension which are located in areas not used by dolphin, HKBCF is a large reclamation within dolphin habitats, and thus would contribute to the impact in terms of both significance of impacts and area size.). If the HKBCF habitat loss to CWD could be effectively mitigated, the severity of cumulative loss of CWD habitat would also be significantly reduced. The measure of setting up a marine protected area is proposed to mitigate the marine habitat loss from HKBCF reclamation (see **Section 10.7.4** below) and is considered an effective measure. As such, the cumulative CWD habitat loss would not require other specific mitigation measure.

Corals

10.6.7.15 Some of the concurrent projects would impact, or have the potential to impact, gorgonians and ahermatypic corals, such as TMCLKL in which gorgonians and ahermatypic corals at Pillar Point would be directly impacted.. However, a similar pre-construction dive survey will be conducted for TMCLKL, and translocation of corals will be proposed if colonies suitable for translocation are identified. These projects will also provide some new habitat in the form of new seawalls around the reclamations which should help compensate for the loss, together with a newly deployed artificial reef and, as such, the cumulative impacts are not expected to be significant, and specific mitigation measure is not required

Benthic Communities

10.6.7.16 All the concurrent projects are located in the same sampling stratum (i.e. the Western waters stratum covering Urmston Road, Deep Bay and North Lantau waters) in the territory-wide benthic survey commissioned by AFCD (CCPC 2002). Benthic species of conservation concern such as the amphioxus *Branchiostoma belcheri* was not recorded in any sampling locations within the Western waters stratum. Though the diversity and abundance might vary, no location of special conservation importance in terms of the benthic communities was reported in this area. As such, the cumulative impacts on benthic communities are not expected to be significant, and specific mitigation measure is not required.

10.7 Mitigation of Adverse Impacts

10.7.1 Design Phase Considerations

10.7.1.1 The following paragraphs identify feasible and practicable mitigation measures to reduce the severity of any negative impacts identified in the previous sections.

10.7.1.2 Following the “Avoid, Minimize and Compensate” approach of dealing with impacts as stipulated in EIAO-TM, the feasibility to avoid impacts was first examined. Where impacts are anticipated, efforts were made to minimise the impacts such as by refining the bridge design or alignment. Mitigation measures were then provided to address the potential impacts.

10.7.1.3 The following sections describe the considerations taken into account during the design process.

HZMB Landing Area at HKSAR

10.7.1.4 The PER (Scott Wilson 2002) compared the advantages and disadvantages of a series of proposed alignments with bridge landing points at three different areas, i.e.

- Area A - North Lantau;
- Area B - Black Point; and
- Area C - South Lantau.

10.7.1.5 The PER verified that the environmentally optimal landing point of the bridge would be at North Lantau. In terms of cetacean conservation, having the landing point at North Lantau could avoid the encroachment of the bridge alignment onto the two highest density Chinese White Dolphin areas, i.e. Lung Kwu Chau and West Lantau (between Tai O to Fan Lau Kok) (**Figure 10.8**).

10.7.1.6 The sea near Sha Chau and Lung Kwu Chau Marine Park is an area of high density of dolphin sightings throughout the year. With the landing point at North Lantau, the proposed alignment is located away from this prime area with high density dolphin sightings.

10.7.1.7 The West Lantau area (between Tai O to Fan Lau Kok) has been found recently to be a very high density area for Chinese White Dolphin (Jefferson 2003). The bridge alignment would not intrude into this area with the landing point at North Lantau.

10.7.1.8 The HKLR landing point at North Lantau is consistent with the strategic planning framework for Hong Kong and Lantau because it is sited in proximity to the Hong Kong International Airport, the North Lantau Highway, MTR Tung Chung Line and the Penny's Bay international theme park. Additional transport routes including Route 10 (TMCLKL) are also being planned to improve connections to Lantau Island.

HKLR Connection Point Location

10.7.1.9 The connection point between the HZMB Main Section and HKLR would be on the western HKSAR boundary. The current connection point lies on the HKSAR boundary about 4 km west of Sham Wat and 2.5 km north of Tai O pier.

10.7.1.10 The proposed location maintains acceptable distances to several sites of conservation importance. It is approximately 6km from Sha Chau and Lung Kwu Chau Marine Park which also contains artificial reefs, and 5km from the proposed marine park at Fan Lau.

10.7.1.11 The water around Sha Chau and Lung Kwu Chau Marine Park is the area with often dolphin sightings throughout the year. The proposed location is southwest of the marine park and remains distant from this prime area of dolphin sightings. The proposed location is also to the north, though less distant, of another prime area of dolphin sightings at the West Lantau waters.

10.7.1.12 If the connection point shifted either northward or southward along the HKSAR boundary, the bridge alignment would shift closer to Sha Chau and Lung Kwu Chau Marine Park or the proposed marine park at Fan Lau. If this were the case, the magnitude of impacts on CWD, such as underwater noise and marine traffic during construction, would be potentially higher.

10.7.1.13 The current proposed location is considered to be appropriate in terms of ecology because it minimises negative impacts to an extent unachievable under the alternative alignments.

HKLR Alignments Selection

10.7.1.14 With the proposed connection point, three options of the HKLR alignment were proposed for selection. All three options would go through the waters to the west of Airport. The option with the tunnel going through North Lantau would cause large scale impacts on natural habitat and is thus abandoned, while the option going alongside the northern edge of Airport Island requires additional reclamation is also undesirable. The option going through Airport Channel is considered the preferred option.

HKBCF Options Selection

10.7.1.15 With refer to Section 3, a number of site options were long-listed in the Site Selection Study for HKBCF. As the Site Selection Study and the Investigation Consultancy proceeded, relevant factors and assessment results were revealed which rendered most of the site options not feasible (see **Section 3** for details). For a finer level ecological assessment, two options were further discussed in the sections below, namely Option WCLK (locating the HKBCF in the waters to the west of airport) and Option NECLK (locating the HKBCF in the water adjacent to the north-eastern side of the Airport Island),

A) Option WCLK

10.7.1.16 The proximity between WCLK and the West Lantau waters however is a concern. The waters around West Lantau have the highest dolphin encounter rate recorded in Hong Kong. Moreover, it is also an important nursery ground for the CWD. The most frequent sightings of calves and juveniles in Hong Kong

have been recorded in these waters (i.e. the area is important for nursing young CWD), and its importance to dolphin nursery is recognized and incomparable. An artificial island constructed in this location will seriously affect the marine ecology.

10.7.1.17 According to the results from the regular AFCD dolphin monitoring surveys, Chinese White Dolphin frequently uses the whole stretch of the West Lantau waters between Fan Lau to Sham Wat, and some of the sightings of juvenile CWD were even beyond Sham Wat. This finding has been further supported by an additional AFCD land-based dolphin survey in 2004-2005 on the shore between Tai O to Sham Wat, specifically for facilitating the assessment of HZMB on CWD in west Lantau (AFCD 2005). It is thus important to safeguard these waters for dolphin conservation. The risk of having large scale reclamation near this dolphin nursery ground would be unacceptable from conservation view point.

10.7.1.18 To locate the HKBCF in WCLK option would reduce the sea area (and also dolphin habitat) in the Western waters, and also pose a higher risk from construction works (mainly water quality risk from accidental incidents) on the natural coastlines and the important area for nursing young CWD as it lacks of any landmass in between as a shelter.

B) Option NECLK

10.7.1.19 For Option to locate the HKBCF to the east of Airport Island, the majority of the nearby coastlines (including the Airport and at and westward to Tung Chung town e.g. the North Lantau Highway) have been converted to artificial shores and are of lower ecological value. The landmass of the Airport could also shelter the western waters from any accidental water quality incident from HKBCF construction, and thus better protect the dolphin nursery ground in West Lantau waters. It was found that during the 2,857 dolphin groups (or 11,189 dolphin individuals) sighted during the 2002-08, only a few dolphin sightings overlapped with the NECLK option while more sightings overlapped with the WCLK option.

10.7.1.20 The importance of the Brothers Islands for dolphin is well aware as stated in recent AFCD dolphin monitoring reports (one of the dolphin hotspots in Hong Kong). Nevertheless, there is a buffer distance of about 750m between the proposed HKBCF and the Brother Islands and stringent environmental mitigation measures will be provided during reclamation.

10.7.1.21 It is important that the West Lantau waters to be maintained in a high level of ecological intactness to ensure sustainability of Chinese White Dolphin. NECLK option (HKBCF on eastern side) is considered a better option after considering all the pros and cons of the various options, including those on dolphin conservation. The current location of NECLK has achieved a balance between conservation considerations and the potential influences to Tung Chung as it has maximized the distance to Tung Chung shore.

Minimize Reclamation Size

10.7.1.22 As discussed in Section 3.7.13 to 3.7.16, the HKBCF needs to provide the necessary facilities for the clearance of vehicles and passengers using HZMB, together with other supporting facilities. Various sub-options have been considered to minimize the reclamation size while not jeopardizing the operation of HKBCF, including (a) Co-locating clearance plazas of cars and goods vehicles; (b) Adopting 2-level design for clearance plaza; and (c) Adopting 2-row arrangement for clearance kiosks. However, substantial problems are envisaged in the sub-option (b) in view of the hazard, air ventilation and traffic operation. This idea of co-locating the cars and GVs facilities and adoption 2 row arrangement for clearance kiosk are thus adopted and taken into account in the finalization of the layout for HKBCF.

Pier Spacing

10.7.1.23 For a viaduct structure (i.e. elevated trestle bridge form) as HKLR, the optimal span-length (i.e. spacings between columns) is often in the range of 50m to 60m from structural points of view. This is also the reason for assuming such a column spacing in Chapter 9 (Water Quality) and in Chapter 10 (Ecology). These two chapters show that such a column spacing should be acceptable as regards water quality and ecology. Nevertheless, a larger span-length (i.e. wider column spacings) up to approximately 75m is structurally feasible, so as to enhance performance as regards ecology and water quality. For this reason, it is recommended that 75m should be adopted as the typical span-length for the portion of HKLR in the waters west of the Airport Island (where larger column spacings will be particularly beneficial not only to ecology and water quality, but also from the point of view of Pearl River Delta water flow). Hence, as described in **Figure 3.20**, the typical spans for the portion of HKLR in the western waters will indeed be 75m, even though for conservatism, the assessment on ecology and water quality will show that it will be acceptable even if the spans are 50m. As discussed in Section 3.5.6, at a finer level, the following further points should be noted:

- Structurally, the local spans adjacent to a movement joint (MJ) will need to be shorter than typical. Hence, though the typical spans are 75m, the spans adjacent to each MJ will only be 60m;
- At individual special locations, the spans will need to deviate from typical due to special reasons. For instance, where HKLR overpasses a navigation channel, its span will need to be even larger than 75m in order to meet marine traffic requirement (exact length of each such navigation span is assessed under the Marine Traffic Impact Assessment, depending on traffic-volume and sizes of vessels involved). And for instance, a local large span is required over the San Shek Wan/Sha Lo Wan headland to avoid toughing the headland physically.

10.7.1.24 The outcome of all the above mentioned efforts during the design phase is a project footprint avoiding all areas with high ecological values, including recognised sites and important habitats. Though local individual parts of the footprint would be near the ecological sensitive areas, the indirect impacts could be mitigated by the measures described below.

10.7.2 Mitigation on Construction Phase – Direct Impacts

Habitat loss during Construction (terrestrial)

10.7.2.1 The only terrestrial habitat loss for this Project would be small areas of developed area (low ecological value) and grassland/shrubland habitat (low ecological value), both on Airport Island. Owning to their small sizes, compensation for construction phase terrestrial habitat loss is not considered necessary.

10.7.2.2 Temporarily affected habitats at Scenic Hill should be re-instated after completion of construction works. Stream(s) on Scenic Hill should not be modified in order to retain suitable breeding habitats of Romer's Tree Frog.

Habitat loss during Construction (Intertidal)

10.7.2.3 No specific mitigation is required for the artificial seawall habitat loss on the southern, southeast, and northeast shores of Airport Island, as the impact was ranked as insignificant. These areas are all of low ecological value.

10.7.2.4 No specific mitigation is required for the remnant disturbed rocky shore with patchy sandy beaches along the southeast shore of Airport Island as the impact was ranked as minor. This habitat type is also of low ecological value (with only common intertidal fauna and without any species of conservation importance recorded; also the diversity is low in view of the limited number of species involved).

Habitat Loss during Construction (Marine)

10.7.2.5 No mitigation is required for the loss of shallow subtidal hard substrate seabed. This habitat type is of low to moderate ecological value and is abundant in Airport Island and North Lantau coastlines. More similar habitat will be provided after reclamation. No mitigation is required for the loss of soft substrate seabed. This habitat type is of low ecological value and is abundant in the Hong Kong western waters.

10.7.2.6 The marine waters to the west of the Airport Island are of moderate to high ecological value due to the close proximity to West Lantau waters, but the habitat loss caused by the marine bridge piers of HKLR to the west of Airport Island is small and scattered, the impact is thus ranked as **Minor** and no mitigation measure is required. The habitat loss caused by the marine bridge pier construction of HKLR inside Airport Channel is similar in nature, but the marine waters there are of low ecological value due to the low occurrence of CWD. The impact is thus ranked as **Minor**. No mitigation measure is required. The habitat loss due to construction would largely be carried forward to the operational phase and become permanent habitat loss, mitigation measures for operation phase (see **Section 10.7.4**) will mitigate this impact as well.

10.7.2.7 37 ha of sea area (27 ha of reclamation footprint and 10 ha of works area) will be lost during construction due to the reclamation for HKLR along the southeast shore of Airport Island. Compensation for this seabed loss is not required as the impact is **Minor** for dolphins. The ecological value of this area is low as it is not utilized by CWD.

10.7.2.8 164 ha of sea area (138 ha of reclamation footprint and 26 ha of works area) will be lost during construction due to the HKBCF reclamation near the northeast Airport Island. Although the sea area is only utilized by limited number of CWD, it is of moderate ecological value due to the close proximity with dolphin hotspot. **Moderate** impact is anticipated and mitigation measure is required. As the habitat loss due to construction would largely be carried forward to the operational phase and become permanent habitat loss, mitigation measures for operation phase (see **Section 10.7.4**) will mitigate this impact as well.

10.7.3 Mitigation on Construction Phase – Indirect Impacts

Water Quality

10.7.3.1 Low disturbance construction method: Any significant changes in water quality or turbidity should be avoided. This could be mitigated through construction methods. Closed-grab dredges and silt curtains around the work areas (wherever feasible) should be used in all dredging activities.

10.7.3.2 Piles of piers would be bored rather than driven. The Shenzhen Western Corridor project demonstrated that bored-piling construction, besides less noisy, caused limited water quality impacts even inside the sheltered Deep Bay area. The potential for sediment resuspension during the pier construction of HKLR is predicted to be very low, since only limited dredging would be required for pier construction, closed-grab dredges would be used, and piles would be bored inside casings that are in turn contained within cofferdams, that were built using closed-grab dredges, surrounded by silt curtains. These measures could effectively prevent any significant deterioration of water quality.

10.7.3.3 Every attempt should be made to avoid resuspension of solids/contaminants back into the water column during dredging and dumping operations. For reclamation, the seawall should be constructed prior to the filling works where possible. Using pipes that bring the sediment directly to the sea bottom during dumping, and conducting operations preferentially at slack tide (when feasible).

10.7.3.4 Reduce dredging scale – The amount to be dredged has been minimized as far as practicable. Details of this effort are provided in **Section 3**.

10.7.3.5 Limit the concurrent works front - The number of concurrent dredging/filling work fronts will be limited (maximum 35 pier sites in the open sea part of HKLR, and 10 pier sites in Airport Channel). For the benefit of water quality protection, the minimum distance between any two pilecap construction sites will be kept as 180 m.

10.7.3.6 Good Site Practices: – The integrity and effectiveness of all silt curtains should be regularly inspected. Effluent monitoring should be incorporated to make sure that the discharged effluent from construction sites meets the relevant effluent discharge guidelines.

10.7.3.7 Strict enforcement on No-dumping – To avoid degrading the Chinese White Dolphin habitat, restrictions prohibiting dumping of rubbish, food, oil, or chemicals will be strictly enforced.

10.7.3.8 Site runoff control - For works on land, standard site runoff control measures will be established and strictly enforced to ensure that discharge of contaminated or silt-laden runoff into North Lantau waters is minimised.

10.7.3.9 Spill response plan – In the event of vessels operating in the works areas transporting oil or other hazardous chemicals, an oil-spill response plan, with specific provisions for protecting marine ecology and CWD, will be formulated.

10.7.3.10 Replacement Artificial Reefs - The artificial reefs near the northeast corner of Airport Island within the Marine Exclusion Area is the nearest marine ecological sensitive receiver to the HKBCF reclamation. They are potentially subject to water quality impact from the reclamation. Even though water mitigation measures will be adopted during the dredging for seawall construction, the artificial reefs may still be potentially influenced by the works. These artificial reefs (ARs) near the HKBCF reclamation had been deployed there for eight years or more. It is considered that the relocation process would not keep the ARs intact once they are mechanically disturbed. As such, it would be more practicable to deploy replacement ARs to mitigate the potential disturbance on ARs by the HKBCF reclamation works. The replacement ARs should have the same volume as the existing ARs (i.e. 3,600 m^3). The implementation of the replacement Artificial Reefs will be incorporated with the deployment of additional Artificial Reefs, as described below for the additional enhancement measure.

Terrestrial Disturbance

10.7.3.11 The impact from this minor and short-term source can be reduced by good site practice, including strictly following the permitted works hours, using quieter machines where practicable, and avoiding excessive lightings during night time.

Sedimentation from Land-based works areas

10.7.3.12 The woodland in Scenic Hill would not be encroached upon by the Project. Nevertheless, in order to protect this habitat for Romer's Tree Frog, protection measures will be implemented as described below.

10.7.3.13 Although the extent of earthwork will not affect habitats of Romer's Tree Frog, good site practices (e.g., watering to reduce dust generation, prevention of siltation of freshwater habitats) are still recommended to be implemented. Site runoff should be desilted, to reduce the potential for suspended sediments, organics and other contaminants to enter streams and standing freshwater (which are potential breeding habitats of Romer's Tree Frog). Caution must be taken to avoid runoff entering the area in which Romer's Tree Frog has been recorded.

Marine Noise and Disturbance

1) Bored piling

10.7.3.14 Avoidance of percussive piling – In view of the potential to cause serious noise impact upon Chinese White Dolphin, percussive piling will not be adopted in the Project.

10.7.3.15 Dolphin Exclusion Zone – Marine bored piling involves the installation of a temporary steel casing, excavation within the casing, concrete filling into the casing and removal of casing. Dolphin exclusion zone of 250m radius should be implemented in marine pier sites of HKLR located in the waters to the west of Airport during the installation of bored pile casing (i.e. the open sea part of the marine section of HKLR). Works will be suspended when any Chinese White Dolphin (CWD) is found within the exclusion zone. After the bored piling casing is installed, all the subsequent works will be conducted inside the casing (a small and completely confined area), and a dolphin exclusion zone is not required.

10.7.3.16 Temporal suspension of installation of bored pile casing at marine pier sites – Though all works involved will be much quieter than percussive piling, the installation of the bored pile casing would be relatively disturbing as steel casing will be drilled onto the rock surface below seabed. For the marine bored piles of HKLR located at the waters to the west of Airport Island (i.e. the open sea part of the marine section of HKLR), installation of steel casing onto rock surface will be suspended during May and June (i.e. the peak months of the dolphin calving season). In other words, the bored-piles for the section of HKLR in the Airport Channel is not subject to such restriction. HKBCF should not be affected by this issue at all as it has no marine-piling anyway. If the HKLR works need to carry out marine bored-piling into rock to the west of Airport Island during May & June, then application of bubble curtains or bubble jackets shall be provided and agreed with AFCD.

2) Sheet piling

10.7.3.17 Vibratory piler for installation of sheet piling – Sheet piling into the soft seabed sediment (i.e. not requiring to drill onto rock surface) is required along the northern edge of HKBCF reclamation for protecting the reclamation site from water current. To minimize the acoustic disturbance to Chinese White Dolphin (CWD), sheet piles wall will be driven by using vibratory piler, which is a type of silence piling equipment and the noise generated is anticipated to be minimal.

10.7.3.18 Dolphin Exclusion Zone – dolphin exclusion zone of 250m radius should be implemented in the northern edge of HKBCF reclamation during the installation of the sheetpile wall. Works will be suspended when any Chinese White Dolphin (CWD) is found within the exclusion zone.

3) Reclamation and Works Vessels

10.7.3.19 Dolphin Exclusion Zone – dolphin exclusion zone of 250m radius should be implemented in the HKBCF and HKLR reclamation sites during the installation of the perimeter silt curtains and any re-deployment of the perimeter silt curtains. Works will be suspended when any Chinese White Dolphin (CWD) is found within the exclusion zone.

10.7.3.20 Dolphin Watching Plan - A dolphin watching plan for works areas will also be implemented and included in the EM&A programme. For reclamation sites, once the perimeter silt curtains are installed or re-deployed, the dredging and filling works would be conducted inside the silt curtains and a dolphin exclusion zone is no longer required. Subsequently, a dolphin watching plan will then be performed. The plan would include regular inspection of the silt curtains, visual inspection of the waters surrounded by the curtains, and an action plan should be devised to cope with any unpredicted incidents such as the case that CWD is found within the waters surrounded by the silt curtains.

10.7.3.21 Acoustic decoupling of compressors and other equipment – Air compressors and other noisy equipment that must be mounted on construction vessels will be acoustically-decoupled.

Marine Traffic

10.7.3.22 Vessel speed limit control – It is known that fast-moving vessels are a threat to CWD and porpoises, a speed limit of 10 knots will be strictly enforced within the work areas. This speed limit for vessels within the boundaries of the Sha Chau/Lung Kwu Chau Marine Park appears to be effective in protecting the CWD from vessel collisions.

10.7.3.23 Skipper training – Captains of construction vessels working in the West Lantau waters and working near the Brothers Islands should undergo training to learn about local CWD and porpoises. They should be trained to be aware of the protocol for "dolphin friendly" vessel operation (refer to the Code of Conduct for Dolphin Watching Activities available from AFCD).

10.7.3.24 Predefined and regular routes for working vessels – Captains of all working vessels should be required to use regular travel routes, in order to minimize the chance of vessel collision. And the routes would not go through the dolphin hotspot in Brothers Islands.

10.7.3.25 Mitigation measures for the construction impacts on ecology are summarised in **Table 10-13**.

10.7.4 Mitigation on Operational Phase – Direct Impacts

Permanent Habitat loss (terrestrial)

10.7.4.1 The only permanent terrestrial habitat loss for this Project would be small areas of developed area, and grassland/shrubland habitat on Scenic Hill, both on Airport Island. Owing to their low ecological value and small size (1 ha each) of the loss, the impact is ranked as insignificant and compensation for habitat loss is not considered necessary.

Permanent Habitat loss (Intertidal)

10.7.4.2 No specific mitigation is required for the artificial seawall habitat loss on the southern, southeast, and northeast shores of Airport Island, or the remnant disturbed rocky shores along the southeast shore of Airport Island, as the impacts are ranked as insignificant (for artificial seawalls) and minor (for remnant rocky shore). This is because the area is of low ecological value (with only common intertidal fauna and without any species of conservation importance recorded; also, the diversity is low in view of the limited number of species involved). In addition to the re-provision of intertidal habitat by the HKLR reclamation seawalls (sloping and rip-rap form) which could provide new intertidal hard bottom habitats for epifauna colonization on the surface of the new seawalls, there will be additional seawalls in the HKBCF reclamation. The total seawalls in the area will increase after the HKBCF reclamation is completed (after the reclamation, about 4km of additional sloping seawalls will be created).

Permanent Habitat loss (Marine)

10.7.4.3 No mitigation is required for the marine habitat loss caused by the marine bridge piers (< 3 ha in total) as the loss for each pier is small and scattered.

10.7.4.4 27 ha of marine habitat will be lost due to the reclamation for HKLR along the southeast shore of Airport Island. Compensation for this marine habitat loss is not required as the impact is ranked as minor given the low ecological value (due to the low occurrence of CWD and other marine species of conservation importance in this area.).

10.7.4.5 138 ha of marine habitat will be lost due to the reclamation for HKBCF near the northeast Airport Island. The sea area is of moderate ecological value for dolphin. **Moderate** impact is anticipated and mitigation measure is required.

10.7.4.6 To enhance the Chinese White Dophin (CWD) habitat, the Administration has made a firm commitment to seek to designate the Brothers Islands as a marine park in accordance with the statutory process stipulated in the Marine Parks

Ordinance. A study will be conducted to work out the details of the proposed marine park before the commencement of the statutory procedures as stipulated in the Marine Parks Ordinance. The designation of the proposed marine park would proceed after the completion of HKBCF.

10.7.4.7 The Administration's commitment to the marine park and subjecting it to control and management in accordance with the Marine Parks Ordinance as well as the Marine Parks and Marine Reserves Regulations would significantly help conserve the CWD, and hence serves as an effective mitigation measure for the loss of CWD habitat arising from these projects. With this committed measure, the residual impact (and cumulative impact) to CWD, in terms of permanent habitat loss, would therefore be acceptable.

10.7.4.8 As part of the ecological EM&A programme, a comprehensive dolphin monitoring survey programme will be conducted during the pre-construction, construction and post-construction of the Projects, which will cover the waters in North and West Lantau waters including Brothers Islands. In addition to the long-term monitoring data collected by AFCD, the additional quantitative data collected from this comprehensive dolphin monitoring programme (covering approximately 6 years) can be used to determine the most suitable location for establishing the marine park for CWD.

10.7.4.9 The project proponent will assist AFCD in the designation of the marine park. The implementation will also involve consultation with green groups, relevant Government departments, and other stakeholders.

10.7.5 Mitigation on Operation Phase – Indirect Impacts

Road Surface Runoff

10.7.5.1 Silt-grease traps should be deployed to prevent a direct input of road surface runoff to the marine waters.

Chemical spillage

10.7.5.2 A Maritime Oil Spill Response Plan (MOSRP) has been developed by Marine Department to deal with oil spill and their potential hazard to the Hong Kong waters. The main objective of the MOSRP is to ensure a timely and effective response to oil spillages and/or their potential treats in the Hong Kong waters.

10.7.5.3 Similar to the Shenzhen Western Corridor project, a contingency plan will be formulated to deal with the accidental event of the serious spillage of oil or other harmful chemicals. A contingency plan in this regard will be primarily for safety issues and water quality, but could also help to safeguard the dolphin population. Following the example of Shenzhen Western Corridor, it will be specified in the contingency plan that AFCD must be alerted by the Hong Kong Police Force or Fire Service Department in case an accident of spillage of chemical or oil is reported.

Positive effects

10.7.5.4 There are also potential positive effects due to change in marine traffic volume, distribution and pattern in the North Lantau waters during the operation phase of HKLR. After the road opening of HZMB, there will be a decreased demand on marine traffic between Hong Kong and Mainland. Marine traffic to/from Mainland and Macau might reduce. If vessels are less frequently to pass through waters of high dolphin abundance, there might be a reduction in risk of CWD colliding with marine vessels. There might also be speed restrictions/regulations on marine traffic near the bridge. Positive effects on the CWD are foreseen during the operation of the bridge.

10.7.5.5 In the present Project, the potential enhancement effect of the bridge piers has been highlighted in the EIA Study Brief Section 3.4.6.5 (vi) and is discussed in sections below.

10.7.5.6 In most of Hong Kong waters, especially the western waters, hard bottom habitat is scarce and most substrates are larger open expanses of soft mud or muddy sand below water depths of about six metres. This rather homogenous habitat excludes the colonisation of some hard surface epifauna. Creation of hard surface habitats, by deploying artificial reefs or other engineered structures, can increase the complexity of habitats in such environments and provide opportunities for fouling organisms to settle and develop. Fouling organisms such as seaweeds, sea squirts, mussels, barnacles and polychaetes on hard surface habitats can attract scavengers and small predators, which in turn provide food resources for higher predators such as dolphins. New and more complex food webs can be created in this way.

10.7.5.7 It has been demonstrated by studies on artificial reefs that hard bottom structures in shallow waters, especially those of high profile and high complexity, can provide habitats for epifauna and even fishes and are effective devices for attracting and supporting large populations of fish.

10.7.5.8 The concrete structures originally proposed for wave protection at the High Island Dam (dollos) function as an artificial reef. They rise from over 12 metres depth to the sea surface and have developed rich and abundant coral community plus an associated fish community.

10.7.5.9 Emerged pile caps (those above the seabed) can provide larger areas of hard surface habitat than submerged pile caps (those partially or completely beneath the seabed). The piles supporting emerged pilecaps are also exposed and this greatly increases the amount of hard-surface habitat over that available from submerged pilecaps. In terms of ecological and fisheries effects, emerged pile caps are therefore more preferred than submerged pile caps.

10.7.6 Mitigation for Cumulative Impacts

10.7.6.1 There will be another 319 (47 from TMCLKL + 272 from others) ha marine habitat loss in the Western Hong Kong waters due to other concurrent projects.

10.7.6.2 In addition, it is noted that Beyond the HKSAR boundary, the HZMB Main Section would also cause marine habitat loss, in particular 80 ha for two artificial islands near HKSAR boundary and less than 10 ha for the marine piers (about 356 piers, and assuming those piers are of similar sizes as Hong Kong piers, i.e. 200 m^2). Other major marine habitat losses include the Zhuhai BCF and the Macao BCF, which would be located close to the western shore of Pearl River Estuary where the dolphin sightings are much less frequent.

10.7.6.3 The HKBCF reclamation is the main contributor towards the cumulative permanent loss of CWD habitat (Different from the future Tung Chung East and West Development or the LLP extension which are located in areas not frequently used by dolphin, HKBCF is a large reclamation within dolphin habitats, and thus would contribute to the impact in terms of both significance of impacts and area size.). As stated in the above sections of mitigation on permanent marine habitat loss, the HKBCF habitat loss to CWD could be effectively mitigated by setting up a marine park. As such, the severity of cumulative loss of CWD habitat would also be significantly reduced.

10.7.6.4 In view of the above, further specific mitigation measures will not be needed for the cumulative CWD habitat loss.

10.7.7 Precautionary/Enhancement Measures

Pre-construction Dive Survey for Corals

10.7.7.1 As a precautionary measure, a dive survey will be conducted (see **Figure 10.14**) at the marine pier sites nearest to intertidal zone (i.e. the pier sites to the west and to the east of the headland to be spanned over in Sha Lo Wan, and the pier site just offshore to the actual landing point on Airport Island) and along the shore of the HKLR reclamation site, prior to marine construction works in these three locations, to identify any coral colonies suitable for translocation, taking

into account the conservation value, the health status and the translocation feasibility. A detailed translocation plan will be prepared if corals (including hard corals, soft corals and octocorals) of conservation importance, in good conditions, and feasible for translocation are identified during the survey.

Provision of Additional Artificial Reefs

10.7.7.2 In addition to the replacement Artificial Reefs mentioned above, additional Artificial Reefs will also be deployed at the same time as compensation to the marine habitat loss. Areas that currently are protected or are restricted would be suitable for deploying the new ARs (both replacement ARs and additional ARs), such as the Sha Chau and Lung Kwu Chau Marine Park or the proposed potential marine park in Fan Lau after its designation, would be possible options for deploying the new ARs. While the replacement ARs would be of the same volume of the existing ARs (i.e. 3,600 m^3), the additional ARs should have at least two times the volume as the existing ARs (i.e. 7,200 m^3).

Fish Fry Release in Artificial Reefs

10.7.7.3 Fish fry release will be conducted at the new ARs (both replacement ARs and additional ARs) as well as the existing ARs in Sha Chau and Lung Kwu Chau Marine Park, to enhance the fish resources in the Western Hong Kong waters. The frequency and quantities of the fish fry to be released will be proposed and agreed by AFCD.

10.7.8 Summary of Measures

10.7.8.1 Mitigation for the construction and operation impacts are summarised in **Table 10-13** below. **Table 10-14** summarised the precautionary/enhancement measures proposed by the Projects.

Table 10-13 Mitigation Measures for Construction and Operation Phase

Impacts	Mitigation measures
Constructional phase	
Potential disturbance on habitat of Romer's Tree Frog	• Good site practices to avoid runoff entering their habitats; • Reinstate works areas; • Avoid stream modification.
Water quality degradation	• Employing Silt curtains; using closed-grab dredging; • Minimised dredging works; limit the works fronts; • Good Site practices; • No dumping policy; • Site runoff control; • Spill response plan; • Reprovision of replacement Artificial Reefs (of the same volume as the existing ARs inside Marine Exclusion Zone).
Sedimentation from Land-based works areas	• Watering to reduce dust generation; • Prevention of siltation of freshwater habitats; • Site runoff should be desilted, • Reducing the potential for suspended sediments, organics and other contaminants to enter streams and standing freshwater.
Terrestrial disturbance	• Good site practices, including strictly following the permitted works hours, using quieter machines where practicable, and avoiding excessive lightings during night time.
Marine disturbance	• Dolphin Exclusion Zone; • Dolphin watching plan.
Marine Noise	• Acoustic decoupling of compressors and other noisy

Impacts	Mitigation measures
	equipment; • Avoidance of percussive piling; • Temporal suspension of drilling bored pile casing onto rock surface during peak dolphin calving season in May and June.
Marine Traffic	• Vessel speed limit for construction vessels; • Skipper training; • Predefined and regular routes for working vessels; avoid Brothers Islands.
Operational phase	
Permanent marine habitat loss	• Setting up of a marine park.
Surface runoff	• Silt-grease traps.
Chemical spillage	• Maritime Oil Spill Response Plan (MOSRP); • Contingency plan.

Table 10-14 Precautionary/Enhancement Measures

Precautionary/Enhancement Measures
• Preconstruction dive survey for corals will be provided. • Additional Artificial Reefs will be provided. • Fish fry release in Artificial Reefs will be provided.

10.8 Residual Impacts

10.8.1 The residual environmental impacts refer to the net environmental impacts after the implementation of mitigation measures, taking into account the background environmental conditions and the impacts from existing, committed and planned projects.

10.8.2 In some instance, measures have been incorporated into the design (e.g. careful sites selection) and construction methods (e.g. avoidance of percussive piling and adoption of vibration piler for sheet piling and bored pile casing) to provide an additional degree of confidence that any residual impacts is not expected to have long term environmental implications.

10.8.3 The loss of 1 ha of grassland/shrubland habitat and some other developed areas on Airport Island is considered acceptable.

10.8.4 With mitigation measures properly implemented, there will be no residual impacts on horseshoe crabs and seagrass beds because the horseshoe crab nursery sites and seagrass habitats (soft shores along Airport Channels) will remain intact. Other residual impacts include the loss of subtidal benthic habitat (168 ha of soft substrate seabed), subtidal hard substrate seabeds (less than 2.5 km along seawalls and remnant rocky shores) and the hard shore intertidal habitat (less than 1 km artificial seawalls and about 1.5 km remnant rocky shores with patchy sandy beaches on Airport Island), and are also considered acceptable.

10.8.5 The marine bridge piers of HKLR (< 3 ha), reclamation of HKLR (27 ha), and reclamation of HKBCF (138 ha) will result in some loss of marine waters habitat, in particular for the Chinese White Dolphin. The total marine habitat loss due to HKLR & HKBCF is about 168 ha. It should also be noted that the 27 ha HKLR

reclamation is located in an area not utilised by CWD, while the loss from the marine bridge piers is small and scattered. So the 138 ha HKBCF reclamation is the main contributor of the CWD habitat loss. But setting up a marine park as a functional enhancement would be an effective mitigation. It is envisaged that with the setting up of a marine park, the residual impact due to the marine habitat loss arising from HKLR and HKBCF would be acceptable.

10.8.6 There will be another 319 (47 from TMCLKL and 272 from others) ha marine habitat loss in the Western Hong Kong waters due to other concurrent projects. Although the cumulative marine habitat loss from these projects is possible as these projects are located in the Western Hong Kong waters, the different concurrent projects' contribution towards the issue of permanent loss of dolphin habitat would not be the same. Quite a significant portion of the loss comes from projects in areas not or seldom used by CWD, such as the future Tung Chung East and West Development which is adjacent to the existing Tung Chung town. For the coastal waters, there are very limited dolphin sightings on Tung Chung coastlines except the waters around Sham Shui Kok (see **Section 10.4.3.102** above). Similarly, the LLP extension is also located in coastal waters near Tung Chung town and limitedly used to CWD. Though outside HKSAR, it is noted that 90 ha of marine habitat inside Mainland waters but near HKSAR boundary will be lost due to the artificial islands for HZMB artificial islands (80 ha) and marine piers (10 ha). The HKBCF reclamation is the main contributor towards the cumulative permanent loss of CWD habitat (Different from the future Tung Chung East and West Development or the LLP extension which are located in areas not used by dolphin, HKBCF is a large reclamation within dolphin habitats, and thus would contribute to the impact in terms of both significance of impacts and area size.). As stated in the above sections of mitigation on permanent marine habitat loss, the HKBCF habitat loss to CWD could be effectively mitigated by setting up a marine park. As such, the severity of cumulative loss of CWD habitat would also be significantly reduced, and no specific mitigation measure for cumulative CWD habitat loss is required. .

10.8.7 It is worth to note that three additional enhancement measures would be provided by the Project, which are beneficial to the general marine environment, including pre-construction dive survey for corals, provision of additional artificial reefs, and release of fish fry in artificial reefs.

10.8.8 Cumulative impacts to CWD in terms of disturbance, noise, marine traffic is considered to be minimal as discussed in Section 10.6.7.6 to 10.6.7.10 and the impact is considered to be low, and no residual impact is expected.

10.9 Environmental Monitoring and Audit

10.9.1 An ecological monitoring and audit programme would be needed for the HKLR and HKBCF, to record the conditions of the impact receivers during construction and after construction, to demonstrate the effectiveness of the mitigation measures and to verify the predictions of impact assessment. The monitoring programme provides a mechanism to rectify any non-compliance and exceedance, to propose remedial actions, and to cope with any unforeseen situations.

10.9.2 The monitoring programme will include monitoring of physical parameters such as water quality, and ecological aspects such as CWD and mudflats. The ecological monitoring and audit programme will monitor potential impacts through construction and operation activities, and will verify the assessments which were made in the EIA report.

10.9.3 The monitoring includes the following tasks which are detailed in the EM&A Manual:

10.9.3.1 Dolphin monitoring – A dolphin monitoring programme at North Lantau and West Lantau waters, in particular the dolphin sighting hotspots (e.g. Brothers

Islands) and areas where juveniles have been sighted (e.g. West Lantau waters), should be set up to verify the predictions of impacts and to ensure that there are no unforeseen impacts on the dolphin population during construction phase. The monitoring period should cover the pre-construction phase (baseline conditions), the entire period of construction phase (tentatively 2010 – 2016), and at least one year after the completion of construction works.

10.9.3.2 Construction-phase underwater noise monitoring –The noise level of the bored piling is known to be much lower than that of the percussive piling, but actual data are insufficient. The actual underwater noise level of bored piling will be monitored during the pile construction in Airport Channel for HKLR. This monitoring is to verify the assessment outcome and to collect field data of this construction method.

10.9.3.3 Dolphin acoustic behaviour monitoring – The acoustic behaviour to bored piling and movement near the bored piling sites of CWD should be monitored during bridge construction.

10.9.3.4 Land-based of dolphin behaviour and movement monitoring – Land-based theodolite tracking to study dolphin behaviour near bored piling work site, and examine their north-south movement across the bridge alignment before, during and after bridge construction.

10.9.3.5 Mudflat monitoring – A monitoring programme on the intertidal soft shore habitats on north Lantau coastlines, in San Tau and Tung Chung Bay where horseshoe crab juveniles and seagrass beds have been sighted, should be set up to verify the predictions of impacts. The monitoring period should cover the pre-construction phase (baseline conditions), the entire period of construction phase, and after the completion of construction works. The monitoring should cover the water quality, sedimentation rate, horseshoe crab population, seagrass beds and soft shore intertidal communities.

10.9.3.6 Pre-construction dive survey for corals – As a precautionary measure, a dive survey will be conducted (see **Figure 10.14**) at the marine pier sites nearest to intertidal zone (i.e. the pier sites to the west and to the east of the headland to be spanned over in Sha Lo Wan, and the pier site just offshore to the actual landing point on Airport Island) and along the shore of the HKLR reclamation site, prior to marine construction works in these three locations, to identify any coral colonies suitable for translocation, taking into account the conservation value, the health status and the translocation feasibility. A detailed translocation plan will be prepared if corals (including hard corals, soft corals and octocorals) of conservation importance, in good conditions, and feasible for translocation are identified during the survey.

10.9.3.7 There will be a water quality monitoring programme for the construction and the operation of the Project, with action and limit level criteria to safeguard the marine water quality in the area.

10.10 Conclusions

10.10.1 The Project has avoided impacts on recognised sites of conservation importance (e.g. SSSIs, Country Parks and Marine Parks), and other ecological sensitive areas (e.g. mudflats, mangroves and nursery sites of horseshoe crabs).

10.10.2 The majority of the HKLR and the entire HKBCF would be on newly reclaimed area or piers in sea areas. Less than 1 ha of grassland / shrubland in Scenic Hill will be affected by the land viaduct of HKLR. As the grassland / shrubland are of low ecological value and the affected area size is very small, the impacts on the habitat area considered insignificant and no mitigation is required. Apart from Scenic Hill, no other identified terrestrial site of conservation importance is in the vicinity of the Projects.

10.10.3 Romer's Tree Frog habitat in Scenic Hill would not be affected by the construction HKLR. Strict site practice will avoid most of the potential impact to their habitat in Scenic Hill. Disturbance impacts to terrestrial ecology would be insignificant due to the distance between their footprint and natural habitats in North Lantau.

10.10.4 Whilst the proposed alignment and reclamation fall within habitats used by Chinese White Dolphin in Hong Kong, they are not located in areas with high dolphin density through careful site options and alignments selection.

10.10.5 The waters to the west of Airport currently feature two areas of dolphin-conservation importance, viz the Sha Chau/Lung Kwu Chau Marine Park, and the waters near Tai O Peninsula to Fan Lau. The HKLR alignment passes between two high dolphin-density areas. Impacts to CWD along this alignment can be expected to be less significant than if the alignment is to pass directly through either of the high-density dolphin areas.

10.10.6 HKLR involves both marine (sea viaduct and reclamation for at-grade road) and land-based construction. It will have marine impacts due to piling in open sea as well as within the Airport Channel. The section of the HKLR alignment along the southern edge of the Airport Island and inside the Airport Channel is expected to have an insignificant impact on CWD, as CWD do not generally use this area. There have been no sightings of Chinese White Dolphin in the channel, and there is no evidence to indicate that the channel is currently used by Chinese White Dolphin or any other cetaceans. A pre-construction dive survey at the pier sites nearest to intertidal zone would be conducted to identify any coral colonies suitable for translocation.

10.10.7 HKLR reclamation, along the east coast of Airport Island, is located at a very low-density area for CWD and with very low coverage of common gorgonians. As a result, impacts on CWD in this area should be much less significant. A pre-construction dive survey inside the reclamation site would be conducted to identify any coral colonies suitable for translocation.

10.10.8 The construction and operation of the HKBCF would cause marine habitat loss and potential water quality impacts. The permanent loss of CWD habitat is a moderate impact requiring mitigation. To enhance the CWD habitat, the Administration has made a firm commitment to seek to designate the Brothers Islands as a marine park in accordance with the statutory process stipulated in the Marine Parks Ordinance. A study will be conducted to work out the details of the proposed marine park before the commencement of the statutory procedures as stipulated in the Marine Parks Ordinance. The designation of the proposed marine park would proceed after the completion of these projects. The Administration's commitment to the marine park and subjecting it to control and management in accordance with the Marine Parks Ordinance as well as the Marine Parks and Marine Reserves Regulations would significantly help conserve the CWD, and hence serves as an effective mitigation measure for the loss of CWD habitat arising from these projects. With this committed measure, the residual impact (and cumulative impact) to CWD, in terms of permanent habitat loss, would therefore be acceptable. Dolphin monitoring survey during the construction will also be carried out.

10.10.9 The artificial reefs (ARs) inside Marine Exclusion Area near the eastern and of the northern runway would be impacted by the Project. The ARs is close to the HKBCF reclamation site and might be affected by water quality deterioration. Though not directly encroached, its functions might be compromised.

10.10.10 It is therefore proposed that new ARs will be installed, not only to replace the existing ARs inside Marine Exclusion Area, but also to serve as an enhancement measures. The volume of ARs to be installed will therefore be greater than that of the existing ARs.

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