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 Southern Water Control Zone (WCZ). Detailed description of the physical characteristics of the marine environment of the Assessment Area and compliance of WQOs is provided in the ***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 reserve, coral communities, intertidal habitat, marine benthos of conservation interest, and marine ecological important species including Finless Porpoises (FPs) and amphioxus. 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 Po Toi (Southeast) 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: 30 Sep 2020, 22 Oct 2020, 30 Oct 2020 Dry Season: 15 Jan 2021, 6 Feb 2021
Coral Survey	20 Nov 2020
Drop Camera Survey	27 Dec 2020

4.3.2.2 Subtidal Benthos Survey

Wet Season

A total of 157 individual organisms were collected from the seven grab samples from Po Toi during the wet season survey (***Figure B2.3 of Appendix 4B***). The specimens belong to 7 Phyla with a total of 8 classes, 26 families and 36 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 comparing to dry season (***Table 4.2*** **and** ***Table 4.3***). In terms of infaunal abundance, the majority (~73%) of organisms recorded were from the Phylum Annelida. The polychaete worms, *Aglaophamus dibranchis* and *Prionospio ehlers*i were the most abundant species from the wet season survey (total abundance of both species = 29 individuals). No species of conservation interest was recorded in the survey. In terms of infaunal biomass, organisms from the Phylum Chordata contributed ~66% of the total biomass recorded, while organisms from Annelida and Arthropoda also contributed significant biomasses (~17% and ~11% respectively). The high biomass of Chordata was contributed by two fish species, *Odontamblyopus rubicundus* and *Paratrypauchen microcephalus* which are not species of conservation interest.

Dry Season

A total of 329 individual organisms were collected from the seven grab samples during the dry season survey. The specimens belong to 7 Phyla with a total of 10 classes, 43 families and 58 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 (~60%) of organisms recorded were from the Phylum Annelida and Nemertea (~16%). Ribbon worm (Phylum: Nemertea) was the most abundant species from the dry season survey (total abundance = 51 individuals). No species of conservation interest were recorded in the survey. In terms of infaunal biomass, organisms from the Phylum Mollusca contributed ~52% of the total biomass recorded, while organisms from Chordata also contributed significant biomasses (~30%). The high biomass of Mollusca was contributed by a number of species, primarily by a bivalve species, *Corbula erythrodon*.

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)
PT1	22	229.17	10	13	0.90	2.30	0.2583	0.0117
PT2	28	291.67	16	17	0.94	2.66	0.5850	0.0209
PT3	20	208.33	8	9	0.85	1.86	0.0930	0.0047
PT4	18	187.50	7	7	0.76	1.48	2.5160	0.1398
PT5	15	156.25	10	11	0.96	2.30	0.4144	0.0276
PT6	19	197.92	8	10	0.88	2.03	0.1763	0.0093
PT7	35	364.58	14	15	0.90	2.45	0.3430	0.0098

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)
PT1	43	447.92	19	20	0.91	2.71	0.1808	0.0042
PT2	34	354.17	13	14	0.92	2.43	0.0507	0.0015
PT3	94	979.17	29	34	0.90	3.18	0.7949	0.0085
PT4	61	635.42	19	25	0.91	2.93	2.2264	0.0365
PT5	24	250.00	14	18	0.97	2.81	0.7641	0.0318
PT6	52	541.67	19	24	0.93	2.96	0.4212	0.0081
PT7	21	218.75	10	11	0.94	2.27	4.8297	0.2300

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 -7 mCD	The seabed was mainly composed of bedrock in both shallow water (-3 to -4 mCD) and deep water (-5 to -7 mCD). Sparse hard coral colonies, such as *Tubastrea / Dendrophyllia* sp. and *Balanophillia* sp. were identified in deep water. Sparse octocorals, such as *Echinomuricea* sp. were recorded in deep water.
T2	-3 to -7 mCD	The site mainly composed of bedrock in both shallow water (-3 to -4 mCD) and deep water (-5 to -7 mCD). Hard coral colonies, such as *Tubastrea / Dendrophyllia* sp., were identified to be common in shallow and in deeper water. Sparse octocorals, such as *Echinomuricea* sp. were recorded in deep water.

Transects are located at southeast natural shores of Po Toi (T1 and T2) **(*Figure B2.1 of Appendix 4B*)**. The site mainly comprised of bedrock (51% - 75%). Colonies of hard coral were sparsely to commonly distributed (<5% - 30%), and octocorals were sparely distributed (<5%) in deeper water. Macroalgae (<5%) and other benthos (11 – 30 %), such as, sea anemones, zoanthids and sponges were also identified (***Table 4C.3*** of ***Appendix 4C***).

A total of thirteen hard corals species, ten octocorals species, three species of sea anemones, one zoanthid, one sponges, two algae species and one ascidian species were identified (***Table 4C.4*** of ***Appendix 4C***). The majority of corals recorded were common and widespread species in Hong Kong. Ahermatypic hard coral *Tubastrea / Dendrophyllia* sp. were common at both shallow and deep area at transect T2. Encrusting sponge was common at deep water of transect T1 and at shallow area of transects T1 and 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% - 30%) in general, with octocorals recorded at deeper waters.

4.3.2.4 Drop Camera Survey

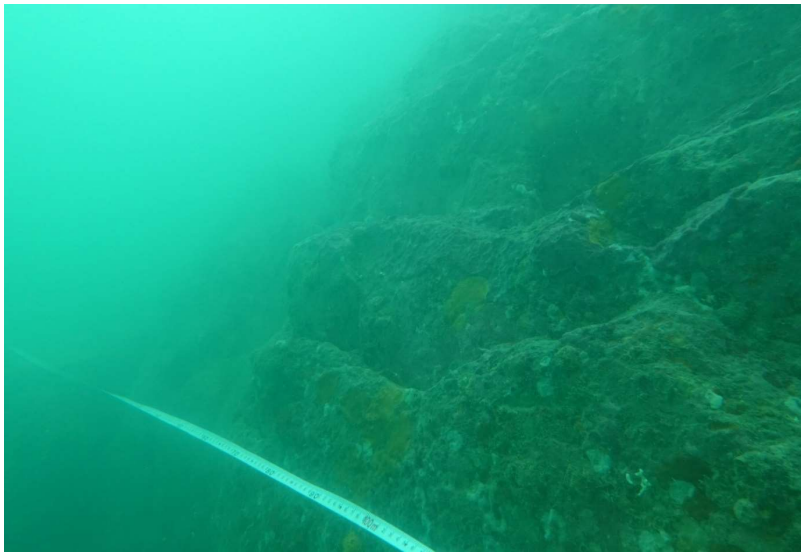
Drop camera surveys were conducted at southeast of Po Toi at the survey locations shown in ***Figure B2.1 of Appendix 4B***. A total of seven stations were surveyed within the Project site with the use of a drop camera system to record the benthic attributes by positioning the system ~1 m above the seabed. The results showed that the seabed at the survey locations (~-30 mCD) was consisted of silty mud without any hard substrate and benthic organisms recorded. Representative photos 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 Marine Reserve, and Site of Special Scientific Interest (SSSI). No designated Country Park and Special Area are



a) Photo of seabed dominant with bedrock recorded in deep waters (-5 to -7 mCD).

b) Photo of encrusting sponge recorded during the survey.

c) Photo of the pink-orange hard coral *Tubastrea* sp. recorded during the survey.

d) Photo of gorgonian *Echinomuricea* sp. recorded during the survey.

ERM

FIGURE 4.1

Representative Photos of Coral Survey at Po Toi (Southeast)

a) Soft substrate with silty mud at PT1.

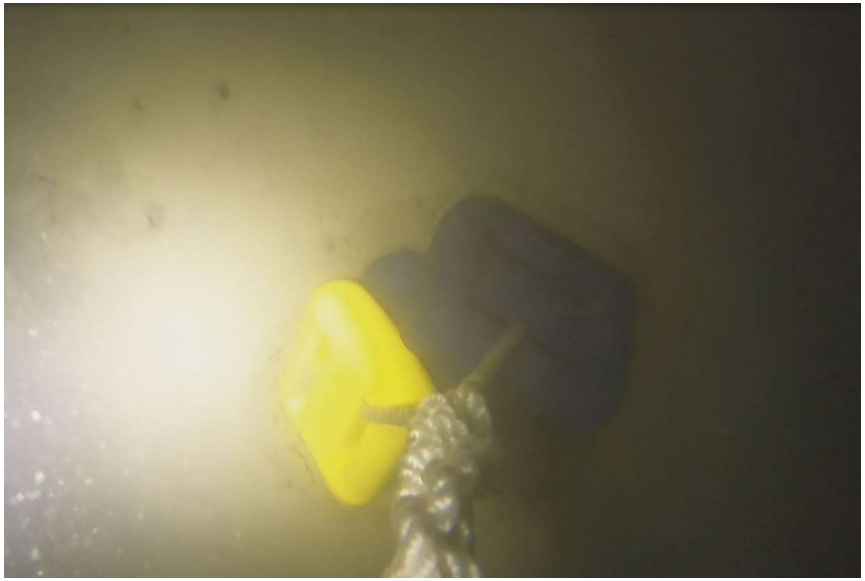
b) Soft substrate with silty mud at PT2.

c) Soft substrate with silty mud at PT3.

d) Soft substrate with silty mud at PT4.

FIGURE 4.2a

Representative Photos of Drop camera Survey at Po Toi (Southeast)



e) Soft substrate with silty mud at PT5.

f) Soft substrate with silty mud at PT6.

g) Soft substrate with silty mud at PT7.

ERM

FIGURE 4.2b

Representative Photos of Drop camera Survey at Po Toi (Southeast)

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 Existing, Proposed and Potential Marine Reserve

Cape D' Aguilar Marine Reserve (CDMR) is the marine reserve within the Assessment Area. No other existing or proposed marine reserves or marine parks are identified within the Assessment Area. Details of the marine reserve are provided in ***Table 4A.2.1 of Appendix 4A***. The location of the marine reserve is provided in ***Figure 4A.2.1 of Appendix 4A*** (41).

4.3.3.3 Sites of Special Scientific Interest

Sites of special scientific interest in the Assessment Area include Hok Tsui (Cape D'Aguilar) Site of Special Scientific Interest (SSSI). Hok Tsui (Cape D'Aguilar) is located at ~4 km away from the Project site which is considered to be too far to be affected by the Project. Details of the SSSI are provided in ***Table 4A.2.1 of Appendix 4A.*** The location of Hok Tsui (Cape D'Aguilar) SSSI is provided in ***Figure 4A.2.1 of Appendix 4A*** (42).

4.3.3.4 Marine Mammals

Finless Porpoises (FPs) are mainly distributed in the southern and eastern waters of Hong Kong, while Chinese White Dolphins (CWDs) are mainly distributed in western and southwestern waters of Hong Kong. As the Project site lies within southern Hong Kong waters, the following discussion will mainly focus on FPs. With reference to the AFCD Marine Mammal Monitoring Report results during 2012-2021 (43), it was reported that porpoise densities were low to moderate around the Po Toi Islands (i.e. Po Toi, Beaufort Island, Sung Kong and Waglan Island), in the offshore waters in Po Toi survey area, as well as at the juncture of the Po Toi and Ninepins survey areas in the wet seasons (June through November). The porpoise densities at the Project site were low compared to offshore waters (***Figure 4A.2.4 of Appendix 4A***). The encounter rate of FP varied over time between 2004-2021 and the FP encounter rate at Po Toi waters was slightly lowered in recent years (2017-2020) (***Figure 4A.2.5 of Appendix 4A***). During 2021, higher density (DPSE values) of FP was recorded at some locations in the Assessment Area, including southern waters of Po Toi. However, it should be noted that the survey effort in Po Toi were considered to be relatively low and could cause bias. Regardless, the survey results from AFCD consistently indicate that FP utilises the waters in the Assessment Area in the recent years but mainly in the summer and autumn months. The encounter rate and seasonal distribution of FPs remain to be similar in recent years and it is considered that the data from the long-term marine mammal monitoring conducted by AFCD are comprehensive and adequate for this Project. No further baseline survey for marine mammals would be necessary.

4.3.3.5 Mangroves and Horseshoe Crab

No mangrove stands were found within the Assessment Area and at the Project site. Species of conservation interest associated with the habitat such as horseshoe crab is not present and the impact of the Project on mangroves and horseshoe crab is therefore not anticipated.

4.3.3.6 Coral Communities

Coral communities in the southern waters of Hong Kong generally have a lower diversity and abundance due to the influence of Pearl River outflow (44) compared to the eastern waters of Hong

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

(42) Planning Department (2021) Register of Sites of Special Scientific Interest (SSSIs).

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

(44) 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.

Kong with higher salinity and lower turbidity [45]. In the southeastern and southern parts of Hong Kong, stony corals generally form small and isolated colonies on hard bottom substrates. Both coral coverage and species diversity are found to be low. A recent study suggested that the southern Hong Kong waters, including Waglan Island and Cape D'Aguilar, featured low coral cover and low generic richness of small encrusting colonies when comparing to northeastern, southeastern and eastern coastal waters [46].

Unlike the hermatypic hard corals, ahermatypic octocorals (including gorgonians, soft corals and black corals) which many of them do not require light for zooxanthellae photosynthesis, are more widely distributed in southern waters and often occur at greater depths. Literatures revealed that hard corals in the areas around Po Toi have a coverage of generally less than 10% and <5% recorded near Po Toi (Southeast) region. No Reef Check surveys were conducted at or near the Project site during 2016-2020. Coral communities with higher ecological value were recorded at Po Toi (northeast), Beaufort Island (east to southeast), Sung Kong (northwest) and Waglan Island (southwest and southeast) which are located at >0.3km, 3 km, 2.4 km and 1.1 km from the Project site respectively. Indicative locations of the coral communities with higher ecological value 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 a total of 25 species of hard corals, 10 species of octocorals and 2 species of black corals were found in southeastern shore of Po Toi. The coral colonies in this region composed of sparse (<5% coverage) and low diversity of hard corals and octocorals. The species recorded are generally common and widespread, including ahermatypic hard corals *Tubastrea / Dendrophyllia* sp., hermatypic hard corals *Plesiastrea versipora* and *Porites* sp. and octocorals *Dendronephthya* sp. and *Echinomuricea* sp.. Coral communities of high ecological concern were not identified within and in the vicinity of the Project site. High coverage of octocorals and black corals (51-75%) were found mainly in deep waters of Lo Chau Mun (Southeast of Beaufort Island).

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. Ahermatypic hard corals *Tubastrea / Dendrophyllia* sp. were common at both shallow and deep areas while other corals and benthos were generally present in isolated colonies. Overall, the surveyed areas showed low to moderate percentage coral coverage (<5% - 30 %) and low to moderate sessile taxa coverage on the subtidal hard substrate. Results of drop camera survey showed that the seabed of this site (~-30 mCD) was dominated of silty mud without any hard substrate or benthic organisms.

4.3.3.7 Amphioxus

Amphioxus are mostly present within Hong Kong's eastern waters, with densities ranging from 10 to 400 ind / m^2 predominantly at sites in Tai Long Wan, Nam She Wan, Long Ke Wan and Pak Lap Wan 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. From the baseline subtidal benthos survey, it was reported that were no findings of amphioxus within the Project site.

(45) AFCD (2005) Field Guide to Hard Corals of Hong Kong.

(46) Yeung YH, Xie JY, Kwok CK, Kei K, Ang P, Chan LL, Dellisanti W, Cheang CC, Chow WK, Qiu JW (2021). Hong Kong's subtropical scleractinian coral communities: Baseline, environmental drivers and management implications. Marine Pollution Bulletin 167: 112289

(47) AFCD (2005) Field Guide to Hard Corals of Hong Kong.

(48) Yeung CW, Cheang CC, Lee MW, Fung HL, Chow WK, Ang P, (2014) Environmental variabilities and the distribution of octocorals and black corals in Hong Kong. *Marine Pollution Bulletin,* 85(2), 774–782.

(49) 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.

(50) Fabricius KE, McCorry D (2006) *Op. cit.*

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

4.3.3.8 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.

Studies showed that benthic communities in the southern waters are generally dominated by common and widespread species without any species of concern identified, such as seagrass species. Therefore, impact of the Project on the subtidal assemblages is not anticipated.

4.3.3.9 White-Bellied Sea Eagle

Breeding behaviour of white-bellied sea eagle (WBSE) was recorded in 4-6 years in the Sung Kong nesting ground from 2002 to 2020 within the Assessment Area, which the nesting ground is located > 1 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. Compared with the rest of the nesting sites found in Hong Kong by the AFCD survey, the usage of the nesting site as breeding ground is relatively low and the majority of nesting sites with more than 10 years of recorded breeding behaviour are mainly located at Sai Kung east like Tsim Chau and in Port Shelter. With the relatively low usage of nesting grounds of WBSE in the vicinity of the Project site, the impact of the Project on the WBSE is therefore not anticipated. Location of the WBSE nesting grounds is provided in ***Figure 4A.2.1 of Appendix 4A*** [52].

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** **4*C*** the ecological importance of each habitat has been determined according to the *EIAO-TM Annex 8* criteria.

Within the Assessment Area (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;
- 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 ***Table 4.5*** to ***Table 4.9***.

(52) 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.

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

Criteria	Cape D' Aguilar Marine Reserve and Cape D' Aguilar SSSI
Naturalness	Natural intertidal and subtidal hard and soft bottom habitat and marine waters
Size	~31.5 ha
Diversity	High
Rarity	Exhibits a high diversity of habitats in a small area which is uncommon in Hong Kong waters. Habitats harbor various marine organisms, including different corals, such as, ahermatypic hard corals, hermatypic corals, soft corals, etc.
Re-creatability	Not re-creatable
Fragmentation	Unfragmented
Ecological Linkage	Linked to the intertidal and subtidal habitats
Potential Value	Already designated as marine reserve
Nursery / Breeding Area	No significant records identified
Age	Designated as marine reserve in July 1996 and SSSI in July 1990
Abundance	High abundance of hard coral has been recorded at the site
Ecological Importance	**High**

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

Criteria	Hard Bottom Intertidal Habitat
Naturalness	Natural habitat
Size	Large, majority of the shoreline within and in the vicinity of the Project site
Diversity	High
Rarity	Intertidal organisms recorded at site such as seasnail, *Diodora cruciata* and red algae, *Hildenbrandia rubra* are generally considered as widespread and common in Hong Kong
Re-creatability	Not re-creatable
Fragmentation	Unfragmented
Ecological Linkage	Not functionally linked to any high value habitat in a significant way
Potential Value	Unlikely to become an area of conservation value
Nursery / Breeding Area	No significant records identified
Age	N/A
Abundance	Low abundance
Ecological Importance	**Low**

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

Criteria	Po Toi (Southeast)	Lo Chau Mun (Beaufort Island Southeast)	Sung Kong Island (Northwest)	Waglan Island
Naturalness	Natural	Natural	Natural	Natural
Size	Large. The natural rocky shore of Po Toi is about 11 km in length	Large. The natural rocky shore southeast to Beaufort Island is about 700 m in length	Small. The natural rocky shore at Sung Kong Island Northwest is about 150 m in length	Moderate. The natural rocky shore at Waglan Island South is about 2 km in length
Diversity	Low to Moderate	Low to moderate	Low to moderate	Low to moderate
Rarity	Assemblages comprise typical common and widespread hard corals and octocorals species in Hong Kong, including ahermatypic hard coral *Tubastrea / Dendrophyllia* sp., hermatypic hard coral *Plesiastrea versipora* and *Porites* sp. and octocoral *Dendronephthya* sp. and *Echinomuricea* sp	Assemblages mainly comprise typical common hard corals and octocorals species in Hong Kong, including ahermatypic hard coral *Tubastrea / Dendrophyllia* sp., hermatypic hard coral *Plesiastrea versipora* and *Cyphastrea serailia* and octocoral *Dendronephthya* sp. and *Echinomuricea* sp	Assemblages are considered to mainly comprise typical common and widespread species in Hong Kong. No rare species is recorded at the site	Assemblages are considered to mainly comprise typical common and widespread species in Hong Kong. No rare species is recorded at the site
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	Not functionally linked to any high value habitat in a significant way
Potential Value	Habitat is relatively undisturbed which might exhibit some potential value	Moderate-high coverage of octocorals and black corals were recorded at the deeper water of the site which exhibit higher ecological value	Habitat is relatively undisturbed which might exhibit some potential value	Habitat is relatively undisturbed which might exhibit some potential value
Nursery / Breeding Area	No significant records identified	No significant records identified	No significant records identified	No significant records identified
Age	N/A	N/A	N/A	N/A

Criteria	Po Toi (Southeast)	Lo Chau Mun (Beaufort Island Southeast)	Sung Kong Island (Northwest)	Waglan Island
Abundance	Low coverage of coral is present	Moderate to high coverage of octocoral and black coral is present	Low to moderate coverage of coral is present	Low to moderate coverage of coral is present
Ecological Importance	**Low**	**Moderate to High**	**Low to Moderate**	**Low to Moderate**

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

Criteria	Po Toi (Southeast)
Naturalness	Natural
Size	~100 ha
Diversity	Low
Rarity	The assemblages are typical of similar habitats in the Hong Kong waters, which are dominated by polychaetes. No rare species has been recorded in the subtidal soft bottom habitat in this area
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	The assemblages are of low to moderate abundance and biomass
Ecological Importance	**Low**

Table 4.9 Ecological Importance of Marine Waters within the Project site

Criteria	Waters in Po Toi and in the vicinity
Naturalness	Natural
Size	Waters around Po Toi, Beaufort Island, Sung Kong and Waglan
Diversity	Mainly FPs in the vicinity of the Project site
Rarity	FP is a resident species in Hong Kong. Commonly observed in southern waters of Hong Kong
Re-creatability	Not re-creatable
Fragmentation	Unfragmented
Ecological Linkage	Linked to FP and marine habitat nearby
Potential Value	Potential habitat to develop conservation importance
Nursery / Breeding Area	Potential nursery and breeding area for FPs
Age	N/A
Abundance	The Project site is located within the potential habitats of FP.
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 Coral (>20 spp.)	*Acropora solitaryensis, Goniopora lobata, Porites* sp., *Duncanopsammia peltata,* etc.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Majority being common and widely distributed in the eastern waters of Hong Kong with some uncommon species	✓	✓	In the vicinity of the Project site and throughout southeastern waters of Hong Kong
Cup Coral	*Balanophyllia* sp.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common and widely distributed in Hong Kong, especially in western waters	✓	✓	In the vicinity of the Project site and throughout southeastern waters of Hong Kong
Cup Coral	*Tubastrea / Dendrophyllia* sp.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common and widely distributed in eastern and southern waters in Hong Kong	✓	✓	In the vicinity of the Project site and throughout southeastern waters of Hong Kong
Black Coral	*Antipathes curvata, Cirripathes sinensis, Antipathes* sp., *Cirripathes* sp.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common but sparsely distributed in the north-eastern waters of Hong Kong	✓		Two species are recorded in the vicinity of the Project site. Generally present at greater depths in the northeastern and southeastern waters of Hong Kong e.g. Lo Chau Mun, 3 km away from the Project site
White-bellied Sea Eagle	*Haliaeetus leucogaster*	Listed in Wild Animals Protection Ordinance (Cap. 170)	Uncommon resident. Widely distributed in coastal areas throughout Hong Kong	✓		Sung Kong Island, 1.1 km away from the Project site

Common Name	Scientific Name	Protection Status	Distribution, Rarity and other Notes	Literature	Surveys	Recorded Location
		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)				
Finless Porpoise	*Neophocaena phocaenoides*	Wild Animals Protection Ordinance (Cap.170) Protection of Endangered Species of Animals and Plants Ordinance (Cap.586) Listed as “Endangered” in the China Species Red List Listed as “Grade II National Key Protected Species” in China Listed as "Vulnerable" in the IUCN Red List of Threatened Species	Range across Hong Kong southern and eastern waters from Soko Islands to Tung Ping Chau, and in PRC waters	✓		In the vicinity of the Project site, and throughout eastern and southeastern waters of Hong Kong

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	Sung Kong Island	1.9
	Waglan Island	2.3
	Po Toi	0.3
	Lo Chau Mun (Southeast of Beaufort Island)	2.3
Designated Marine Reserve	Hok Tsui (Cape D'Aguilar Marine Reserve)	4.0
Designated SSSI	Hok Tsui (Cape D'Aguilar SSSI)	4.0

4.4 Assessment Methodology

The *Method Statement on Marine Ecological Impact Assessment for Po Toi (Southeast) 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 100 ha and a small area of benthic habitat. 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 CDMR which is located far away (~4 km from Project site), 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 was not recorded within the Project site. The overall coral coverage within and in the vicinity of the Project site is considered to be low to moderate coral coverage (<5% - 30 %) with mostly common and widespread species. Other species recorded are considered to occur frequently in Hong Kong. Overall, the subtidal habitat within the Project site was considered as of low ecological importance. FPs usage of marine waters around Po Toi and Southern waters of Hong Kong were shown to be moderate and no recorded sightings were found within the Project site. Considering that the area affected represents only a small portion of the available habitat for the FPs and a minor portion of an individual animal's movement range, and only a small number of marine vessels will be present within and in the vicinity of the Project site during the construction phase, the potential risk of vessel collision with FPs is also not expected.

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, the disturbance would represent a small fraction of the widely available habitat. The 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 organisms, such as fish species and marine mammals, 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. Dredging and other noise-intensive construction activities are absent from this Project, therefore underwater sound generated from construction activities is not expected to produce pulsed high-energy sound sources that would affect the hearing and echolocation ability of marine mammals within and in the vicinity of the Project site.

Waters within the Assessment Area and its vicinity is subject to high levels of marine traffic by similar types of vessels. It is reasonable to assume that marine organisms, are habituated to high 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 <100 ha. The relatively small extent of area affected compared to similar habitats within the Assessment Area which is of overall low ecological importance, impacts are considered to be of minor significance and unacceptable impacts on marine ecological resources are not expected. The area affected also represents only a small portion of the available habitat for the FPs and a minor portion of an individual animal's movement range, and only a small number of marine vessels will be present within and in the vicinity of the Project site during the operation phase, the potential risk of vessel collision with FPs is therefore not anticipated, unacceptable impacts on marine mammals due to the Project 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 the creation of artificial habitat may also include an increase of biological productivity and 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 organisms, such as fish species and marine mammals, 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 the marine organisms, such as fish species and marine mammals. 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 Po Toi FCZ and marine traffic at ferry routes near Po Toi pier. Marine organisms, such as fish species and marine mammals 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 CDMR which is located far away (~4 km from Project site).

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.

Relevant assessment criteria, i.e. Water Quality Objectives (WQOs) in the Southern WCZ, was 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, there are no notable changes for the predicted SS levels between baseline and project scenarios, which are 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 temporary 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. Changes in SS levels also do not appear to have a direct impact on marine mammals since these animals are air breathing and have evolved to inhabit areas near river mouths and estuarine-influenced coastal waters with high turbidity. Unacceptable impacts to ecological assemblages, including species of conservation importance such as marine mammals and amphioxus, if present in the vicinity of the Project site arising from elevated SS levels are therefore not anticipated. Other marine ecological sensitive receivers are predicted to be unaffected (as defined by the WQO and tolerance criterion).

With the fish farm production scale kept within the Project site’s maximum carrying capacity and the use of pellet feed within fish farms, potential impacts to marine ecological assemblages will be well managed. The Project site only occupies a small proportion of the habitats and supported ecological assemblages of low ecological value. Areas which supported marine ecological resources of moderate to high values are recorded at CDMR which is located far away at ~4 km from the Project site. As such, unacceptable impacts from fish farm operation on marine ecological resources, due to potential elevations of SS 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. Depletion of DO, however, do not appear to have a direct impact on marine mammals since these animals are air breathing and have evolved to inhabit areas near river mouths and estuarine-influenced coastal waters with high turbidity.

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 for both wet and dry seasons. The predicted 10th-percentile depth-averaged DO level at the Project site is above the corresponding assessment criterion. The comparison between the baseline and project scenarios shows that the mariculture operation at the Project site would result in no notable change in DO level and the predicted changes in DO levels were even lower or undetectable at other marine ecological sensitive receivers.

Overall, there is limited change in the predicted DO levels under with project scenario, 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 decrease 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 such as corals, which cannot escape from the hypoxia zone. Decreased oxygen content, however, do not appear to have a direct impact on marine mammals since these animals are air breathing and have evolved to inhabit areas near river mouths and estuarine-influenced coastal waters with high turbidity.

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 unionized ammonia at the Project site and all marine ecological sensitive receivers are below the corresponding assessment criterion, except for Total Inorganic Nitrogen (TIN). The predicted levels of TIN were higher than the corresponding assessment criterion at the Project site and all WSRs under baseline and project scenarios, as a result of relatively high background levels for TIN levels in the Southern WCZ. There was slight increase of predicted TIN levels at the Project site and the adjoining waters which are located within Finless Porpoise habitats in southern waters. Given such areas of TIN elevation are considered very small (<1% when comparing to the available Finless Porpoise habitats in Hong Kong waters), unacceptable impact to the Finless Porpoise habitat due to the Project is not anticipated. In addition, the corals at southeastern side of Po Toi Island are also expected to experience the slight increase of predicted TIN levels under the Project. Literatures suggested that the corals in Hong Kong have adapted to eutrophic condition with higher nitrogen concentrations [(53)(54)] and thus such slight increase in TIN levels is not expected to adversely affect the corals. According to historical records, minor increase of TIN levels of up to 0.2 mg/L were occasionally recorded at Po Toi FCZ, which is similar to the predicted levels under both the baseline and project scenarios and yet there was no adverse impact from Po Toi FCZ to the marine ecological sensitive receivers in the vicinity. Mariculture in Hong Kong has previously been operated under waters with elevated TIN levels and associated risks, such as algal blooms are some well-known risks that have

(53) Zhao Y, Law YS, Zhai XH, Zhou K, Chen MR, Qiu JW (2022). Urban coral communities and water quality parameters along the coasts of Guangdong Province, China. Marine Pollution Bulletin 180: 113821.

(54) Duprey NN, Yasuhara M, Baker DM (2016). Reefs of tomorrow: eutrophication reduces coral biodiversity in an urbanized seascape. Global Change Biology 22: 3550–3565.

been accustomed by mariculturists. Preventative measures, such as real-time water quality monitoring at existing FCZs and notification of heightened risk of algal bloom to mariculturists have been adopted by AFCD.

With the historical record of elevated TIN in Southern WCZ and also preventative measures to be adopted, 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 such as corals, which cannot escape from the hypoxia zone. Decreased oxygen content, however, do not appear to have a direct impact on marine mammals since these animals are air breathing and have evolved to inhabit areas near river mouths and estuarine-influenced coastal waters with high turbidity.

The water quality modelling results have indicated that the levels of chlorophyll-a were generally low across the Assessment Area, which were generally higher at the surface levels and at areas with shallower water depth. There is no change of the predicted levels of chlorophyll-a at the Project site and the levels are below the corresponding assessment criterion. All other marine ecological sensitive receivers within the Assessment Area are also below the 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 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, Table 1)*. 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		
Construction phase										
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 and ribbon worms.	All of the Project site (~100 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 and ribbon worms.	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
Operation phase										
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 and ribbon worms.	Localised to the vicinity of fish farm structures (<100 ha).	Long-term over Project duration.	Reversible	Small	Minor	No
Temporary relocation of	Fish farm	Marine waters and	Low	Common fish species and	Localised to the immediate vicinity	Temporary	Reversible	Small	Minor	The licensees will review the need of

Potential Impact	Source	Receiver	Nature of Impact						Overall Impact Significance	Mitigation / Precautionary Measures Required
			Habitat Quality	Species Affected	Size	Duration	Reversibility	Magnitude		
fish rafts / cages		benthic habitats within and in the vicinity of the Project site.		benthic fauna dominated by polychaetes.	of the area of fish rafts / cages relocation.					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 and ribbon worms.	Localised to the immediate vicinity of the sound-generating activities e.g. maintenance of the fish cages and marine vessel movement.	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 natural shores and benthic habitat within and in vicinity of the Project site.	Low	Common fish species and benthic fauna dominated by polychaetes and ribbon worms.	Localised to the vicinity of the fish farm.	Long-term over Project duration	Reversible	Small	Minor	Water quality mitigation measures would further reduce impacts.
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 (~100 ha).	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 and horseshoe crabs were not found within and in the vicinity of the Project site and WBSE nesting ground is found only to be of low usage at Sung Kong, potential cumulative impacts on these animals are not anticipated and these impacts are expected to mainly affect marine mammals, 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 southern Hong Kong waters. Outcomes of this evaluation, excluding the impact on water quality are summarised as follows:

- Changes in Marine Habitat: Since no other FCZ is currently proposed in the southeastern waters, the changes in habitat would approximately be 100 ha in total. Although the area affected covers a certain extent of Hong Kong waters, the provision of the proposed FCZ 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 southeastern 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 at 2.3 km away from the existing Po Toi FCZ and the cumulative effect of underwater sound will therefore consider the impact from the nearby Po Toi FCZ only. 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 Po Toi FCZ. 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 sufficient distance from the existing Po Toi FCZ. 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 at the southern waters of Hong Kong with high levels of marine traffic within and in the vicinity of the Project site, the cumulative effects of marine traffic disturbance to the 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, intertidal habitats, nearby marine reserve 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 far from key marine ecological habitats, such as key coral habitats around Lo Chau Mun (southeast of Beaufort Island) and CDMR, 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 (***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:

- <100 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 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 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.

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 values, whereas sensitive receivers of ecological values such as corals located at Lo Chau Mun (southeast of Beaufort Island) and existing marine reserve, CDMR are at a distance from the Project site. Species of conservation importance such as Finless Porpoises are found to have moderate abundance in the vicinity of the Project site and within the Assessment Area. Records of White-Bellied Sea Eagle nesting site was also found on Sung Kong but with relatively low usage. Other species of concern including amphioxus and horseshoe crabs are not found 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. ~100 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, such as fish species and marine mammals, 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 nearby Po Toi FCZ and Po Toi pier. 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 (<100 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, such as fish species and marine mammals, 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 high level of marine vessel operations near waters of Po Toi. The 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. Considering the historical record of elevated TIN levels in Southern WCZ and also preventative measures to be adopted at the Project site, the impact due to the predicted increase of TIN levels at the Project site only is expected to be of minor significance. Impact on the introduction of invasive species would be considered minor with regular monitoring of mariculture facilities. No marine ecological-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.