

4. MARINE ECOLOGY

4.1 Introduction

This **Section** presents the findings of the marine ecological impact assessment associated with the construction and operation of the Project. It also summarises the key findings on the baseline ecological conditions, the details of which are presented in **Appendices 4A to 4C**.

4.2 Legislative Requirements and Evaluation Criteria

The criteria and scope for evaluating marine ecological impacts are laid out in the *Annexes 8 and 16* of the *EIAO-TM* and the Study Brief. Legislative requirements and evaluation criteria relevant to this assessment are listed below. The details on each are presented in **Appendix 4A**.

- Marine Parks Ordinance (Cap. 476);
- Wild Animals Protection Ordinance (Cap. 170);
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586);
- Country Parks Ordinance (Cap. 208);
- Town Planning Ordinance (Cap. 131);
- Environmental Impact Assessment Ordinance (Cap. 499) and the Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (*EIAO-TM*);
- Environmental Impact Assessment Ordinance (*EIAO*) Guidance Notes No. 6/2010, 7/2010 and 11/2010;
- Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG);
- United Nations Convention on Biodiversity (1992); and
- Peoples' Republic of China (PRC) Regulations and Guidelines.

4.3 Baseline Conditions

4.3.1 Assessment Area

In accordance with Clause 3.4.4.2 of the Study Brief, the Assessment Area for marine ecological impact assessment (**Figure B1.1 of Appendix 4B**) shall be the same as the assessment area for Water Quality Impact Assessment covering the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ. Detailed description of the physical characteristics of the marine environment of the Assessment Area and compliance of WQOs is provided in **Section 3**.

Marine ecological important habitats and species within and in the vicinity of the Project site as well as within the Assessment Area are evaluated, including existing marine parks, horseshoe crab breeding and nursery grounds, mangroves, seagrass beds, coral communities, marine benthos of conservation interest, and marine ecological important species including Finless Porpoises (FPs), amphioxus and horseshoe crabs. The marine ecological profiles and characteristics of these habitats and species are described in further details below. A habitat map on the marine ecology of the Assessment Area is provided in **Figure 4A.2.1 of Appendix 4A**.

4.3.2 Field Survey Findings

A literature review was conducted to review the baseline marine ecological conditions within the Assessment Area and to identify information gaps to determine whether field surveys are required to provide sufficient information for the marine ecological impact assessment. Findings of this literature review are presented in detail in **Appendix 4A**.

Some of the baseline information was collected recently and is considered to be up-to-date and representative of the existing conditions of the Assessment Area. In accordance with the requirements in Appendix C of the Study Brief, field surveys at selected habitats within the Assessment Area where potential impact could occur and up-to-date baseline information is not present were conducted to fill the identified data gaps, verify and update the latest marine ecological conditions of these habitats. The methodology for the field surveys is presented in **Appendix 4B**. Field survey findings are presented in detail in the following sections.

4.3.2.1 Survey Schedule

Marine ecological surveys were conducted in Outer Tap Mun in accordance to the methodology as stated in **Appendix 4B**. Surveys were conducted from September 2020 to February 2021 and the details are summarised in **Table 4.1**.

Table 4.1 Marine Ecological Baseline Surveys

Survey	Season & Date
Subtidal Benthos Survey	Wet Season: 25 Sep 2020, 19 Oct 2020 Dry Season: 26 Jan 2021, 1 Feb 2021
Coral Survey	17 Nov 2020, 23 Nov 2020
Drop Camera Survey	18 Dec 2020

4.3.2.2 Subtidal Benthos Survey

Wet Season

A total of 119 individual organisms were collected from the five grab samples from Outer Tap Mun during the wet season survey (**Figure B2.3 of Appendix 4B**). The specimens belong to 5 Phyla with a total of 7 classes, 19 families and 25 species identified. **Table 4.2** provides a summary on the abundance, biomass, taxonomic richness, Pielou's Evenness and Shannon Diversity of infauna collected at each location. A complete set of raw data is presented in **Table 4C.1 of Appendix 4C**.

Results of the wet season survey showed that infaunal abundance, biomass and taxonomic richness (here represented by number of families and species of infaunal organisms) were low in general compared to dry season (**Table 4.2** and **Table 4.3**). In terms of infaunal abundance, the majority (~81%) of organisms recorded were from the Phylum Annelida. The polychaete worm *Sigambra hanaokai* was the most abundant species (total abundance = 50 individuals). No species of conservation interest were recorded in the survey. In terms of infaunal biomass, organisms from the Phylum Mollusca contributed ~54% of the total biomass recorded, while organisms from Annelida also contributed significant biomass (~36%). The high biomass of Mollusca was contributed by a number of species, primarily by a bivalve species, *Jitlada culter*.

Dry Season

A total of 835 individual organisms were collected from the five grab samples during the dry season survey. The specimens belong to 7 Phyla with a total of 10 classes, 44 families and 59 species identified. **Table 4.3** provides a summary on the abundance, biomass and taxonomic richness of infauna collected at each location. A complete set of raw data is presented in **Table 4C.2 of Appendix 4C**.

Results of the dry season survey showed that infaunal abundance, biomass and taxonomic richness (here represented by number of families and species of infaunal organisms) were relatively high comparing to wet season (**Table 4.2** and **Table 4.3**). In terms of infaunal abundance, the majority (~76%) of organisms recorded were from the Phylum Annelida. The polychaete worm, *Sigambra*

hanaokai, was the most abundant species (total abundance = 143 individuals). No species of conservation interest were recorded in the survey. In terms of infaunal biomass, organisms from the Phylum Annelida contributed ~58% of the total biomass recorded, while organisms from Mollusca also contributed significant biomass (~37%). The high biomass of Annelida was contributed by a number of species, primarily by a polychaete species, *Anelassorhynchus sabinus*.

Table 4.2 Density and Indices of Richness, Evenness and Diversity of Infaunal Assemblages at the Sampling Locations for the Soft Bottom Habitat Surveys at the Assessment Area during the Wet Season

Station	Number of Infaunal Individuals	Number of Individuals per m ²	Taxonomic Richness (No. Families)	Taxonomic Richness (No. Species)	Pielou's Evenness (J)	Shannon Diversity (H')	Total Biomass (g wet weight)	Mean Biomass per Individual (g wet weight)
OTM1	37	385.42	7	7	0.56	1.10	0.0730	0.0020
OTM2	8	83.33	5	5	0.86	1.39	0.0227	0.0028
OTM3	7	72.92	4	4	0.92	1.28	0.0102	0.0015
OTM4	23	239.58	8	9	0.82	1.81	0.1579	0.0069
OTM5	44	458.33	15	17	0.91	2.57	0.0501	0.0011

Table 4.3 Density and Indices of Richness, Evenness and Diversity of Infaunal Assemblages at the Sampling Locations for the Soft Bottom Habitat Surveys at the Assessment Area during the Dry Season

Station	Number of Infaunal Individuals	Number of Individuals per m ²	Taxonomic Richness (No. Families)	Taxonomic Richness (No. Species)	Pielou's Evenness (J)	Shannon Diversity (H')	Total Biomass (g wet weight)	Mean Biomass per Individual (g wet weight)
OTM1	201	2093.75	15	21	0.75	2.28	5.2208	0.0260
OTM2	142	1479.17	12	17	0.76	2.16	1.1418	0.0080
OTM3	155	1614.58	17	20	0.75	2.26	1.3613	0.0088
OTM4	69	718.75	15	19	0.83	2.43	0.4120	0.0060
OTM5	268	2791.67	40	46	0.86	3.29	2.4827	0.0093

4.3.2.3 Coral Survey

During the surveys, the weather was fine and the sea was calm. The visibility was however poor and generally ranged between 0.5 m and 2 m. The general substrata and biological conditions noted along each transect during the qualitative spot dive reconnaissance check are presented in **Table 4.4**.

Table 4.4 Description of the Seabed Recorded along Each Transect during the Qualitative Surveys (Spot Dive Reconnaissance Check Surveys)

Transect	Depth	Description
T1	-3 to - 6 mCD	The seabed was mainly composed of boulders, sand and hard corals in shallow water (-3 to - 4 mCD) with mixture of sand, boulders and rocks in deep water (-5 to -6 mCD). <i>Plesiastrea versipora</i> was found to be common in shallow water. Black coral <i>Antipathes curvata</i> was found to be sparse in shallow and deep waters.
T2	-3 to -6 mCD	The seabed was mainly composed of hard corals and boulders in shallow water (-3 to - 4 mCD) with a mixture of mainly sand, rocks and hard corals in deep water (-5 to -6 mCD). <i>Pavona decussata</i> was observed to be abundant at shallow water while <i>Goniopora columna</i> were observed to be common at deeper water.
T3	-3 to -6 mCD	The seabed was mainly composed of rocks, rubbles, sand and hard corals in shallow water (-3 to - 4 mCD) with sandy substrate in deep water (-5 to -6 mCD). <i>Favites flexuosa</i> was observed to be common at shallow and deep waters.

Transects are located at West natural shores of Tap Mun (T1, T2 & T3) (**Figure B2.1 of Appendix 4B**). The site mainly comprised of large boulders, rocks and sand. On the hard substrata, sessile benthos primarily comprised of isolated barnacles. At most transects, relative low to moderate coverage of hard coral colonies (5% - 50%) and other benthos (<5% - 30%), such as sea anemones, zoanths and sponges were identified (**Table 4C.3 of Appendix 4C**).

A total of thirty-five hard coral species, one species of black coral, four species of sea anemones, one zoanthid species and one sponge species were identified (**Table 4C.4 of Appendix 4C**). The majority of coral recorded were common and widespread species in Hong Kong, abundant or common species included hard corals *Pavona decussata*, *Plesiastrea versipora* and *Goniopora columna*. Small amount of black coral *Antipathes curvata* were recorded at transect T1. *Pavona decussata* was recorded with relatively higher abundance at shallow water of transect T2. Other corals and benthos were generally present in isolated colonies. Representative photos of the seabed and coral conditions during the surveys are presented in **Figure 4.1**.

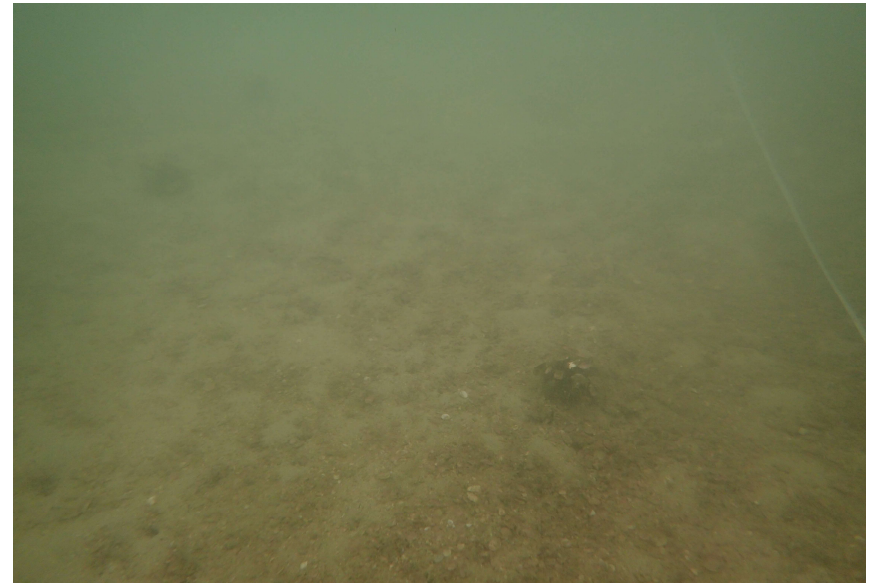
Overall, results of the dive surveys indicated that the subtidal hard substrate of the Assessment Area showed relatively low to moderate sessile taxa. Common and widespread hard corals were recorded in low to moderate percentage cover (5% - 50%) in general, with relatively higher coral coverage recorded at shallow water of transect T2.

4.3.2.4 Drop Camera Survey

Drop camera surveys were conducted at Outer Tap Mun at survey locations shown in **Figure B2.1 of Appendix 4B**. A total of five stations were surveyed within the Project site with the use of a drop camera system to record the benthic attributes by positioning the system ~1 m above the seabed. The results showed that the seabed at the survey locations (~-16mCD) consisted of silty mud without



a) Seabed with boulders, sand and rocks mixture recorded in shallow waters (-3 to -4 mCD) at Transect T1.



b) Seabed with mostly sandy substrate recorded in deeper waters (-5 to -6 mCD) at Transect T3.



c) Black coral *Antipathes curvata* recorded at Transect T1.



d) Abundant hard coral *Pavona decussata* recorded in shallow waters (-3 to -4 mCD) at Transect T2.

any hard substrate and benthic organism recorded. Representative photographs are presented in **Figure 4.2a** and **Figure 4.2b**.

4.3.3 Ecological Profiles

The key findings of the literature review and field surveys are summarised below.

4.3.3.1 Recognised Sites of Conservation Importance

Recognised sites of conservation importance within the Assessment Area include Country Parks, Marine Parks, and Sites of Special Scientific Interest (SSSI). No Special Area is located within the Assessment Area. Some of these that are relevant to marine ecology and are located in the Assessment Area are discussed below.

4.3.3.2 Country Parks

The existing country parks in the Assessment Area include the Sai Kung East Country Park, Sai Kung West Country Park and Sai Kung West Country Park (Wan Tsai Extension). However, as all three country parks are of terrestrial conservation interest, it is considered that the impact of the Project on these country parks are not anticipated. Locations of the country parks are provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁴²⁾.

4.3.3.3 Existing, Proposed and Potential Marine Parks

Hoi Ha Wan Marine Park (HHWMP) is the existing marine park within the Assessment Area. No proposed or potential marine parks are identified within the Assessment Area. Details of HHWMP is provided in **Table 4A.2.1 of Appendix 4A**. Location of HHWMP is provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁴³⁾.

4.3.3.4 Sites of Special Scientific Interest

The SSSI which is considered relevant to the marine works of the Project is the Hoi Ha Wan SSSI. Details of Hoi Ha Wan SSSI are provided in **Table 4A.2.1 of Appendix 4A**. Location of Hoi Ha Wan SSSI is provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁴⁴⁾.

4.3.3.5 Marine Mammals

According to the latest AFCD Marine Mammal Monitoring Report 2021/22, no records of Hong Kong's resident marine mammal species, the Finless Porpoise, *Neophocaena phocaenoides* and the Chinese White Dolphin (CWD) *Sousa chinensis* were reported in the Assessment Area. Considering the Project site located at the northeastern waters in Outer Tap Mun while CWDs in Hong Kong are mainly distributed at western and southwestern Lantau waters and FPs are mostly distributed in the southern and eastern waters of Hong Kong, the impact to marine mammals from the Project is therefore not anticipated. The distribution of FPs in Hong Kong waters is provided in **Figure 4A.2.4 of Appendix 4A** ⁽⁴⁵⁾.

4.3.3.6 Horseshoe Crab, and its Breeding and Nursery Grounds

Two species of horseshoe crab, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*, have previously been recorded around Hong Kong waters. Based on the abundance of juveniles, Luk Keng and Sha Tau Kok are identified as the key nursery grounds for *C. rotundicauda* and *T. tridentatus*. Adult horseshoe crabs are not recorded in the northeastern waters of Hong Kong. The

(42) AFCD (2021) Country Parks.

(43) AFCD (2021) Designated Marine Parks and Marine Reserve.

(44) Planning Department (2005) Hoi Ha Wan.

(45) AFCD (2022) Monitoring of Marine Mammals in Hong Kong Waters (2021-2022).



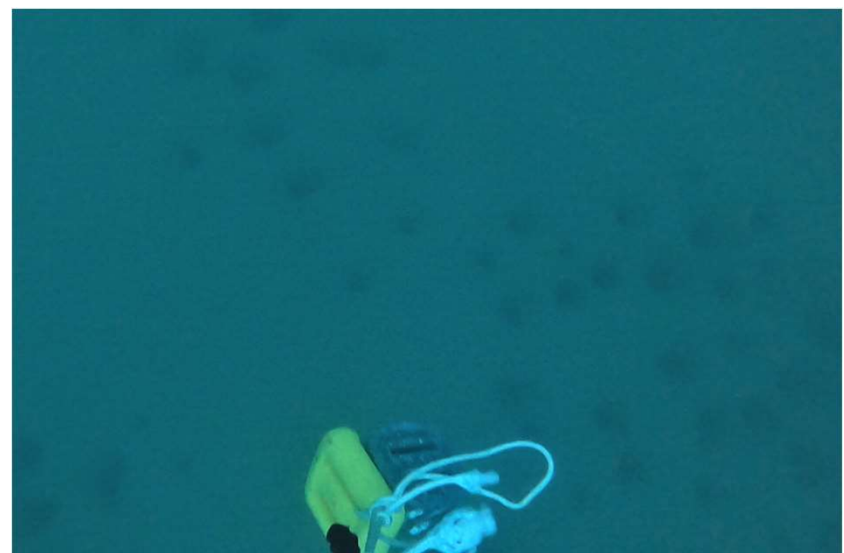
a) Soft substrate with silty seabed recorded at OTM1.



b) Soft substrate with silty seabed recorded at OTM2.



c) Soft substrate with silty seabed recorded at OTM3.



d) Soft substrate with silty seabed recorded at OTM4.



e) Soft substrate with silty seabed recorded at OTM5.

nearest records of occurrence were from the beaches in Lai Chi Wo in Yan Chau Tong Marine Park which is located out of the Assessment Area (**Figure 4A.2.1 of Appendix 4A**), therefore, the impact of the Project on horseshoe crabs is not anticipated.

4.3.3.7 Mangroves

Three mangrove stands are found in the Mirs Bay FCZ and two mangrove stands are found in the Tolo Harbour and Channel WCZ within the Assessment Area. No mangrove stands were found at the Project site. The nearest mangrove stand from the Project site is located at Hoi Ha Wan which is 2.6 km away. The site is considered to be far away from the Project site and the impact of the Project on mangroves is therefore not anticipated. Locations of the mangroves are provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁴⁶⁾.

4.3.3.8 Coral Communities

Coral communities in the eastern waters of Hong Kong generally have a higher diversity and abundance as the surrounding marine environment is less influenced by the Pearl River outflow compared to the western waters of Hong Kong with lower salinity and higher turbidity. Literatures have reported that hard coral, octocoral and black coral were recorded within the Assessment Area, with a wide range of hard coral coverage recorded in HHWMP (10- 50% to >50%) and in Port Island (Chek Chau) (30-75%) in some early studies. Recent surveys including those conducted during Reef Check 2021 have also recorded 19.3% and ~50% coral coverage at Port Island and HHWMP respectively. Locations of the coral communities are provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁴⁷⁾ ⁽⁴⁸⁾ ⁽⁴⁹⁾ ⁽⁵⁰⁾.

Results of the Feasibility Study of this Project has revealed that coral communities mainly composed of scattered hard coral colonies with high hard coral coverage (76 – 100%) recorded at shallow water region of one transect. A total of 29 hard coral species and 1 black coral species were identified in at the eastern shoreline of Tap Mun during these surveys. The species identified during the survey were generally regarded as common and widespread species in Hong Kong waters, such as *Pavona decussata*, *Favites chinensis*, *Dipsastraea speciosa* and *Platygyra acuta*.

Field surveys were conducted to fill in the information gap of the Feasibility Study, with findings showing that the majority of corals recorded were common and widespread species in Hong Kong, including hard corals *Pavona decussata*, *Plesiastrea versipora* and *Goniopora columna*. Small amount of black coral *Antipathes curvata* was also recorded. Overall, the surveyed areas showed low to moderate coral coverage in shallow waters (<5% - 50 %) and deep waters (5% - 10 %) and low to moderate sessile taxa coverage on the subtidal hard substrate. Results of drop camera survey showed that the seabed of this site (~-16 mCD) was dominated by silty mud without any hard substrate or benthic organisms.

4.3.3.9 Amphioxus

Amphioxus are mostly present within Hong Kong's eastern waters, with densities ranging from 10 to 400 ind / m² predominantly at sites in Tai Long Wan, Nam She Wan, Long Ke Wan and Pak Lap Wan

(46) AFCD (2020) Distribution Map.

(47) AFCD (2021) Hong Kong Reef Check 2021 Results Summary.

(48) Goodkin NF, Switzer AD, McCorry D, DeVantier L, True JD, Hughen KA, Angeline N, Yang TT (2011) Coral communities of Hong Kong: long-lived corals in a marginal reef environment. *Marine Ecology Progress Series*. 426:185-196.

(49) Fabricius, KE, McCorry D (2006) Changes in octocoral communities and benthic cover along a water quality gradient in the reefs of Hong Kong. *Marine Pollution Bulletin*, 52(1), 22–33.

(50) ERM (2003) The Proposed Submarine Gas Pipeline From Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong. EIA Study (EIA-089/2003). Prepared for The Hong Kong and China Gas Company Limited.

off the Sai Kung Peninsula ⁽⁵¹⁾. However, no studies have been conducted at the Project site previously. Field surveys were conducted to fill in this information gap. The baseline subtidal benthos surveys reported that no records of amphioxus was found at the Project site, therefore, the impact of the Project on amphioxus is not anticipated.

4.3.3.10 Other Intertidal, Subtidal Assemblages and Seagrass Bed

Other intertidal and subtidal benthos species reported in the Assessment Area from the field surveys and literature review are common and widespread in Hong Kong with no species of conservation importance. As the Project site is located away from the shorelines, the assessment on intertidal hard bottom assemblages is considered not necessary. Potential marine ecological impact would occur mostly on the subtidal environment and the impact on intertidal habitats is not anticipated.

There are studies which showed that benthic communities at northeastern waters, Tolo Channel and western Mirs Bay which overlaps with the Assessment Area are impoverished. None of these species is unique to a particular location of the Assessment Area, and many of these species were also reported elsewhere in Hong Kong waters. Seagrass (*Halophila minor*), with high ecological value was reported to be present at To Kwa Peng, however, as it is located at 4.3 km away from the Project site, the impact of the Project on the seagrass is therefore not anticipated. Location of the seagrass bed is provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁵²⁾.

4.3.3.11 White-Bellied Sea Eagle

Findings of white-bellied sea eagle (WBSE) was spotted on Port Island within the Assessment Area, located ~2.7 km away from the Project site. It was reviewed from literature and previous field surveys that the species is uncommon but widespread in Hong Kong. As the nesting grounds of WBSE is far away from the Project site and that the foraging distance generally reaches 2 km from their nesting location, the impact of the Project on the WBSE is therefore not anticipated. Locations of the WBSE nesting grounds are provided in **Figure 4A.2.1 of Appendix 4A** ⁽⁵³⁾.

4.3.4 Ecological Importance

4.3.4.1 Evaluation of Marine Ecological Habitats

The existing conditions of the marine ecological habitats and resources within the Assessment Area have been assessed. These baseline conditions have been based on available literature and, where considered necessary, focused field surveys and data review to update and supplement the data. Based on this information presented in **Section 4.3.2, Section 4.3.3, Appendices 4A and 4C** the ecological importance of each habitat has been determined according to the *EIAO-TM Annex 8* criteria.

Within the Assessment Areas (mainly marine ecology) of this EIA, which covers quite a large areal extent, variations in the ecological characteristics of habitats across different locations (which are kilometres apart) are likely to be present. To provide information of key relevance to the marine ecological assessment, the ecological importance of habitats presented in this baseline is therefore primarily focused on the vicinity of the works areas of the Project site.

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

- Literature review;
- Findings of the field surveys;

(51) Chen Y (2007) The Ecology and Biology of Amphioxus in Hong Kong. PhD. Thesis. The City University of Hong Kong.

(52) Kwok BLH, Lam Chun-pong & Yip JKL Yip (2005) Discovery of the Fifth Seagrass Species in Hong Kong – *Halophila minor*. Hong Kong Biodiversity, AFCD Newsletter: Issue 10.

(53) So WY, Yuen NF (2020) A Short Note on the Breeding of White-bellied Sea Eagle in Hong Kong. Hong Kong Biodiversity, AFCD Newsletter: Issue 26.

- Comparison with other areas in Hong Kong; and
- Annexes 8 and 16 of the *EIAO-TM*.

Outcomes of the evaluation of ecological importance of the marine habitats and species within the Assessment Areas are presented in **Tables 4.5 to 4.9**.

Table 4.5 Marine Ecological Importance of Existing Marine Parks and SSSI within the Assessment Area

Criteria	Hoi Ha Wan Marine Park (HHWMP)	Hoi Ha Wan SSSI
Naturalness	Natural intertidal and subtidal hard and soft bottom habitat and marine waters	Natural intertidal and subtidal hard and soft bottom habitat and marine waters
Size	~260 ha	~278 ha
Diversity	Moderate	Moderate
Rarity	Habitat and species are uncommon in the northeastern water of Hong Kong. Species of conservation importance including numerous species of hermatypic hard coral, ahermatypic cup coral, black coral, and octocoral	Habitat and species are uncommon in the northeastern water of Hong Kong. Species of conservation importance including numerous species of hermatypic hard coral, ahermatypic cup coral, black coral, and octocoral
Re-creatability	Not re-creatable	Not re-creatable
Fragmentation	Unfragmented	Unfragmented
Ecological Linkage	Linked to the intertidal and subtidal habitats	Linked to the intertidal and subtidal habitats.
Potential Value	Already designated as marine park	Already designated as a SSSI
Nursery / Breeding Area	Nursery grounds for juvenile of fishes and other marine invertebrates	Nursery grounds for juvenile of fishes and other marine invertebrates
Age	Designated as marine park in July 1996	Designated as SSSI in January 1989
Abundance	Historically high abundance of hard coral. Old coral colonies and regarded as location of considerable carbonate accumulation	Historically high abundance of hard coral. Old coral colonies and regarded as location of considerable carbonate accumulation
Ecological Importance	High	High

Table 4.6 Ecological Importance of Intertidal Habitats within and in the vicinity of the Project site

Criteria	Soft Bottom Intertidal Habitat	Hard Bottom Intertidal Habitat	Artificial Intertidal Habitat
Naturalness	Natural habitat	Natural habitat	Artificial
Size	Small, only small patches of sandy shore recorded	Large, majority of the shoreline within and in the vicinity of the Project site	Small, comprise of small piers and seawall
Diversity	Low	High	Low
Rarity	Ghost crab (<i>Ocypode cordimana</i> , previously known as <i>Ocypode cordimanus</i>), oligochaete worms (<i>Heronidrilus bihamis</i>) and fiddler crabs (<i>Uca lactea</i>) were recorded. No rare species found	Common rocky shore flora and fauna were recorded e.g. bivalve <i>Perna viridis</i> , and short-spined sea urchin <i>Heliocidaris crassispina</i>	Not surveyed in the literature reviewed, it is assumed that the assemblages comprise common and widespread intertidal species in Hong Kong like Barnacle <i>Balanus amphitrite</i> , Bivalve <i>Grafrarium pectinatum</i> , and snails <i>Nassarius festivus</i> , <i>Monodonta labio</i> , <i>Batillaria multiformis</i> , <i>B. zonalis</i>
Re-creatability	Re-creatable; substrata may be re-colonised by intertidal and subtidal organisms	Not re-creatable	Re-creatable; substrata may be re-colonised by intertidal and subtidal organisms
Fragmentation	Fragmented	Unfragmented	Fragmented
Ecological Linkage	Not functionally linked to any high value habitat in a significant way	Not functionally linked to any high value habitat in a significant way	Not functionally linked to any high value habitat in a significant way
Potential Value	Unlikely to become an area of conservation value	Unlikely to become an area of conservation value	Unlikely to become an area of conservation value
Nursery / Breeding Area	No significant records identified	No significant records identified	No significant records identified
Age	N/A	N/A	N/A
Abundance	Lower abundance compared to natural rocky shore habitat	Low abundance	Lower abundance compared to natural rocky shore habitat
Ecological Importance	Low	Low	Low

Table 4.7 Ecological Importance of Subtidal Hard-Bottom Habitats within and in the vicinity of the Project site

Criteria	West of Tap Mun	Hoi Ha Wan Marine Park and SSSI	West of Port Island	Mirs Bay
Naturalness	Natural	Natural	Natural	Natural
Size	Large. The natural rocky shore at Outer tap Mun is about 1.5 km in length.	~260 ha for marine park and 278 ha for SSSI	Large. The natural rocky shore at the West of Port island is about 1 km in length.	Large. About 4.8 km across waters between Kung Chau and Nam She Wan.
Diversity	Low to Moderate	High	Low to Moderate	Moderate
Rarity	Assemblages mainly comprise typical common and widespread species in Hong Kong. Coral communities of high ecological concern were not identified within and in the vicinity of this site	Habitat and species are uncommon in the northeastern water of Hong Kong. Species of conservation importance including numerous species of hermatypic hard coral, ahermatypic cup coral, black coral, and octocoral	Assemblages is considered to mainly comprise typical common and widespread species in Hong Kong, except <i>Montipora mollis</i>	Assemblages comprise typical common and widespread species in Hong Kong, except for some uncommon coral species identified. Coral communities of high ecological concern identified at Nam She Wan
Re-creatability	Not re-creatable	Not re-creatable	Not re-creatable	Not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological Linkage	Not functionally linked to any high value habitat in a significant way	Not functionally linked to any high value habitat in a significant way	Not functionally linked to any high value habitat in a significant way	Functionally linked to amphioxus habitat at Nam She Wan
Potential Value	One particular site at the mid of west shore of Tap Mun has higher hard coral coverage which exhibit higher ecological value	Already designated as marine park and SSSI	Habitat has some potential value for a few uncommon coral species	Habitat is relatively undisturbed which might exhibit some potential value.
Nursery / Breeding Area	No significant records identified	Nursery grounds for juvenile of fishes and other marine invertebrates	No significant records identified	No significant records identified
Age	N/A	Designated as marine park in July 1996 and as SSSI in January 1989	N/A	N/A

Criteria	West of Tap Mun	Hoi Ha Wan Marine Park and SSSI	West of Port Island	Mirs Bay
Abundance	Low coverage of coral is present in general, except at the mid of west shore of Tap Mun where higher coral coverage was recorded	Historically high abundance of hard coral. Old coral colonies and regarded as location of considerable carbonate accumulation	Moderate to high hard coral cover was recorded in literatures, however, low coverage of coral is recorded in recent studies	Low coverage of coral is present in general with higher coral coverage identified near shores at Nam She Wan
Ecological Importance	Low to Moderate	High	Low to Moderate	Low to Moderate

Table 4.8 Ecological Importance of Subtidal Soft Benthos Assemblages within the Project site

Criteria	Outer Tap Mun
Naturalness	Natural
Size	~55 ha
Diversity	Low
Rarity	The assemblages are typical of similar habitats in the Hong Kong waters, which are dominated by polychaetes
Re-creatability	Re-creatable; substrata may be recolonised by benthic organisms
Fragmentation	Unfragmented.
Ecological Linkage	Not functionally linked to any high value habitat in a significant way
Potential Value	It is unlikely that the habitat could develop conservation importance
Nursery / Breeding Area	No significant records identified
Age	N/A
Abundance	In comparison to other parts of the eastern waters the assemblages are of low to moderate abundance and biomass
Ecological Importance	Low

Table 4.9 Ecological Importance of Marine Waters

Criteria	Waters in Outer Tap Mun and in the vicinity
Naturalness	Natural
Size	~55 ha
Diversity	Potential sighting of FP but rarely present
Rarity	FP is a resident species in Hong Kong. Commonly observed in eastern waters but not in northeastern waters of Hong Kong
Re-creatability	Not re-creatable
Fragmentation	Unfragmented.
Ecological Linkage	Linked to FP and marine habitat nearby
Potential Value	It is unlikely that the habitat could develop conservation importance
Nursery / Breeding Area	No significant records identified
Age	N/A
Abundance	Very low density of FP in comparison to other waters of Hong Kong
Ecological Importance	Low

4.3.4.2 Species of Conservation Importance

In accordance with *EIAO-TM Annex 8* criteria, an evaluation of species of conservation importance recorded from the Assessment Area is presented in **Table 4.10**.

Table 4.10 Species of Conservation Importance within the Assessment Area

Common Name	Scientific Name	Protection Status	Distribution, Rarity and Other Notes	Literature	Surveys	Recorded Location
Hard Corals (>40 spp.)	<i>Duncanopsammia peltata</i> <i>Oulastrea crispata</i> <i>Porites</i> sp., etc.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common and widely distributed in the eastern waters of Hong Kong	✓	✓	In the vicinity of the Project site at the western coastline of Tap Mun and throughout northeastern waters of Hong Kong, such as Port Island located at ~2 km from the Project site
Black corals	<i>Antipathes curvata</i> , <i>Cirripathes sinensis</i> , <i>Antipathes</i> sp., <i>Cirripathes</i> sp.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common but sparsely distributed in the north-eastern waters of Hong Kong	✓	✓	One species is recorded in the vicinity of the Project site and one species is recorded at Mirs Bay. Mostly present throughout the northeastern waters of Hong Kong, e.g. Port Island, Fung Wong Wat, Gruff Head
Cup corals	<i>Balanophyllia</i> sp.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common and widely distributed in the Hong Kong, especially in western waters	✓		In the vicinity of the Project site
Amphioxus	<i>Branchiostoma belcheri</i>	Listed as “Grade II National Key Protected Species” in China Listed as “Endangered” in the China Species Red List	Recorded from across Hong Kong waters, but major records were found in eastern waters	✓		Mostly present within Hong Kong’s eastern waters, present more than >3 km from the Project site, including Nam She Wan and Tai Long Wan

Common Name	Scientific Name	Protection Status	Distribution, Rarity and Other Notes	Literature	Surveys	Recorded Location
Seagrass	<i>Halophila minor</i>	Considered as important habitats in Environmental Impact Assessment Ordinance	Uncommon / rare in Hong Kong	✓		Mainly in To Kwa Peng, ~4.3 km from Project site
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	Listed in Wild Animals Protection Ordinance (Cap. 170) Listed in Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) Class II Protected Animal of PRC Listed as Regional Concern in Fellowes et al. (2002)	Uncommon resident. Widely distributed in coastal areas throughout Hong Kong	✓		Port Island, ~2.7 km away from the Project site

4.3.5 Marine Ecological Sensitive Receivers

Based on the review of available information within the Assessment Area, marine ecological sensitive receivers have been identified in accordance with the *EIAO-TM* criteria. These sensitive receivers and their distance from the Project site are listed in **Table 4.11**. Locations of sensitive receivers can be referred to **Figure 4A.2.1 of Appendix 4A**.

Table 4.11 Approximate Shortest Distance to Marine Ecological Sensitive Receivers (SRs) around the Project site

	Name	Shortest Separation (Geodesic) Distance (km)
Corals	Port Island (CR3)	2.0
	Wong Wan Tsai (CR8)	4.7
	Fung Wong Wat (CR9)	4.0
	Gruff Head (CR10)	3.0
	South Wong Wan Tsui (CR11)	3.1
	Wong Chuk Kok Tsui (CR12)	3.5
	Hoi Ha Wan Moon Island (CR13)	1.5
	Hoi Ha Wan Coral Beach (CR14)	1.7
	Heung Lo Kok (CR16)	2.4
Mangrove Stand / Intertidal Habitat	Fung Wong Wat (M5)	4.5
	Hoi Ha Wan (M6)	2.6
	Tai Tan (M7)	3.3
	To Kwa Peng (M8)	4.3
	Chek Keng (M9)	4.5
Designated Marine Park	Hoi Ha Wan Marine Park and Artificial Reef within the Marine Park (MP2)	0.7
Artificial Reef	Long Harbour (AR1-AR6)	0.7
Designated SSSI	Hoi Ha Wan SSSI (SSSI1)	0.7

4.4 Assessment Methodology

The *Method Statement on Marine Ecological Impact Assessment for Outer Tap Mun Fish Culture Zone* under this assignment was approved on 12 October 2020 and is presented in **Appendix 4B**. A desktop literature review and supporting field surveys were conducted in order to establish the ecological profile of the area within and surrounding the Project. The importance of potentially-impacted marine ecological resources identified within the Assessment Areas was evaluated using the methodology defined in the *EIAO-TM*.

Potential impacts to these resources due to the construction and operation of the Project were assessed (following the *EIAO-TM Annex 16* guidelines) and the impacts evaluated (based on the criteria in *EIAO-TM Annex 8*). Findings of water quality modelling are used, where appropriate, to assess potential impacts on the identified marine ecological resources.

4.5 Potential impacts and impact assessment

4.5.1 Construction Phase

The construction of the proposed Project will mainly involve the setup of fish farm structures, including fish rafts / cages, auxiliary facilities and mooring system. No dredging work is required during the construction phase.

The scale of construction work on-site is relatively small. Main components of the rafts / cages are manufactured off-site and will be towed to the Project site using tug boat. On-site assembly and anchoring of the fish rafts / cages will be assisted by a small number of marine vessels such as sampans and small speed boats for up to a few trips per day. Anchoring of these vessels might be required. No heavy construction plant would be used. Fish rafts / cages and auxiliary facilities, such as storage space and shelters, would be positioned by anchor lines attaching to the anchorage points on the seabed. Use of winch might be required during the assembly and anchorage of fish rafts / cages. All construction activities shall be conducted during daylight hours.

Potential impacts to marine ecological resources arising from these works may be divided into those related to:

- Disturbance of marine habitats; and
- Underwater sound from marine construction activities and marine vessels.

4.5.1.1 Habitat Disturbance

Direct impacts to marine ecology include disturbance caused by assembly and installation activities on-site. The installation of fish farm structures are expected to be completed within a few weeks for each fish raft, and would cause temporary disturbance to marine habitats, such as marine waters with an area of approximately 55 ha and small area of benthic habitats. Fish farm structures, such as fish cages will occupy a section of the water column and the disturbance of seabed due to the anchorage of fish farm structures will be confined to a thin surface layer (<0.5 m) within a small area. It should be noted that only a small number of vessels will be used and the frequency / trip of these vessels would also be relatively low. No disturbance to other marine ecological sensitive receivers, including HHWMP which is located ~0.7 km away, is expected.

Within the Project site, the seabed composition was found to mainly consist of silty mud without any hard substrate with benthic assemblages dominated by polychaete worms and characterised by similar species diversity and biomass as elsewhere in Hong Kong. Species of conservation importance, such as amphioxus, marine mammals and horseshoe crabs were not observed within the Project site. The overall coral coverage within and in the vicinity of the Project site is considered to be low to moderate and other species recorded are considered to occur frequently in Hong Kong. Overall, the subtidal habitats within the Project site were considered as of low ecological importance. Similar habitats are present in the surrounding areas and the disturbance would represent a very small fraction of the widely available habitat.

Considering the temporary nature of the disturbance (a few weeks for each fish raft / cage), the small extent of area affected and low ecological importance of the affected area, impacts are considered to be of minor significance and unacceptable impacts on marine ecological resources are not expected. Marine ecological resources are expected to return to the area following the cessation of fish farm construction activities.

Construction activities, such as during the assembly of fish raft, would generate noise, glare and dust which may affect marine ecology. Potential impacts to marine life, mostly fish species, would include temporary avoidance of areas in the vicinity of works area or close to the source of disturbance. Considering the temporary nature of the construction works, impacts from the generation of noise, glare and dust on marine habitats are considered negligible, and unacceptable impacts on the marine ecological resources are not anticipated. Major lighting sources will be pointed inward and

downwards to avoid disturbance to wildlife, unacceptable impacts on the marine ecological resources are not anticipated.

4.5.1.2 Underwater Sound

Intermittent sounds, which occur during assembly and installation activities on-site and marine vessel movement, may have an impact on marine ecological resources. Potential effects of increased underwater sound include physiological stress, avoidance and injury (at high pressure levels). The level of impact is however dependent upon background sound, number and type of species affected, proximity of organism to the sound source, attenuation properties of seabed sediments and hearing capabilities of the species affected, etc.

Most marine invertebrates do not possess air-filled space and thus it is generally considered that sound would have limited physiological or behavioural effects on marine invertebrates, except if they are located within a few metres of the sound source. Therefore, underwater sound generated from marine works is expected to have negligible impact on marine invertebrates in the Assessment Area.

The impact of underwater sound generation from construction activities on fish is highly depended upon the hearing capabilities of the different species present in the area, with the hearing specialists being of greatest concern. The significance of these effects is dependent upon the proximity of fish to the sound source. Considering that a small number of marine vessels would be present temporarily at the Project site during fish farm construction, fish species that are sensitive to the generation of sound are likely to instinctively avoid the area once works commence and would be temporarily displaced to other areas where similar habitat conditions are present. Fishes are expected to return to the area following the cessation of fish farm construction activities.

Waters within the Assessment Area and its vicinity is subject to moderate to high levels of marine traffic by similar types of vessels. It is reasonable to assume that marine organisms are habituated to background level of underwater sound, and a small increase in vessel activity associated with the construction of this Project is not anticipated to result in unacceptable impacts on marine organisms at and in the vicinity of the Project site. Overall, unacceptable impacts on marine ecological resources are not expected.

4.5.2 Operation Phase

Mariculture activities, such as management of fish raft / cages and fish stocks within the Project site will be undertaken during operational phase. Limited numbers of small power generators will be used on fish rafts to support daily mariculture activities. The transportation of fish stocks, fish feed, fish raft equipment and workforce as well as occasional visitors will make use of mainly small marine vessels such as sampans and speed boats for a few trips a day. No maintenance dredging or sediment removal is anticipated during FCZ operation. All operation activities shall be conducted during daylight hours. The potential impacts on marine ecology of the Assessment Area include:

- Changes in marine habitats (marine waters and benthic habitat);
- Temporary relocation of rafts under typhoons or algal blooms;
- Underwater sound from daily operations and marine vessels;
- Perturbations to key water quality parameters during fish farm operation, including fish feed wastage, fish excretion and dead fish; and
- Introduction of invasive species.

4.5.2.1 Changes in Marine Ecological Habitat

As discussed in **Section 4.5.1.1**, the fish farm structures will not fully occupy all of the Project site area but mainly a section of the water column and a small area of seabed confined to a thin surface layer (<0.5 m), the area of marine ecological habitat affected is <55 ha. The small extent of area

affected which is of low ecological importance, impacts are considered to be of minor significance and unacceptable impacts on marine ecological resources are not expected.

Fish rafts / cages and anchoring equipment would provide hard substrate for the settlement of epifaunal organisms that would not otherwise be successful in colonising the area. Where permitted, colonisation of the structures over time is expected to lead to the development of a marine fouling community. Effects associated with creation of artificial habitat may include increased biological productivity and increased diversity of habitats. Overall, the structures of the fish farm are expected to result in potential positive effect on marine ecological resources of the waters within and in the vicinity of the Project site.

All the fish rafts / cages will be floating with permeable nets to allow water exchanges with the marine environment. Consequently, it is predicted that no unacceptable changes in hydrodynamics will occur.

Operational activities, such as cleaning of fish cages and the use of lighting, would generate noise, glare and dust which may affect marine ecology. Potential impacts to marine life, mostly fish species, would include temporary avoidance of areas in the vicinity of works area or close to the source of disturbance. Considering the temporary nature of the cleaning activities, impacts from the generation of noise, glare and dust on marine habitats are considered negligible, and unacceptable impacts on the marine ecological resources are not anticipated. Major lighting sources will be pointed inward and downwards to avoid disturbance to wildlife, unacceptable impacts on the marine ecological resources are not anticipated.

4.5.2.2 Temporary Relocation of Fish Rafts

In general, relocation of fish rafts adopting advanced mariculture technologies are not necessary under adverse weather (e.g. typhoon) given the framework of fish cages would use weather-resistant and durable materials (e.g. HDPE cages, steel truss cages). For other potential circumstances (e.g. red tide event, outbreak of fish disease), the licensees will review the need of fish raft relocation and propose the fish raft relocation plan as necessary for agreement with AFCD on a case-by-case basis, depending on the type of algal bloom (any toxicity to fish), expected duration of such circumstances, feasibility for early harvesting of fish stock, feasibility of implementing onsite control measures etc. In case fish raft relocation is considered necessary, the fish rafts will be relocated away from the areas of circumstances, avoid marine fairways and utilities and at some distance away from ecological and fisheries sensitive receivers (e.g. about 200 m away from established coral communities) to minimise potential impacts to these sensitive receivers. Such relocation will be temporary (e.g. a few weeks) and the fish rafts will return to the Project site upon the cease of the circumstances. The mobilisation of the fish rafts will cause temporary disturbance to marine habitat. Increased operation of marine vessels will occur due to the towing of fish rafts to the new location, and the re-anchoring of fish rafts will cause temporary disturbance to the water column and seabed. The corresponding impacts would be similar to those occurred in the construction phase (**Section 4.5.1**). Overall, impacts are considered to be of minor significance and unacceptable impacts on marine ecological resources are not expected.

4.5.2.3 Underwater Sound

Operation of the fish farm would produce underwater sound from the management of fish rafts / cages and fish stocks, and operation of marine vessels. The daily operations of mainly small marine vessels, such as sampans or speed boats would be temporary which the underwater sound characteristics of these vessels are similar to the operations at Tap Mun FCZ and marine traffic at ferry routes nearby. Marine organisms in these waters are habituated to the background level of underwater sound, and a small increase in mariculture and vessel activities associated with the operation of this Project are not anticipated to result in unacceptable impacts on marine ecological resources and also marine habitats within HHWMP which is located ~0.7 km away.

4.5.2.4 Changes in Water Quality

Mariculture activities would result in an increase in water quality pollutants primarily from fish feed, feed wastage, fish excretion and dead fish. The increase in pollution load would affect the water quality in the receiving waters and the potential impacts on marine ecological resources are as follows:

- Suspended solids (SS) dispersion;
- Dissolved oxygen (DO) depletion; and
- Elevated nutrient levels.

To estimate the impacts on marine ecological sensitive receivers of the Assessment Area, computer modelling of changes in water quality were conducted under two scenarios:

- Baseline scenario, which covered the “without-project” condition in 2023; and
- Project scenario, which took into account the additional pollution load from the mariculture activities at the Project site, as well as the other nearby proposed new fish culture zones at Outer Tap Mun and Mirs Bay (each at their carrying capacity).

Relevant assessment criteria, i.e. Water Quality Objectives (WQOs) in the Mirs Bay and Tolo Harbour and Channel WCZs, were then used to assess potential impacts on marine ecological resources.

Suspended Solids (SS)

Fish farm operation are expected to generate SS within the water column as a result of fish feed, fish feed wastage and fish excretion, contributing to an increase in sediment deposition in close proximity of the Project site.

The water quality modelling results have indicated that at all marine ecological sensitive receivers, SS elevations as a result of fish farm operation are predicted to be compliant with the relevant WQOs for both wet and dry seasons. Impacts to subtidal assemblages, such as fish, corals and benthic assemblages within and in the vicinity of the Project site are expected to occur temporarily as the modeling results indicate that the mariculture activities would only result in short-term, localised elevations of SS. The habitats affected are expected to be generally confined to the Project site and subtidal assemblages in proximity to the Project site are considered to be of low ecological value. As the areas affected are predicted to have limited or no change of SS levels between baseline and project scenarios, organisms are expected to be exposed under similar environmental conditions as the fish farm operates. Based on the assumption that eventually the affected areas will be recolonised by fauna typical of the area, the temporary impact on these low ecological assemblages is not considered to be unacceptable. Unacceptable impacts to ecological assemblages, including species of conservation importance such as amphioxus, marine mammals and horseshoe crabs, if present in the vicinity of the Project site arising from elevated SS levels are not anticipated. Other marine ecological sensitive receivers are predicted to be unaffected (as defined by the WQO and tolerance criterion).

With the fish farm standing stock kept within the Project site’s maximum carrying capacity and the use of pellet feed within fish farms, potential impacts to marine ecological resources will be well managed. The Project site only occupies a very small proportion of the habitats and supported ecological assemblages of low ecological value, whereas areas which supported marine ecological resources of moderate to high values are recorded at HHWMP which is located at ~0.7 km from the Project site. Consequently, unacceptable impacts on marine ecological resources are not expected to occur.

Dissolved Oxygen (DO)

The relationships between SS and DO are complex, with elevated SS in the water column together with a number of other factors to reduce DO concentrations. Elevated SS (and turbidity) reduces light penetration, lowers the rate of photosynthesis by phytoplankton (i.e. primary productivity) and thus

lowers the rate of oxygen production in the water column. Furthermore, the decomposition of organic matter in fish feed, fish excretion and dead fish in the water column may consume DO in the receiving waters. The resulting overall DO depletion has the potential to cause an adverse effect on marine organisms, especially to sessile organisms, such as corals, which cannot escape from the hypoxia zone and could potentially cause mortality.

The water quality modelling results have indicated that DO depletion associated with fish farm operation are predicted to be low and remain compliant with the relevant WQO DO criteria at all marine ecological sensitive receivers. Lower DO levels recorded at the northern areas are likely a result of relatively high pollution loading from dry weather load and treated sewage effluent from the Starling Inlet (also known as Sha Tau Kok Hoi), as well as pollution load from Yantian area of Guangdong. In general, the levels of DO are predicted to remain rather stable in the Long Harbour embayment with and without fish farm operation. Outside of the Long Harbour embayment, no unacceptable change in DO level is predicted at other marine ecological sensitive receivers in both baseline and project scenarios.

Overall, there is limited change in the predicted DO levels at baseline and project scenarios and unacceptable impacts to marine ecological resources are not expected to occur.

Nutrients

High levels of nutrients released from fish feeds, fish excretion and dead fish to the water column may potentially cause rapid increases in phytoplankton population, on occasions to the point that an algal bloom occurs. An intense bloom of algae can lead to sharp decreases in the levels of DO. This decrease will initially occur in the surface water, and then spread to deeper waters as dead algae fall through the water column and decompose on the seabed. Anoxic conditions may result if DO concentrations are already low or are not replenished. This may result in mortality of marine organisms due to oxygen deprivation.

The water quality modelling results have indicated that the levels of nutrients as a result of fish farm operation are expected to be low in general within the Assessment Area. Predicted levels of Total Inorganic Nitrogen (TIN) and unionized ammonia at the Project site and all marine ecological sensitive receivers are below the corresponding assessment criterion. Overall, the increased levels of nutrients in the water column as a result of fish farm operation are considered to be of minor significance and unacceptable impacts to marine ecological resources are not expected to occur.

Chlorophyll-a

Chlorophyll-a is a photosynthetic pigment of phytoplankton and is commonly used as a direct indicator of algal biomass. As mentioned above, increased levels of phytoplankton due to nutrients released from fish farms could potentially trigger algal blooms, in which could reduce DO levels in the water column and result in mortality of marine organisms.

The water quality modelling results have indicated that the levels of chlorophyll-a vary spatially across the Assessment Area and are generally higher at the surface level and areas with shallower water depth. The predicted change of chlorophyll-a levels between baseline and project scenarios at the Project site and all other marine ecological sensitive receivers within the Assessment Area is limited and below the corresponding assessment criterion. Therefore, fish farm operation is not expected to result in significant increase of chlorophyll-a and unacceptable impacts to marine ecological resources are not expected to occur.

4.5.2.5 Introduction of Invasive Species

The new fish stocks to the Project site will have potential risks in introducing invasive species to the marine environment if invasive species are cultivated and escaped from the fish farms. Invasive species may result in increased biological interactions (e.g. competition and predation) with native marine species, and therefore may pose threats to the local marine biodiversity.

Regular maintenance of fish farm equipment, typically the condition of fish cages and fish nets would be performed by the fish farm owner, to minimise the potential risk of fish escape to the nearby marine environment. Details of these operation measures and practices are presented in **Appendix 2A**. Upon implementation of these measures, unacceptable impacts on the marine ecological resources are not anticipated.

4.6 Impact Evaluation

Based upon the information presented in **Section 4.5**, the significance of marine ecological impacts associated with the construction and operation of the Project has been evaluated in accordance with the *EIAO-TM* (*Annex 8*, Table1). The outcomes of this evaluation are summarised in **Table 4.12**.

Table 4.12 Significance of Marine Ecological Impacts Associated with the Construction and Operation of the Project Evaluated in accordance with EIAO-TM

Potential Impact	Source	Receiver	Nature of Impact						Overall Impact Significance	Mitigation / Precautionary Measures Required
			Habitat Quality	Species Affected	Size	Duration	Reversibility	Magnitude		
<i>Construction phase</i>										
Habitat disturbance	Construction of fish farm structures (including the production of noise, glare and dust).	Marine waters and benthic habitats within and in the vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes.	All of the Project site (~55 ha).	Temporary and short term (a few weeks) in the active works area	Reversible	Small	Minor	No
Underwater sound	Construction of fish farm structures and marine vessels.	Marine waters within and in the vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes.	Localised to sound-generating activities, e.g. assembly of fish rafts, installation of mooring system, marine vessels.	Temporary and short-term (a few weeks) in the active works area.	Reversible	Small	Minor	No
		HHWMP	High	Rare and common fish species.	Localised to sound-generating activities, e.g. assembly of fish rafts, installation of mooring	Temporary and short term (a few weeks) in the active works area	Reversible	Small	Minor	No

Potential Impact	Source	Receiver	Nature of Impact						Overall Impact Significance	Mitigation / Precautionary Measures Required
			Habitat Quality	Species Affected	Size	Duration	Reversibility	Magnitude		
					system, marine vessels; mostly affect area near the marine park boundary.					
<i>Operation phase</i>										
Changes in marine habitat	Fish farm operational activities (including the production of noise, glare and dust).	Marine waters and benthic habitat within and in the vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes.	Localised to the vicinity of fish farm structures (<55 ha).	Long-term over Project duration	Reversible	Small	Minor	No
Temporary relocation of fish rafts / cages	Fish farm	Marine waters and benthic habitats within and in the vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes.	Localised to the immediate vicinity of the area of fish rafts / cages relocation.	Temporary	Reversible	Small	Minor	The licensees will review the need of fish raft relocation and propose the fish raft relocation plan as necessary for agreement with AFCD.
Underwater sound	Operational activities of fish farm and marine vessels	Marine waters within and in the vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes.	Localised to the immediate vicinity of the sound-generating activities e.g. maintenance of	Long-term over Project duration but reversible.	Reversible	Small	Minor	No

Potential Impact	Source	Receiver	Nature of Impact						Overall Impact Significance	Mitigation / Precautionary Measures Required
			Habitat Quality	Species Affected	Size	Duration	Reversibility	Magnitude		
					the fish cages and marine vessel movement.					
		HHWMP	High	Rare and common fish species	Localised to the immediate vicinity of the sound-generating activities e.g. marine vessel movement; potential affect areas near the marine park boundary.	Long term over Project duration but reversible.	Reversible	Small	Minor	No
Changes in water quality due to fish farm operational activities	Fish farm operational activities (e.g. fish feed, fish drugs, waste water, etc.)	Marine waters, intertidal shores and benthic habitat within and in vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes.	Localised to the vicinity of the fish farm.	Long-term over Project duration.	Reversible	Moderate	Minor	Water quality mitigation measures would further reduce impacts.
		HHWMP	High	Rare and common fish species and corals	Localised to the vicinity of the fish farm; potentially	Long term over Project duration.	Reversible	Small	Minor	Water quality mitigation measures would further reduce impacts.

Potential Impact	Source	Receiver	Nature of Impact						Overall Impact Significance	Mitigation / Precautionary Measures Required
			Habitat Quality	Species Affected	Size	Duration	Reversibility	Magnitude		
					affect areas near the marine park boundary.					
Introduction of invasive species	Fish stock in fish farm	Marine waters within and in vicinity of the Project site	Low	Common fish species.	Within and in the vicinity of Project site (~55 ha).	Long-term over Project duration.	Reversible but with difficulty	Small	Minor	Operation measures and Practices in Appendix 2A would further reduce impacts.
		HHWMP	High	Rare and common fish species.	Within the HHWMP.	Long-term over Project duration.	Reversible but with difficulty	Small	Minor	Operation measures and Practices in Appendix 2A would further reduce impacts.

4.7 Cumulative Impact

As there are no other existing or committed non-FCZ projects identified in the vicinity of the Project site, the *Water Quality Impact Assessment* conducted is based on the worst-case scenarios of concurrent operation of all existing and planned FCZs as sources of pollution. It is expected that all FCZs will be operated within the maximum carrying capacity and therefore, unacceptable impacts to water quality are not anticipated. Consequently, unacceptable cumulative impacts to marine ecological resources are not predicted to occur.

As other marine organisms, including amphioxus, marine mammals and horseshoe crabs are not found within and in the vicinity of the Project site, potential cumulative impacts on these animals are not anticipated and these impacts are expected to mainly affect fishes and benthic assemblages if identified. Potential operational impacts presented in **Section 4.5.2** were examined to evaluate potential cumulative impacts with other operations / developments in the northeastern Hong Kong waters. Outcomes of this evaluation, excluding the impact on water quality are summarised as follows:

- **Changes in Marine Habitat:** In the northeastern waters, the changes in habitat would be approximately be 500 ha in total, including the Project site (55 ha), the proposed Wong Chuk Kok Hoi FCZ (35 ha) and the proposed Mirs Bay FCZ (410 ha). Although the area affected covers a certain extent of Hong Kong waters, the provision of the proposed FCZs would support more mariculture operations in Hong Kong and thus providing more fisheries resources to the local and global fisheries market. Considering that the marine ecological resources in the northeastern waters where the Project site is located are generally regarded as of low ecological value, the overall impacts are minor, it is unlikely that the construction of the Project would exert an unacceptable cumulative effect on the marine environment.
- **Underwater Sound:** This Project is located ~0.3 km and 0.9 km away from Tap Mun FCZ and Kau Lo Wan FCZ respectively, while other existing and planned FCZs are >2 km away. The cumulative effect of underwater sound will therefore consider the impact from the nearby Tap Mun FCZ and Kau Lau Wan FCZ. For this Project, mainly small marine vessels e.g. sampans and speed boats operated by fishermen would be used during FCZ operation. The underwater acoustic profiles generated by works vessels of this Project would therefore be similar to the daily operations of the nearby Tap Mun and Kau Lau Wan FCZ as well as marine traffic near the Tap Mun pier. Cumulative effects of works vessels operational sound, if any, are anticipated to be negligible. It is not expected to result in significant cumulative impact to the marine ecological resources within the Assessment Area.
- **Marine Traffic:** This Project is located at sufficient distance from other FCZs in the vicinity. It is expected to involve a relatively small number of mainly small marine vessels, such as sampans and speed boats that travel to and from the Project site during daily operations. Given that existing marine traffic is present within Tap Mun from Tap Mun FCZ and nearby ferry routes, and that the waters off northeastern Hong Kong have moderate levels of existing marine traffic, such as the ferry route between Ma Liu Shui to Lai Chi Wo / Kat O and Ma Liu Shui to Tap Mun, the cumulative effects of marine traffic disturbance to the nearby marine ecological resources are anticipated to be negligible.

Overall, the cumulative impacts on marine ecological resources within the Assessment Area are predicted to be minor and acceptable.

4.8 Mitigation Measures

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

- **Avoidance:** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives;
- **Minimisation:** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as confining works in specific area or season; and
- **Compensation:** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

To summarise, this assessment of impacts demonstrates that impacts will largely be avoided and minimised during the construction and operation of the proposed Project, particularly to the key marine ecological sensitive receivers, such as corals, mangroves, intertidal habitats, ARs, nearby marine parks and SSSIs.

Impacts to marine ecological resources and habitats have largely been avoided and minimised through proper planning and design of the works. The Project site is selected to be at a distance from key marine ecological habitats, such as coral habitats in HHWMP and ARs in Long Harbour, such that impact to these habitats are avoided. The construction work of the FCZ is properly designed such that no dredging work is required. To minimise the impacts to the vicinity of the Project site, it is designed to have minimal construction work on site. The scale of construction work on-site is relatively small, and the number of vessels operating concurrently are limited to a small number. The installation time of fish farm structures is minimised and is expected to be completed within a few weeks for each fish raft which would only cause temporary disturbance to marine ecological habitat. Main components of the rafts / cages are manufactured off-site and will be towed to the Project site using tug boat. On-site assembly and anchoring of the fish rafts / cages will be mainly assisted by a small number of marine vessels such as sampans and small speed boats for up to a few trips per day. No heavy construction plant would be used. To minimise change of marine habitat, the fish farm is designed to occupy minimal space which will only occupy a thin surface layer (<0.5 m) within a small area. These measures are expected to control and reduce potential impacts to marine ecological resources, and no marine ecology-specific mitigation measures are thus required during construction.

The mitigation measures proposed to mitigate water quality impact would also mitigate the potential impact to marine ecological resources during construction and operation phase. Detail of the relevant mitigation measures proposed are presented in **Section 3.9**.

4.9 Residual Impact

Taking into consideration the impact assessments in the previous sections and with effective implementation of the proposed mitigation measures, the significance of residual impacts on marine ecological sensitive receivers such as marine park (**Table 4.12**) have been evaluated in accordance with *Annex 8* of the *EIAO-TM*. Residual impacts occurring as a result of the proposed Project have been determined and are discussed as follows:

- <55 ha of marine ecological habitat will be affected during operation of the FCZ. While the design of fish farm will only occupy a section of the water column and a small area of seabed, with the small extent of affected habitat and the overall low marine ecological value in the context of surrounding similar habitat, the impact due to the change in marine habitat is considered to be of minor significance and acceptable. Furthermore, with the implementation of the proposed mitigation measures, the potential impact on marine ecological resources will be further minimised. No unacceptable residual marine ecological impacts during the construction and operation of the Project are therefore anticipated.
- In addition, the fish farm structures, which would provide artificial substrates for forming habitat and shelter for juveniles or adult fisheries, would provide positive effects on marine ecological resources within and adjacent to the Project Site.

Overall, the residual impacts of the Project would be considered to be minor and acceptable.

4.10 Environmental Monitoring & Audit

As no unacceptable impacts have been predicted to occur during the construction and operation of this Project, monitoring of marine ecological resources during these project phases is not considered necessary.

4.11 Summary and Conclusions

A review of baseline information on marine ecological resources surrounding the waters of the proposed Project from available literatures and field surveys has been undertaken, covering the intertidal, subtidal soft bottom and hard bottom habitats, and marine waters. Results of the review and field surveys indicated that marine ecological resources in the vicinity to the Project site are generally regarded as of low ecological value, whereas further afield habitats and sensitive receivers of ecological value, including the corals and artificial reefs within existing marine park (i.e. HHWMP) are located at some distance from the Project site. Species of conservation importance such as horseshoe crabs and marine mammals are not reported within the Assessment Area.

During the construction of the Project, direct impacts arising from the proposed marine works include disturbance to the marine habitat (i.e. ~55 ha, including the water column and a small area of seabed confined to a thin surface layer (<0.5 m)). Considering the temporary nature of the disturbance and the overall low ecological value of marine ecological resources at and in the vicinity of the Project site, unacceptable impacts on marine ecological resources are not expected. Impact of elevated levels of underwater sound as a result of construction activities are considered acceptable with the presence of existing underwater sound from the nearby Tap Mun FCZ, Kau Lau Wan FCZ, as well as nearby ferry routes. No marine ecological-specific mitigation measures are required during construction.

During FCZ operation, there will be changes in marine habitat at the location of fish farm structures (<55 ha). The structures mainly occupy a section of the water column and a small area of seabed confined to a thin surface layer (<0.5 m). The presence of fish farm structures will also provide hard substrates that could be colonised by a variety of marine organisms and bringing potential positive effect on marine ecological resources. Considering the relatively small area affected in the context of surrounding similar habitat and the overall low marine ecological importance at and in the vicinity of the Project site, unacceptable impacts on marine ecological resources are not expected. Potential impacts of elevated levels of underwater sound generated from the marine vessels in the vicinity of the Project site are considered acceptable with the presence of existing underwater sound from the nearby Tap Mun FCZ, Kau Lau Wan FCZ, as well as nearby ferry routes. Temporary relocation of fish rafts due to potential circumstances may occur over a short time, therefore, unacceptable impacts are not anticipated. Impacts of changes in water quality arising from FCZ operation are predicted to be largely confined in the vicinity of the Project site within the maximum carrying capacity. No unacceptable change in water quality is predicted at all marine ecological sensitive receivers in both baseline and project scenarios. Impact on the introduction of invasive species would be considered minor with regular monitoring of mariculture facilities. No marine ecology-specific mitigation measures are required during operation.

Overall, no unacceptable impacts to marine ecological resources and species of conservation importance are expected to occur. All of the potential construction and operational marine ecological impacts identified are deemed acceptable.