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Agriculture, Fisheries and Conservation Department

Consultancy Ref.: AFCD/FIS/02/19 Consultancy Service for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

Environmental Impact Assessment (EIA) Report for Establishment of Fish Culture Zone at Wong Chuk Kok Hoi

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1. INTRODUCTION

1.1 Background

Marine fish culture has been an important activity for fisheries production in Hong Kong over decades. Mariculture activities are required to operate under licence in designated Fish Culture Zones (FCZs) under the *Marine Fish Culture Ordinance (MFCO) (Cap. 353)*. In view of the environmental impact resulting from mariculture, there has been a moratorium on the issue of new marine fish culture licences (MFCLs) and licensed raft area extensions in the existing FCZs since 1990, as well as on the designation of new FCZs, except for a limited number of forced re-siting necessitated by public works. Given the technical advancement in mariculture techniques and strengthening of regulatory measures, together with the changes in the operation of the sector over the years, the environment of FCZs and marine environment in the vicinity have improved significantly in the past two decades.

In 2010, the Committee on Sustainable Fisheries (CSF), which was established by the Government to study the long-term goals, direction and feasible options for the sustainable development of local fisheries industry, recommended a review of the moratorium to facilitate fishermen to switch from capture fisheries to mariculture. Mariculture is considered a practical alternative for capture fishermen to make a living as their knowledge on marine environment and fish would be useful in farming marine fish.

To pave the way for facilitating the sustainable development of the local mariculture sector, the Agriculture, Fisheries and Conservation Department (AFCD) proposed to lift the moratorium by designating new FCZs and issuing new MFCLs. In 2014, the AFCD commissioned a consultancy study to explore suitable sites as new FCZs on the basis of a list of social and environmental criteria with reference to the latest international fish culture practices (1). Relevant stakeholders, including Government bureaux / departments and mariculture representatives, have been consulted to gauge their views on site selection. The mariculture sector in general supported the designation of new FCZs and agreed that the sector should be modernised. Four locations have been shortlisted as potential sites for the designation of new FCZs, including Wong Chuk Kok Hoi FCZ, Outer Tap Mun FCZ, Mirs Bay FCZ and Po Toi (Southeast) FCZ. The Chief Executive announced in the 2018 Policy Address that the Government would recommend designating new FCZs at suitable locations, which would create room for the mariculture sector to grow further, including allowing capture fishermen to switch to this sustainable mode of operation, making it possible for the development of newer type of deep-water mariculture in the open sea, and attracting new entrants.

This Environmental Impact Assessment (EIA) report presents the assessment findings of one of the proposed FCZ sites, i.e. Wong Chuk Kok Hoi FCZ (hereafter referred to as “the Project”). The location plan of the Project is shown in ***Figure 1.1***.

1.2 Nature of the Project

The Project aims to establish a new FCZ at Wong Chuk Kok Hoi to facilitate the sustainable development of the local mariculture sector. The scope of the Project includes:

- Assembly and anchorage of fish farm structures which are manufactured off-site, including fish rafts / cages, auxiliary facilities and mooring system, within the Project site; and
- Marine fish culture activities within the Project site regulated under the *Marine Fish Culture Ordinance (Cap. 353).*

No land-based works, structures and activities will be involved in the Project.

(1) ERM (2018) Consultancy Ref. AFCD/FIS/01/14 Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study

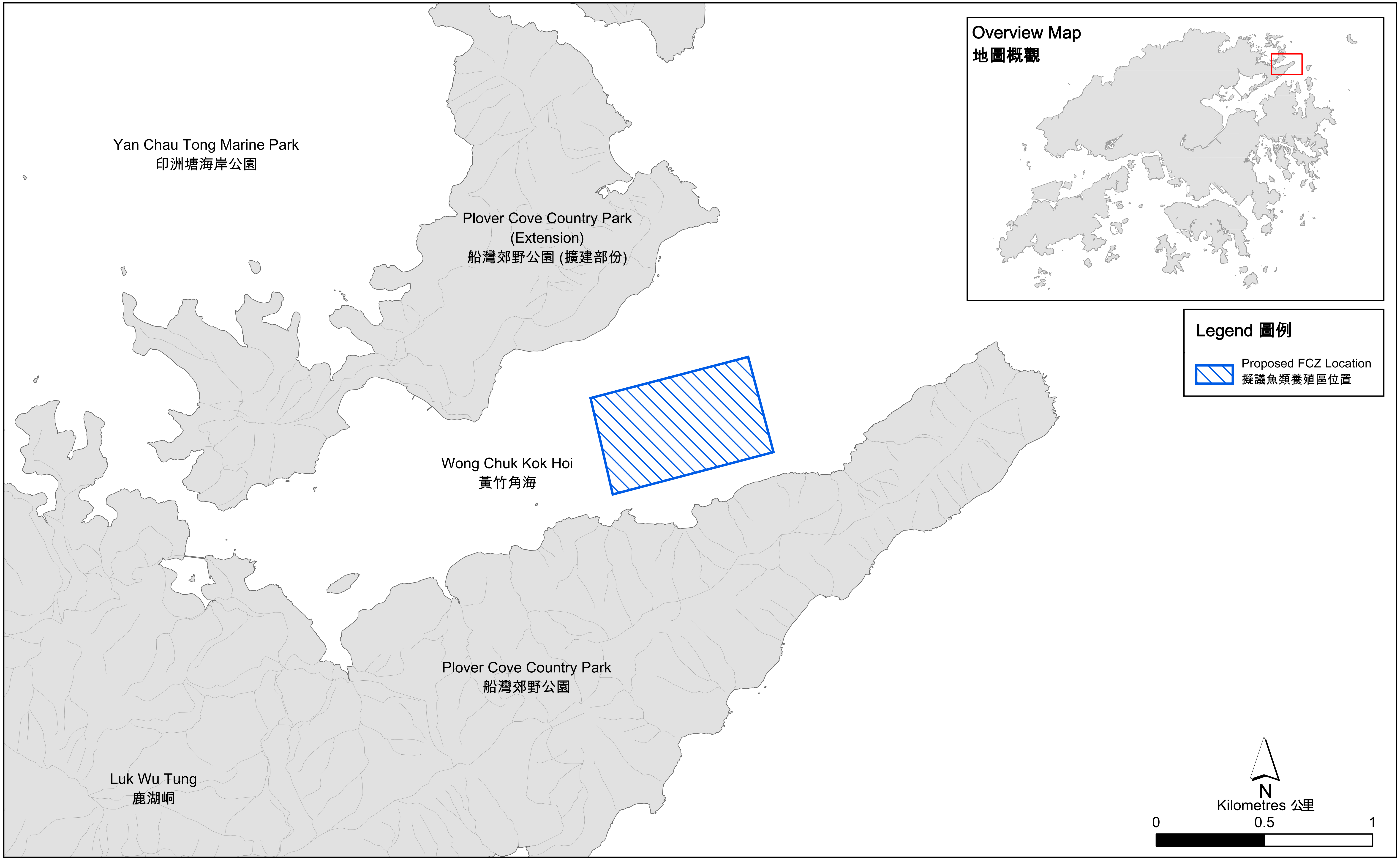

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Figure 1.1
圖 1.1

Location Plan for the Establishment of Fish Culture Zone (FCZ) at Wong Chuk Kok Hoi
在黃竹角海設立魚類養殖區的位置圖

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1.3 Designated Project

The Project is a designated project by virtue of Item M.1(a) of Part I of Schedule 2 of the *EIAO*, which specifies "A fish culture zone more than 5 ha in size" and requires an Environmental Permit (EP) under the *EIAO* for its construction and operation.

In accordance with the requirements of Section 5(1)(a) of the *EIAO*, an application for an EIA Study Brief for the Project was submitted on 15 October 2019 under *EIAO* with a Project Profile (PP) (No. PP-590/2019). An EIA Study Brief (No.ESB-324/2019) for the Project (hereafter referred to as "the Study Brief") was issued on 27 November 2019 in accordance with Section 5(7)(a) of the *EIAO*.

1.4 Purpose and Objectives of this EIA Study

The purpose of this EIA study is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the Project and associated works that will take place concurrently. This information will contribute to decisions by the Director of Environmental Protection on:

- the overall acceptability of any adverse environmental consequences that are likely to arise as a result of the Project;
- the conditions and requirements for the detailed design, construction and operation of the Project to mitigate against adverse environmental consequences wherever practicable; and
- the acceptability of residual impacts after the proposed mitigation measures are implemented.

In more detail, the specific objectives of this EIA study defined in the Study Brief are as follows:

(i) to describe the Project and associated works together with the requirements and environmental benefits for carrying out the proposed project;

(ii) to identify and describe the elements of the community and environment likely to be affected by the Project and/or likely to cause adverse impacts to the Project, including both the natural and man-made environment and the associated environmental constraints;

(iii) to identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

(iv) to identify and quantify any potential losses or damage to flora, fauna and natural habitats;

(v) to identify and quantify any potential water quality, marine ecological and fisheries impacts arising from the construction and operation of the Project and to propose measures to mitigate these impacts;

(vi) to identify any landscape and visual impacts and to propose measures to mitigate these impacts;

(vii) to identify any negative impacts on sites of cultural heritage and to propose measures to mitigate these impacts;

(viii) to propose the provision of infrastructure or mitigation measures so as to minimise pollution, environmental disturbance and nuisance during construction and operation of the Project;

(ix) to investigate the feasibility, effectiveness and implications of the proposed mitigation measures;

(x) to identify, predict and evaluate the residual environmental impacts (i.e. after practicable mitigation) and the cumulative effects expected to arise during the construction and operation phases of the Project in relation to the sensitive receivers and potential affected uses;

(xi) to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project which are necessary to mitigate these residual environmental impacts and cumulative effects and reduce them to acceptable levels;

(xii) to design and specify the environmental monitoring and audit requirements; and

(xiii) to identify any additional studies necessary to implement the mitigation measures of monitoring and proposals recommended in this EIA report.

This EIA Report has been prepared in accordance with the requirements in the EIA Study Brief (No. ESB-324/2019) and the *Technical Memorandum on Environmental Impact Assessment Process* issued under the EIAO (*EIAO-TM*) for the Project, the aim being to obtain an EP under the EIAO. The description of the Project presented in this EIA Report has been based on the best available information from AFCD that describes the relevant construction activities, operational details and baseline information describing the conditions relating to the Project and its surrounding environment.

1.5 Public Engagement

Project Profile No. PP-590/2019 was exhibited to the public for comments on 16 October 2019. Public offered their views during the 14-day public inspection period of the Project Profile. The key comments received from the public and responses are summarised in ***Appendix 1A***.

During the course of this EIA Study for the Project, AFCD have been reaching out to potential stakeholders to explain the Project, and seek their views and opinions. Stakeholder engagement activities, which commenced in June 2021, included briefings and meetings with interest groups including members of the Legislation Council, fishermen groups, mariculturists, environmental bodies etc. Details of the stakeholder engagement activities undertaken and the feedback received are presented in ***Appendix 1A***. The feedback and opinions obtained from the stakeholders have been fully considered and incorporated, where applicable, as part of the technical assessments undertaken in this EIA Study.

1.6 Structure of this Report

Following this introductory section, the remainder of this EIA Report is arranged as follows:

- ***Section 2*** presents the description of the Project and need for the new FCZ and site selection;
- ***Section 3*** presents the water quality impact assessment;
- ***Section 4*** presents the marine ecological impact assessment;
- ***Section 5*** presents the fisheries impact assessment;
- ***Section 6*** presents the assessment of the waste management implications;
- ***Section 7*** presents the visual impact assessment;
- ***Section 8*** presents the noise impact assessment;
- ***Section 9*** presents the assessment of cultural heritage impact including marine archaeological impact;
- ***Section 10*** presents the Environmental Monitoring and Audit Requirements; and
- ***Section 11*** provides a summary of the conclusions and environmental outcomes.

2. PROJECT DESCRIPTION

2.1 Purposes and Objectives of the Project

The Project involves the establishment of a new FCZ at Wong Chuk Kok Hoi for mariculturists to operate their fish rafts. The main purpose and objective of the Project is to provide opportunities to develop a newer type of deep-water mariculture, create room for the mariculture sector to grow further and attracting new entrants, potentially allowing capture fishermen to switch to a sustainable mode of operation.

2.2 Background and History of the Project Site

The Project site at Wong Chuk Kok Hoi is within the waters of the Northeast New Territories and is located within the Geopark (Northeast New Territories Sedimentary Rock Region) (***Figure 1.1***). The Project area will be approximately 35 hectares (~750 m long and ~450 m wide) in size. Major environmental elements surrounding the Project include Plover Cove Country Park and Yan Chau Tong Marine Park (YCTMP). The Tolo Channel (Northern Coast) is located more than 100 m south of the Site and was designated as a Site of Special Scientific Interest (SSSI) in 1982 due to geological interest [(2)]. The Project site is exposed to prevailing northeastern and eastern winds during the winter months. The Project is situated in an area with a water depth ranging from -10 to -15 m.

The land surrounding the Project site is generally rural area with no planned developments within the vicinity of the FCZ area. There is no historic use of the Project site based on the existing information. The Project is not located within and / or in the vicinity of historical or existing infrastructure facilities. No historical contamination concern is identified within the Project site. There is a general lack of infrastructure in and within the vicinity to the Project site. The closest non-gazetted beaches are over 1,000 m away at Double Island and Crescent Island. There is an existing fish culture operation at Wong Wan FCZ, ~900 m west to the Project site.

In terms of ecological conditions, Wong Chuk Kok Hoi FCZ has been identified as being within spawning ground and nursery area of commercial fisheries resources with majority of fisheries resources of low commercial value. Coral communities have been recorded within the vicinity to the Project site, and the Project site boundary has later been refined to avoid areas with moderate coral cover.

2.3 Environmental Benefits of the Project

2.3.1 Sustainable Mariculture Development in Hong Kong

AFCD has been actively supporting the modernization and sustainable development of the local fisheries industry and enhancing their competitiveness through a multi-pronged approach. Amongst the various measures that have been recommended, the designation of new FCZs and the promotion of the adoption of advanced and environmentally friendly culture practices are practical means to promote mariculture development. The sustainable development of mariculture and the designation of new FCZs can have the following benefits:

- Increase local mariculture production to support local demand for live marine fish, with a quality, healthy, safe, diversified and stable supply with low carbon footprint;
- Provide an avenue for capture fishermen, who face various operational challenges, to switch to a sustainable operation mode, which in turn alleviates local fishing pressure and promotes the conservation and recovery of fisheries resources and preservation of the marine environment;

(2) Planning Department (2005) Tolo Channel (North Coast).

- Allow mariculturists of the existing FCZs to consider pursuing modernised and sustainable modes of operation in the new FCZs, such that the marine environment of the existing FCZs can improve when the level of mariculture activities there decreases;
- Larger production scale enabled with technology can allow operating costs to be optimised, and hence improving cost-efficiency and competitiveness;
- Provide high value-added fisheries products and assists the fisheries sector to seize the opportunities in the Greater Bay Area (GBA) and other places;
- Attract new entrants and business opportunities to further grow the sector and related trades organically, also providing employment opportunities.

Overall, the sustainable development of mariculture in Hong Kong, by means of designating new FCZs, plays a critical role in fostering support for the fisheries industry which is an important local cultural asset with a long history and valuable contributions to Hong Kong's economy and society. A sustainable fisheries industry will help establish and maintain marine biodiversity such that our future generations can enjoy a diverse and rich marine ecological environment.

Deep sea mariculture with advanced technologies is a global trend in sustainable fisheries development. The environmental considerations of different development options including site selection to establish the new FCZ for sustainable mariculture at deeper and open water are further discussed in ***Section 2.5***.

2.3.2 Advanced Mariculture Operation in Deeper Waters

Advanced mariculture technologies which promote modernisation of mariculture activities and sustainable modes of operation will be used at the new FCZ. The new FCZ at deeper water depths allows fish cages of larger size to be used; and while more fish stock can be kept within a larger area of the water column to achieve optimal stock density and a good mariculture environment with sufficient circulation, sufficient separation distance between the bottom of the fish cage and the seabed as well as among fish cages can still be maintained to minimise water quality impact. This setting together with the open sea environment allows adequate water circulation and prevents the build-up of organic content and degradation of the nearby marine environment. Consequently, organic content is also not built up on the seabed and maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided.

The framework of fish cages would use weather-resistant materials such as high-density polyethylene (HDPE) and steel truss cages which are highly durable compared to traditional cages on rafts and are less prone to damage that may cause general / floating refuse on the sea. These modern fish cages can also be a submersible/ semi-submersible design to withstand strong waves and surges such that the fish cages can remain onsite during typhoons with minimal fish loss/ escape. This would reduce the need of fish cage relocation during adverse weather and thereby reducing the risk and potential impact on local ecology and fisheries associated with fish escape.

Only pellet feed or alternative feed with better feed conversion ratio will be permitted within the proposed FCZ. Pellet feed generally floats on the water surface that could minimise feed wastage to seabed, thus reducing the potential pollution loading and minimising impacts to water and sediment quality. On the other hand, pellet feed contains less moisture (~10%) that can be easily stored at FCZ and minimise the potential transmission of parasitic and infectious disease to fishes, thus reducing potential organic waste generation due to feed wastage and fish carcasses and dead fish arising from the fish culture operation.

In addition, operations at these larger fish cages at deeper waters will involve green technology and automation, such as the use of renewable energy (solar and wind energy systems) and automated/ remote fish feeder machines to reduce feed wastage and physical labour. The use of technology and automation can reduce emissions (e.g. from diesel generators for electricity generation), wastes and water quality impacts.

Fish farm structures will provide artificial substrates as potential marine habitats. The structures will form habitat and shelter for fishes and a range of marine organisms. With the use of Integrated Multi-trophic Aquaculture (IMTA) (***Section 2.6.2.3***), a more complex habitat with food webs can be built where wastage from mariculture is the food sources for filter feeders, deposit feeders and other fishes around the fish farm. This may have potential positive effect on marine ecological resources within and adjacent to the Project site. Some of these species serve not only as nutrient sinks which help maintain the water quality of the surrounding area, but also as harvested species to improve commercial return.

All in all, the advanced modes of mariculture operations in deeper waters are considered to be by far more environmentally friendly than the more conventional modes of operations in the existing FCZs. Locally produced fisheries products at this scale can provide low carbon, sustainable and secure food sources for Hong Kong.

2.4 Scenarios with and without the Project

2.4.1 Without Project Scenario

In the absence of new FCZs, the fisheries sector would need to rely on existing FCZs to provide grounds for mariculture development. Consequently, the industry would have limited capacity to make use of advanced, and most importantly more environmentally friendly, mariculture technologies which work best in deeper waters and have limited potential and cost-efficiency to be adopted in the existing FCZs mostly in shallow waters. Even though some elements of the mariculture operations could be modernised and improved, e.g. use of more weather resistant and durable materials, renewables energy and technology, better quality of fish feed etc., there is little room to enhance the mariculture environment and production in the existing FCZs given the lack of incentives from the existing family-based, small-scale operations, and the reluctance of new entrants to invest in mariculture in these existing FCZs which is once perceived as environmentally constrained and financially risky. These existing FCZs operating as status quo are not suitable for the sustainable development of mariculture in Hong Kong. Without new mariculture sites and methods, it will be challenging for mariculturists to invest and diversify, mariculture production will continue to decline in quality and quantity with reference to the production trend of previous years, fishermen's livelihood will be adversely affected, and the development of the fisheries sector will be halted.

2.4.2 With Project Scenario

The proposed FCZ at Wong Chuk Kok Hoi is one of the measures that support the sustainable development of mariculture in Hong Kong through the designation of new FCZs. With the Project in place, the environmental benefits associated with the sustainable development of mariculture and the use of advanced mariculture operation (***Section 2.3***) can be realised. Ultimately, in line with the long-term goals developed by the Committee on Sustainable Fisheries that AFCD set up in late December 2006, the establishment of new FCZs can contribute to the sustainable management of marine resources and preservation of the marine environment for our society to enjoy, while providing a supply of fresh and quality fisheries products to local consumers, and creating job opportunities to the fisheries sector and related trades such that fishermen and fish farmers can achieve self-reliance and maintain their livelihoods in the changing business operating environment.

2.5 Consideration of Different Development Options

As the main purpose and objective of the Project is to provide opportunities to develop a newer type of deep-water mariculture, create room for the mariculture sector to grow further and attract new entrants, potentially allowing capture fishermen to switch to a sustainable mode of operation, different development options have been explored.

2.5.1 Option on Project Siting

2.5.1.1 Expansion of the Existing FCZs

The development option by expanding the existing FCZs was explored. Given most of the existing FCZs are located in inshore areas with shallow water depths, these locations are not feasible to support the more advanced type of deep-water mariculture in line with the global practice. In addition, there exists other development constraints around the existing FCZs, such as existing marine usage, ecological sensitive receivers, etc. Sediment removal may also be required periodically to maintain a suitable environment for mariculture. As such, the environmental impacts are likely to be more detrimental for FCZs in inshore areas with shallow water depths. This will limit the potential for developing sustainable mariculture and promoting the modernisation and competitiveness of the fisheries industry. Therefore, expansion of existing FCZs is not a feasible development option for the Project.

2.5.1.2 Establishment of New FCZ Sites

The criteria for the site selection of sustainable mariculture were reviewed with reference to international guidelines (e.g. the Food and Agriculture Organization (FAO)), which include minimum water depth, wave exposure, water quality, the compatibility with the existing usage and environment, accessibility and infrastructure and site security. The key considerations of these criteria are summarised in ***Table 2.1***.

Table 2.1 Summary of the Key Considerations of Site Selection Criteria

Criteria	Key Considerations
Minimum Water Depth	▪ Allow sufficient clearance (at least 2 m) of the bottom of cage to the seabed. ▪ Water depth of preferably > 10 m for the use of advanced type of deep-water mariculture.
Wave Exposure	▪ Greater wave exposure will have better water flushing and hence facilitate the dispersion of pollution loading from mariculture operation in general. ▪ While there could be higher potential risk of cage damage due to greater wave exposure (e.g. during monsoon wind / typhoon), the modernised cages with advanced technologies (see ***Section 2.6.2***) have been designed to withstand strong wind, strong wave and strong water currents. Therefore, site with greater wave exposure would be preferred.
Water Quality	▪ Oceanic conditions are generally preferred for mariculture (e.g. culturing of grouper / snapper species). ▪ Oxygen consumption for each species of fish varies, with pelagic fish requiring more oxygen than demersal species. Dissolved oxygen is preferably no less than 4 mg/L for pelagic fish or 3 mg/L for demersal fish in general. ▪ Levels of turbidity / suspended solids are low enough to minimize clogging of fish gills which may lead to mortality from asphyxiation or cause gill epithelial tissues to proliferate and thicken. ▪ Higher water flushing rate and lower levels of nutrients, such as chlorophyll-*a*, nitrate, phosphate, are preferred to minimize potential algal bloom and hence reduce the likelihood of red tide occurrence.

Criteria	Key Considerations
Compatibility with the Existing Usage and Environment	▪ Conflicts with existing / planned / potential usage of coastal resources such as shipping, fishing, recreational activities, submarine utilities, development projects and other industries are avoided as far as practicable. ▪ Key environmental sensitive receivers, such as marine parks and marine reserve, coastal protection areas, seawater intake point, Sites of Special Scientific Interest (SSSIs), key coral communities, artificial reefs, marine mammal habitats, wintering and nesting grounds for birds, mangroves and horseshoe crab habitats are avoided as far as practicable. ▪ Sites should be located at remote areas to minimise impacts on air quality, noise and visual sensitive receivers.
Accessibility and Infrastructure	▪ Proximity to jetty and main road is preferred for distribution of fisheries products, transport of feed, fingerlings, fuel, equipment, supplies and other necessities. ▪ Presence of infrastructure is preferred to facilitate daily mariculture operation.
Site Security	▪ Sites preferably in areas not frequented by public to prevent poaching.

A site search was conducted to identify suitable locations in Hong Kong waters for the development of new FCZs considering the above site selection criteria. Incompatible areas with absolute constraints were excluded, while the compatible areas for a suitable location were considered taking into account environmental, physical and operational constraints. The new FCZ sites should avoid encroaching into ecological sensitive receivers (e.g. marine parks, coral habitats of high ecological value and areas of high fisheries importance) to avoid impacts to marine ecology and fisheries. The new FCZ sites should be located at remote area to minimise impacts on air quality, noise, and visual sensitive receivers. In addition, the locations should have better water flushing rate for mariculture to allow adequate water dispersion and prevent the build-up of organic content and degradation of the nearby marine environment. Consequently, organic content is also not built up on the seabed and maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided.

As western Hong Kong waters are under the influence of freshwater discharges from the Pearl River Estuary, eastern Hong Kong waters are preferred when identifying suitable sites for new FCZs and various areas for development of FCZs were identified (***Figure 2.1***). While these areas have avoided encroaching into ecological sensitive receivers and are located at remote areas to minimise impacts on air quality, noise, and visual sensitive receivers, the viability of these areas was further determined based on the following key criteria for mariculture.

- **Higher flushing rate**: Higher flushing rate would facilitate water circulation to avoid accumulation of pollutants that may affect fish health. In addition, higher flushing rate of a site will generally have a higher carrying capacity per unit area that can support mariculture activities under sustainable environmental conditions. In essence, higher flushing rate can minimize impacts on water quality and marine ecological and fisheries resources of the surrounding environment.
- **Accessibility and infrastructure**: The FCZ area should be near a shore preferably with a jetty for boat connections with FCZ and near main road networks for land transportation of the mariculture products. Good accessibility facilitates distribution of fisheries products, transport of feed, fingerlings, fuel, equipment, supplies and other necessities. The presence of infrastructure, e.g. communal raft, is also important to facilitate sustainable and effective mariculture operation

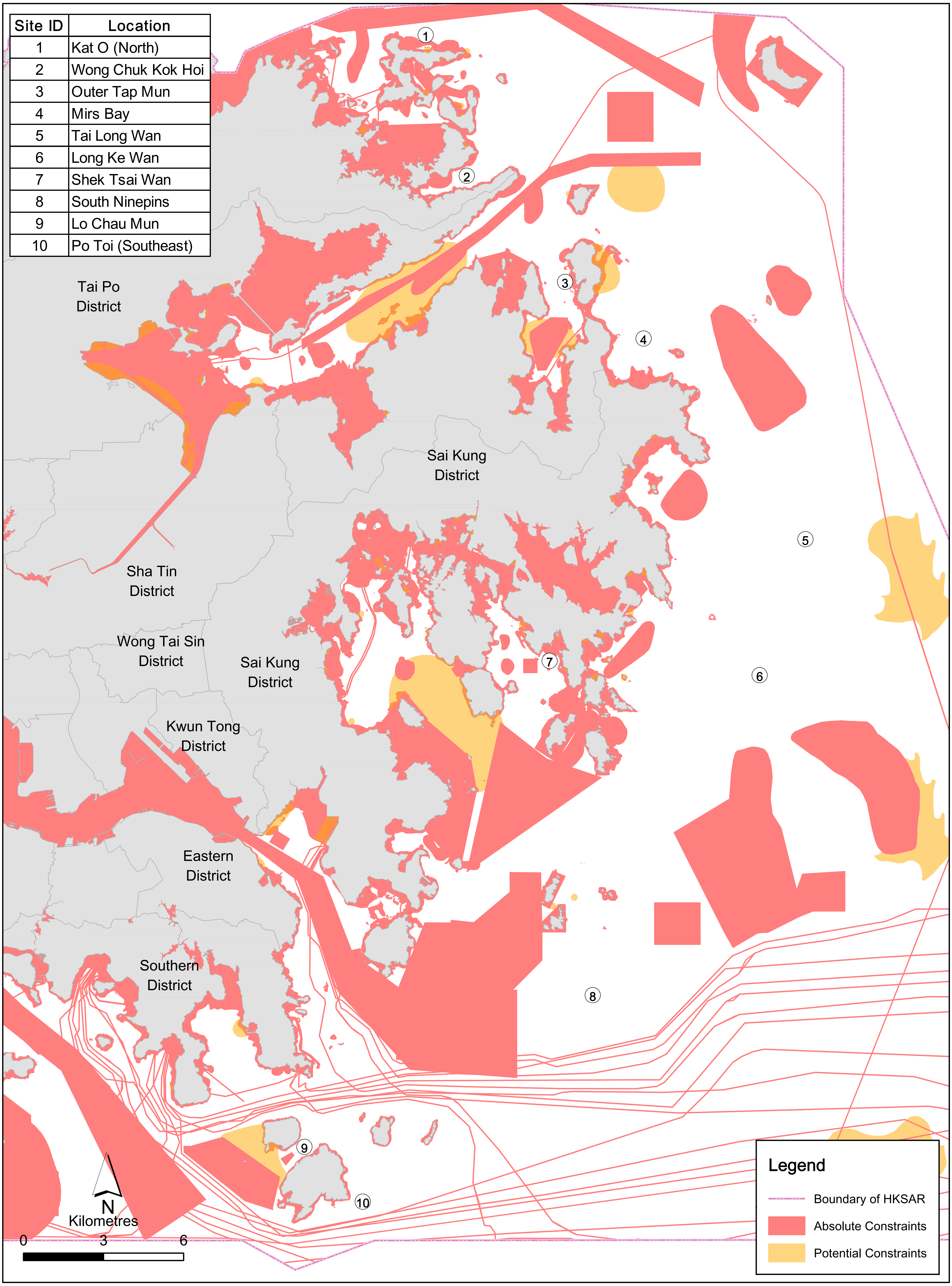

Figure 2.1

Potential Areas for Development of Fish Culture Zones based on Constraint Mapping

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by providing storage (e.g. for pellet feed) and equipment (e.g. air pumps, water quality monitoring equipment). This would also mean that the construction of new infrastructure can be avoided, hence avoiding the associated impacts on the environment.

- **Site security**: As FCZ area is located in open waters, site security will be one of the considerations. The FCZ should preferably be sited at sites not frequented by public to prevent poaching.

In addition, consultation with relevant stakeholders was conducted to determine the sites suitable for establishment of new FCZs. The summary of site evaluation is presented in ***Table 2.2***.

Table 2.2 Summary of Site Evaluation

Potential Site	Evaluation	Preferred Site (Y/N)
Kat O (North)	▪ The site is semi-exposed and susceptible to the prevailing northeastern winds during the winter months. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is limited and the nearest jetty is located at Sha Tau Kok with restricted entry. ▪ The site is close to Hong Kong SAR boundary. Site security could be a potential concern.	N
Wong Chuk Kok Hoi	▪ The site is semi-exposed and susceptible to the prevailing northeastern winds during the winter months. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is favourable, including Wong Shek Pier and Tai Po piers which are accessible to public and connecting to main road network. ▪ The site is not frequented by public and shielded by Wong Wan Chau. Site security is not a concern.	**Y**
Outer Tap Mun	▪ The site is semi-exposed and sheltered by Tap Mun on the east side. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is favourable, including Wong Shek Pier and Tai Po piers which are accessible to public and connecting to main road network. ▪ The site is located near Tap Mun and not frequented by public. Site security is not a concern.	**Y**
Mirs Bay	▪ The site is exposed to wind from all directions. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is favourable, including Wong Shek Pier and Tai Po piers which are accessible to public and connecting to main road network. ▪ The site is not frequented by public and is shielded by Tap Mun and Nam She Wan. Site security is not a concern.	**Y**
Tai Long Wan	▪ The site is exposed to wind from all directions. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is limited and the nearest jetty is located at Sai Kung.	N

Potential Site	Evaluation	Preferred Site (Y/N)
	▪ The site is close to Hong Kong SAR boundary. Site security could be a potential concern.	
Long Ke Wan	▪ The site is exposed to wind from all directions. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is limited and the nearest jetty is located at Sai Kung. ▪ The site is close to Hong Kong SAR boundary without shielding by land mass. Site security could be a potential concern.	N
Shek Tsai Wan	▪ The site is sheltered. Flushing rate is expected to be less suitable for mariculture. ▪ Accessibility is favourable, including Sai Kung piers which are accessible to public and connecting to main road network. ▪ The site is not frequented by public and shielded by High Island. Site security is not a concern.	N
South Ninepins	▪ The site is exposed to wind from all directions. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is limited and the nearest jetty is located at Sai Kung / Shau Kei Wan. ▪ The site is situated in open water without shielding by land mass. Site security could be a potential concern.	N
Lo Chau Mun	▪ The site is exposed to wind from all directions. Flushing rate is expected to be suitable for mariculture. However, due to the deep water of the area (>60m deep), there exists constraint in deploying suitable cages for mariculture activities. ▪ Accessibility is favourable and the nearest jetty is located at Stanley. ▪ The site is not frequented by public and shielded by Beaufort Island and Po Toi. Site security is not a concern.	N
Po Toi (Southeast)	▪ The site is exposed to wind from all directions. Flushing rate is expected to be suitable for mariculture. ▪ Accessibility is favourable and the nearest jetty is located at Stanley. ▪ The site is not frequented by public and shielded by Po Toi. Site security is not a concern.	**Y**

In summary, four sites, namely Wong Chuk Kok Hoi, Outer Tap Mun, Mirs Bay, Po Toi (Southeast) (***Figure 2.2***), are selected for the establishment of new FCZs based on the site selection criteria and views from stakeholders. These sites avoid the encroachment to areas with ecologically important habitats, such as marine parks / reserve, coral habitats with high ecological value, key marine mammal habitats, wintering and nesting grounds for birds, mangroves and horseshoe crab habitats. The identified sites are also relatively remote, which minimise impacts on air quality, noise and visual sensitive receivers.

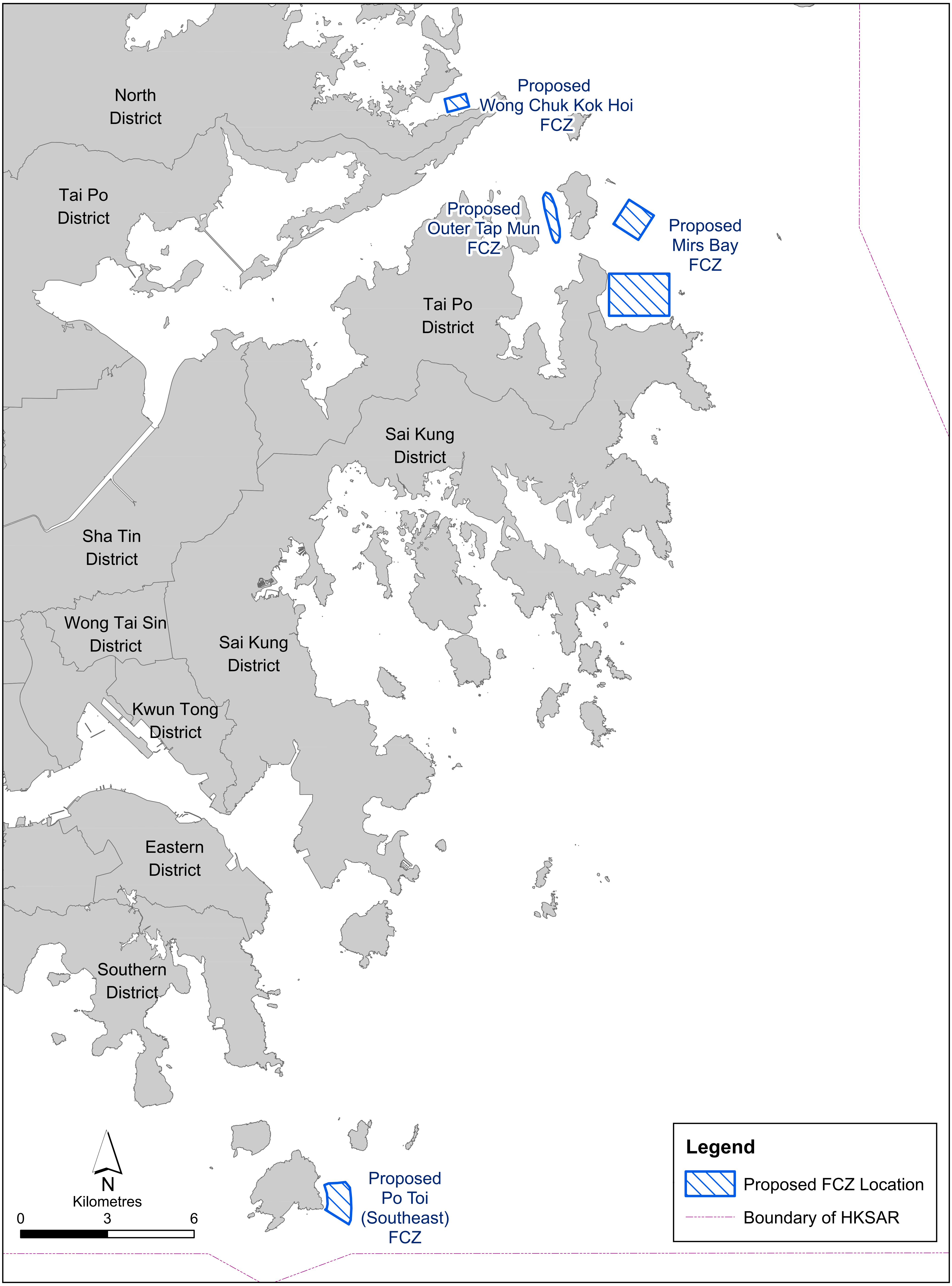

Figure 2.2

Proposed Locations for Establishment of Fish Culture Zones

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2.5.2 Consideration of the Size and Boundary of the Project Site

The Project site boundary has been designed taking into account the environmental, physical and operational constraints. The Project has been sized to provide sufficient capacity for sustainable mariculture activities without compromising the existing surrounding environment. For instance, the options between the establishment of a single larger FCZ and smaller FCZ at different locations have been considered. While the establishment of a single larger FCZ will concentrate the pollution loading in a particular area, the establishment of small FCZ at different locations will reduce the organic loading and therefore minimise the impact to coral communities and habitat for marine ecological and fisheries resources in the surrounding waters.

Besides, the extent and boundary of the Project site has also been optimized with sufficient clearance to minimise the impacts to coral communities along the coastline, as well as habitats for marine ecological resources and fisheries resources. Meanwhile, sufficient clearance to navigation routes[(3)] has been provided to minimise the potential risk of fish escape and introduction of invasive species to the marine environment due to accidents/ collisions of marine vessels with fish farm facilities. The Project site has also been positioned with a 50 m clearance between the low water mark and the inshore boundary.

2.6 Fish Farm Designs to be Adopted at the Proposed FCZ

A number of different fish farm designs have been considered with regard to the Project site at Wong Chuk Kok Hoi. Technologies including traditional cages and advanced technologies have been considered. The type of fish farm/ raft to be deployed at the proposed FCZ will be subject to the fish farm operational plan submitted by the future licensees for agreement with AFCD. The advantages and disadvantages of different designs are described below.

2.6.1 Traditional Cages on Rafts

In Hong Kong, the majority of mariculture operations are conducted in traditional cages on rafts. These cages are in an artisanal level, the designs are simple, small and rough (***Figure 2.3***). The raft is built of timber (average size about 180m^2) and is supported by a number of floating units made of empty plastic drums or polystyrofoam floats [(4)]. Net cages (3 x 3 x 3 m) are hung from the raft and the structure anchored to the seabed. Most of the traditional rafts are built on-site, which may lead to waste being released to the sea during the construction. Most of the cages were not tailored made for aquaculture operation purposes. Although these cages are cheaper to build compared to cages used with advanced aquaculture technologies and some recycled materials are adopted as the floating units which has some contribution to waste reduction, traditional cages are not weather resistant and require frequent maintenance and major repairing, which result in more waste generation during mariculture operation. Moreover, these cages cannot withstand swirls caused by typhoon or swift current, therefore, they have to be installed in inshore and sheltered waters, where the water depth is not in favour for the dispersion of pollution loading from mariculture operation. Maintenance dredging and sediment removal maybe required, which will result in adverse water quality impacts and the subsequent ecological and fisheries impacts.

As the Project aims to promote sustainable mode of operation in deeper waters, the traditional cages on rafts are considered technically not suitable and thus is not preferred.

(3) Maritime New Zealand (2005) Guidelines for Aquaculture Management Areas and Marine Farms.

(4) Wu RSS and Lee, JHW (1989) Grow-out mariculture techniques in tropical waters: a case study of problems and solutions in Hong Kong. Advances in Tropical Aquaculture Tahiti Feb 20-March 4, 1989. pp.129-136.

Figure 2.3 Example of the Traditional Fish Farms (Source: AFCD)

2.6.2 Advanced Technologies

In order to explore alternative fish farming methods that will support sustainable mode of mariculture operation, advanced technologies have been examined and considered suitable for the Project. Four types of advanced technologies have been considered. The sizes of each type of advanced technologies will be subject to further design based on the operational need proposed by the licensees. The typical dimensions of the floating gravity cages, submersible gravity cages and integrated multi-trophic aquaculture (IMTA) are 50 – 100 m in diameter. The height of the cages will be normally no more than 3 m above water (except during maintenance).

2.6.2.1 Floating Gravity Cage

Floating gravity cage is a simple and common type of cage with a buoyancy collar system and a weighted net enclosure suspended beneath (5). The cage may have walkways around for operation on the cage depending on the design (***Figure 2.4***). The cage has the capacity to withstand wind up to Beaufort scale of 11 (104-117 km/h), wave height of 5 m and current flow of 1.5 m/s (6). In view of Hong Kong being susceptible to typhoon of more than 118 km/h with gusts of more than 220 km/h during summer, the cage is suitable to be used in sheltered to semi-exposed water.

Traditionally, fish cage arrays are orientated with their longest dimension parallel to the predominant current flow to reduce the forces on the mooring systems. However, the most downstream cages will experience reduction in water exchange resulting in lower dissolved oxygen conditions and increased waste loads (7). To maximise water flow, cages should be positioned individually with sufficient separation distances in between. Rows of individual cages should be staggered in relation to one another, and consideration should be given to positioning arrays of cages so that their longest axis is perpendicular to the predominant current direction (8).

An example of the floating gravity cage is the HDPE cage system (***Figure 2.5***) that is anti-corrosive, anti-freeze, anti-oxidised, UV-resistant and environmentally friendly. The cage system is widely used in other countries due to the versatility of the materials used and the comparatively limited investment capital required. It is able to withstand sea conditions with strong wind, strong wave and strong water

(5) James MA and Slaski R (2006) Appraisal of the opportunity for offshore aquaculture in UK waters. Report of Project FC0934, commissioned by Defra and Seafish from FRM Ltd. 119 pp.

(6) Qingdao Qihang Fishing Cage Co., Ltd (2016) HDPE Pisciculture Floating Farming Cages.

(7) Klebert P, Lader P, Gansel L and Oppedal F (2013) Hydrodynamic interactions on net panel and aquaculture fish cages: a review. Ocean Engineering 58: 260-274.

(8) Madin J, Chong VC, Hartstein ND (2010) Effect of water flow velocity and fish culture on net biofouling in fish cages. Aquaculture Research 41(10): e602-e617.

currents. It has a long life span of ~15 years without the need of major maintenance. It is also easy to be set up with anchorage system deployed at the corners of the cage.

Figure 2.4 Example of the Floating Gravity Cage (Source: Polarcirkel Plastic Cage)

2.6.2.2 Submersible Gravity Cage

The submersible cage is similar to the floating gravity cage with a buoyancy collar systems and a weighted net enclosure suspended beneath (see ***Figure 2.6***). The design and installation of the cage is similar to the floating gravity cage, but additionally the cage is submersible. The cage can be submerged to a certain depth to avoid damage by wave and swells to protect the cage and the culture fishes during typhoons and adverse weathers while maintaining 90% of its volume [(9)]. The cage has the capacity to withstand wind up to Beaufort scale of 13 (133-149 km/h), wave height of 6 m and current flow of 1.5 m/s [(10)] and is suitable for typhoon prone area. The submergible cage could be submerged underwater to more than 6 m within 15 minutes by lifting devices [(11)]. As the cage is suitable for exposed and typhoon prone area, it could be used in exposed water with higher current flow.

Similar to floating gravity cage, these cages can be made from HDPE material (see ***Section 2.6.2.1***) and should be positioned individually with sufficient separation distances in between. Rows of individual cages should be staggered in relation to one another, and consideration should be given to positioning arrays of cages so that their longest axis is perpendicular to the predominant current direction [(12)]. As the cage is to be used in exposed water with higher current flow, mariculture activities will be conducted with the help of support vessels.

(9) 沅江市福利渔网 (2013) 深海养殖网箱.

(10) Qingdao Qihang Fishing Cage Co., Ltd. (2016) HDPE Pisciculture Floating Farming Cages.

(11) Qingdao Qihang Fishing Cage Co., Ltd. (2016) Aquaculture Submergible Cage.

(12) Madin J, Chong VC, Hartstein ND (2010) *Op. Cit.*

Overview of High-Density Polyethylene (HDPE) Cage System

(Source: Qingdao Qihang Fishing Cage Co., LTD)

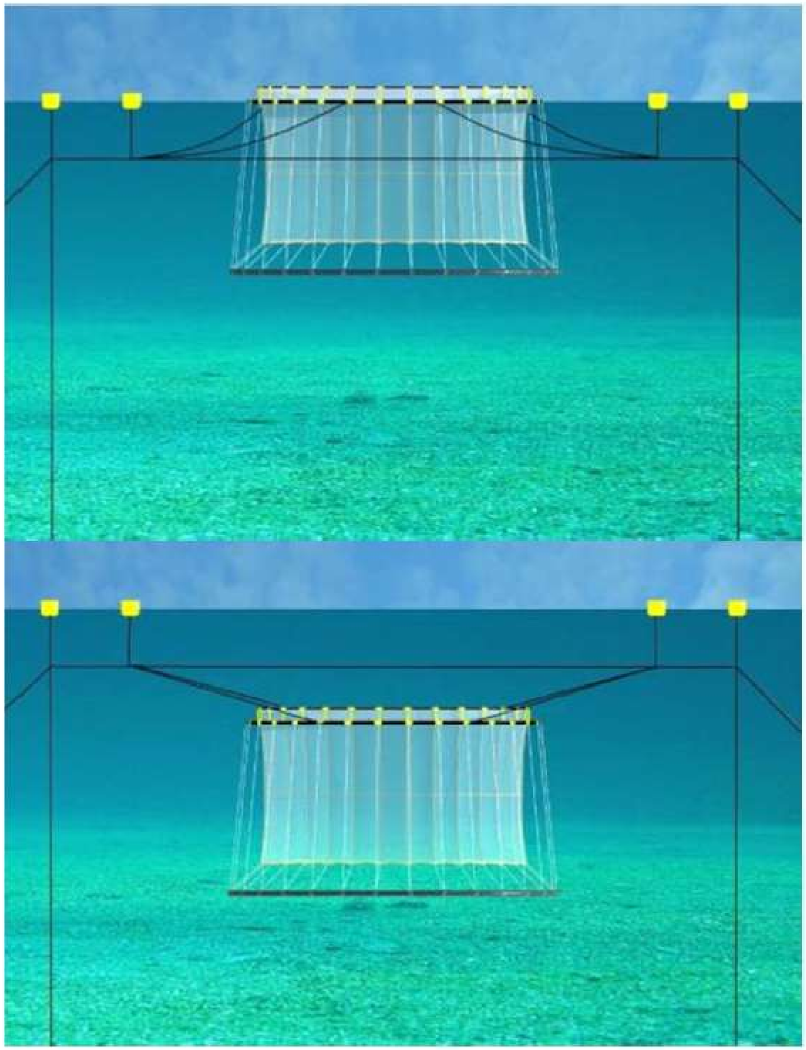


Illustration of HDPE Floating and Submersible Cage System

(Source: https://www.linkedin.com/pulse/offshore-aquaculture-submersible-hdpe-cages-oceanis-1-ciattaglia)

FIGURE 2.5

Example of Newer Type of Mariculture

DATE: 24/06/2022

Figure 2.6 Example of Submersible Cage for Fish Culture (Source: Qingdao Qihang Fishing Cage Co., LTD.)

2.6.2.3 Integrated Multi-trophic Aquaculture (IMTA)

The IMTA involves the culture of fish in combination with organisms of different trophic levels that utilise waste particulates and dissolved nutrients could be promoted for the new FCZs (***Figure 2.7***). The filter feeders and deposit feeders cultured with fish stocks not only could utilise excessive waste generated by uneaten fish feeds and mariculture operations, but these species, if economically valuable, would increase the economical return as well as reduce environmental impact caused by mariculture operations.

2.6.2.4 Culture Species

The following criteria shall be considered when determining the species to be cultured together with the fish stocks and some of the proposed organisms and example species are shown in ***Table 2.3***:

- The availability of seed stocks from hatchery, preferably sourced from a captive brook stock to reduce pressure in catching wild population;
- Native species is preferred to prevent the spread of invasive, exotic species that may threaten the local ecosystems; and
- Species with higher economic value to attract interest in the application of IMTA in mariculture operations.

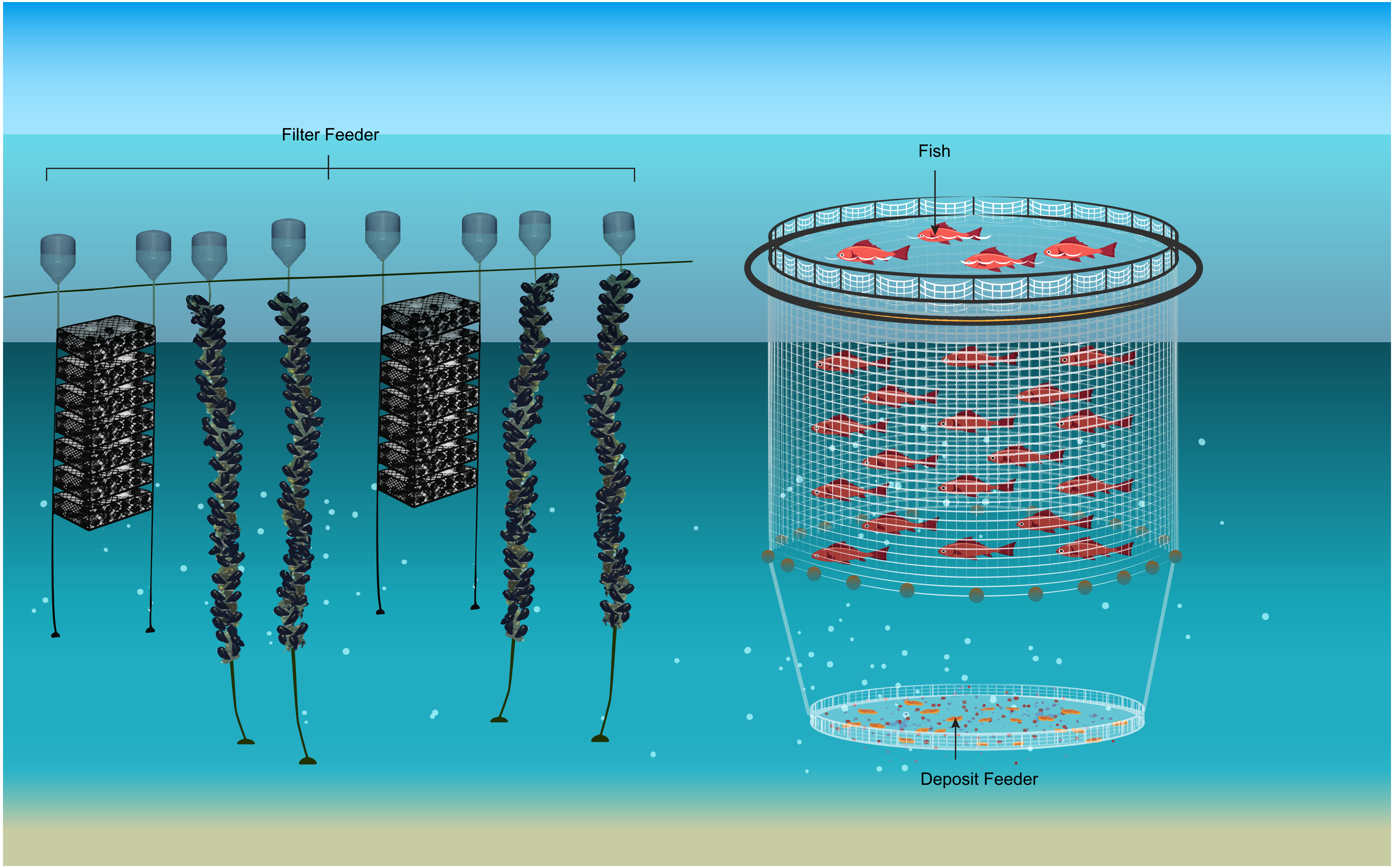


Figure 2.7

Sample Layout of IMTA

Table 2.3 Proposed Organisms and Example Species for IMTA

Category	Organisms	Examples	Reason
Deposit Feeders	Sea urchins	Collector urchin (*Tripneustes gratilla*) Purple sea urchin (*Anthocidaris crassispina*)	High economic value and native species of Hong Kong.
	Sea cucumbers	Japanese spiky sea cucumber (*Apostichopus japonicas*)	No common species in Hong Kong but are of high commercial value. This species is commonly farmed in China and well known about its delicacy and its medicinal properties.
	Lobsters	*Panulirus homarus*	Commonly farmed and of high economical value.
Filter feeders	Mussels	Green-lipped mussel (*Perna viridis*)	Native species and an adult green-lipped mussel can filter 30 L of seawater per day. However, it is of relatively low economical value.
	Scallops	*Chlamys farreri,* *Argopecten irradians*	Commonly farmed in China and of high economical value.
	Abalones	*Haliotis discus*	Commonly farmed and of high economical value.

2.6.2.5 Configuration and Design

Submerged bottom cages with deposit feeders (e.g. sea cucumber, sea urchin) could be positioned on the seabed or under the cage to allow the organisms to feed on waste generated by the mariculture operations. Studies have shown that sea urchins and sea cucumbers have high assimilation efficiency of fish wastes (13) and grew significantly faster under fish farms than at control sites (14) (15). Tailor-made submerged cage for sea cucumber culture is available and capable of being submerged to a depth of up to 30 m and withstanding wind of 12 Beaufort scale (118 – 132 km/h). The cages should be positioned under or in close proximity of the cage.

Longline culture or lantern nets hung vertically from lines are suitable for culture of bivalves. It is considered that lantern nets are preferable under sheltered conditions while longlines are preferred under exposed conditions (16). The longline or lantern nets should be placed in close proximity to the cages (e.g. within 50 m) (17). Sample arrangement of IMTA design is presented in ***Figure 2.7***.

(13) Nelson EJ, MacDonald BA and Robinson SMC (2012) The absorption efficiency of the suspension-feeding sea cucumber, *Cucumaria frodosa,* and its potential as an extractive integrated multi-trophic aquaculture (IMTA) species. Aquaculture 370-371: 19-25.

(14) Ahlgren MO (1998) Consumption and assimilation of salmon net pen fouling debris by the red sea cucumber *Parastichopus californiens*: implications for polyculture. Journal of the World Aquaculture Society 29(2): 133-139.

(15) Cook EJ and Kelly MS (2007) Enhanced production of the sea urchin *Paracentrotus lividus* in integrated open-water cultivation with Atlantic salmon *Salmo Salar*. Aquaculture 273(4): 573-585.

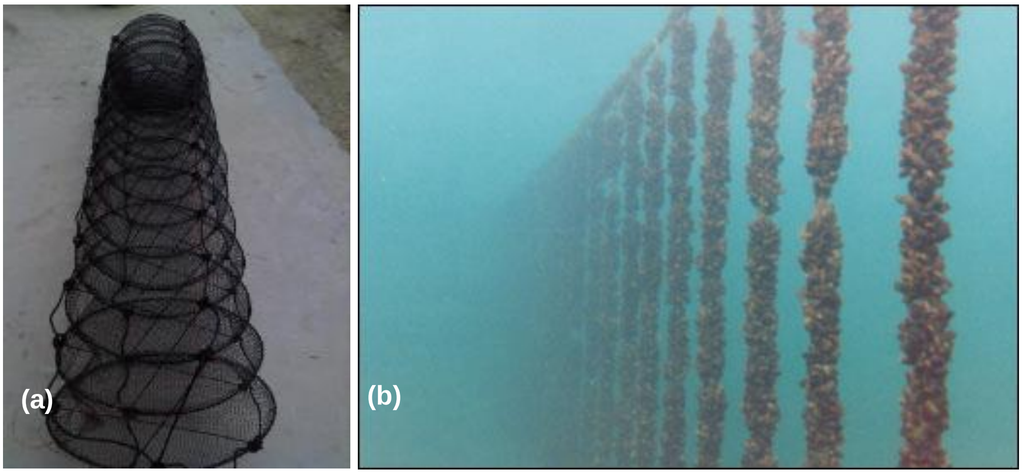
(16) BC Shellfish Grower's Association (n.d.) Longline Culture Systems.

(17) Chopin T, Robinson SMC, Troell M, Buschmann AH and Fang J (2008) Multitrophic Integration for Sustainable Marine Aquaculture. Ecological Engineering. Elsevier. pp.2463-2475.

Examples of submerged cages and lantern nets are shown in ***Figure 2.8*** and ***Figure 2.9****.* IMTA is commonly used in open water areas of Fujian and Shandong provinces in mainland China [(18)].

Figure 2.8 Example of Deep Cage for Echinoderm Culture (Source: 青岛利东海洋网箱科技有限公司)

Figure 2.9 Examples of (a) Lantern Nets and (b) Longlines for Bivalve Culture (Source: Qingdao Mansheng Industry and Trade Co., Ltd., Department of Fisheries and Oceans)



(18) Dong, S., Fang, J., Jansen, H.M. & Verreth, J. 2013. Review on integrated mariculture in China, including case studies on successful polyculture in coastal Chinese waters. Workpackage 3: support the application of integrated multi-trophic aquaculture (IMTA). ASEM Aquaculture Platform, Seventh framework programme.

2.6.2.6 Semi-submersible Steel Truss Cage

In 2021, AFCD has established a modern mariculture demonstration farm at Tung Lung Chau FCZ with the use of the semi-submersible steel truss cage fish farm design (***Figure 2.10***). The dimensions of this cage are about 91 m in length, 28 m in width and 7.5 m in depth, with a design draft of about 6.5 m [19]. The height of the cage (i.e. from the tip of the truss structure to the water surface) is about 3 m above water (except during maintenance). It is composed of a main structure in all-welded steel, connected to four floating steel ballast tanks. It uses a five-point mooring system to secure the farm in the designated location with three main cages which the culture nets are fixed to the main steel structure. The level in which the cage can be partially submerged is adjustable to avoid damage by wave and swells to protect the cage and the cultured fishes during typhoons and adverse weather. The effective mariculture water volume is about 11,000 m^3. The cage has the capacity to withstand wind up to Beaufort scale of 17 (202-220 km/h), wave height of 9 m and current flow of 1 m/s and is suitable for typhoon prone area. As the cage is suitable for exposed and typhoon prone area, it could be used in exposed water with higher current flow. In addition, this cage is equipped with modernised technology and management, such as a real-time surveillance system, a real-time water quality monitoring system, an automated feeding system and a solar and wind power generation system.

Similar to floating gravity cage, these cages should be positioned with sufficient separation distances with other cages in the vicinity. The cages should be staggered in relation to one another, and consideration should be given to positioning arrays of cages so that their longest axis is perpendicular to the predominant current direction [20]. As the cage is to be used in exposed water with high current flow, mariculture activities will be conducted with the help of support vessels.

Figure 2.10 Example of Semi-submersible Steel Truss Cage (Source: AFCD)

2.6.3 Environmental Benefits of Modern Fish Farm

Overall, modern fish farm with advanced technologies have the following environmental benefits:

- Fish farm components are prefabricated offsite which reduces construction activities and duration onsite and hence impacts to the surrounding environment;
- Use of technology (e.g. real-time surveillance and water quality monitoring, renewable energy sources such as solar and wind) and automation (e.g. fish feeder) can reduce labour intensive activities, hence reduce potential disturbance to ecology and environment from feed wastage, workforce wastes, vessel trips, etc.;

(19) AFCD (2021) Press Release - AFCD sets up modern mariculture demonstration farm.
(20) Madin J, Chong VC, Hartstein ND (2010) *Op. Cit.*

- Cages made of weather-resistant materials such as high-density polyethylene (HDPE) and steel truss cages are more durable and of good quality, less likely to be damaged or repaired with less waste generation;
- Submersible/ semi-submersible fish cages are designed to endure adverse weather conditions. Fish loss/ escape due to cage/raft damage can therefore be minimised and potential impact of introduction of invasive species on local ecology and fisheries could be reduced. Besides, the need for temporary relocation of fish raft due to adverse weather is also reduced and therefore reducing the associated potential impact;
- Separation distance between fish cages and between the cage bottom and seabed would be maintained to allow adequate water flow in between and reduce impacts on water quality such as changes in flow regime and build-up of organic content, reducing the subsequent ecological and fisheries impacts in the vicinity and degradation of the nearby marine environment;
- These sizable cages can avoid overcrowding of fish stock, and with good mariculture practice and dispersion by the open sea, organic content is not built up on the seabed. Maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided; and
- Fish farm structures have the potential to provide artificial substrates for marine organisms to colonise and build diverse and functional habitats.

All four types of advanced technologies are considered suitable and preferable for the new FCZ and the environmental performance of each type of advanced technologies is similar. Given the mariculturists will culture fish within the maximum allowable stock as specified in the licence condition, there will not be significant difference in assessing the worst-case scenario in terms of pollution loadings when adopting different type of advanced mariculture cages/ raft designs. The mariculturists will propose any of the advanced technologies for mariculture operation within the Project site to suit their business need for agreement with AFCD.

2.7 Consideration of Construction Methods and Sequence

With the use of advanced mariculture technologies, a majority of the framework of the fish cages will be prefabricated off-site, and then tow the fish farm framework to the Project site for assembly and anchorage. It is in fact unlikely that this more advanced type of deep-water mariculture can be completely assembled from raw materials on-site and there is no alternative construction method. Prefabrication work off-site can minimize the construction duration on-site and hence reducing the duration when potential impacts to the environment can occur. It is expected to avoid generation of C&D materials and potential water quality impact from construction site run-off during the construction of the Project. Generation of underwater sound is minimised in this method, with less disturbance to marine and fisheries habitats. Also, less labour input required on site would result in reduction of waste generated from human activities.

2.8 Summary of Alternative Mitigation Measures

Viable sites of the Project have been considered during the Project's Feasibility Study, based on the environmental benefits and dis-benefits for the construction and operation of the new FCZs. Various development options are reviewed and considered in the EIA study. The environmental benefits and dis-benefits of the development options are summarised in ***Table 2.4***. Wong Chuk Kok Hoi is one of the proposed sites which met the selection criteria for new FCZs and is sited to avoid encroaching sensitive receivers (e.g. ecologically important habitats, areas of high fisheries importance). To further minimise potential impacts, the Project site will adopt modernized and advanced type of aquaculture technologies and operate within the maximum standing stock as identified in this EIA study.

Table 2.4 Summary of Environmental Benefits and Dis-benefits of the Development Options and Alternative Mitigation Measures Considered for the Project

Development Options	Benefits	Dis-benefits
Project Siting		
Preferred Option Site selection of sustainable mariculture with reference to international guidelines, which include minimum water depth, wave exposure, water quality and the compatibility with the existing usage and environment	▪ Avoid encroaching into ecological sensitive receivers e.g. marine reserves, coral habitats of high ecological value and areas of high fisheries importance, thus avoid impacts to marine ecology and fisheries ▪ Better water flushing rate for mariculture to allow adequate water dispersion and prevent the build-up of organic content and degradation of the nearby marine environment. Consequently, organic content is also not built up on the seabed and maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided ▪ Remote area at Wong Chuk Kok Hoi minimises impacts on air quality, noise, and visual sensitive receivers	▪ May pose potential environmental impacts to newly affected areas. However, careful site selection and fish farm design have been done to avoid / minimise potential impacts
Alternative Option Expanding existing FCZs	▪ Limit environmental impacts to areas that are already affected by existing FCZs	▪ Development constrained by existing marine usage and nearby ecological sensitive receivers. Water flushing rate is generally lower due to inshore and shallow waters of the existing FCZs. Impacts to water quality, including restricted dispersion and accumulation of organic loading due to FCZ operation, are likely to occur when more mariculture production is necessary to support the development of mariculture in Hong Kong. ▪ Sediment removal may be required periodically to maintain a suitable environment for mariculture. The environmental impacts are likely to be more detrimental

Development Options	Benefits	Dis-benefits
		for FCZs in inshore areas with shallow water depths. Alternative mitigation measures such as deployment of silt curtain and control of dredging rate, etc would be required to minimise the water quality and marine ecology impact.
Project Size / Scale		
Preferred Option Establishment of smaller FCZ at different locations	▪ Establishment of smaller FCZs to reduce the organic loading at individual site, to minimise impact to coral communities and habitat for marine ecological and fisheries resources. ▪ With sufficient clearance to navigation routes, accidents / collision of marine vessels with fish farm facilities, and potential risk of fish escape and introduction of invasive species to the marine environment can be minimised.	▪ Affect more areas with potential environmental impacts but better control of impact intensity to within relevant criteria
Alternative Option Establishment of a single larger FCZ	▪ Limit environmental impacts to single location but with higher intensity	▪ The pollution loading from mariculture operation will concentrate in a particular area. The potential impacts to water quality, marine ecology and fisheries of the surrounding waters are expected to increase.
Fish Farm Layout and Design		
Preferred Option Use of advanced mariculture fish farm designs (e.g. HDPE cages, steel stuss cages)	▪ Durable and weather-resistant material would less likely to get damaged or repaired and result in less waste generated. ▪ Less susceptible to damage during adverse weather condition, such as typhoons, and minimise potential risk of fish loss / escape, and subsequent impact on local ecology and fisheries; and also minimise impact due to fish cage relocation.	▪ Higher setup cost

Development Options	Benefits	Dis-benefits
	▪ Adequate water flow and dispersion of organic content between cages / rafts, and along the water column is allowed. Adequate clearance from seabed will also be maintained. Water quality impacts such as changes in flow regime and build-up of organic content are minimised. Subsequent ecological and fisheries impacts in the vicinity and degradation of the nearby marine environment could be reduced. The need for maintenance dredging and sediment removal during construction and operation of the Project is also avoided. ▪ Use of green technology and automation could reduce feed wastage and physical labour, hence reduce potential disturbance to water quality, ecology and environment from feed wastage, workforce wastes, vessel trips, etc.	
Alternative option Use of traditional fish farm designs (e.g. made of timber supported by floating units made of empty plastic drums or polystyrofoam floats)	▪ Lower setup cost	▪ Non-weather resistant materials and easy to get damaged or repaired. More wastes are expected to be generated. ▪ Susceptible to damage from adverse weather conditions such as typhoons. Potential risk of fish loss / escape is higher, and subsequent impact on local ecology and fisheries; and also impact due to fish cage relocation would increase. ▪ Potential impact on water flow and dispersion of organic content between cages / rafts, and along the water column might be present, and result in the build-up of organic content on seabed. Maintenance dredging and sediment removal may be required periodically and water quality impacts would arise. Subsequent ecological and fisheries impacts in the vicinity and

Development Options	Benefits	Dis-benefits
		degradation of the nearby marine environment would also increase. Other mitigation measures will be required to control and minimise impacts to water quality, such as the use of silt curtains, closed grab dredger, etc. ▪ Require more labour input and hence increase potential disturbance to ecology and environment from feed wastage, workforce wastes, vessel trips, etc.
Construction Methods and Sequence of Works for the Project		
<u>Preferred option</u> Fish farm framework are pre-fabricated off-site, then assemble and anchored on-site	▪ Minimisation of construction duration on-site and hence reducing the duration when potential impacts to the environment can occur. ▪ No generation of C&D materials on-site and potential water quality impact from construction site run-off during the construction of the Project is avoided. The use of silt curtain and construction boats for silt curtain deployment are therefore not required, the subsequent impacts to marine and fisheries habitats such as underwater sound from marine vessels are minimised ▪ Less labour input required on site would result in reduction of waste generated from human activities	▪ N/A
<u>Alternative option</u> No alternative option applicable as the fish farm framework used for advanced type of mariculture is large in scale, and could not be constructed from raw materials on site.	▪ N/A	▪ N/A

2.9 Details of the Project

After the designation of the new FCZ, AFCD will grant new marine fish culture licences to mariculturists who applied. The Project will then involve fish raft and cages construction and culture operation by the licenced mariculturists. No land-based works are involved in the Project, and no land will be taken by the Project.

2.9.1 Design and Configuration

Separation distance will be maintained between fish rafts / cages, as a condition in the licence to be issued to mariculturists by AFCD, primarily aimed at reducing any potential biosecurity risk caused by disease and mortality of fishes. The sufficient separation distance could also help to maintain adequate water flow within the FCZ as well as allow access to individual fish cage by vessels. For example, typical separation distance of around 100 m will be provided between each fish rafts / cages with typical size around one hectare of sea area. The detailed number, size and separation distance of the fish rafts / cages would be determined by the applicant at a later stage and agreed with AFCD.

There will also be communal rafts for mutual use amongst licensees within the Project site. Water monitoring equipment would be installed by AFCD at the Project site for real-time monitoring of water quality, including dissolved oxygen, turbidity, etc. The licensees could make use of the water quality data to determine if any precautionary measures should be conducted, e.g. additional air pumping, fish stock relocation. In addition, the communal raft can also be used as a supply base for keeping pellet feed and other common operational utility/equipment for the licensees within the FCZ. The communal rafts are not for living purpose. All of the facilities will be controlled under the licence to mariculturists.

2.9.2 Construction Activities

For all types of advanced aquaculture technologies, the construction of the proposed Project will mainly involve the setup of fish farm structures, including fish rafts / cages, auxiliary facilities (such as storage areas on communal rafts) and mooring system at sea. No land-based works, structures and activities are involved in the Project and no landscape areas will be affected. The scale of construction work on-site is relatively small and the installation of fish farm structures are expected to be completed within a few weeks for each fish raft. 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. These vessels will be the major means of transport to the Project site during the construction phase and anchoring of these vessels might be required. No dredging works are required during the construction phase and no heavy construction plant would be used. Fish rafts / cages and auxiliary facilities, such as storage space and shelters, will be positioned by anchor lines attaching to the anchorage points on the seabed. Use of winch might also be required during the assembly and anchorage of fish rafts / cages. All construction activities shall be conducted during daylight hours.

2.9.3 Operation Activities

Mariculture activities, such as management of fish raft / cages and fish stocks within the Project site at sea will be undertaken during operational phase with all types of advanced technologies. No land-based works, structures and activities are involved in the Project and no landscape areas will be affected. 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. These vessels will be the major means of transport to the Project site during operation phase. As the fish farm facilities will be used mainly for mariculture, auxiliary facilities such as storage space and shelters will be present, and automated / remote fish feeder machines will be adopted in the Project to reduce physical labour input. There will be no facilities to support on-site living and activities such as cooking is not anticipated at the Project site. No maintenance dredging or sediment removal will be required during FCZ operation.

2.9.3.1 General Management of the FCZs

Mariculture in Hong Kong is protected and regulated by the *Marine Fish Culture Ordinance (Cap. 353)* which states that a person should have the required license to be engaged in fish culture within a fish culture zone and the fish culture zone should be used for mariculture purposes only. This will help to restrict the types of activities that would occur within the FCZ and restrict sources of water pollution to fish farms and associated marine vessels. The general management of the new FCZs therefore shall follow the *Marine Fish Culture Ordinance (Cap. 353)* and *Marine Fish Culture Regulations (Cap. 353A)*.

Mariculture rafts made of more durable materials (e.g. HDPE, steel truss cages) will be encouraged during the approval process by AFCD for licence in the Project site. AFCD will issue licences to the successful applicants (“licensees”) with specific terms and conditions. Licensees would be required to submit a fish farm operational plan to AFCD under the *Marine Fish Culture Ordinance (Cap. 353)* during the application of the fish culture licence, aiming to implement good site practices and prevent impacts on the environment. Licensees should, for example, ensure that the mesh size and quality of the nets will provide a complete barrier to retain fish stocks within cages and free from holes to prevent fish escape, the design of the cages can prevent fish stocks from “jumping” out of the cage, and cages (except cages used for the cultivation of deposit feeders for IMTA) will be positioned and securely anchored to have at least 2 m clearance from the seabed at all times to avoid impacts to the seabed and allow sufficient water exchange within the cage. Licensees should ensure their rafts and cages have the ability to withstand adverse weather conditions (e.g. typhoon) by using cage types with appropriate anchors and moorings. Licensees are required to operate machinery in a manner that minimise disturbance to the seabed. AFCD will conduct regular inspection and review on FCZ operation to determine substantial use of the licensed area and consider the renewal of licenses where applicable. Performance criteria will be monitored and audited for the mariculture operations to ensure the appropriate use of the licensed area and the implementation of proper fish farm management. When licensees do not comply with the licence conditions, the licence may be suspended or revoked.

Operation practices and measures to be adopted in the Project are listed in ***Appendix 2A***.

2.10 Tentative Implementation Programme

Subject to the completion of this EIA study and issuance of EP, legislative exercise will be carried out to amend the *Schedule to the Fish Culture Zone (Designation) Order (Cap. 353B)* by negative vetting for designating new FCZ. Consequential amendments to other related ordinances will also be made as necessary. After the designation of the new FCZ tentatively in Year 2023, AFCD will grant new marine fish culture licences to mariculturists who successfully apply to operate in this FCZ.

Construction activities by licensees are expected to commence in Year 2024, subject to the timing of application and approval of the new marine fish culture licence. The construction period of the Project, i.e. from the commencement of the construction and installation works until the new FCZ has reached its design capacity, will be subjected to future application and approval process. Typically, the construction, transfer, and on-site assembly and anchorage of a modern fish raft / cages with ancillary facilities will take a few weeks to complete.

Mariculture operation is expected to be commenced by stages upon complete installation of fish farm by individual mariculturist. Modern design fish farm, depending on the material adopted, would typically last for over 10 years without major repair.

2.11 Interactions with Other Surrounding Projects

The Project may have the potential to interact with the proposed establishment of FCZs at Outer Tap Mun and Mirs Bay, subject to the timing of completion of legislative exercise to amend the *Schedule to the Fish Culture Zone (Designation) Order (Cap. 353B)* and existing FCZs in the vicinity. No other existing or committed project is identified in the vicinity of the Project site, which may potentially interface with the construction and operation of this Project. Cumulative impacts due to the proposed establishment of FCZs at Outer Tap Mun and Mirs Bay and existing FCZs in the vicinity have been addressed in the relevant technical assessments in this EIA study as appropriate.

3. WATER QUALITY

3.1 Introduction

This ***Section*** presents an evaluation of the potential water quality impacts from the construction and operation of the Project, and the results were assessed with reference to the relevant environmental legislation, standards and criteria.

3.2 Relevant Legislation and Guidelines

The following legislation and relevant guidance or non-statutory guidelines are applicable to the evaluation of water quality impacts associated with the construction and operation of the Project:

- *Water Pollution Control Ordinance* (*WPCO*);
- *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (*TM- ICW*);
- *Hong Kong Planning Standards and Guidelines (HKPSG)*; and
- *Environmental Impact Assessment Ordinance (EIAO) and the Technical Memorandum on EIA Process* (*EIAO-TM*), *Annexes 6* and *14*.

3.2.1 Water Pollution Control Ordinance (WPCO)

The Water Pollution Control Ordinance (WPCO) is the primary legislation for the control of water pollution and water quality in Hong Kong. Under the WPCO, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs).

The proposed Project is located within the Mirs Bay WCZ and close to the boundary of the Tolo Harbour and Channel WCZ. The applicable WQOs for these WCZs are presented in ***Table 3.1***.

3.2.2 Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-ICW)

All discharges from the construction and operation phases of the proposed Project are required to comply with the *Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (*TM-ICW*) issued under Section 21 of the WPCO.

The TM-ICW defines acceptable discharge limits to different types of receiving waters. Under the *TM-ICW*, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for specified discharge volumes. These are defined by the Environmental Protection Department (EPD) and are specified in licence conditions for any new discharge within a WCZ.

3.2.3 Hong Kong Planning Standards and Guidelines (HKPSG)

Mariculture is identified as one of the sensitive uses under Section 5.3 of Chapter 9 of the HKPSG. The HKPSG highlighted the importance of good water quality for the mariculture environment, as well as the potential water quality impact from mariculture operation. Limitation on new effluent within 200m of the seaward boundaries and 100m of the landward boundaries of a marine fish culture zone should be observed. The HKPSG also highlighted the importance of good water circulation to allow pollutants be readily dispersed, as well as control of other sources of pollution that could affect water quality.

3.2.4 Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM)

Annexes 6 and *14* of the *EIAO-TM* provide general guidelines and criteria to be used in assessing water quality impacts.

The *EIAO-TM* recognises that, in the application of the above water quality criteria, it may not be possible to achieve the WQO at the point of discharge as there are areas which are subjected to greater impacts (which are termed by the EPD as the mixing zones), where the initial dilution of the discharge takes place. The definition of this area is determined on a case-by-case basis. In general, the criteria for acceptance of the mixing zones are that it must not impair the integrity of the water body as a whole and must not damage the ecosystem.

Table 3.1 Summary of Water Quality Objectives for Mirs Bay WCZ and Tolo Harbour and Channel WCZ

	Water Quality Objective	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
A	AESTHETIC APPEARANCE		
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone	Not applicable
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone	Not applicable
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam.	Whole zone	Not applicable
d)	There should be no recognisable sewage-derived debris.	Whole zone	Not applicable
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone	Not applicable
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone	Not applicable
g)	Waste discharges shall cause no noxious or offensive odour or offensive taint or colour in either waters or edible aquatic organisms in the subzone to be present in concentrations detectable by bioassay or organoleptic tests.	Not applicable	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.
h)	Waste discharges shall cause no visible foam, oil, grease, scum, litter or other objectionable matter in waters of the subzone.	Not applicable	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.
B	BACTERIA		
a)	The level of *Escherichia coli* should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzones and Fish Culture Subzones	Secondary Contact Recreation Subzones and Fish Culture Subzones
b)	The level of *Escherichia coli* should be zero per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Water Gathering Ground Sub-zones	Not applicable

	Water Quality Objective	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
c)	The level of *Escherichia coli* should not exceed 1 000 per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Other inland waters of the Zone	Not applicable
C	COLOUR		
a)	Waste discharges shall not cause the colour of water to exceed 30 Hazen units.	Water Gathering Ground Sub-zones	Not applicable
b)	Waste discharges shall not cause the colour of water to exceed 50 Hazen units	Other inland waters of the Zone	Not applicable
D	DISSOLVED OXYGEN		
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as the water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth, and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones	Not applicable
b)	The dissolved oxygen level should not be less than 5 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Fish Culture Subzones	Not applicable
c)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 milligrams per litre.	Water Gathering Ground Sub-zones and Other inland waters of the Zone	Not applicable
d)	Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 2 milligrams per litre	Not applicable	Harbour subzone

	Water Quality Objective	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
	within two metres of the bottom, or to be less than 4 milligrams per litre in the remainder of the water column.		
e)	Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 3 milligrams per litre within two metres of the bottom, or to be less than 4 milligrams per litre in the remainder of the water column.	Not applicable	Buffer subzone
f)	Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 4 milligrams per litre at any point in the water column.	Not applicable	Channel subzone
E	pH		
a)	The pH of the water should be within the range of 6.5-8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters	Not applicable
b)	Waste discharges shall not cause the pH of the water to exceed the range of 6.5-8.5 units.	Water Gathering Ground Sub-zones	Not applicable
c)	The pH of the water should be within the range of 6.0-9.0 units.	Other inland waters of the Zone	Not applicable
d)	Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than +/- 0.5 pH units at any time.	Not applicable	Harbour subzone
e)	Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than +/- 0.3 pH units at any time.	Not applicable	Buffer subzone
f)	Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than +/- 0.1 pH units at any time.	Not applicable	Channel subzone
F	TEMPERATURE		
a)	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 degree Celsius.	Whole Zone	Not applicable
b)	Waste discharges shall not cause the natural daily temperature range in waters of the subzone to be extended by greater than +/- 1.0℃ at any location or time. The rate of temperature	Not applicable	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.

	Water Quality Objective	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
	change shall not exceed 0.5℃ per hour at any location, unless due to natural phenomena.		
G	SALINITY		
a)	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole Zone	Not applicable
b)	Waste discharges shall not cause the normal salinity range of any waters of the subzone to be extended by greater than +/- 3 parts per thousand at any time.	Not applicable	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.
H	SUSPENDED SOLIDS		
a)	Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters	Not applicable
b)	Waste discharges shall not cause the annual median of suspended solids to exceed 20 milligrams per litre.	Water Gathering Ground Sub-zones and Other inland waters of the Zone	Not applicable
I	AMMONIA		
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole Zone	Not applicable
J	NUTRIENTS		
	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters	Not applicable
	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.3 milligram per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed).	Marine waters	Not applicable
K	5-DAY BIOCHEMICAL OXYGEN DEMAND		
a)	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 3 milligrams per litre.	Water Gathering Ground Sub-zones	Not applicable

	Water Quality Objective	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
b)	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 milligrams per litre.	Other inland waters of the Zone	Not applicable
L	CHEMICAL OXYGEN DEMAND		
a)	Waste discharges shall not cause the chemical oxygen demand to exceed 15 milligrams per litre.	Water Gathering Ground Sub-zones	Not applicable
b)	Waste discharges shall not cause the chemical oxygen demand to exceed 30 milligrams per litre.	Other inland waters of the Zone	Not applicable
M	TOXINS / TOXICANTS		
a)	Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other.	Whole Zone	Not applicable
b)	Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole Zone	Not applicable
c)	Waste discharges shall not cause the toxicants in waters of the subzone to attain such a level as to produce significant toxic effects in humans, fish or any other aquatic organism, with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other.	Not applicable	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.
N	CHLOROPHYLL-A		
a)	Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 20 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Not applicable	Harbour subzone
b)	Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 10 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Not applicable	Buffer subzone

	Water Quality Objective	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
c)	Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 6 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Not applicable	Channel subzone
O	LIGHT PENETRATION		
a)	No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 20 per cent of the normal level in the subzone at any location or any time.	Not applicable	Harbour subzone
b)	No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 15 per cent of the normal level in the subzone at any location or any time.	Not applicable	Buffer subzone
c)	No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 10 per cent of the normal level in the subzone at any location or any time.	Not applicable	Channel subzone
P	SETTLEABLE MATERIAL		
	Waste discharges shall give rise to no bottom deposits or submerged objects which adversely influence bottom living communities, alter the basic Harbour geometry or shipping channels, present any hazard to shipping or diving activities, or affect any other beneficial use of the waters of the subzone.	Not applicable	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.

(1) CAP358U Statement of Water Quality Objectives (Mirs Bay Water Control Zone)

(2) CAP358B Tolo Harbour and Channel Water Control Zone Statement of Water Quality Objectives

3.3 Baseline Conditions

3.3.1 Assessment Area

In accordance with the Study Brief, the Assessment Area for water quality impact assessment covers the Mirs Bay WCZ and the Tolo Harbour and Channel WCZ. Wong Chuk Kok Hoi, where the proposed Wong Chuk Kok Hoi FCZ is located, is an embayment between the Wong Chuk Kok Tsui landmass and the Double Island. The embayment is generally over 10 m deep except for the nearshore areas as well as the south-western corner. The embayment connects to the Mirs Bay in the north-eastern direction, which itself is also an embayment. Water depth for the majority of Mirs Bay is around 10 m – 20 m.

3.3.2 Marine Water Quality

Baseline marine water quality of the Assessment Area has been determined through a review of EPD routine water quality monitoring data collected between 1986 and 2020. This dataset provides Hong Kong's most comprehensive long-term water quality monitoring data and allows an indication of temporal and spatial change in marine water quality in Hong Kong. Water quality monitoring data from EPD monitoring stations that are located within or close to the Assessment Area were reviewed and summarised in ***Table 3.2***. Locations of these stations are presented in ***Figure 3.1***.

According to EPD's *Marine Water Quality in Hong Kong in 2020*, Mirs Bay attained an overall marine WQO compliance rate of 98% in 2020. The water quality was very good with high DO, and low nutrient and *E. coli* levels. For the Tolo Harbour and Channel WCZ, the overall marine WQO compliance rate in 2020 was 93%. Tolo Harbour consistently complied with the bacteriological WQO for secondary contact recreational uses applicable to the entire marine waters of the WCZ. Tolo Channel, however, was subject to a natural hydrological phenomenon of water column stratification and associated lower bottom DO level due to restricted water exchange with the open waters. Compliance with the WQOs is generally observed in most parameters at the selected monitoring stations at the two WCZs. There have been exceedances of chlorophyll-a level at TM8 (Tolo Channel subzone) but the situation has significantly improved since the implementation of the Tolo Harbour Effluent Export Scheme (THEES) as well as a number of measures under the Livestock Waste Control Scheme (LWCS). According to EPD's *Marine Water Quality in Hong Kong* (various years), the percentage of samples taken at TM8 with ≤6 μg/L level of chlorophyll-a gradually increases from the low point of 70.7% in 1988 up to average of around 90% in the recent 10 years from 2011-2020 (with 100% in 2020).

Table 3.2 Summary of EPD Routine Water Quality Monitoring Data from Selected Stations of the Tolo Harbour and Channel WCZ and Mirs Bay WCZ (1986 – 2020)

Parameters	TM8	MM7	MM17
Temperature (°C)	22.7	23.5	23.8
	(11.7-30.4)	(11.5-30.4)	(14.1-29.7)
Salinity (psu)	32.1	32.1	32.2
	(26.8-35.4)	(24.0-34.2)	(30.3-34.3)
Dissolved Oxygen (mg/L)	6.1	6.4	6.2
	(1.4-14.2)	(2.4-12.1)	(4.2-9.0)
Dissolved Oxygen (mg/L) - Bottom	5.0	5.8	5.4
	(0.0-19.5)	(0.2-12.4)	(1.1-8.6)
Dissolved Oxygen (%saturation)	84	90	87
	(33-167)	(38-144)	(63-115)
Dissolved Oxygen (%saturation) - Bottom	68	80	75
	(0-200)	(3-160)	(16-109)

Parameters	TM8	MM7	MM17
pH	8.2	8.1	8.0
	(7.5-8.9)	(7.5-8.6)	(7.6-8.3)
Secchi Disc Depth (M)	3.5	3.5	3.7
	(0.5-13.0)	(1.1-9.1)	(1.5-7.0)
Turbidity (NTU)	3.9	4.1	1.4
	(0.2-33.1)	(0.3-17.5)	(0.1-5.5)
Suspended Solids (mg/L)	3.2	2.9	5.1
	(0.5-71.2)	(0.5-17.7)	(0.7-16.0)
5-day Biochemical Oxygen Demand (mg/L)	1.1	1.0	0.8
	(0.1-5.8)	(0.2-3.2)	(0.2-2.0)
Ammonia Nitrogen (mg/L)	0.044	0.040	0.029
	(0.01-0.68)	(0.01-0.57)	(0.01-0.08)
Unionised Ammonia (mg/L)	0.003	0.002	0.002
	(0.000-0.077)	(0.001-0.044)	(0.000-0.003)
Nitrite Nitrogen (mg/L)	0.013	0.012	0.011
	(0.002-0.103)	(0.002-0.101)	(0.002-0.067)
Nitrate Nitrogen (mg/L)	0.026	0.023	0.028
	(0.002-0.609)	(0.002-0.160)	(0.003-0.103)
Total Inorganic Nitrogen (mg/L)	0.07	0.06	0.06
	(0.01-0.70)	(0.01-0.60)	(0.01-0.15)
Total Kjeldahl Nitrogen (mg/L)	0.37	0.26	0.38
	(0.08-4.79)	(0.08-1.13)	(0.11-0.88)
Total Nitrogen (mg/L)	0.40	0.28	0.41
	(0.05-4.80)	(0.08-1.13)	(0.12-0.89)
Orthophosphate Phosphorus (mg/L)	0.013	0.010	0.008
	(0.002-0.068)	(0.002-0.081)	(0.002-0.028)
Total Phosphorus (mg/L)	0.05	0.04	0.04
	(0.02-0.58)	(0.02-0.24)	(0.02-0.11)
Silica (mg/L)	0.77	0.65	0.66
	(0.05-2.00)	(0.06-2.16)	(0.07-1.24)
Chlorophyll-a (µg/L)	3.4	3.0	2.1
	(0.3-120.8)	(0.3-14.4)	(0.3-5.1)
E. coli (cfu/100mL)	2	2	2
	(1-510)	(1-161)	(1-32)
Faecal Coliforms (cfu/100mL)	3	3	2
	(1-6000)	(1-1171)	(1-59)

Notes:
1. Data presented are depth-averaged values calculated by taking the means of three depths, i.e. surface (S), mid-depth (M) and bottom (B), except as specified.
2. Data presented are annual arithmetic means except for *E. coli*, which are geometric means.
3. Shaded cells indicate non-compliance with the WQOs.

3.3.3 Marine Sediment Quality

Baseline marine sediment quality in the Assessment Area has been determined through a review of EPD routine sediment quality monitoring data collected between 1986 and 2020. Sediment monitoring data from EPD monitoring stations that are located within or close to the Assessment Area were reviewed and summarised in ***Table 3.3***. Locations of these stations are presented in ***Figure 3.1***.

Sediment monitoring data from the EPD monitoring stations were compared with the relevant sediment quality criteria specified in *ETWB TC(W) No. 34/2002 Management of Dredged/Excavated*

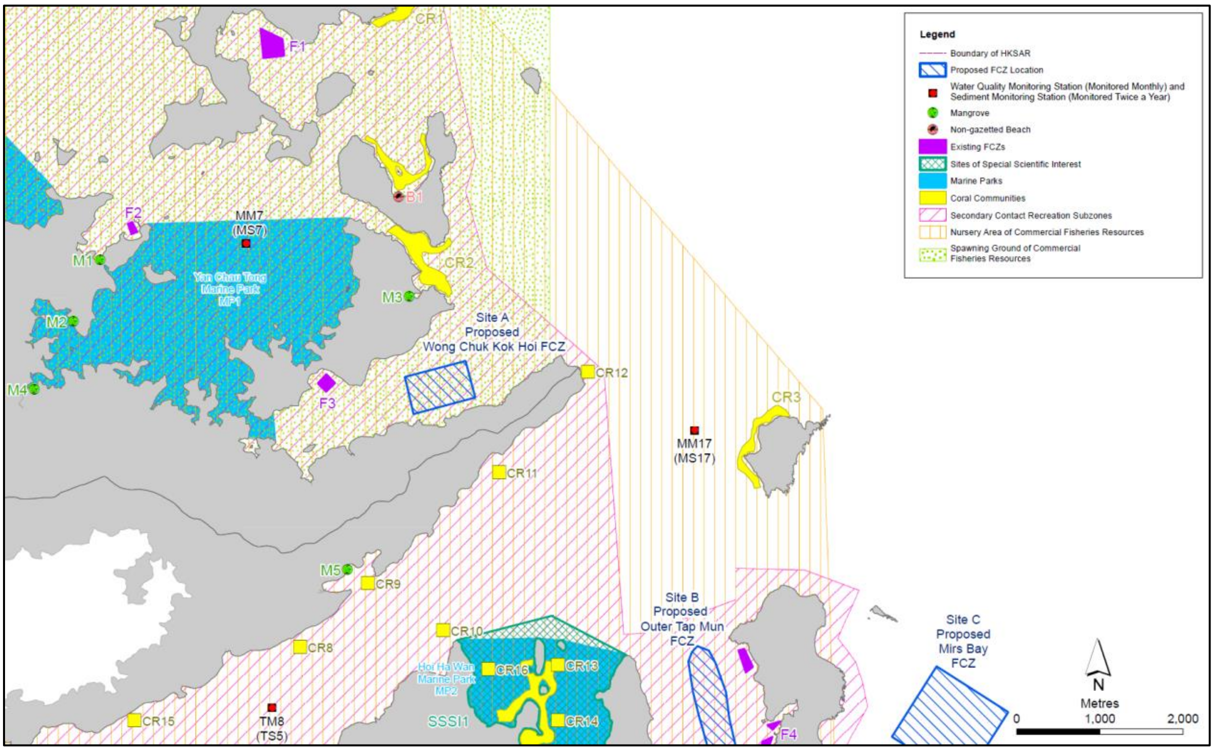
Sediment. The EPD routine monitoring data indicate that the contaminant levels in the sediments in the vicinity of the Project are all below the Lower Chemical Exceedance Level (LCEL).

Table 3.3 Summary of EPD Routine Sediment Monitoring Data from Selected Stations of the Tolo Harbour and Channel WCZ and Mirs Bay WCZ (1986 – 2020)

Parameters	LCEL	UCEL	TS5	MS7	MS17
Arsenic (mg kg^{-1})	12	42	6.6	7.2	6.9
			(3.2-12.0)	(4.0-10.0)	(2.2-11.0)
Cadmium (mg kg^{-1})	1.5	4	0.5	0.4	0.3
			(0.1-7.5)	(0.1-9.8)	(<0.1-8.3)
Chromium (mg kg^{-1})	80	160	32.5	34.5	32.8
			(11.0-85.0)	(25.0-57.0)	(6.0-44.0)
Copper (mg kg^{-1})	65	110	21.8	19.9	16.3
			(5.0-70.0)	(11.0-28.0)	(<0.2-55.0)
Lead (mg kg^{-1})	75	110	53.1	43.8	43.9
			(35.0-86.0)	(27.0-65.0)	(26.0-67.0)
Mercury (mg kg^{-1})	0.5	1	0.10	0.08	0.06
			(<0.05-0.59)	(0.05-0.38)	(<0.05-0.55)
Nickel (mg kg^{-1})	40	40	23.3	23.4	23.9
			(7.0-50.0)	(17.0-35.0)	(6.0-34.0)
Silver (mg kg^{-1})	1	2	<0.2	<0.2	<0.2
			(<0.2-<0.2)	(<0.2-<0.2)	(<0.2-0.5)
Zinc (mg kg^{-1})	200	270	121.3	99.2	96.9
			(64.0-220.0)	(77.0-140.0)	(36.0-170.0)
Total Polychlorinated Biphenyls	23	180	18	18	14
(PCBs) (µg kg^{-1})			(8-26)	(10-18)	(3-18)
Low Molecular Weight	550	3,160	<180	<180	<180
Polycyclic Aromatic Hydrocarbons (PAHs) (µg kg^{-1})			(<180-<180)	(<180-260)	(<180-185)
High Molecular Weight	1,700	9,600	36	50	35
Polycyclic Aromatic Hydrocarbons (PAHs) (µg kg^{-1})			(<32-130)	(<32-267)	(<32-139)
Chemical Oxygen	--	--	18796	17537	16266
Demand (mg kg^{-1})			(8300-40000)	(12000-28000)	(8400-38000)
Total Kjeldahl Nitrogen	--	--	737.4	715.4	669.7
(mg kg^{-1})			(23.0-2000.0)	(210.0-3600.0)	(18.0-1600.0)

Note:
1. Data presented are arithmetic means; data in brackets indicate ranges.
2. All data are on a dry weight basis unless stated otherwise.

Figure 3.1 Location of Water Sensitive Receivers and Nearby EPD Marine Water / Sediment Quality Monitoring Stations



3.3.4 Water Sensitive Receivers

The WSRs have been identified in accordance with *Annex 14* of the *Technical Memorandum on EIA Process* (*EIAO, Cap.499, S.16*) and Section 3.4.3.2 of the Study Brief. These WSRs are illustrated in ***Figure 3.1*** and listed in ***Table 3.4***. Key WSRs include:

- Recreational areas, such as secondary contact recreation subzones of WCZs (21);
- Yan Chau Tong Marine Park (MP1), as well as the Hoi Ha Wan Marine Park (MP2);
- Existing FCZs at Wong Wan and other nearby areas (F1 to F4);
- Proposed FCZs at Outer Tap Mun and Mirs Bay (Site B and Site C, respectively);

(21) The entirety of the Tolo Harbour and Channel WCZ as well as the nearshore waters of the Mirs Bay are categorized as Secondary Contact Recreation Subzone. The predicted water quality at these areas are represented by other WSRs and thus do not have the respective WSRs for Secondary Contact Recreation Subzone only. Specifically, all WSRs identified under this Study except Site C and CR3 are located within Secondary Contact Recreation Subzone.

- Ecological habitats for marine organisms including coral and benthic communities, and Finless Porpoise (22) at / near the Project site (CR1 to CR3, CR8 to CR16, M1 to M5);
- Spawning ground and nursery areas of commercial fisheries resources (23);
- Artificial reefs in Yan Chau Tong Marine Park (MP1) and Hoi Ha Wan Marine Park (MP2);
- Intertidal area of Plover Cove Country Park (M1 to M5);
- Hoi Ha Wan SSSI (SSSI1); and
- Non-gazetted beach (B1).

There is no seawater intake identified within 5 km from the Project Site, and other WSRs outside of 5 km from the Project Site is expected to be too far away to be impacted by the proposed mariculture operation. They are therefore not considered in this assessment.

In accordance with the Study Brief, the Project site itself is also considered as a sensitive receiver for assessment.

Table 3.4 Water Sensitive Receivers (WSRs) in the Vicinity of the Proposed FCZ Site at Wong Chuk Kok Hoi

WSR ID	WSR	Distance to the Proposed FCZ site at Wong Chuk Kok Hoi (km)
B1	Non-gazetted beach of Crescent Bay	2.0
CR1	Coral at Northeast Crooked Island	4.1
CR2	Coral at Crescent Island and Double Island	0.8
CR3	Coral at Port Island	3.3
CR8	Coral at Wong Wan Tsai	3.1
CR9	Coral at Fung Wong Wat	2.1
CR10	Coral at Gruff Head	2.6
CR11	Coral at South Wong Wan Tsui	0.9
CR12	Coral at Wong Chuk Kok Tsui	1.3
CR13	Coral at Hoi Ha Wan Moon Island	3.4
CR14	Coral at Hoi Ha Wan Coral Beach	4.0
CR15	Coral at Sam Mun Shan	4.9
CR16	Coral at Heung Lo Kok	3.1
F1	O Pui Tong Fish Culture Zone	4.0
F2	Sai Lau Kong Fish Culture Zone	3.7

(22) Similar to the case of Secondary Contact Recreation Subzone, ecological habitat for finless porpoise is an areal WSR with wide coverage. The predicted water quality at these areas are represented by other WSRs and thus do not have the respective WSRs for ecological habitat for finless porpoise only. Note that according to the latest AFCD Marine Mammal Monitoring Report 2021/22, no records of finless porpoise were recorded in the assessment area.

(23) Similar to the case of Secondary Contact Recreation Subzone and ecological habitat for finless porpoise, spawning ground and nursery area of commercial fisheries resources is an areal WSR with wide coverage. The predicted water quality at these areas are represented by other WSRs and thus do not have the respective WSRs for spawning ground and nursery area of commercial fisheries only. Specifically, all WSRs identified under this Study except Site C are located within nursery area of commercial fisheries resources. WSRs located within spawning ground of commercial fisheries resources include M1-M4, F1-F3, CR1-2, MP1 and the Project Site itself.

WSR ID	WSR	Distance to the Proposed FCZ site at Wong Chuk Kok Hoi (km)
F3	Wong Wan Fish Culture Zone	0.9
F4	Tap Mun Fish Culture Zone	4.4
M1	Mangrove Stand / Intertidal at Ngau Shi Wu Wan	4.1
M2	Mangrove Stand / Intertidal at Ngor Tau Tsui	4.5
M3	Mangrove Stand / Intertidal at Tung Wan	1.0
M4	Mangrove Stand / Intertidal at Sam A Chung	4.5
M5	Mangrove Stand / Intertidal at Fung Wong Wat	2.3
MP1	Yan Chau Tong Marine Park and Artificial Reef within the Marine Park	1.1
MP2	Hoi Ha Wan Marine Park and Artificial Reef within the Marine Park	2.7
SSSI1	Hoi Ha Wan SSSI	2.8
Site A	Proposed Wong Chuk Kok Hoi FCZ	Project Site
Site B	Proposed Outer Tap Mun FCZ	3.9
Site C	Proposed Mirs Bay FCZ	6.3

3.4 Assessment Criteria

The proposed establishment of new fish culture zone would potentially result in an increase in pollution from fish farming operation. Such pollution may increase nutrient levels as well as decrease dissolved oxygen level in the surrounding waters. The relevant assessment criteria for non-FCZ WSRs are stipulated in the WQO and are shown in ***Table 3.5***.

Table 3.5 Summary of Assessment WQO Criteria

Parameters	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
Dissolved Oxygen (Bottom) (mg/L)	Not less than 2 mg/L for 90% of samples	Not less than 2 mg/L for the Harbour subzone. Not less than 3 mg/L for the Buffer subzone. Not less than 4 mg/L for the Channel subzone.
Dissolved Oxygen (Depth-averaged) (mg/L)	Not less than 4 mg/L for 90% of samples	Not less than 4 mg/L.
Suspended Solids (mg/L)	Change not more than 30% due to waste discharge	Not applicable
Total Inorganic Nitrogen (mg/L)	≤ 0.3	Not applicable
Unionized Ammonia (mg/L)	≤ 0.021 mg/L	Not applicable
Chlorophyll-a (µg/L)	Not applicable	5-day running average not more than 20 µg/L for the Harbour subzone. 5-day running average not more than 10 µg/L for the Buffer subzone. 5-day running average not more than 6 µg/L for the Channel subzone.
E.coli (no./100mL)	≤ 610 no./100mL for the Secondary contact recreation subzone and the Fish culture subzones	≤ 610 no./100mL for the Secondary contact recreation subzone and the Fish culture subzones

In addition to the WQO criteria for various water quality parameters in the two WCZs, reference has been made to other past approved EIA reports / project profiles for applicable assessment criterion for protection of coral within the Tolo Harbour and Channel WCZ. Assessment criterion of 10 mg/L of total suspended solids levels would be adopted following the approved EIA of Development of a Bathing Beach at Lung Mei, Tai Po (AEIAR-123/2008), as well as the Project Profile for Sediment Removal at Yim Tin Tsai, Yim Tin Tsai (East) Fish Culture Zones and Shuen Wan Typhoon Shelter (DIR-191/2009). For fish culture zone in Mirs Bay, an additional criterion for chlorophyll-a of 20 µg/L would be adopted to protect the fish stock from excessive algal growth based on criterion adopted in previous Project WATERMAN Study [(24)]. A summary of applicable assessment criteria for each category of WSRs are provided below in ***Table 3.6***.

There will be no marine dredging or other major marine works that could cause significant sediment disturbance and the associated release of sediment-bounded contaminants. Therefore, assessment criteria for dissolved metals and organic compounds are not necessary for this Study.

(24) Wong *et.al.* (2012). Project WATERMAN Carrying Capacity of Fish Culture Zones in Hong Kong – Technical Note TN-2012-02

Table 3.6 Summary of Applicable Assessment Criterion for Identified WSRs

Category of WSR	ID	WSR	Annual								
			10th-percentile		Mean						Geomean
			Depth-averaged	Bottom	Depth-averaged	Bottom	Depth-averaged				
			Dissolved Oxygen				Total Inorganic Nitrogen	Unionized Ammonia	Chlorophyll-a	Suspended Solids	*E.coli* Note
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(mg/L)	(no./100 mL)
Non-gazetted beach – Mirs Bay	B1	Non-gazetted beach of Crescent Bay	≥4	≥2	N/A	N/A	≤0.3	≤0.021	N/A	increase ≤30% baseline	≤610
Coral – Mirs Bay	CR1	Coral at NE Crooked Island	≥4	≥2	N/A	N/A	≤0.3	≤0.021	N/A	increase ≤30% baseline	≤610
	CR2	Coral at Crescent Island and Double Island									
	CR3	Coral at Port Island									
	CR12	Coral at Wong Chuk Kok Tsui									
Coral – Tolo Harbour and Channel	CR8	Coral at Wong Wan Tsai	N/A	N/A	≥4	≥4	N/A	N/A	≤6	≤10	≤610
	CR9	Coral at Fung Wong Wat									
	CR10	Coral at Gruff Head									
	CR11	Coral at South Wong Wan Tsui									
	CR13	Coral at Hoi Ha Wan Moon Island									
	CR14	Coral at Hoi Ha Wan Coral Beach									
	CR15	Coral at Sam Mun Shan									
	CR16	Coral at Heung Lo Kok									
Fish Culture Zone – Mirs Bay	F1	O Pui Tong Fish Culture Zone	≥5	≥2	N/A	N/A	≤0.3	≤0.021	≤20	increase ≤30% baseline	≤610
	F2	Sai Lau Kong Fish Culture Zone									
	F3	Wong Wan Fish Culture Zone									
	F4	Tap Mun Fish Culture Zone									
	Project site	Proposed Wong Chuk Kok Hoi FCZ									
	Site B	Proposed Outer Tap Mun FCZ									

Category of WSR	ID	WSR	Annual								
			10^{th}-percentile		Mean						Geomean
			Depth-averaged	Bottom	Depth-averaged	Bottom	Depth-averaged				
			Dissolved Oxygen				Total Inorganic Nitrogen	Unionized Ammonia	Chlorophyll-a	Suspended Solids	*E.coli* Note
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(mg/L)	(no./100 mL)
	Site C1	Proposed Mirs Bay FCZ (Northern Part)									
Mangrove Stand / Intertidal – Mirs Bay	M1	Mangrove Stand / Intertidal at Ngau Shi Wu Wan	≥4	≥2	N/A	N/A	≤0.3	≤0.021	N/A	increase ≤30% baseline	≤610
	M2	Mangrove Stand / Intertidal at Ngor Tau Tsui									
	M3	Mangrove Stand / Intertidal at Tung Wan									
	M4	Mangrove Stand / Intertidal at Sam A Chung									
Mangrove Stand / Intertidal – Tolo Harbour and Channel	M5	Mangrove Stand / Intertidal at Fung Wong Wat	N/A	N/A	≥4	≥4	N/A	N/A	≤6	≤10	≤610
Marine Park – Mirs Bay	MP1	Yan Chau Tong Marine Park and Artificial Reef within the Marine Park	≥4	≥2	N/A	N/A	≤0.3	≤0.021	N/A	increase ≤30% baseline	≤610
Marine Park – Tolo Harbour and Channel	MP2	Hoi Ha Wan Marine Park and Artificial Reef within the Marine Park	N/A	N/A	≥4	≥4	N/A	N/A	≤6	≤10	≤610
SSSI – Tolo Harbour and Channel	SSSI1	Hoi Ha Wan SSSI	N/A	N/A	≥4	≥4	N/A	N/A	≤6	≤10	≤610

Note: WQO criterion for *E.coli* is only applicable to fish culture zones, bathing beaches as well as secondary contact recreation subzone. Given secondary contact recreation subzone covers significant area around the Project Site and is represented by a lot of WSRs in this list, the criterion is deemed applicable to these WSRs groups as well.

3.5 Assessment Methodology

3.5.1 General Methodology

The methodology employed to quantitatively assess potential water quality impacts associated with the operation of the Project is presented in the Water Quality Modelling Plan (***Appendix 3A***), which provides full technical details of the modelling works as well as model validation. The WSRs assessed are presented in ***Figure 3.1***.

For other potential sources of water quality impact in construction and operation phase, qualitative approach would be adopted in the assessment.

3.5.2 Uncertainties in Assessment Methodology

The uncertainties associated with the operation phase water quality modelling and carrying capacity estimation include:

- Potential change in pollution loading from the Guangdong side of Mirs Bay; and
- Potential change in mariculture practice which leads to different level of pollution loading from fish farms.

Future year of 2023 was chosen because the future loading from the Guangdong Province of China is expected to decrease continuously and therefore the estimated loading in 2023 would be conservative (***Section 4*** of ***Appendix 3A*** referred). Model prediction of water quality under 2016 presented in ***Appendix 3D*** compared observed and predicted water quality at EPD Marine Water Quality Monitoring Stations. Results indicated the model developed can generally represent key water quality features including stratification and seasonal differences, while providing predictions that are generally more conservative the observed conditions. This means the model would provide conservative estimation of water quality thus being acceptable.

In terms of change in mariculture practice, the overall trend has been heading towards a more environmentally friendly direction in the past decades. The wider adoption of pellet feed has reduced wastage. Improved fish farming practice has reduced overfeeding, disease and fish mortality. Future improvement in technology and fish farming practice is expected to further the trend on small environmental footprint for mariculture, and thus the current assumptions are considered conservative and appropriate for impact assessment. In particular, the pollution loading from mariculture operation at the Project site was based on feed conversion ratio (FCR) of 2, whereas literatures reviewed under this Study indicated typical pellet feed nowadays can achieve FCR of close to 1 [25] [26] [27]. The adoption FCZ of 2 instead of 1 means the amount of feed assumed for mariculture operation would be doubled, and the associated wastage, leachage [28] of nutrient from waste would be notably higher than typical average conditions for fish farm using pellet feeds. This will ensure conservative estimation of pollution load from the mariculture operation at the Project site.

It should be highlighted that the water quality modelling exercise covered a typical annual cycle based on typical hydrodynamic of spring neap cycle in dry and wet seasons. Extreme conditions, such as typhoon is not expected to result in water quality conditions much worse than the typical conditions and is typically not considered in other water quality simulation in past EIAs. Also, in case of deterioration of water quality, it is typical for mariculturists to move the mariculture operation within or out of the Project site temporarily, which in the sense of modelling exercise means moving sensitive

(25) Sim SY, Rimmer MA, Toledo JD, Sugama K, Rumengan I, Williams KC, Phillips MJ (2005). A Practical Guide to Feeds and Feed Management for Cultured Groupers. NACA, Bangkok, Thailand. 18pp.

(26) FAO (2012). Transition from low-value fish to compound feeds in marine cage farming in Asia. Fisheries and Aquaculture Technical Paper No. 573

(27) AFCD (2009). Fish Feed Management. In Good Aquaculture Practices Series 1.

(28) "Leachage" refers to the release of dissolvable content from materials passing through the water column.

receiver as well as pollution source. In this Study, such movement has not been taken into account and thus represents the worst case scenario where avoidance is not possible.

To ensure robustness of the modelling exercise, performance of the hydrodynamic and water quality prediction have been demonstrated to be on par with past approved model (Annex A-B of ***Appendix 3A***) and able to reproduce realistic water quality conditions in the past (***Appendix 3D***). This shows the adopted model would be able to predict the water quality conditions under the baseline and project scenarios of the Project with reasonable accuracy and reliability, ensure reliable assessment and conclusion be drawn.

3.6 Potential Sources of Impact

3.6.1 Construction Phase

The construction for this Project will not involve civil or marine works. Most of the construction works would involve the assembly of parts to form fish rafts for mariculture, as well as the towing and anchoring of fish rafts from other location(s) to the new FCZ using tug boat. Potential water quality impact from the assembly of parts to form fish rafts would include accidental spillage, construction waste, as well as sewage from construction workforce. Anchoring and de-anchoring of fish rafts may result in transient, localised elevation of suspended solids near seabed.

3.6.2 Operation Phase

Mariculture activities at the Project site would result in an increase in pollution loads primarily from fish feed, feed wastage, fish excretion and dead fish. The increase in pollution loads would result in a change in water quality in the receiving waters, affecting the water quality at nearby sensitive receivers, such as other existing FCZs, marine ecological as well as fisheries resources. Other potential operation phase water quality impacts include change in hydrology / flow regime due to the presence of fish rafts, spillage of fish drugs, chemical and feed, wastewater from workforces and increased marine traffic and visitor activities.

Maintenance dredging and sediment removal were typically needed at FCZs sited at shallow and sheltered as a result of building up of organic content at the seabed level of the FCZs because of prolong mariculture operation. Build-up of organic content could be contributed by fish faeces, unconsumed feed, lodged off attached growth from cleaning, etc., and could results in deterioration of local water quality, increased risk of local red tide and upwelling of anoxic and toxic gas [(29)]. The Project site was chosen to be deep enough to (1) allow sufficient dispersion of any mariculture waste (fish faeces, unconsumed feed, lodged off attached growth, etc.) that sinks could be brought away by tidal current and dispersed at a larger area of the seabed so there is no significant build-up of the seabed, and (2) provide sufficient distance from the seabed to the bottom level of fish cages. Specifically, at least 2 m of clearance from the seabed would be maintained at all times. Maintenance dredging and sediment removal are therefore not required for the Project and hence no water quality impact would be expected from maintenance dredging and sediment removal.

In case of adverse weather / water quality conditions or approaching of harmful algal bloom, there may be a need for mariculturists to temporarily relocate their fish rafts (or equivalent) to safe location(s) to avoid fish kill or other damage. During the brief period of relocation, the pollution load from the relocated mariculture operation would be released into the relocated locations, thus affect the local water quality.

(29) DIR-191/2009 Sediment Removal at Yim Tin Tsai, Yim Tin Tsai (East) Fish Culture Zones and Shuen Wan Typhoon Shelter.

3.7 Impact Assessment – Construction Phase

The towing and anchoring of fish rafts is expected to have very limited impact on water quality, as the level of sediment suspended in the water column from anchoring will be very limited, primarily localised near the seabed and the impact will be transient because suspended sediment will settle shortly close to the anchor. Anchoring is routinely conducted for all kinds of vessel activities and floating structures in the surrounding waters and is considered to have limited level of impact on water body. The Project site is more than 10 m in water depth such that propeller would not have interaction with the seabed sediment and so SS elevation due to propeller wash is not anticipated.

Depending on the design and specifications, required works to assemble fish rafts onsite could vary and may include tighten up connections by nuts and bolts, ropes or equivalent, assembling parts with pre-casted grooves, etc. Modern fish rafts are available in modular form and with appropriate surface treatment [(30)], hence the onsite assembly can be done quicker and will require less onsite use of equipment and materials. In general, construction materials and tools are inert and use of these items is not expected to result in notable changes in water quality. It is noted that wood or other structural materials that require surface treatment (e.g. water-proofing, anti-fouling) are generally treated offsite (in factories / workshops) instead of onsite during assembly. The use of chemicals onsite is expected to be minimal and no unacceptable water quality impact from the onsite installation of fish raft would be expected. Details of tools and materials adopted on-site would be determined by the future licensees.

Because of the lack of major works to be conducted, it is unlikely there will be a significant workforce presence during construction phase, and any sewage / wastewater generated shall be collected at the transportation / work vessel(s) for disposal at appropriate facilities on land. Discharge of sewage from workforce or other wastewater should be strictly forbidden. No unacceptable water quality impact from sewage / wastewater from workforce is anticipated.

In view of the above, no unacceptable water quality impact is anticipated from fish raft installation.

3.8 Impact Assessment – Operation Phase

3.8.1 Changes in Water Quality from Pollution Loadings arising from Mariculture Operation

Mariculture activities at the Project site would result in an increase in pollution loads primarily from fish feed, feed wastage, fish excretion and dead fish. The increase in pollution loads would result in a change in water quality in the receiving waters, affecting the water quality at nearby sensitive receivers, such as other existing FCZs, marine ecological as well as fisheries resources. A carrying capacity [(31)] estimation was conducted (detailed in ***Appendix 3B***) to determine the suitable production capacity allowed onsite to ensure mariculture activities there would not result in, or be affected by, water quality impact from over-stocking. The estimation of carrying capacity was conducted using the methodology and box model developed by Project WATERMAN which was used in the carrying capacity estimation for the existing FCZs in Hong Kong. The carrying capacity estimation took into account various aspects affecting the water quality for mariculture operation, including tidal flushing, loading contribution from mariculture activities, as well as various water quality parameters interaction (e.g. nitrogen, phosphorus, dissolved oxygen). Based on the WATERMAN model, the carrying capacity for mariculture operation at the Project Site is found to be limited by the criterion for total inorganic nitrogen in both wet and dry seasons. The carrying capacity estimation indicated the

(30) Surface treatment like waterproofing and rush control is typically necessary for floating facilities such as fish rafts. By using material with surface treatment completed offsite (e.g. in a factory or workshop), the time required for onsite works can be reduced.

(31) Carrying capacity is defined as the maximum standing stock of a FCZ without significant deterioration of water quality under the typical average condition. It is a measurement of standing stock, i.e. amount of biomass of fish being kept on site.

Project site can support mariculture operation of 755.2 ton of standing stock based on typical mariculture practice in HK without significant deterioration of water quality under the typical average condition. The corresponding pollution load from such level of mariculture operation is presented in ***Appendix 3B***.

The estimated loading at Project site was taken into account in the Delft3D model to verify the acceptability of change in water quality at Project site itself as well as to determine the offsite water quality impact on nearby WSRs. Two modelling scenarios were conducted. The baseline scenario covers the “without project” condition of the Assessment Area in 2023. The project scenario has taken into account the additional pollution load from 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) [32]. The change in water quality as a result of the additional mariculture activities were assessed according to the WQO. Statistics of key water quality parameters are presented in ***Table 3.8*** [33]. Contour plots showing spatial distribution of key water quality parameters are presented in ***Appendix 3C***.

Following sections discuss the predicted level and change for key water quality parameters separately at the Project site as well as major nearby WSRs.

3.8.1.1 Dissolved Oxygen

Predicted levels of dissolved oxygen were generally good in most identified WSRs under both baseline and project scenarios except for certain embayed areas, mostly at the north, as 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. Typical depth-averaged levels of dissolved oxygen were predicted to be around 5 mg/L to 7 mg/L, which were close to the observed range at EPD Marine Water Quality Monitoring Stations (***Table 3.2***). Predicted levels of dissolved oxygen are generally lower in the bottom level and the predicted depth-averaged levels are typically slightly higher than that of the bottom level. Changes in dissolved oxygen due to mariculture production at the Project site and other locations were predicted to be limited at most locations away from these proposed new FCZ sites.

Within the Wong Chuk Kok Hoi embayment, the levels of dissolved oxygen were predicted to remain rather stable with and without project operation outside of the Project Site. The mean level of depth-averaged dissolved oxygen at the existing Wong Wan FCZ, which is the closest WSR to the Project site, was predicted to be 6.6 mg/L for baseline scenario and 6.4 mg/L for project scenario, and the mean levels of bottom dissolved oxygen were predicted to be 6.4 mg/L and 6.2 mg/L for respectively. For the Project Site, the predicted mean levels of depth-averaged dissolved oxygen at the predicted to be 5.8 mg/L for both scenarios, and the mean level of bottom dissolved oxygen was predicted to be 5.2 mg/L and 5.1 mg/L baseline and project scenarios respectively. The lower dissolved oxygen level at the Project site is a result of much deeper water at the Project site. In general, deeper water is more likely have lower dissolved oxygen level because of much longer diffusion distance from surface (particularly for sheltered waters with limited vertical mixing) and reduced photosynthesis. The predicted 10th-percentile depth-averaged dissolved oxygen levels at the existing Wong Wan FCZ were above the proposed assessment criterion of 5 mg/L under both scenarios while those at the Project Site are below 5 mg/L were below assessment criterion. The predicted 10th-percentile depth-averaged dissolved oxygen levels at the Project site was 4.0 mg/L under both scenarios. The relatively low dissolved oxygen levels at Project Site is contributed by the higher water temperature and stratification during the summer period. Such episodes of low dissolved oxygen levels were also observed at Wong Wan in the past years (***Figure 3.2***), without affecting the mariculture operation

(32) As a result of the relatively low baseline dissolved oxygen level at Project Site in wet season, the project scenario considered the effect of aeration at individual fish farm operation of the Project Site. Please refer to ***Appendix 3E*** for details.

(33) ***Table 3.8*** also include prediction at nearby EPD Marine Water Quality Monitoring Stations for reference. These EPD Marine Water Quality Monitoring Stations are not WSRs.

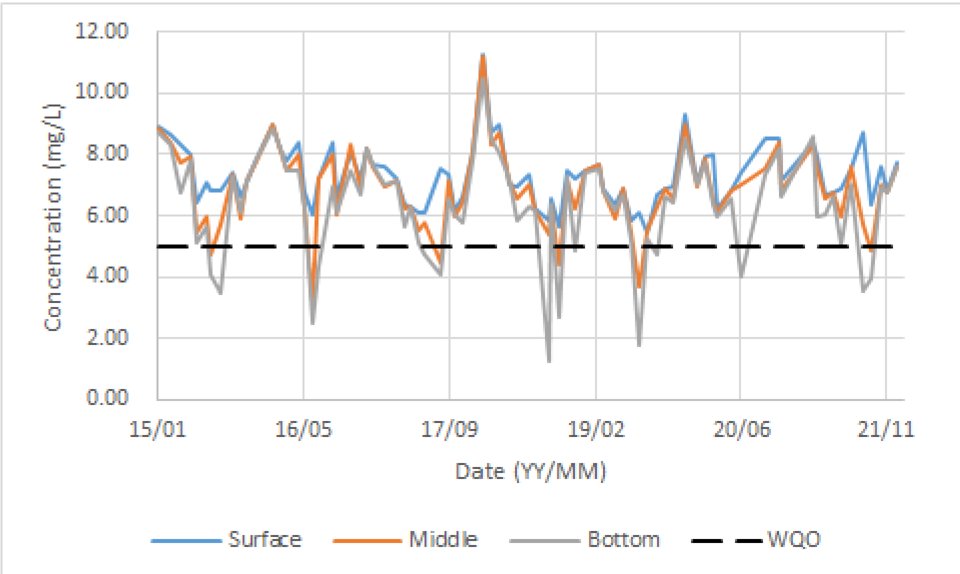
which are typically driven by low bottom dissolved oxygen levels in summer months, and the situation at the Project Site is worse than that of the existing Wong Wan FCZ given the higher water depth. It should be highlighted that even though the 10th-percentile depth-averaged dissolved oxygen levels at Site A was predicted to be lower than the corresponding assessment criterion of 5 mg/L, the dissolved oxygen levels predicted at the upper part of the water column (where the majority of fish stock is expected to stay) is generally higher. Based on AFCD's past records, dissolved oxygen levels of 4 mg/L or higher at surface level would not cause any notable impact to mariculture operation in general.

Additional time series plots of predicted dissolved oxygen levels at the surface, mid-depth and bottom levels at 4 locations within the Project site under both baseline and project scenarios are provided in ***Appendix 3C***. As shown, the predicted dissolved oxygen levels at various locations of the proposed site showed similar pattern of seasonal variation, with higher level in dry season and lower level in wet season. Also, some level of stratification is also predicted in wet season, with difference in dissolved oxygen levels up to 2 mg/L between the surface and bottom levels up in the deeper corner of the proposed site (northwestern corner), while that for the shallower side (southern) is predicted to around 1 mg/L. In terms of changes due to project operation, the predicted levels of dissolved oxygen for both baseline and project scenarios match each other very closely and have similar range of fluctuation.

Outside of the Wong Chuk Kok Hoi embayment, one FCZ WSR at O Pui Tong FCZ (F1) was predicted to have 10th-percentile depth-averaged dissolved oxygen levels below the corresponding assessment criterion in both scenarios and there is no predicted deterioration of DO level under the project scenario. Therefore, no unacceptable change in dissolved oxygen level at O Pui Tong FCZ would be expected.

Overall, according to the results listed in ***Table 3.8***, there is limited change in the predicted dissolved oxygen levels between baseline and project scenarios, the proposed mariculture operation at the Project site is not expected to result in significant deterioration of dissolved oxygen levels at the surrounding waters and identified WSRs.

Figure 3.2 Observed Dissolved Oxygen Level at Wong Wan FCZ from 2015-2021 (Source: AFCD Monitoring Data)



3.8.1.2 Total Inorganic Nitrogen

Predicted levels of total inorganic nitrogen were generally low in the assessment area. Predicted levels at WSRs were generally around 0.1 mg/L, which are lower than the assessment criterion of 0.3

mg/L for Mirs Bay. Similar levels were recorded at nearby EPD Marine Water Quality Monitoring Stations shown in ***Table 3.2***. The differences between baseline and project scenarios were predicted to be limited at WSRs away from proposed new FCZ sites at the Project site and other locations.

At the Wong Wan FCZ, the predicted level of total inorganic nitrogen remains stable with the mariculture operation at Project site. Predicted levels of total inorganic nitrogen at the Wong Wan FCZ were 0.05 mg/L under baseline scenario and 0.07 mg/L under project scenario. For the Project site, the mariculture operation result in slight increase of predicted levels of total inorganic nitrogen from 0.10 mg/L to 0.13 mg/L, which are both below the corresponding assessment criterion of 0.3 mg/L. No unacceptable elevation in total inorganic nitrogen is expected from the proposed mariculture operation at the Project site.

As shown in ***Table 3.8***, total inorganic nitrogen levels at all other identified WSRs were predicted to be below the corresponding assessment criterion of 0.3 mg/L under both baseline and project scenario. No unacceptable change in TIN level would be expected from the proposed mariculture operation at the Project site.

3.8.1.3 Unionized Ammonia

Given the small increase in total inorganic nitrogen level due to the operation of the Project, the corresponding predicted increase in unionized ammonia is also small. The increases at all WSRs between the baseline and project scenarios in unionized ammonia levels were either undetectable or at most 0.002 mg/L. The predicted levels of unionized ammonia were at or below 0.010 mg/L at all identified WSRs, which is below the assessment criterion of 0.021 mg/L. Predicted levels of unionized ammonia at Wong Wan FCZ were 0.003 mg/L in baseline scenario and 0.004 mg/L in project. For the Project site, predicted levels of unionized ammonia were 0.006 mg/L and 0.008 mg/L respectively in baseline and project scenarios. No unacceptable elevation in unionized ammonia is expected from the proposed mariculture operation at the Project site.

3.8.1.4 Suspended Solids

Predicted levels of suspended solids varies spatially across the assessment area, ranging from 1 to 6 5 mg/L. There are limited or no change for the predicted levels between baseline and project scenarios at all identified WSRs. Predicted SS level at Wong Wan FCZ was 2.6 mg/L under baseline scenario and 2.7 mg/L under project scenario, while that for the Project site was 2.0 mg/L and 2.1 mg/L respectively for baseline and project scenarios. None of the identified WSR show change in SS levels that exceed assessment criterion of 30% change level in baseline level. No unacceptable change in suspended solids level is expected.

3.8.1.5 Chlorophyll-a

Predicted levels of chlorophyll-a also vary spatially across the assessment area, ranging up to above 20 µg/L. Similar to the case of dissolved oxygen, chlorophyll-a levels are generally higher at surface level and thus area with shallower depth tends to have higher chlorophyll-a levels. The differences between baseline and project scenarios were predicted to be limited at WSRs away from proposed new FCZ sites at the Project site and other locations. No exceedance of chlorophyll-a criterion was predicted at all identified WSRs. No unacceptable water quality impact on chlorophyll-a is expected from the mariculture operation of the Project.

3.8.1.6 E.coli

In both baseline and project scenarios, the predicted levels of *E.coli* around the Project site were predicted to be very low because of the lack of major sources of *E.coli* (e.g. sewage). Since faecal pollution of dogs/cats is not expected within the Project site [34], the operation of fish farm at Project site will not introduce additional *E.coli* loading and thus the prediction under baseline and project scenarios are the same. No unacceptable water quality impact on identified beach, secondary contact recreation subzone and fish culture zone is expected. Further discussion on sewage and wastewater generation from staff and visitors onsite is provided under ***Sections 3.8.4*** and ***3.8.5*** below.

3.8.1.7 Impact on the Use of IMTA

As discussed under ***Section 2.6.2.3***, the use of IMTA would be considered at the Project Site to (1) enhance productivity and (2) reduce environmental impact by utilizing waste feed and other waste from the fish stock onsite. Given the uncertain nature of its implementation (e.g. trophic levels / species involved / other designs), the effect on the pollution loading from these non-fish secondary trophic level(s) has not been taken into account in the pollution loading estimation for the proposed mariculture operation at the Project Site. The following section provides a simple analysis on the potential impact on pollution loading estimation from these non-fish trophic level.

Deposit feeders in IMTA typically feed on wasted feed, fecal matters and other waste sink from the fish stock on top. This means their presence would reduce the pollution loading from waste feed and fish faeces from the mariculture operation. According to the pollution loading estimation provided under ***Table 4.16*** of ***Appendix 3A***, the combined contribution of these two sources of pollution from mariculture would be over 90% of all pollution from mariculture for all parameters except for ammonia-N (which is mainly contributed from fish excretion). Since these deposit feeders will only consume and assimilate the organic part of these waste, therefore the introduction of deposit feeders could potential affect about 13.9% of the total nitrogen budget, 67.4% of the total phosphorus budget and 100% of the 5-day biochemical oxygen demand budget.

Table 3.7 Pollution Loading Contribution from Wasted Feed and Fish Faeces for Production Level of 1 ton at Proposed FCZs

Sources	Wasted Feed	% Contribution	Fish Faeces	% Contribution	Total % Contribution	Total
Oxidized-N (g/day)	0.0968	7.1%	1.205	88.6%	95.7%	**1.3597**
Ammonia-N (g/day)	0.0415	0.0%	0.371	0.2%	0.2%	**236.0373**
Org-N (g/day)	21.9176	57.4%	16.265	42.6%	100.0%	**38.1865**
TIP (g/day)	0.0394	2.3%	1.624	95.7%	98.0%	**1.6969**
TOP (g/day)	2.6986	76.8%	0.813	23.1%	100.0%	**3.5119**
BOD (g/day)	45.2051	8.4%	495.095	91.6%	100.0%	**540.3082**
TSS (g/day)	24.6477	92.2%	-		92.2%	**26.7298**

Filter feeders, including oysters, clams and mussels, which are commercially cultivated feed on planktons or suspended organic matters. According to Jansen *et. al.* (2019) [35], biodeposit represents a significant pathway in bivalve nutrient recycling. Jansen *et. al.* reviewed a number of literature for mussel farming and indicated biodeposition rate could be up to around 10% of soft body weight of the mussel population in a culture area. The biodeposit could constitute of 0.3% to 2.3% of nitrogen and 0.08% to 0.3% phosphorus. Since biodeposit is solids and could sink to the bottom, a

(34) The service provided by dogs and cats in traditional fish rafts is expected to be no longer needed in the more modern mariculture operations. Also, these new mariculture operation is not expected to be manned continuously, thus no longer suitable for keep dogs and cats onsite.

(35) Feedbacks from Filter Feeders: Review on the Role of Mussels in Cycling and Storage of Nutrients in Oligo- Meso- and Eutrophic Cultivation Areas. Henrice Maria Jansen, Øivind Strand, Wouter van Broekhoven, Tore Strohmeier, Marc C. Verdegem, and Aad C. Smaal (2019)

significant portion of the nutrient would be lock up and will not return to the water column quickly. Furthermore, the growth of fleshy tissues of these bivalves also lock up a notable amount of organic nutrients from the water column. For instance, Jansen *et. al.* reviewed a number of literature for nutrients composition in mussel tissue, which constitutes of 33.3% to 62.3% of organic carbon, 5.5% to 12.6% of organic nitrogen and 0.4% to 1.2% of organic phosphorus. While these figures are indicative of only several species covered in the review and may vary from species, locations and cultivation method, this still support the notion of additional cultivation of filter feeders would result in a net reduction of pollution load from the water column, thus be beneficial to the water quality.

Overall, the inclusion of IMTA would result in different levels of pollution reduction from the proposed mariculture operation at the Project Site by means of (1) reduction of wasted feed, fecal matters and other waste, and (2) filter feeding of plankton and biodeposition. While the effect of IMTA on water quality cannot be quantified given the lack of detail design information, its effect would positively affect the water quality at the Project Site if implemented in sufficient scale.

Table 3.8 Predicted Water Quality under Baseline and Project Scenarios

ID	WSR	Scn.	Annual								
			10th-percentile		Mean						Geomean
			Depth-averaged	Bottom	Depth-averaged	Bottom	Depth-averaged				
			Dissolved Oxygen				Total Inorganic Nitrogen	Unionized Ammonia	Chlorophyll-a	Suspended Solids Note2	*E.coli*
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(mg/L)	(no./100 mL)
Non-gazetted beach – Mirs Bay Assessment Criteria			**≥4**	**≥2**	**N/A**	**N/A**	**≤0.3**	**≤0.021**	**N/A**	**increase ≤30% baseline**	**≤610**
B1	Non-gazetted beach of Crescent Bay	Baseline	5.2	5.0	6.3	6.2	0.06	0.003	6	1.9	0
		Project	5.2	4.7	6.3	6.1	0.07	0.003	7	2.0	0
Coral – Mirs Bay Assessment Criteria			**≥4**	**≥2**	**N/A**	**N/A**	**≤0.3**	**≤0.021**	**N/A**	**increase ≤30% baseline**	**≤610**
CR1	Coral at NE Crooked Island	Baseline	5.2	4.5	6.4	6.0	0.07	0.003	7	2.0	0
		Project	5.2	4.4	6.3	6.0	0.07	0.004	7	2.1	0
CR2	Coral at Crescent Island and Double Island	Baseline	4.2	3.4	5.9	5.6	0.09	0.005	6	1.9	0
		Project	4.2	3.3	5.8	5.5	0.10	0.005	6	2.0	0
CR3	Coral at Port Island	Baseline	5.2	5.1	6.4	6.2	0.07	0.003	4	1.5	0
		Project	5.2	5.1	6.4	6.2	0.08	0.003	5	1.6	0
CR12	Coral at Wong Chuk Kok Tsui	Baseline	5.2	5.0	6.3	6.2	0.07	0.003	5	1.7	0
		Project	5.2	5.0	6.3	6.2	0.09	0.004	6	1.8	0
Coral – Tolo Harbour and Channel Assessment Criteria			**N/A**	**N/A**	**≥4**	**≥4**	**N/A**	**N/A**	**≤6**	**≤10**	**≤610**
CR8	Coral at Wong Wan Tsai	Baseline	5.1	4.4	6.2	6.0	0.07	0.003	3	1.4	0
		Project	5.0	4.3	6.1	5.9	0.09	0.004	3	1.5	0
CR9	Coral at Fung Wong Wat	Baseline	5.1	4.7	6.2	6.1	0.07	0.003	3	1.4	0
		Project	5.0	4.5	6.1	6.0	0.09	0.004	3	1.5	0
CR10	Coral at Gruff Head	Baseline	5.2	4.6	6.3	6.0	0.07	0.003	3	1.5	0
		Project	5.1	4.4	6.2	5.9	0.09	0.004	4	1.6	0
CR11	Coral at South Wong Wan Tsui	Baseline	5.1	4.8	6.2	6.2	0.07	0.003	3	1.4	0
		Project	4.9	4.6	6.2	6.1	0.09	0.004	4	1.5	0

ID	WSR	Scn.	Annual								
			10th-percentile		Mean						Geomean
			Depth-averaged	Bottom	Depth-averaged	Bottom	Depth-averaged				
			Dissolved Oxygen				Total Inorganic Nitrogen	Unionized Ammonia	Chlorophyll-a	Suspended Solids Note2	*E.coli*
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(mg/L)	(no./100 mL)
CR13	Coral at Hoi Ha Wan Moon Island	Baseline	5.1	4.5	6.2	6.0	0.09	0.004	3	1.4	0
		Project	5.0	4.3	6.1	5.9	0.11	0.004	4	1.5	0
CR14	Coral at Hoi Ha Wan Coral Beach	Baseline	5.2	4.3	6.3	6.0	0.08	0.004	4	1.6	0
		Project	5.1	4.3	6.2	5.9	0.10	0.005	5	1.7	0
CR15	Coral at Sam Mun Shan	Baseline	5.1	4.4	6.2	6.0	0.07	0.003	3	1.5	0
		Project	4.8	4.3	6.1	5.9	0.08	0.004	4	1.6	0
CR16	Coral at Heung Lo Kok	Baseline	5.1	4.4	6.2	6.0	0.09	0.004	3	1.4	0
		Project	5.0	4.3	6.1	5.9	0.10	0.004	4	1.5	0
Fish Culture Zone – Mirs Bay Assessment Criteria			**≥5**	**≥2**	**N/A**	**N/A**	**≤0.3**	**≤0.021**	**≤20**	**increase ≤30% baseline**	**≤610**
F1	O Pui Tong Fish Culture Zone	Baseline	**4.2**	2.3	5.9	4.9	0.09	0.006	8	2.2	0
		Project	**4.2**	2.2	5.9	4.8	0.10	0.006	8	2.3	0
F2	Sai Lau Kong Fish Culture Zone	Baseline	5.2	4.3	6.5	6.1	0.06	0.003	11	2.4	0
		Project	5.2	4.2	6.5	6.1	0.07	0.004	11	2.5	0
F3	Wong Wan Fish Culture Zone	Baseline	5.2	5.2	6.6	6.4	0.05	0.003	12	2.6	0
		Project	5.1	4.9	6.4	6.2	0.07	0.004	12	2.7	0
F4	Tap Mun Fish Culture Zone	Baseline	5.4	5.2	6.5	6.4	0.08	0.003	4	1.5	0
		Project	5.4	5.2	6.5	6.4	0.10	0.004	5	1.6	0
Project site	Proposed Wong Chuk Kok Hoi FCZ	Baseline	**4.0**	2.9	5.8	5.2	0.10	0.006	6	2.0	0
		Project	**4.0**	2.8	5.8	5.1	0.13	0.008	7	2.1	0
Site B	Proposed Outer Tap Mun FCZ	Baseline	5.2	4.2	6.3	5.8	0.10	0.004	3	1.4	0
		Project	5.2	4.2	6.2	5.7	0.12	0.005	4	1.5	0
Site C1	Proposed Mirs Bay FCZ (Northern Part)	Baseline	5.2	4.2	6.1	5.7	0.12	0.005	3	1.4	0
		Project	5.1	4.2	6.1	5.6	0.15	0.006	3	1.4	0

ID	WSR	Scn.	Annual								
			10th-percentile		Mean						Geomean
			Depth-averaged	Bottom	Depth-averaged	Bottom	Depth-averaged				
			Dissolved Oxygen				Total Inorganic Nitrogen	Unionized Ammonia	Chlorophyll-a	Suspended Solids Note2	*E.coli*
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(mg/L)	(no./100 mL)
Mangrove Stand / Intertidal – Mirs Bay Assessment Criteria			**≥4**	**≥2**	**N/A**	**N/A**	**≤0.3**	**≤0.021**	**N/A**	**increase ≤30% baseline**	**≤610**
M1	Mangrove Stand / Intertidal at Ngau Shi Wu Wan	Baseline	4.2	2.2	6.1	5.1	0.08	0.005	11	2.5	0
		Project	4.1	2.0	6.1	5.0	0.08	0.006	11	2.6	0
M2	Mangrove Stand / Intertidal at Ngor Tau Tsui	Baseline	5.2	3.6	6.5	5.7	0.05	0.004	22	4.2	0
		Project	5.1	3.4	6.4	5.6	0.06	0.004	23	4.4	0
M3	Mangrove Stand / Intertidal at Tung Wan	Baseline	4.5	4.2	6.2	6.0	0.07	0.004	8	2.1	0
		Project	4.4	4.2	6.2	5.9	0.08	0.004	8	2.1	0
M4	Mangrove Stand / Intertidal at Sam A Chung	Baseline	5.1	4.2	6.6	6.2	0.03	0.002	27	5.6	0
		Project	5.1	4.0	6.6	6.2	0.03	0.003	29	5.9	0
Mangrove Stand / Intertidal – Tolo Harbour and Channel Assessment Criteria			**N/A**	**N/A**	**≥4**	**≥4**	**N/A**	**N/A**	**≤6**	≤10	**≤610**
M5	Mangrove Stand / Intertidal at Fung Wong Wat	Baseline	5.2	5.1	6.3	6.2	0.06	0.003	4	1.5	0
		Project	5.2	5.0	6.3	6.1	0.08	0.003	4	1.6	0
Marine Park – Mirs Bay Assessment Criteria			**≥4**	**≥2**	**N/A**	**N/A**	**≤0.3**	**≤0.021**	**N/A**	**increase ≤30% baseline**	**≤610**
MP1	Yan Chau Tong Marine Park and Artificial Reef within the Marine Park	Baseline	4.2	3.2	5.9	5.2	0.09	0.005	7	2.2	0
		Project	4.2	3.1	5.9	5.2	0.09	0.006	7	2.3	0
Marine Park – Tolo Harbour and Channel Assessment Criteria			**N/A**	**N/A**	**≥4**	**≥4**	**N/A**	**N/A**	**≤6**	≤10	**≤610**
MP2	Hoi Ha Wan Marine Park and Artificial Reef within the Marine Park	Baseline	5.2	4.6	6.2	6.0	0.09	0.004	4	1.5	0
		Project	5.1	4.4	6.2	5.9	0.11	0.004	4	1.6	0
SSSI – Tolo Harbour and Channel Assessment Criteria			**N/A**	**N/A**	**≥4**	**≥4**	**N/A**	**N/A**	**≤6**	≤10	**≤610**

ID	WSR	Scn.	Annual								
			10th-percentile		Mean						Geomean
			Depth-averaged	Bottom	Depth-averaged	Bottom	Depth-averaged				
			Dissolved Oxygen				Total Inorganic Nitrogen	Unionized Ammonia	Chlorophyll-a	Suspended Solids Note2	*E.coli*
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(μg/L)	(mg/L)	(no./100 mL)
SSSI1	Hoi Ha Wan SSSI	Baseline	5.1	4.3	6.2	5.9	0.09	0.004	3	1.4	0
		Project	5.1	4.3	6.1	5.8	0.11	0.005	4	1.5	0
EPD Marine WQ Monitoring Stations Assessment Criteria			**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
TM8	EPD Marine WQ Monitoring Station	Baseline	5.2	4.2	6.2	5.8	0.07	0.003	3	1.5	0
		Project	5.1	4.2	6.2	5.6	0.08	0.004	4	1.6	0
MM7	EPD Marine WQ Monitoring Station	Baseline	4.2	3.2	5.9	5.3	0.09	0.005	7	2.2	0
		Project	4.2	3.1	5.9	5.2	0.09	0.006	8	2.3	0
MM17	EPD Marine WQ Monitoring Station	Baseline	4.3	3.3	5.9	5.2	0.10	0.004	3	1.5	0
		Project	4.3	3.2	5.9	5.1	0.11	0.005	3	1.5	0

Note1: Values in exceedance of the corresponding assessment criteria are bold and shaded.
Note2: Assessment criterion for suspended solids is based on 30% of the predicted values for each WSRs under the baseline scenario and thus cannot be listed in the assessment criterion row for each group of WSRs.
Note3: As a result of the relatively low baseline dissolved oxygen level at Project Site in wet season, the project scenario considered the effect of aeration at individual fish farm operation of the Project Site. Please refer to ***Appendix 3E*** for details.

3.8.1.8 Temporary Relocation of Fish Rafts under Circumstances

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. Given the temporary nature of the fish raft relocation and the sufficient buffer distance to the ecological and fisheries sensitive receivers, unacceptable water quality impacts to these sensitive receivers near the relocated sites are not anticipated. In addition, the relocated pollution load from these mariculture operation would likely be distributed at a wider area around the proposed site. As shown in the water quality modelling exercise, the presence of additional pollution load from the mariculture operation at 755.2 ton of standing stock at the proposed site would not result in notable change in water quality. If some of the mariculture operation is temporarily relocated, the associated pollution load would likely to be more spread out and the potential change in water quality would be less significant. The relocation would involve anchoring and de-anchoring, which would result in minor disturbance to the bottom sediment as assessed under ***Section 3.7***. In general, the water depth around Wong Chuk Kok Hoi is more than 10 m. Given the sufficient water depth at the surrounding water, sufficient clearance from the seabed is expected from the structure of fish fam during the relocation, and thus sediment disturbance is not expected during the relocation. Based on the above assessment, given the temporary nature of the fish raft relocation, relocation to be sited minimising the impacts to sensitive receivers, pollution load would spread out and potential change in water quality would be less significant than normal operation, the potential impacts due to temporary relocation of fish rafts under circumstances are expected to be minor.

3.8.1.9 Summary of Findings and Recommendations

The results of the water quality simulations indicated that the proposed mariculture operation would only result in very limited and very localized changes of water quality parameters at identified WSRs, including recreational areas, marine parks, existing and proposed FCZs, ecological habitats, spawning ground and nursery area of commercial fisheries resources and other fisheries sensitive receivers, artificial reefs, intertidal areas of various country parks, and beaches. For all WSRs identified other than the Project Site itself, the water quality parameters were predicted to be in compliance with the corresponding WQO criteria, and project operation would not result in notable deterioration. Relatively low dissolved oxygen at the Project Site was contributed by existing sources / general hydrology resulted in WQO non-compliance under the baseline conditions. The predicted reduction in dissolved oxygen at Project Site during operation could be controlled by adopting aeration as necessary and unacceptable water quality impact is not anticipated for mariculture operation at Project Site. Therefore, it is concluded that the proposed mariculture operation at the carrying capacity of 755.2 ton of standing stock or below would not result in unacceptable change in water quality at the identified WSRs. The licensees will adopt the operational measures and best practice for mariculture activities as stated in ***Appendix 2A*** to further minimise water quality impacts from the mariculture activities of the Project.

3.8.2 Changes in Hydrology and Flow Regime due to Presence of Mariculture Facilities

Structures of fish raft are highly porous to allow water flow and removal of excreta. Fouling by attached growth would increase drag and would typically be cleared regularly by mariculturists therefore such increase in drag would be limited. Separation distance of around 100 m will be provided between each fish rafts / cages with typical size around one hectare of sea area. The detailed number, size and separation distance of the fish rafts / cages would be determined during the later detailed design stage. The maintenance of separation distance will form a licensing condition for prospective licensees. Therefore, the presence of floating structures of fish rafts will not exert significant drag on the tidal stream and no notable change in flow regime due to the presence of floating structures would be expected.

3.8.3 Spillage of Fish Drugs, Pharmaceutical Chemicals, Feed Additives

The use and storage of chemicals would be limited to pharmaceuticals for fish, as well as those required to maintain equipment for the fish farm operation. Mariculturists at the Project site would be required to strictly observe the requirement under *Cap. 529 Veterinary Surgeons Registration Ordinance* and have strict control on prescription drugs. In addition, the mariculturists will follow the rules for using fish drugs as described in *Good Aquaculture Practices* published by AFCD (36) which detail the appropriate dosage of drugs and prohibit the use any fish drugs not prescribed by AFCD or registered veterinarian. AFCD will also provide technical support on the use of pharmaceuticals for fish. In AFCD's regular inspection of existing FCZs in recent years, there was no identified case of excessive storage of drugs or pharmaceuticals. Therefore, it is expected that there would be very limited pharmaceuticals for fish kept onsite and those would be stored at secured locations, and discharge of water containing pharmaceuticals is not expected from daily operation. In view of the above, the risk of spillage of fish drugs or pharmaceuticals is low.

Unlike spillage of chemical, spilled/ excess fish feed with feed additives generally does not persist for considerable amount of time as the presence of fish feed with feed additives would attract existing fish population to feed on the spill feed. For floating type fish feed, the majority of feed spilled can simply be recovered by the mariculturists. Commercially available fish feed with feed additives comes in tough fabric bags of 20-25 kg each. In case such bags of feed dropping into the sea during storage or transportation, they will be recovered by the crew. Even if not recovered, the bag would limit the exchange materials such that the nutrient content would unlikely be released all at once and result in significant water quality impact. In view of this, together with the adoption of the operational measures and best practice for mariculture activities as stated in ***Appendix 2A***, the risk and consequence of such scenario are deemed minimal and no unacceptable impact on water quality is expected.

3.8.4 Wastewater from Daily Operation of Fish Farms, Disinfection of Gears, and Sewage from Workforce

Operational activities would involve the removal of fouling organisms of the rafts. Fouling organisms are usually removed mechanically (e.g. using pressurised jet of seawater) so chemical is generally not required. Dislodged fouling biomass falling into the sea would not constitute additional pollution load because such biomass has fed on the original pollution source from the fish farm operation.

Disinfection of culture gears (primarily nets and cages) is required for disease control on regular basis (e.g. once a year prior to the start of fish farming cycle). According to AFCD's recommendation for good practice (37), disinfection could be done via steaming, or submerge under water dosed with formaldehyde or bleach within enclosed containers. For any fishing gears that need to be disinfected onsite, solution of any chemical used will be required to be stored properly onsite and disposed of by

(36) Good Aquaculture Practices Series 4 - Prevention and Treatment of Fish Diseases. AFCD, 2009

(37) Good Aquaculture Practices Series 4 - Prevention and Treatment of Fish Diseases. AFCD, 2009

licensed contractor and no onsite disposal would be allowed. It should be noted that disinfection under sunlight is considered more effective and practical option for cultural gears of large size and chemicals are not necessary to be dosed. In addition, based on the past experience of existing FCZs, it is not necessary to store and use a large amount of chemicals during FCZ operation. Therefore, it is not anticipated a large amount of chemicals would be stored and disposed during the operation of the Project.

Deep water mariculture operation at the Project site is typically manned minimally onsite and relies mostly on automated / remote control. Therefore, generation of sewage by staff and visitors onsite would be limited. Sewage shall be stored on vessels or at the mariculture facilities and be regularly disposed by licensed contractor, and no sewage from staff and visitors will be discharged into the sea.

Storage of chemicals / lubricant oil onsite would be maintained at minimal level. If major maintenance of gears or machineries onsite is needed, technicians / relevant staff should be brought to the site together with the necessary tools and chemicals. Remaining chemicals, together with any chemical waste generated from the maintenance process should be taken away by the same crew for disposal to appropriate facilities or licensed contractor when the crew leaves the site. Given the limited exposure period as well as proper storage and control, together with the adoption of the operational measures and best practice for mariculture activities as stated in ***Appendix 2A***, no unacceptable change in water quality associated with the storage of chemicals onsite is expected.

Latest mariculture operation often rely on renewable sources of energy (solar and wind), supplemented by minor backup generator for prolonged cloudy / windless period. Limited amount of fuel may be stored onsite. To minimize potential risk of fuel spillage, fuel should be stored at sheltered and secure location for each mariculture operation. Excessive storage of fuel should be prohibited onsite as a risk control measure. Given the limited storage as well as other safety measures regarding proper storage, together with the adoption of the operational measures and best practice for mariculture activities as stated in ***Appendix 2A***, no unacceptable change in water quality associated with the storage of fuel onsite is expected.

3.8.5 Increased Marine Traffic, Boating and Visitor Activities

Increased marine traffic would be anticipated at the Project site for moving of staff and visitors and goods (fish feed and gears, waste and produced fish etc.). Such marine traffic activities would not result in notable change in water quality. To ensure no sewage from staff and visitors be discharged into the sea, sewage should be stored on vessels or at the mariculture facilities and be regularly disposed by licensed contractor. Littering in the sea is an offence under *Cap. 228 Summary Offences Ordinance* and all staff and visitors should be warned against littering in the sea. Unacceptable water quality impacts due to the increased marine traffic, boating and visitor activities are not anticipated.

3.9 Mitigation Measures

3.9.1 Construction Phase

No marine work or other major source of pollution is expected from the construction phase of the Project. It is unlikely there will be a significant workforce presence during construction phase (because of the lack of major works to be conducted), and any sewage / wastewater generated should be collected at the transportation / work vessel(s) for disposal at appropriate facilities on land

3.9.2 Operation Phase

During operation, the licensees will adopt the operational measures and best practice for mariculture activities as stated in ***Appendix 2A***. Apart from these measures, the following precautionary/ mitigation measures should be implemented to minimize water quality impact from the proposed mariculture operation at the Project site:

- Standing stock should not exceed 755.2 ton at any given time. AFCD will ensure the production scale of the Project site will not exceed the maximum standing stock level by controlling the mariculture production scale permitted under individual license.
- AFCD and mariculturists should be aware of potential occurrence of low dissolved oxygen at the Project Site by self-monitoring and the mariculturists will apply suitable control measures (e.g. aeration) as necessary.
- In case of 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.
- Only pellet feed or alternative feed with better feed conversion ratio will be permitted within the proposed FCZ.
- No chemically-laden solution from culture gears disinfection should be discharged into the sea.
- Onsite storage of chemicals should be controlled and minimized as far as practicable. Excess chemicals as well as chemical waste generated should be removed from the site at appropriate facilities by licensed contractor as soon as possible.
- Fuel storage onsite should be minimized, and if needed, be located at sheltered and secured location.
- Littering of the sea should be prohibited.

3.10 Residual Impact

3.10.1 Construction Phase

No marine work or other major source of pollution is expected from the construction phase of the Project. No unacceptable construction phase water quality impact is expected.

3.10.2 Operation Phase

Modelling results indicated that compliance with WQO criterion is achieved at most of the water sensitive receivers, and no project contribution to exceedance in baseline scenario would be expected from the operation phase of the Project with suitable control measure (e.g. aeration) in place as necessary. No unacceptable operation phase water quality impact is expected.

3.11 Cumulative Impact

No marine work or other major source of pollution is expected from the construction phase of the Project. No unacceptable cumulative construction phase water quality impact is expected.

For operation phase, the water quality modelling assessment has already taken into account the following sources of pollution:

- mariculture operation at the Project site;
- mariculture operation at existing FCZs within Mirs Bay and Tolo Harbour and Channel [38];
- proposed mariculture operation at Site B (Outer Tap Mun) and Site C (Mirs Bay);
- dry weather flow (i.e. pollution load from land drainage) within Mirs Bay and Tolo Harbour and Channel;
- rainfall-related load within Mirs Bay and Tolo Harbour and Channel;

(38) Note that other mariculture operation outside of Mirs Bay and Tolo Harbour and Channel are also taken into account indirectly through model nestling for generation of boundary condition of water quality boundary.

- treated sewage effluent from the Sha Tau Kok Sewage Treatment Works; and
- other sources including pollution load from the Guangdong side of Mirs Bay.

The assessment confirmed that no unacceptable cumulative water quality impact is expected.

3.12 Environmental Monitoring and Audit

With the implementation of proposed mitigation / precautionary measures, the construction and operation of the Project would not result in unacceptable change water quality at and around the Project site. Environmental monitoring is considered not necessary for construction of the Project. For project operation, water quality monitoring is recommended when the standing stock is expected to achieve 75% of the carrying capacity [39] (i.e. 755.2 ton x 75% = 566.4 ton) or when the standing stock is expected to achieve 95% of the carrying capacity (i.e. 755.2 ton x 95% = 717.4 ton) for at least a month in a fish farming cycle to ensure no unacceptable change in water quality at the nearby water sensitive receivers. Detailed recommendations would be provided in the stand-alone Environmental Monitoring and Audit Manual of this EIA.

In additional to the standard EM&A exercise under *EIAO*, AFCD will conduct regular water quality monitoring within and outside the Project site during Project operation to check the water quality (e.g. suspended solids and nutrients) for detection of abnormality and issuance of alerts to mariculturists as part of the management measures for the Project. Real time water quality monitoring stations will also be installed by AFCD at the Project site, and notification to mariculturists for the Project site will be implemented to ensure timely actions be taken. With reference to AFCD's previous installation of real time water quality monitoring stations at the other existing FCZs including Tung Lung Chau FCZ, Sok Kwu Wan FCZ and Lo Tik Wan FCZ, mariculturists there will be alerted in case of substantial deterioration of water quality (e.g. red tide, low dissolved oxygen level). Monitoring parameters should at least include temperature, salinity, and dissolved oxygen (level and saturation).

3.13 Conclusion

3.13.1 Construction Phase

No marine work or other major source of pollution is expected from the construction phase of the Project. No unacceptable construction phase water quality impact is expected.

3.13.2 Operation Phase

Carrying capacity estimation at the Project site has been conducted to determine the standing stock that would not result in an unacceptable change in water quality. The carrying capacity estimation indicated the Project site can support mariculture operation of 755.2 ton standing stock based on typical mariculture practice in HK without significant deterioration of water quality under the typical average condition. Accordingly, the corresponding pollution load generated is calculated for subsequent Delft3D modelling.

Delft3D water quality modelling has been conducted to predict the potential change in water quality at the WSRs of the Assessment Area. Compliance with WQO criterion is achieved at most of the identified water sensitive receivers, and no project contribution to exceedance in baseline scenario is expected from the proposed mariculture operation at the Project site. The results indicated the project operation would not result in a significant change in water quality with 755.2 ton of standing stock. Unacceptable water quality impact from Project operation is not anticipated.

(39) From the modelling results, the 95th-percentile safety margin of the carrying capacity, which is a conservative estimate taking into account possible fluctuations in the weather, hydrodynamic and environmental conditions as well as the farming practices, is about 75% of the estimated carrying capacity under typical average condition. Therefore, it is considered representative to conduct operational water quality monitoring at 75% of the maximum allowable standing stock level to monitor potential water quality at the surrounding sensitive receivers during project operation.

Other potential sources of water quality impacts from operation have been identified and assessed. Appropriate precautionary and mitigation measures have been recommended to minimise the potential water quality impact from these sources. The licensees will also adopt the operational measures and best practice for mariculture activities as stated in ***Appendix 2A***. No unacceptable adverse impact on water quality is expected from Project operation.

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); and
- 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 Wong Chuk Kok Hoi 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, 21 Oct 2020 Dry Season: 26 Jan 2021, 1 Feb 2021
Coral Survey	17 Nov 2020
Drop Camera Survey	28 Dec 2020

4.3.2.2 Subtidal Benthos Survey

Wet Season

A total of 38 individual organisms were collected from the five grab samples from Wong Chuk Kok Hoi during the wet season survey (***Figure B2.3 of Appendix 4B***). The specimens belong to 4 Phyla with a total of 4 classes, 6 families and 7 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 and were lower than that in dry season in general (***Table 4.2*** **and** ***Table 4.3***). In terms of infaunal abundance, the majority (~87%) of organisms recorded were from the Phylum Annelida. The polychaete worm, *Sigambra hanaokai* was the most abundant species (total abundance = 19 individuals). The Amphioxus, *Branchiostoma belcheri*, was recorded in the survey at sites WCKH1 and WCKH2 with low abundance (total abundance = 3 individuals). In terms of infaunal biomass, organisms from the Phyla Mollusca, Annelida and Chordata contributed significant biomasses (~39%, ~34% and ~27% respectively). The high biomass of Mollusca was contributed by 1 scaphopod species, *Episiphon kiaochowwanense*.

Dry Season

A total of 541 individual organisms were collected from the five grab samples during the dry season survey. The specimens belong to 5 Phyla with a total of 6 classes, 17 families and 24 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

(~84%) of organisms recorded were from the Phylum Annelida. The polychaete worms *Sigambra hanaokai* was the most abundant species (total abundance = 162 individuals). No species of conservation interest were recorded in the dry season survey. In terms of infaunal biomass, organisms from the Phylum Mollusca contributed ~73% of the total biomass recorded, while organisms from Annelida also contributed significant biomasses (~27%). The high biomass of Mollusca was contributed by a number of species, primarily by a bivalve species, *Nitidotellina lischkei*.

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 m²	Taxonomic Richness (No. Families)	Taxonomic Richness (No. Species)	Pielou's Evenness (*J*)(Note1)	Shannon Diversity (*H'*)	Total Biomass (g wet weight)	Mean Biomass per Individual (g wet weight)
WCKH1	7	72.92	4	4	0.92	1.28	0.0200	0.0029
WCKH2	1	10.42	1	1	****	0.00	0.0009	0.0009
WCKH3	21	218.75	2	3	0.94	1.04	0.0122	0.0006
WCKH4	7	72.92	3	3	0.87	0.96	0.0306	0.0044
WCKH5	2	20.83	1	1	****	0.00	0.0011	0.0006

Note:
(1) Pielou's Evenness cannot be calculated for sites WCKH2 and WCKH5, as the taxonomic richness (no. of species) is 1.

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 m²	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)
WCKH1	110	1145.83	11	15	0.76	2.05	0.5054	0.005
WCKH2	86	895.83	12	15	0.77	2.09	0.9951	0.012
WCKH3	40	416.67	11	12	0.84	2.09	0.1297	0.003
WCKH4	122	1270.83	11	14	0.78	2.06	0.7088	0.006
WCKH5	183	1906.25	9	13	0.79	2.02	0.9643	0.005

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 in shallow water (-3 to - 4 mCD) and sandy / silty substrate in deep water (-5 to -6 mCD). Sparse hard coral colonies, such as *Porites* sp., *Oulastrea crispata*, *Bernardpora stutchburyi* and *Psammocora profundacella* were identified in shallow and deep waters.
T2, T3	-3 to -7 mCD	The sites were mainly composed of sand in both shallow water (-3 to -4 mCD) and deep water (-5 to -7 mCD). More coral species were identified at T2 at shallow water, while more coral species were identified at deeper water at T3. A high number of *Platygyra carnosa* was recorded in shallow waters of T2 but absent in T3.

Transects are located at North (T1) and South (T2 and T3) natural shores of Wong Chuk Kok Hoi **(*Figure B2.1 of Appendix 4B*)**. The site mainly comprised of large boulders, sand and mud. On the hard substrata, sessile benthos primarily comprised of isolated barnacles. Only sparse colonies of hard coral (<5% - 10%), macroalgae (<5%) and other benthos (<5%), such as sea anemones and sponges, were identified (***Table 4C.3*** of ***Appendix 4C***).

A total of twenty-seven hard corals, three species of sea anemones and one sponge species were identified (***Table 4C.4*** of ***Appendix 4C***). The majority of corals recorded were common and widespread species in Hong Kong, including *Porites* sp., *Oulastrea crispata* and *Platygyra carnosa*. Octocoral and black corals were not recorded at the surveyed transect. 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 limited sessile taxa. Common and widespread corals were recorded in low percentage cover (<10%) in both shallow and deep waters.

4.3.2.4 Drop Camera Survey

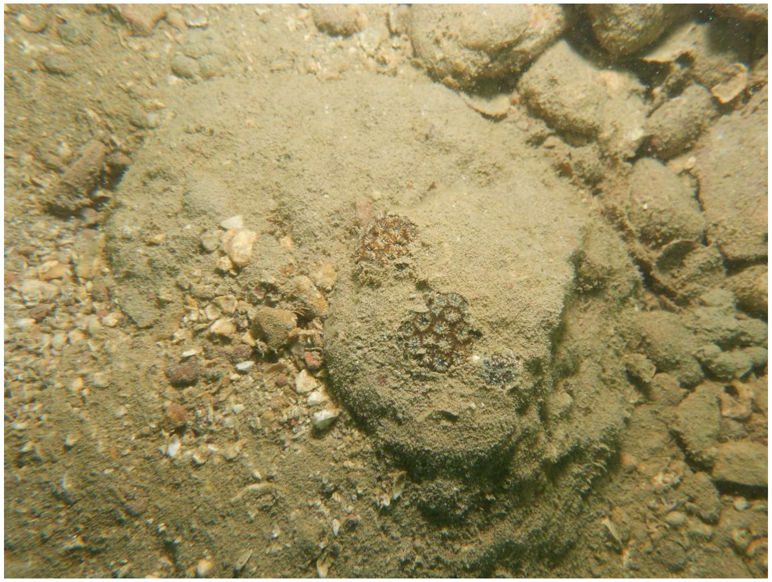
Drop camera surveys were conducted at Wong Chuk Kok Hoi at the survey locations shown in ***Figure B2.1 of Appendix 4B***. A total of five stations were surveyed within the Project site with the use of a drop camera system to record the benthic attributes by positioning the system ~1 m above the seabed. The results showed that the seabed at the survey locations (~-15 mCD) consisted of silty mud without any hard substrate and benthic organisms recorded. Representative photos extracted from the video footages are presented in ***Figure 4.2a*** and ***Figure 4.2b***.

4.3.3 Ecological Profiles

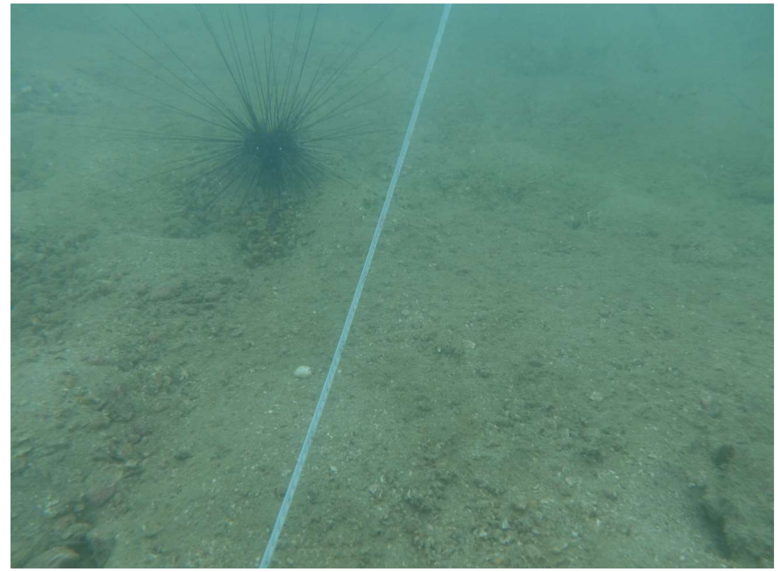
The key findings of the literature review and field surveys are summarised below.

4.3.3.1 Recognised Sites of Conservation Importance

Recognised sites of conservation importance within the Assessment Area include Country Parks, Special Areas, Marine Parks, and Sites of Special Scientific Interest (SSSI). Some of these which are relevant to marine ecology and are located in the Assessment Area are discussed below.

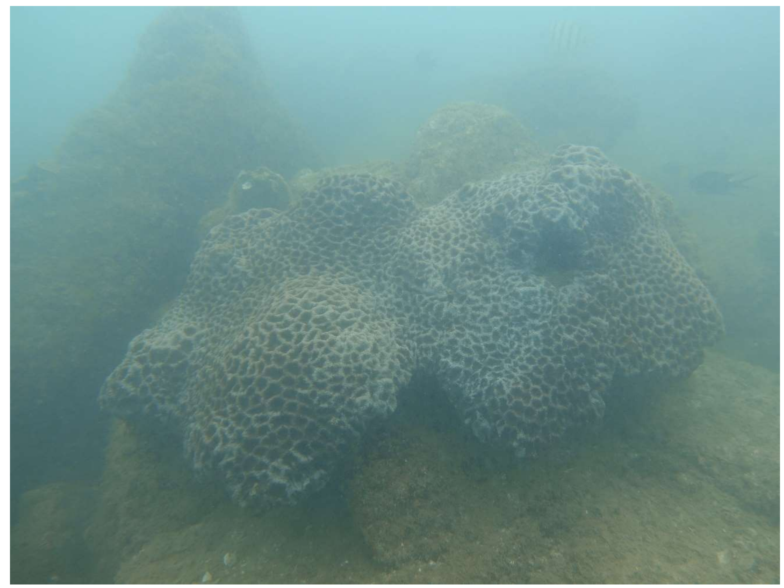


a) Rocky substrate with hard coral species *Oulastrea crispata*, sand and rubble on the seabed in shallow waters (-3 to -4 mCD).



b) Sandy and silty seabed recorded along the survey transect in deeper waters (-5 to -6 mCD).

c) Hard coral species *Porites* sp. recorded during the survey.



d) Hard coral *Platygyra carnosa* recorded at Transect 2 in shallow waters (-3 to -4 mCD).

FIGURE 4.1

Representative Photos of Coral Survey at Wong Chuk Kok Hoi

ERM

a) Soft substrate with silty seabed recorded at WCKH1.

b) Soft substrate with silty seabed recorded at WCKH2.

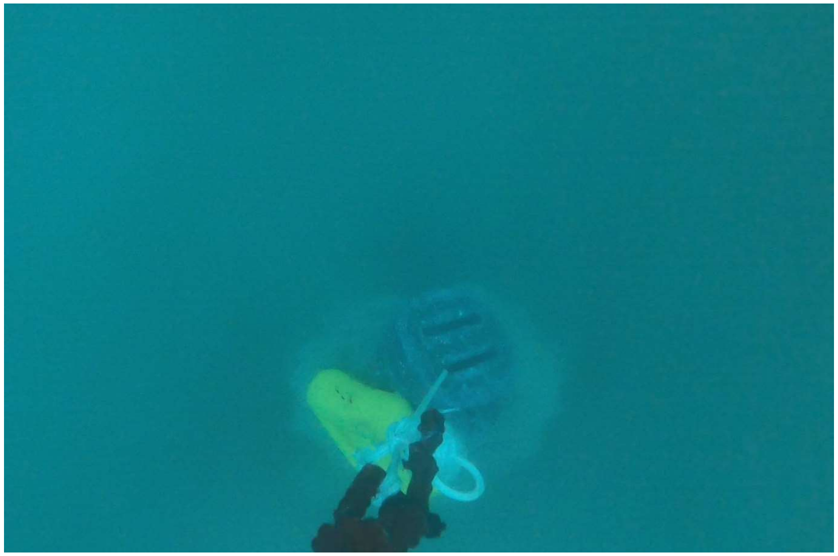
c) Soft substrate with silty seabed recorded at WCKH3.

d) Soft substrate with silty seabed recorded at WCKH4.

ERM

FIGURE 4.2a

Representative Photos of Drop Camera Survey at Wong Chuk Kok Hoi



e) Soft substrate with silty seabed recorded at WCKH5.

4.3.3.2 Country Parks

The existing country parks in the Assessment Area include the Plover Cove Country Park and Plover Cove (Extension) Country Park. Plover Cove Country Park was designated in 1978 with an area of 4,594 ha and have terrestrial conservation interest. Plover Cove (Extension) Country Park was designated on 1979 covering several islands in the northeastern waters including Tung Ping Chau, Port Island, Double Heaven and Crooked Island. Some of these islands were also known to have nested with White-bellied Sea Eagles (*Haliaeetus leucogaster*). However, as both 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*** (40).

4.3.3.3 Special Area

The existing special area in the Assessment Area is the Double Haven Special Area located at ~3 km from the Project site. Double Haven Special Area was designated in 2011 with an area of 0.8 ha and mainly of geological interest. As Double Haven Special Area does not have major marine ecological related interest, it is considered that the impact of the Project on the site is not anticipated. Location of the special area is provided in ***Figure 4A.2.1 of Appendix 4A*** (41).

4.3.3.4 Existing, Proposed and Potential Marine Parks

Yan Chau Tong Marine Park (YCTMP) and Hoi Ha Wan Marine Park (HHWMP) are the existing marine parks within the Assessment Area. No proposed or potential marine parks are identified within the Assessment Area. Details of the marine parks are provided in ***Table 4A.2.1 of Appendix 4A***. Locations of the marine parks are provided in ***Figure 4A.2.1 of Appendix 4A*** (42).

4.3.3.5 Sites of Special Scientific Interest

Tolo Channel (Northern Coast) SSSI and Hoi Ha Wan SSSI are the SSSIs within the Assessment Area. However, Tolo Channel (Northern Coast) SSSI located nearest to the Project site is of geological interest and therefore is considered not affected by the Project works which are all marine based. Ho Ha Wan SSSI is located at 2.8 km away from the Project site, which is considered to be far away to be affected by the Project. Details of the SSSI are provided in ***Table 4A.2.1 of Appendix 4A***. Locations of the SSSIs are provided in ***Figure 4A.2.1 of Appendix 4A*** (43).

4.3.3.6 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* was reported in the Assessment Area. Considering the Project site located at the northeastern waters in Wong Chuk Kok Hoi 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*** (44)***.***

(40) AFCD (2021) Country Parks.

(41) The Legislative Council Commission (2021) LEGISLATIVE COUNCIL BRIEF Country Parks Ordinance (Chapter 208) DOUBLE HAVEN AND OTHERS (SPECIAL AREAS) ORDER 2010.

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

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

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

4.3.3.7 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 nearest records of occurrence were from the beaches in Lai Chi Wo in YCTMP 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.

4.3.3.8 Mangroves

Four mangrove stands are found in the Mirs Bay FCZ and one mangrove stand is found in the Tolo Harbour and Channel WCZ within the Assessment Area. No mangrove stands are found within the Project Site. The nearest mangrove stand from the Project site is located at Tung Wan which is ~1 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*** [45].

4.3.3.9 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 [46]. Literatures have reported that hard coral, octocoral and black coral were recorded at Wong Chuk Kok Tsui (south coast at the mouth of Wong Chuk Kok Hoi) and early studies reported that a coral coverage of 10 – 50% is found at Wong Chuk Kok Hoi. Recent surveys including those conducted during Reef Check 2021 have also recorded 10.4% coral coverage at Wong Chuk Kok Hoi. Locations of the coral communities are provided in ***Figure 4A.2.1 of Appendix 4A*** [47] [48] [49].

Results of the Feasibility Study of this Project has revealed that coral communities were sparse with low coverage (<5%), except from shallow areas in the northern shoreline of Wong Chuk Kok Hoi (~200m away from the Project site) which the hard coral coverage was 11 – 30%. A total of 34 hard coral species and one octocoral species were identified in Wong Chuk Kok Hoi during these surveys. The species identified during the survey were generally regarded as common and widespread species in Hong Kong waters, apart from some uncommon corals; *Montipora mollis, Galaxea astreata, Acanthastrea echinata, Cyphastrea chalcidicum, Favites flexuosa, Goniopora djiboutiensis and Psammocora haimiana*.

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 *Porites* sp., *Oulastrea crispata* and *Platygyra carnosa*. Octocoral and black corals were not recorded at the surveyed transect. Overall, the coral coverages at the surveyed areas in both shallow and deep waters were low (<10%). Results of drop camera survey also showed that the seabed of this site (~15 mCD) was dominated by silty mud without any hard substrate or benthic organisms.

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(45) AFCD (2020) Distribution Map.

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

(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) 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.

4.3.3.10 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 [(50)]. 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, very low numbers of amphioxus, *Branchiostoma belcheri* were found within the Project site during the wet season.

4.3.3.11 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 overlapping with the Assessment Area were 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. Marine Eel Grass (*Zostera japonica*), with high ecological value was reported to be abundant at the Lai Chi Wo Beach, however, as it is located out of the Assessment Area, therefore, the impact of the Project on the seagrass is not anticipated.

4.3.3.12 White-Bellied Sea Eagle

Findings of white-bellied sea eagle (WBSE) was spotted on Crooked Island and Port Island within the Assessment Area, located both >3 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*** [(51)].

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.

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

(51) 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.

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 ***Tables 4.5 to 4.9***.

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

Criteria	Yan Chau Tong Marine Park (YCTMP)	Hoi Ha Wan Marine Park (HHWMP)	Tolo Channel (Northern coast) SSSI	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	Natural land mass with rocky shoreline consisting of sedimentary rock	Natural intertidal and subtidal hard and soft bottom habitat and marine waters
Size	~680 ha	~260 ha	~1,287 ha	~278 ha
Diversity	Moderate	Moderate	Low	Moderate
Rarity	Habitat and species are uncommon in the northeastern water of Hong Kong. Species with conservation importance, included the main assemblages of seagrass *Zostera japonica,* hermatypic hard coral and ahermatypic cup coral	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	No documented marine ecological importance associated with the SSSI	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	Not re-creatable	Not re-creatable
Fragmentation	Made up of two portions, 1 km apart	Unfragmented	Unfragmented	Unfragmented
Ecological Linkage	Linked to the intertidal, subtidal habitats and seagrass bed	Linked to the intertidal and subtidal habitats	Not functionally linked to any high value habitat in a significant way	Linked to the intertidal and subtidal habitats
Potential Value	Already designated as marine park	Already designated as marine park	Already designated as a SSSI	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	Key known nesting ground for green turtle	Nursery grounds for juvenile of fishes and other marine invertebrates

Criteria	Yan Chau Tong Marine Park (YCTMP)	Hoi Ha Wan Marine Park (HHWMP)	Tolo Channel (Northern coast) SSSI	Hoi Ha Wan SSSI
Age	Designated as marine park in July 1996	Designated as marine park in July 1996	Designated as SSSI and Restricted Area in September 1982	Designated as SSSI in January 1989
Abundance	First local site of observing seagrass *Zostera japonica* in Hong Kong. Abundance of seagrass *Zostera japonica* is high	Historically high abundance of hard coral. Old coral colonies and regarded as location of considerable carbonate accumulation	No documented abundance of marine ecological species associated with the SSSI	Historically high abundance of hard coral. Old coral colonies and regarded as location of considerable carbonate accumulation
Ecological Importance	**High**	**High**	**Moderate**	**High**

Table 4.6 Ecological Importance of Intertidal Habitats 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 (*Ocypode cordimana*, previously known as *Ocypode cordimanus*), oligochaete worms (*Heronidrilus bihamis*) and starfish *Luidia longispina* were recorded. No rare species found	Common rocky shore flora and fauna were recorded e.g. seaweeds *Ulva lactuca*, *Colpomenia sinuosa*, short-spined sea urchin *Heliocidaris crassispina*	Not surveyed in the literature reviewed, it is assumed that the assemblages comprise common and widespread intertidal species in Hong Kong like Barnacle *Balanus amphitrite*, Bivalve *Grafrarium pectinatum*, and snails *Nassarius festivus*, *Monodonta labio*, *Batillaria multiformis*, *B. zonalis*
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	Wong Chuk Kok Hoi	Yan Chau Tong Marine Park (YCTMP)
Naturalness	Natural	Natural
Size	Large. Subtidal area of the northern and southern shoreline of Wong Chuk Kok Hoi, including Wong Chuk Kok Tsui is about 3 km	Large. ~680 ha
Diversity	Low to Moderate	High
Rarity	Assemblages comprise typical common and widespread species in Hong Kong, except *Montipora mollis, Galaxea astreata, Acanthastrea echinata, Cyphastrea chalcidicum, Favites flexuosa, Goniopora djiboutiensis* and *Psammocora haimiana*. 'Old corals' were documented in the vicinity	Habitats and species are uncommon in the northeastern water of Hong Kong. Species with conservation importance, included the main assemblages of seagrass *Zostera japonica,* hermatypic hard coral and ahermatypic cup coral
Re-creatability	The habitat can be recreated through the deployment of artificial reefs or through rubble mound / rock armour seawalls	Not re-creatable
Fragmentation	Unfragmented	Made up of two portions, 1 km apart
Ecological Linkage	Not functionally linked to any high value habitat in a significant way	Linked to seagrass bed and mudflats and horseshoe crab habitats in inner Starling Inlet
Potential Value	Generally low since it is a common natural habitat with low coral coverage. Wong Chuk Kok Tsui has higher ecological interest with the presence of diverse hard corals and medium coverage of Antipatharia recorded	Already designated as marine park
Nursery / Breeding Area	No significant records identified	Nursery grounds for juvenile of fishes and other marine invertebrates
Age	Hard corals are known to be long lived and some recorded old corals are likely to be more than 60 years old	Designated as marine park in July 1996
Abundance	Low coral coverage (<10%) in general, except for some shallow areas at northern shoreline of Wong Chuk Kok Hoi with 11-30% coverage; and moderate abundance of hard corals and Antipatharia recorded at Wong Chuk Kok Tsui	First local site of observing seagrass *Zostera japonica* in Hong Kong. Abundance of seagrass *Zostera japonica* is high
Ecological Importance	**In general low; moderate to high near Wong Chuk Kok Tsui**	**High**

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

Criteria	Wong Chuk Kok Hoi
Naturalness	Natural
Size	~35 ha
Diversity	Low
Rarity	The assemblages are typical of similar habitats in the Hong Kong waters, which are dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season
Re-creatability	Re-creatable; substrata may be recolonised by benthic organisms
Fragmentation	Unfragmented
Ecological Linkage	Linked to the subtidal habitats nearby
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 Wong Chuk Kok Hoi and in the vicinity
Naturalness	Natural
Size	~35 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.)	*Duncanopsammia peltata, Oulastrea crispata* *Porites* sp., etc.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Majority are common and widely distributed in the eastern waters of Hong Kong, with a few uncommon species	✓	✓	In the vicinity of the Project site and throughout northeastern waters of Hong Kong, such as Port Island and Tolo Channel both located at >3 km from the Project site
Black corals	*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	✓		Wong Chuk Kok Tsui, South Wong Chuk Kok Tsui and Port Island located ~1.3 km, ~1.5 km and ~3.3 km from the Project site respectively
Octocorals	*Echinomuricea* sp., *Dendronephthya* sp., *Euplexaura* sp.	Protection of Endangered Species of Animals and Plants Ordinance (Cap.586)	Common but sparsely distributed in the eastern waters of Hong Kong	✓		One species is recorded within Wong Chuk Kok Hoi and at Wong Chuk Kok Tsui (~1.3 km away). Other species are recorded at South Wong Chuk Kok Tsui located at ~1.5 km from the Project site
Amphioxus	*Branchiostoma belcheri*	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	✓	✓	Within Project site and mostly present within Hong Kong's eastern waters, such as Nam She Wan and Tai Long Wan in Sai Kung

Common Name	Scientific Name	Protection Status	Distribution, Rarity and other Notes	Literature	Surveys	Recorded Location
White-bellied Sea Eagle	*Haliaeetus leucogaster*	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	✓		Nesting ground recorded on Crooked Island and Port Island located at ~4.1 km and ~3.3 km from the Project site respectively

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	NE Crooked Island (CR1)	4.1
	Crescent Island and Double Island (CR2)	0.8
	Port Island (CR3)	3.3
	Wong Wan Tsai (CR8)	3.1
	Fung Wong Wat (CR9)	2.1
	Gruff Head (CR10)	2.6
	South Wong Wan Tsui (CR11)	0.9
	Wong Chuk Kok Tsui (CR12)	1.3
	Hoi Ha Wan Moon Island (CR13)	3.4
	Hoi Ha Wan Coral Beach (CR14)	4.0
	Sam Mun Shan (CR15)	4.9
	Heung Lo Kok (CR16)	3.1
Mangrove Stand / Intertidal Habitat	Ngau Shi Wu Wan (M1)	4.1
	Ngor Tau Tsui (M2)	4.5
	Tung Wan (M3)	1.0
	Sam A Chung (M4)	4.5
	Fung Wong Wat (M5)	2.3
Designated Marine Park	Yan Chau Tong Marine Park and Artificial Reef within the Marine Park (MP1)	1.1
	Hoi Ha Wan Marine Park and Artificial Reef within the Marine Park (MP2)	2.7
Designated SSSI	Hoi Ha Wan SSSI (SSSI1)	2.8

4.4 Assessment Methodology

The *Method Statement on Marine Ecological Impact Assessment for Wong Chuk Kok Hoi 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 works 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 35 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 YCTMP and HHWMP which are located ~1.1 km away and ~2.7 km away respectively, 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. Although a species of conservation importance (i.e. the amphioxus, *Branchiostoma belcheri) was* recorded within the Project site, only very low abundance of the species was recorded. The overall coral coverage is considered low and other species 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 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 have 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 <35 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 Wong Wan FCZ and private mooring site 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 YCTMP which is located ~1.1 km away. HHWMP is considered to be far away (~2.7 km from Project site) to be affected by the Project.

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 YCTMP and HHWMP which are located at ~1.1 km away and ~2.7 km away respectively 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 most 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. The predicted 10^{th}-percentile depth-averaged DO levels at the Project site are below the corresponding assessment criterion. Such episodes of low DO levels were also observed at Wong Wan FCZ in the past years without affecting the mariculture operation which are typically driven by low bottom DO levels in summer months, and the situation at the Project site is worse than that of the existing Wong Wan FCZ given the higher water depth. Mariculture operation at the Project site and other proposed FCZs would result in some change in the mean and 10^{th}-percentile depth-averaged DO levels. In response to lowered DO levels, mariculturists could consider providing aeration onsite to improve DO levels at the fish farm by observing changes in fish behaviour due to low DO levels, and real-time water quality monitoring device set up by AFCD onsite will also help to detect signs of low DO levels and inform mariculturists. Additional modelling scenario has been conducted for the provision of aeration and results indicated that aeration would be able to replenish DO levels consumed by mariculture operation. Therefore, the predicted reduction in DO levels at the Project site is expected to be controlled by aeration as necessary and impacts from DO depletion due to fish farm operation are considered to be of minor significance.

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 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. There is no change of 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 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, 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 to moderate	Common fish species and benthic fauna dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season within the Project site.	All of the Project site (~35 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 to moderate	Common fish species and benthic fauna dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season within the Project site.	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
		YCTMP	High	Rare and common fish species.	Localised to sound-generating activities, e.g. assembly of fish rafts, installation of mooring system, marine vessels; mostly affect area near the marine park boundary at Hung Shek Mun.	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 the Project site.	Low to moderate	Common fish species and benthic fauna dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season within the Project site.	Localised to the vicinity of fish farm structures (<35 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 to moderate	Common fish species and benthic fauna dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season within the Project site.	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 to moderate	Common fish species and benthic fauna dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season within the Project site.	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

Potential Impact	Source	Receiver	Nature of Impact						Overall Impact Significance	Mitigation / Precautionary Measures Required
			Habitat Quality	Species Affected	Size	Duration	Reversibility	Magnitude		
		YCTMP	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 at Hung Shek Mun.	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 to moderate	Common fish species and benthic fauna dominated by polychaetes. Scarce amount of amphioxus (lancelet) *Branchiostoma belcheri* was recorded in wet season within the Project site.	Localised to the vicinity of the fish farm.	Long-term over Project duration.	Reversible	Small	Minor	Water quality mitigation measures would further reduce impacts.
		YCTMP	High	Rare and common fish species and corals	Localised to the vicinity of the fish farm; potentially affect areas near the marine park boundary at Hung Shek Mun.	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 to moderate	Common fish species.	Within and in the vicinity of Project site (~35 ha).	Long-term over Project duration.	Reversible but with difficulty	Small	Minor	Operation measures and Practices in ***Appendix 2A*** would further reduce impacts.
		YCTMP	High	Rare and common fish species.	Within the YCTMP.	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 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 marine habitat would be approximately be 500 ha in total, including the Project site (35 ha), the proposed Outer Tap Mun FCZ (55 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 ~1 km away from Wong Wan FCZ and >3.5 km away from other existing and planned FCZs. The cumulative effect of underwater sound will therefore consider the impact from the nearby Wong Wan FCZ only as other FCZs are far away from the Project site. 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 Wong Wan FCZ and private mooring site. 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 Wong Chuk Kok Hoi near Wong Wan FCZ and the private mooring site, 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 far from key marine ecological habitats, such as key coral habitats around Wong Chuk Kok Tsui and Port Island, and mangroves and ARs in YCTMP, 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 parks (***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:

- <35 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 (apart from very low abundance of amphioxus (lancelet), *Branchiostoma belcheri*, identified within the Project site during wet season), whereas further afield habitats and sensitive receivers of ecological values, including the artificial reefs and corals within existing marine parks (i.e. YCTMP and HHWMP) are located at some distances from the Project site. Species of conservation importance such as horseshoe crabs and Marine Eel Grass are found to be located out of the Assessment Area, and no records of marine mammals in the Assessment Area have been reported.

During the construction of the Project, direct impacts arising from the proposed marine works include disturbance to the marine habitat (i.e. ~35 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 Wong Wan FCZ and private mooring site. 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 (<35 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 Wong Wan FCZ and private mooring site. 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. The predicted reduction in DO levels at the Project site is expected to be controlled by aeration as necessary and impacts from DO depletion due to fish farm operation are considered to be of minor significance. 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.

5. FISHERIES

5.1 Introduction

This ***Section*** presents the findings of an assessment of potential impacts on existing capture and culture fisheries, including fisheries resources, fishing operations and fish culture activities associated with the construction and operation of the proposed Project with the available Project information to-date.

5.2 Legislative Requirements and Evaluation Criteria

5.2.1 Technical Memorandum

The criteria for evaluating fisheries impacts are stated in the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*). *Annex 17* of the *EIAO-TM* prescribes the general approach and methodology for the assessment of fisheries impacts deriving from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential impacts. *EIAO-TM Annex 9* recommends the criteria that are to be used for evaluating fisheries impacts.

5.2.2 Other Legislation

Other legislation which applies to fisheries includes:

- *Fisheries Protection Ordinance (Cap. 171)*, which provides for conservation of fish and other aquatic life, regulates fishing practices and prevents activities detrimental to the fishing industry;
- *Marine Fish Culture Ordinance (Cap. 353)*, which regulates and protects marine fish culture and other related activities and requires all marine fish culture activity to operate under licence in designated FCZs;
- *Water Pollution Control Ordinance (Cap. 358)*, which aims to control water pollution in Hong Kong waters. Water Control Zones (WCZs) are designated with individual water quality objectives to promote the conservation and best use of those waters in the public interest; and
- *Environmental Impact Assessment Ordinance (Cap. 499)*, the Study Brief Section 3.4.5 and Appendix D which outline the key fisheries impacts to be reviewed and assessed in this EIA report.

5.3 Baseline Conditions

5.3.1 Assessment Area

In accordance with Clause 3.4.5.2 of the Study Brief, the Assessment Area for fisheries impact assessment (***Figure A1.1 of Appendix 5A***) 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 and biological characteristics of the marine environment of the Assessment Area is provided in ***Section 3*** and ***Section 4*** respectively.

5.3.2 Summary of Existing Conditions

A literature review was conducted to review the baseline fisheries conditions within the Assessment Area and to identify information gaps to determine whether field surveys are required to provide sufficient information for the fisheries impact assessment. Findings of the literature review are presented in ***Sections 5.3.2.1*** to ***5.3.2.6***.

5.3.2.1 Overview of Hong Kong Fisheries

Commercial fishing operations in Hong Kong are broadly identified into culture and capture fisheries. Marine-based culture fishery operations occur at 26 FCZs which altogether occupy about 209 ha of Hong Kong waters with some 920 licensed operators. They involve rearing of marine fish from fry or fingerlings to marketable size in cages suspended by floating rafts usually in sheltered coastal areas. Fish farms are typically small scale operations comprising only one or two rafts with an average total size of about 304 m^2 (52).

With effect from June 2002, the marine fish culture licence is transferable. The existing moratorium for FCZs has been reviewed and was partially lifted in 2013 to launch a pilot scheme for the issuance of new marine fish culture licenses (MFCLs). Ten MFCLs were issued in three FCZs with surplus carrying capacity, including the O Pui Tong, Wong Wan and Sham Wan FCZs, in which four licences remained valid, with three at Wong Wan FCZ and one at Sham Wan FCZ by the end of 2018 (53).

In 2021, the marine fish culture industry produced about 332 tonnes of fish valued at HK$34 million which accounts for about 2% of local demand for live marine fish (54). Some recent figures on the local marine culture fisheries are presented in ***Table 5.1***.

Table 5.1 Marine Culture Fisheries Summary Statistics 2008-2021 (Source: AFCD)

AFCD Estimate	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Licensed Mariculturists	1,050	1,035	1,010	1,008	987	968	969	949	938	931	923	925	920
Production (tonnes)	1,437	1,512	1,185	1,299	1,005	1,255	1,219	1,031	1,004	850	889	687	332
Value (HK$ million)	92	118	94	117	94	115	105	86	78	71	72	52	34

Capture fisheries is vastly distributed in the waters of Hong Kong, the Pearl River Estuary and the adjacent continental shelf of the South and East China Seas (55). AFCD reported that in 2021 an estimated 112,000 tonnes of fish was produced, which was equivalent to an economic value of about HK$2.8 billion. Also, 10,510 local fishermen with approximately 5,170 vessels were servicing in the fishing industry (56). The major fishing methods consist of long-lining, gill-netting and purse-seining.

In 2016-17, AFCD carried out the latest round of port survey to collect the updated data of distribution of fishing operations and production for 2016. According to the survey results, the highest fisheries production of 400 to 600 kg ha^{-1} in Hong Kong was recorded in the vicinity of the south of Cheung Chau and Shek Kwu Chau (57). The highest number of fishing vessels were distributed around Soko Islands, Shek Kwu Chau, Cheung Chau, west of Lamma, northwest of Ninepin Island, Tap Mun and Wong Chuk Kok Tsui. Mullet (Mugilidae), sardine / shad (Clupeidae), scad / jack (Carangidae), seabream (Sparidae), croaker (Sciaenidae), squid, crab, rabbitfish (Siganidae), shrimp and flathead (Platycephalidae) were the top 10 families captured in Hong Kong waters.

To promote the sustainable development of fishing industry and to conserve fisheries resources in Hong Kong waters, AFCD has implemented a number of fisheries management and conservation measures. On 31 December 2012, trawling (including pair, stern, shrimp and hang trawling) was

(52) AFCD (2021) Marine fish culture, pond fish culture and oyster culture.

(53) Legislative Council Panel on Food Safety and Environmental Hygiene (2019) Development of Mariculture.

(54) AFCD (2021) *Op. cit.*

(55) Sumaila UR, Cheung WWL and Teh L (2007) Rebuilding Hong Kong's Marine Fisheries: An Evaluation of Management Options. Fisheries Centre Research Reports 15 (3). pp.112.

(56) AFCD (2021) Capture Fisheries Overview.

(57) AFCD (2017) Port Survey 2016/17.

prohibited to restore the seabed and the decreased fisheries resources [(58)]. Other fisheries management practises are implemented to supplement the ban, including:

- Setting up a registration system for local fishing vessels;
- Limiting new entrants to control the fishing effort;
- Restricting fishing activities of non-fishing vessels and prohibiting fishing activities of non-local fishing vessels;
- Designating fisheries protection areas;
- Habitat enhancement and restoration (i.e. artificial reefs); and
- Fish restocking trials.

Since 1999, Mainland Authorities have implemented a fishing moratorium for the South China Sea fishing ground. In 2022, the revised fishing moratorium has extended from 1 May to 16 August. The moratorium prohibits all fishing operations except lining by the Hong Kong fleet outside of Hong Kong waters and also banning on the operation of fish collectors [(59)] in order to conserve fisheries resources and promote sustainable development of the fishing industry [(60)].

5.3.2.2 Culture Fisheries of the Assessment Area

Four FCZs are located within the Assessment Area and their separation sea distances from the Project site are presented in ***Table 5.2***. The FCZ nearest to the Project site is Wong Wan FCZ located at ~0.8 km (by sea distance) from the site. The other FCZs are located >5 km away from the Project site. There are no fish ponds or oyster farms identified in the northeastern part of Hong Kong waters (***Figure 5.1***).

Table 5.2 Distances between the FCZs in the Assessment Area and the Proposed FCZ at Wong Chuk Kok Hoi

Fish Culture Zone	Shortest Separation Sea Distance (km)
O Pui Tong	5.2
Sai Lau Kong	5.2
Wong Wan	0.8
Tap Mun	5.6

5.3.2.3 Capture Fisheries of the Assessment Area

Trawling has been banned in Hong Kong waters since 31 December 2012. Apart from historical data, only some published information after the trawl ban was available for review.

The most systematic information on commercial fishing operation and fisheries production of the Assessment Area was obtained primarily from the AFCD Port Survey 2016/17 (***Figures 5.2*** to ***Figure 5.3)***. The survey was conducted from 2015 to 2016 through a comprehensive interview survey of local fishermen by AFCD [(61)]. The survey achieved a sampling rate of about 36% which included various fishing vessels from different homeports. Apart from the Port Survey, other recently approved EIA and fisheries studies undertaken in the Assessment Area have also been reviewed.

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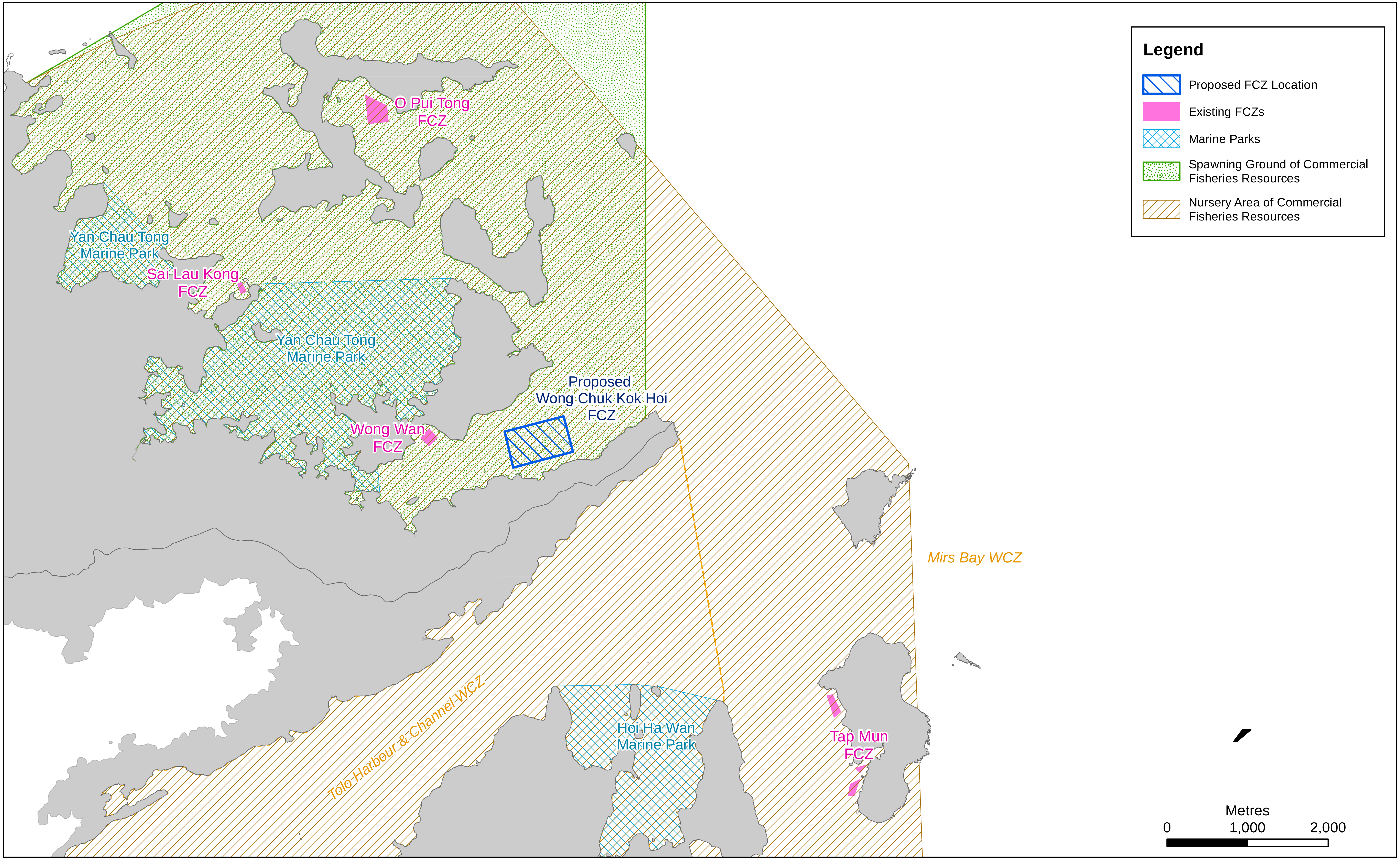
(58) AFCD (2020). *Op. Cit.*

(59) Refers to the fisheries ancillary vessels which are used to gather catch from fishing vessels, and operate either in Hong Kong waters or further afield.

(60) AFCD (2020) Proposed Injection into the Fishing Moratorium Loan Scheme. Paper presented in Legislative Council Panel on Food Safety and Environmental Hygiene.

(61) AFCD (2017) *Op. cit.*

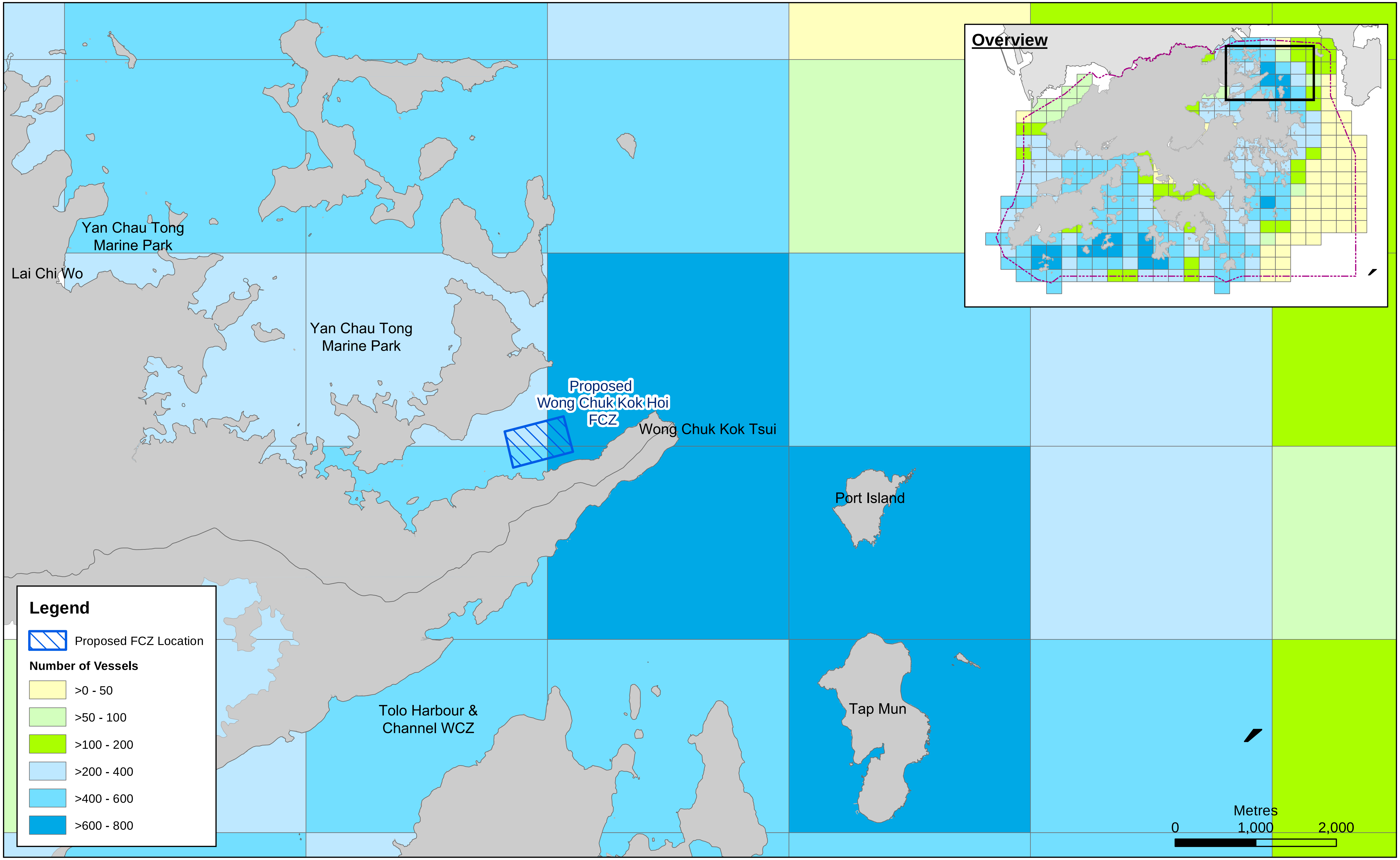


ERM

Figure 5.1

Fisheries Sensitive Receivers in the Assessment Area

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_Fisheries_Sensitive_Receivers_of_Wong_Chuk_Kok_Hoi.mxd
Date: 19/7/2022

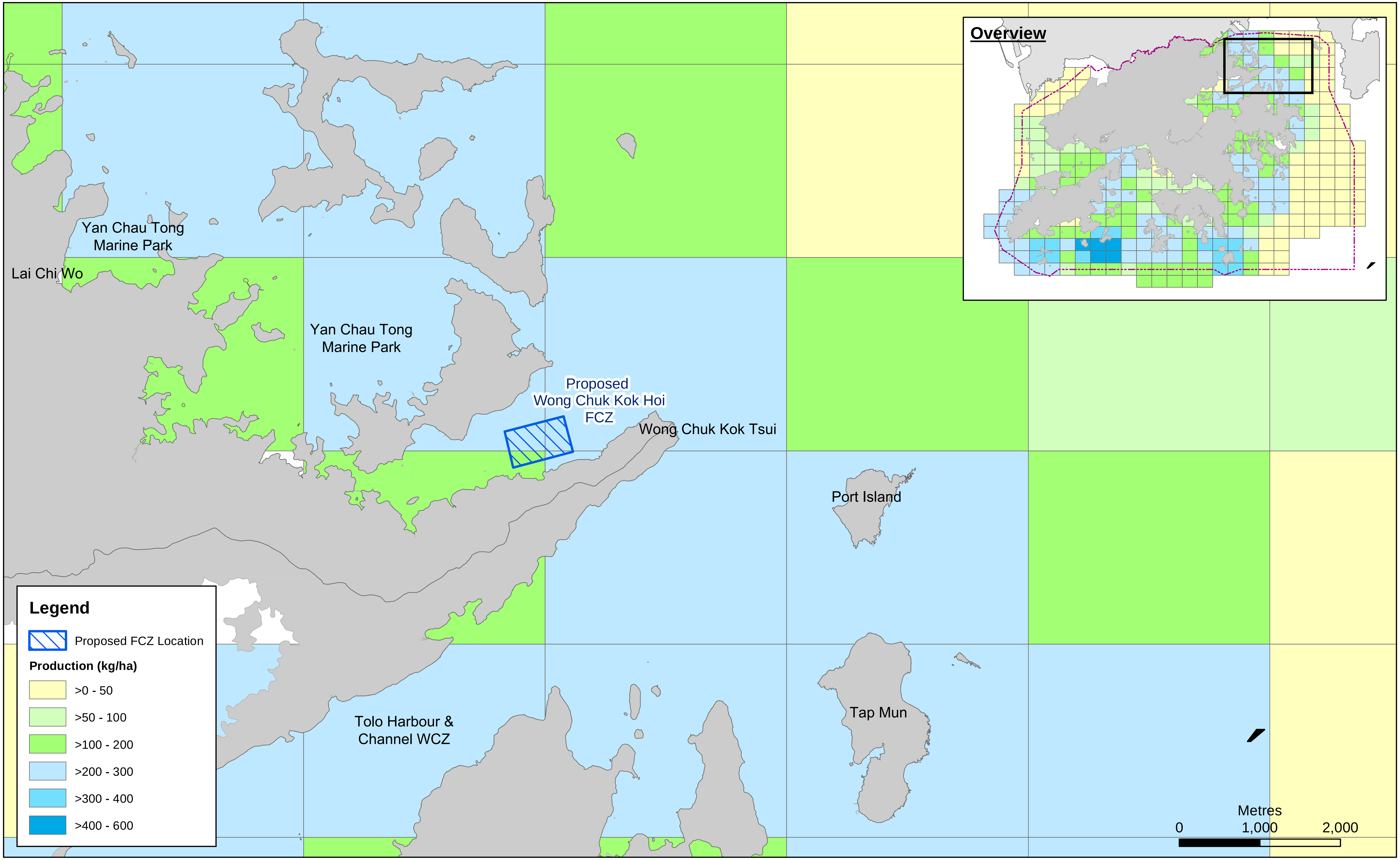


ERM

Figure 5.2

Distribution of Fishing Operations (All Vessels) in Hong Kong Water as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2016/17

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_Distribution_of_Fishing_Operations_All_Vessels_Wong_Chuk_Kok_Hoi.mxd
Date: 19/7/2022



ERM

Figure 5.3

Distribution of Fisheries Production (All Vessels) in Hong Kong Water as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2016/17

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_Distribution_of_Fishing_Production_Wong_Chuk_Kok_Hoi.mxd
Date: 14/7/2022

Fishing Operations

Data from AFCD Port Survey 2016/17 indicated that the majority of vessels that operated throughout the Assessment Area were sampans and other vessels including gill netter, long liner, purse seine etc., were present in smaller numbers. The data indicated that the areas within and in the vicinity of the Project site has a range of low to high levels (>200-400 vessels, >400-600 vessels and >600-800 vessels) of fishing operations (***Figure 5.2***). Moderate to high levels of fishing operation (>400-600 vessels and >600-800 vessels) were recorded in other areas around the coastline of Wong Chuk Kok Tsui, Tolo Harbour, Port Island and Tap Mun, while the area in the vicinity of Lai Chi Wo and within Yan Chau Tong Marine Park (YCTMP) supported low to moderate levels of fishing operations (>200-400 vessels). Under the Marine Parks and Marine Reserves (Amendment) Regulation 2019 which came into effect on 1 April 2020, commercial fishing would be banned and eventually phase out in YCTMP to protect coral communities and enhance the overall fisheries resources in Hong Kong [62]. A transitional period of two years is provided under the ban which new fishing permits will no longer be granted and existing fishing permits will not be renewed for YCTMP.

Fisheries Production

Fisheries production of the Assessment Area in terms of weight as reported in the AFCD Port Survey 2016/17 is presented in ***Figure 5.3***. Results showed that fisheries production within and in the vicinity of the Project site is low to moderate, with >100-200 kg/ha and >200-300 kg/ha production in Wong Chuk Kok Hoi, waters around Tolo Harbour, Port Island and Tap Mun. Low level of fisheries production (>0-50 kg/ha) was noted at offshore areas of northeastern waters.

Fisheries Resources

Historically, Tolo Harbour was found to consist of fish assemblages of moderate species richness with low diversity identified [63]. It was recorded that the majority of fish assemblages was fast growing but with low commercial value thriving in heavily eutrophic waters. The species captured that were considered of medium commercial value were sea breams, rock fish and chicken grunt [64]. The lowest species evenness was recorded at north-west Mirs Bay, which was attributed to the majority of the catch consisting of Ponyfish (*Leiognathus brevirostris*) [65].

A more recent review of the fisheries resources data could be referred to the monitoring of local fisheries resources from 2010-2015 initiated by AFCD with the implementation of the trawl ban in 2012. Demersal fisheries surveys were conducted using stern and shrimp trawlers across four areas in Hong Kong waters and the results showed that there were signs of recovery of fisheries resources. In the northeastern waters relevant to this Assessment Area, it was reported that the abundance and biomass of seabreams (Sparidae) and hairtails (Trichiuridae), and the abundance of threadfin breams (Nemipteridae) had increased [66]. The main commercial fisheries resources (ranked based on the biomass of each family) found in the northeastern waters of Hong Kong [67] are summarised in ***Table 5.3*** below. Overall, the northeastern waters generally supported fish families of low commercial value,

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(62) AFCD (2020) Marine Park Permit.

(63) Leung AWY (1997) The epibenthic ichthyofauna of Tolo Harbour and Hong Kong's Northeastern waters: a long term record of change. In: The Marine Flora and Fauna of Hong Kong and Southern China IV, Proceedings of the Eighth International Marine Biological Workshop 1995, B Morton (ed), pp. 463-487, Hong Kong University Press, Hong Kong.

(64) 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.

(65) Leung AWY (1997) *Op. cit.*

(66) South China Sea Fisheries Research Institute (2017) Report on Survey of Fisheries Resources in Hong Kong (2010-2015). Prepared for AFCD.

(67) South China Sea Fisheries Research Institute (2017) Main Commercial Families of Fisheries Resources in Hong Kong. Prepared for AFCD.

such as Ponyfish (*Leiognathus* sp.), with some commercially important families recorded in the area, such as swimming crabs (Portunidae), seabreams (Sparidae), flatheads (Platycephalidae) of lower biomass ranking.

A study on Marine Parks and Marine Reserve fisheries resources in 2016 showed that the abundant fishes in YCTMP and Hoi Ha Wan Marine Park (HHWMP) included both fishes of low and moderate commercial values (68). The most abundant species in YCTMP and HHWMP were jarbua terapon (*Terapon jarbua*) and pearl-spotted spinefoot (*Siganus canaliculatus*) respectively which were of low commercial values. Other abundant species in YCTMP included threadfin porgy (*Evynnis cardinalis*), rice-paddy eel (*Pisodonophis boro*), striped eel catfish (*Plotosus lineatus*) and golden-lined sea bream (*Rhabdosargus sarba*); and abundant species in HHWMP included rice-paddy eel, Japanese golden thread (*Nemipterus japonicas*), red pargo (*Pagrus major*), threadfin porgy and black bream (*Acanthopagrus schlegelii*). Among the abundant species, threadfin porgy, golden-lined sea bream, Japanese golden thread, red pargo and black bream were commercially important. It should be noted that both YCTMP and HHWMP are at some distances from the Project Site (~1.7 km and ~5.1 km respectively).

Table 5.3 Main Commercial Families of Fisheries Resources in Northeastern Hong Kong Waters from Fishery Surveys (Source: AFCD Hong Kong Fisheries Resources Monitoring Report (2010-2015))

Rank	Main Commercial Families from Shrimp Trawl Surveys	Main Commercial Families from Stern Trawl Surveys	Main Commercial Families from Purse-Seine Surveys
1	Leiognathidae	Leiognathidae	Clupeidae
2	Platycephalidae	Clupeidae	Carangidae
3	Portunidae	Sparidae	Engraulidae
4	Clupeidae	Carangidae	Scombridae
5	Sparidae	Polynemidae	Sphyraenidae
6	Gerreidae	Trichiuridae	
7	Synodontidae	Siganidae	
8	Squillidae	Synodontidae	
9	Sciaenidae	Sciaenidae	
10	Soleidae	Nemipteridae	

5.3.2.4 Spawning Ground

The northeastern Hong Kong waters were previously identified in 1998 as fisheries spawning grounds for various fish species (69). In Hong Kong, spawning period differs among fisheries species with the majority of commercial species aggregate and spawn in the open waters during June to September. Some fish species, including flathead (*Platycephalus indicus*) and shad (*Clupanodon (Konosirus) punctatus*), spawn in late winter / early spring (i.e. February to April) and a few are known to spawn in January. Shrimp scad (*Alepes djedaba*) spawns in early summer (around June) whilst pony fish (*Leiognathus brevirostris*) and croakers were found to be reproductive throughout most of the year from May to December. The spawning period of most of the crustacean species was found to be from April to November, with spawning concentrated between June and August.

Field surveys were conducted in Tolo Channel and Long Harbour from May 2016 to May 2017 to investigate the abundance, composition and distribution of the ichthyoplankton, zooplankton, juvenile

(68) Country and Marine Parks Board Marine Parks Committee (2020) Fisheries Resources Surveys at Existing and Proposed Marine Parks, and Cape D'Aguilar Marine Reserve – Results and Conclusion.

(69) ERM (1998) Fisheries Resources and Fishing Operations in Hong Kong Waters, Final Executive Summary, for Agriculture, Fisheries and Conservation Department.

fish and crustacean (70). The study recognised the areas as spawning ground and nursery area which supported a diverse assemblage of fisheries resources. The ichthyoplanktons of several commercially important species, such as rockfish (*Sebastiscus marmoratus*), seabreams (*Acanthopagrus schlegelii*, *Sparidae* spp.), grunt (*Parapristipoma trilineatum*), shad (*Nematolosa japonica*) and flatheads (*Inegocia japonica*, *Platycephalus indicus*), were recorded in the surveys.

The recognised spawning ground in northeastern Hong Kong waters is approximately >7 km long covering waters from the north of Kat O to Wong Chuk Kok Hoi (***Figure 5.1***). The Project site is located within the recognised spawning ground of the northeastern waters (***Figure 5.1***).

5.3.2.5 Nursery Area

The waters in Tolo Channel and northeastern Mirs Bay was identified as important nursery areas for high commercial value species in 1998, which extends approximately >10 km from the north of Kat O, covering waters near Port Island, Tap Mun and Tolo Harbour (***Figure 5.1***). This recognised nursery area is an important habitat for commercial species, namely red pargo (*Pagrus major*) and the goldlined seabream (*Rhabdosargus sarba*) (71). The fish fry of *Pagrus major* have been found to be most abundant during February and March, whereas juveniles of other commercial species were found abundantly from July to August. A juvenile fish survey conducted between 2013 and 2014 identified the mangrove and seagrass bed in YCTMP as important nursery areas but the dominant species, such as bald glassy (*Ambassis gymnocephalus*), are of low commercial value (72). The Project site is located within this recognised nursery area (***Figure 5.1***).

As mentioned in ***Section 5.3.2.4***, Tolo Channel and Long Harbour were also recognised by a study conducted between 2016 and 2017 as nursery area which supported a diverse assemblage of fisheries resource (73), with some commercially important families such as barracuda (*Sphyraena flavicauda*), jack mackerel (*Trachurus japonicus*), rabbitfish (*Siganus fuscescens*) and seabreams (*Acanthopagrus schlegelii*, *Rhabdosargus sarba*, *Evynnis cardinalis*, *Pagrus major*) were recorded in the area (74).

5.3.2.6 Artificial Reef Deployment

An Artificial Reef (AR) program has been implemented in Hong Kong's waters by AFCD since 1996 as an effort to enhance fisheries resource whilst promoting biodiversity (75). ARs are recognised worldwide as having the ability to encourage growth and development of a great number and variety of marine organisms, which in turn provide food, shelter and protection for fishes. Therefore, the ARs are considered to be fisheries sensitive receivers. There has been a total of 673 units of ARs with a total volume of over 179,200 m^3 (76) deployed in Hong Kong waters, the location of all ARs deployed is recorded by the Hong Kong Artificial Reef Project.

There are three AR deployment sites within the Assessment Area, including YCTMP, HHWMP and Kat O Fisheries Station. No AR has been deployed within the Project site. The nearest AR from the Project site would be those deployed in YCTMP (~1.7 km away) where a total of 13 units of ARs with a total volume of ~19,820 m^3 were deployed from 1998-2003 to provide hard, bottom, high profile habitat in areas without natural cover and act as biofilters to enhance habitat quality and marine

(70) State Key Laboratory of Marine Pollution, City University of Hong Kong (2018) Provision of Survey Services of Ichthyoplankton, Zooplankton and Juvenile Fish and Crustacean in the Potential Fisheries Protection Areas. Final Executive Summary, for Agriculture, Fisheries and Conservation Department.

(71) ERM (1998) *Op. cit.*

(72) Leung PTY, Mak S, Ip J, Yau C, Lai V and Leung KMY (2014) Survey of Juvenile Fish Resources at the Three Marine Parks at Northeast Hong Kong. Prepared for Agriculture, Fisheries and Conservation Department, HKSAR Government.

(73) State Key Laboratory of Marine Pollution, City University of Hong Kong (2018) *Op. Cit.*

(74) State Key Laboratory of Marine Pollution, City University of Hong Kong (2018) *Op. Cit.*

(75) AFCD (2021) Conservation of Fisheries Resources.

(76) AFCD (2021) *Op. Cit.*

resources [77]. Other ARs deployed at Kat O Fisheries Station are considered to be far away from the Project site (>5 km).

5.3.3 Fisheries Importance

Based on the baseline information reviewed, low to high levels of fishing operation with low to moderate levels of fisheries production were reported at the Project site, and similar levels of fisheries operation and production were also reported elsewhere in the broad Assessment Area, which indicates the Project site does not represent a unique fishing ground. The Assessment Area including the Project site also supported fisheries resources that are mainly with low commercial value, and areas that support fisheries of higher commercial value, such as YCTMP (located at ~1.7 km of the Project site) and HHWMP (located at ~5.1 km away of the Project site) and ARs deployed within, are located at some distances from the Project site.

Annex 9 of the *EIAO-TM* states that spawning ground and nursery area can be regarded as important habitats to fisheries. The Project site is located within the recognised spawning ground and nursery area in northeastern Hong Kong waters which covers a large area of over 7 km long. Consequently the Project Site only occupies a very small proportion of the habitats. Key nursery habitats, including the nearest mangrove and seagrass bed in YCTMP, are again distant from the Project site (>4 km and >5 km respectively). The potential for the Project site and its immediate vicinity to function as a unique spawning ground and nursery area is relatively low.

5.3.4 Fisheries Sensitive Receivers

Based on the preceding review of the available information on the capture and culture fisheries of the waters in the vicinity of the proposed Project, the potential sensitive receivers that may be affected by the Project activities are identified as follows:

- Recognised spawning ground and nursery area of commercial fisheries resources in northeastern waters which are located within the Project site;
- FCZ at Wong Wan (located at ~0.8 km west of Project site). Other FCZs which are located >5 km away from Project site;
- Yan Chau Tong Marine Park (located at ~1.7 km of the Project site) and the 19,820 m^3 of ARs deployed within; and
- Hoi Ha Wan Marine Park (located at ~5.1 km away of the Project site) and the 9,530 m^3 of ARs deployed within.

The locations of the sensitive receivers are shown in ***Figure 5.1***.

5.4 Assessment Methodology

A review of baseline fisheries conditions from available literature was conducted for the purpose of establishing the fisheries importance of the waters in the Assessment Area and its vicinity. Information from the water quality impact assessment has been examined to assess potentially affected area by perturbations to water quality parameters.

The potential impacts due to the construction and operation of the Project were then identified and evaluated (with reference to the *EIAO-TM Annex 17* guidelines and the criteria in *EIAO-TM Annex 9*).

(77) AFCD (2021) Hong Kong Artificial Reef Project.

5.5 Potential Impacts and Impact Assessment

5.5.1 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 works 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 fisheries resources and fishing operations arising from these works may be divided into those related to:

- Disturbances of fisheries habitat (including spawning ground and nursery area) and loss of access to fishing grounds; and
- Underwater sound from marine construction activities and marine vessels.

5.5.1.1 Habitat Disturbance and Loss of Access to Fishing Grounds

Direct impacts to fisheries resources, habitats (including spawning ground and nursery area) and fishing operations 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 fisheries habitat and loss of access to potential fishing grounds with an area of approximately 35 ha. 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 the identified fisheries sensitive receivers, including Wong Wan FCZ (~0.8 km from the Project site), and ARs of YCTMP and HHWMP (~1.7 km and ~5.1 km from the Project site respectively) is expected.

In the context of the size of fisheries habitats and fishing ground available in the vicinity, the size of the area affected would be small. Considering the temporary nature of the disturbance (a few weeks for each fish raft / cage), impacts are considered to be of minor significance and unacceptable impacts on fisheries resources, habitats and fishing activities are not expected. Fisheries 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 fisheries resources. Potential impacts, mostly to fish species, would have 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 fisheries habitats are considered negligible, and unacceptable impacts on the fisheries resources are not anticipated. Major lighting sources will be pointed inward and downwards to avoid disturbance to wildlife, unacceptable impacts on the fisheries resources are not anticipated.

5.5.1.2 Underwater Sound

Intermittent sounds, which occur during assembly and installation activities on-site and marine vessel movement, may have an impact on fisheries 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. Fisheries resources 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 a range of low to high levels of marine traffic by similar types of vessels. It is reasonable to assume that fish are habituated to low to high background levels 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 fisheries resources. Overall, the fisheries sensitive receivers, including Wong Wan FCZ (~0.8 km from the Project site), and ARs of YCTMP and HHWMP (~1.7 km and ~5.1 km from the Project site respectively), are located at some distances from the Project site and unacceptable impacts on these fisheries sensitive receivers are not expected.

5.5.2 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 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 fisheries of the Assessment Area include:

- Changes in fisheries habitats and loss of access to fishing grounds;
- 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 and fish excretion; and
- Fish diseases.

5.5.2.1 Changes in Fisheries Habitat and Loss of Access to Fishing Grounds

As discussed in ***Section 5.5.1.1***, 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). In the context of the size fisheries habitats and fishing ground available in the vicinity, the size of the area affected would be small and the majority of fisheries resources found in and around the vicinity of the Project site are of low commercial value, impacts on fisheries resources and fisheries habitat are considered to be of minor significance and unacceptable impacts on fisheries resources and fisheries habitat are not expected.

Fish farm structures would provide hard substrate that could be colonised by a variety of marine organisms. Although periodic cleaning will be implemented as part of the fish farm management practice to maintain good aquaculture environment, regular cleaning activities will be mainly applied to fish cages / nets, while the majority of the fish farm structures, such as the main framework of the fish raft, auxiliary facilities and mooring system will remain intact most of the time. There is considerable knowledge in Hong Kong and elsewhere on the colonisation of marine structures with species such as seaweeds, crustaceans, octocorals, bivalves, amphipods, anemones, bryozoans and more mobile fauna including crabs. Colonisation of these structures could attract fish and marine invertebrates into the area. Overall, the structures of the fish farm are expected to result in potential positive effect on fisheries resources and habitats 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.

The impact from the construction works on fishing activity is of temporary nature. Furthermore, although part of the project site is located in an area with high level of fishing activities, the loss of access to fishing ground is considered to be small compared to the availability of fishing grounds elsewhere in northeastern Hong Kong waters available for fishing activities. Overall, the impacts on fishing activity are of minor significance and no unacceptable impacts are expected.

Operational activities, such as cleaning of fish cages and the use of lighting, would generate noise, glare and dust which may affect fisheries resources. Potential impact, mostly to fish species, would have temporary avoidance of areas in the vicinity of the operational 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 fisheries resources are considered negligible, and unacceptable impacts on the fisheries resources are not anticipated. Major lighting sources will be pointed inward and downwards to avoid disturbance to wildlife, unacceptable impacts on the fisheries resources are not anticipated.

5.5.2.2 Temporary Relocation of Fish Rafts / Cages

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 fisheries 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 5.5.1***). Overall, impacts are considered to be of minor significance and unacceptable impacts on fisheries resources, habitats and fishing activities are not expected.

5.5.2.3 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 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 Wong Wan FCZ and private mooring site nearby. Fish 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 fisheries.

5.5.2.4 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 fisheries are as follows:

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

The use and storage of chemicals, such as pharmaceuticals for fish and those used for equipment maintenance will be limited on site and stored at secured locations, discharge of water containing such chemicals is not expected from daily operations. Human activities, such as the removal of fouling organisms on fish net / cages and the generation of sewage by the staff on site will be limited. The dislodged biomass will not be constituted as additional pollution load by feeding on the original pollution source at the fish farm, and automated / remote operation of mariculture activities is expected for the new FCZ with minimal manual labour required. Water quality impacts as a result from chemical and sewage discharge from the Project site are therefore not anticipated, and mainly impacts from fish feed, feed wastage, fish excretion and dead fish are discussed below.

To estimate the impacts on fisheries 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, including pollution loading from existing FCZs (including Wong Wan FCZ (~0.8 km from the Project site), O Pui Tong FCZ (~5.2 km from the Project site), Sai Lau Kong FCZ (~5.2 km from the Project site) and Tap Mun FCZ (~5.6 km from the Project site)); 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 fisheries.

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.

Fluxes of SS naturally occur in the marine environment and as a result, fish have evolved behavioural adaptations to tolerate changes in SS load (e.g. clearing their gills by flushing water over them). Beyond the Project site, dispersion will cause a rapid decrease in the suspended solids concentrations. Compared to adult fish, larvae and post-juvenile fish are relatively more susceptible to variations in SS concentrations as their sensory system is less developed. Adult fish are more likely to move away from area of disturbance when they detect sufficiently elevated SS concentrations and therefore are unlikely to be significantly impacted.

The SS level at which fish move into clearer water is defined as the tolerance threshold which varies among species and different stages of the life cycle. If SS levels exceed tolerance thresholds and the fish are not able to move away from the affected area, the fish are likely to become stressed, injured and may eventually die. The rate, timing and duration of SS elevations influence the type and extent of impacts upon fish and potentially crustaceans.

Findings from literature reviews indicated that lethal responses had not been reported in adult fish at SS values below 125 mg/L (78) and that sub-lethal effects were only observed when levels exceeded 90 mg/L (79). However, as part of a study for AFCD, *Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment* guideline values have been identified for fisheries and selected marine ecological sensitive receivers based on international marine water quality guidelines for the protection of ecosystems (80). The AFCD study recommends a maximum SS concentration of 50 mg/L (based on half of the no observable effect concentrations). However, the study cautioned that site-specific data should be considered in environmental assessments on a case-by-case basis. In order to provide a more conservative assessment (i.e. with a lower tolerance criterion), the relevant WQOs for SS elevation are adopted instead in this study as the assessment criteria for fisheries sensitive receivers.

The water quality modelling results have indicated that at all fisheries 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. SS elevations are expected to be temporary in nature and localised to the Project site. 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 fisheries will be well managed. Although the Project site is located within the recognised spawning ground and nursery area in northeastern Hong Kong waters, the Project site only occupies a very small proportion of the habitats and generally supported fish families of low commercial value. Areas which supported fisheries of higher commercial value, such as YCTMP and HHWMP which are at some distance away from the Project site. As such, unacceptable impacts from fish farm operation on fisheries resources and habitats (including spawning ground or nursery area) 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 the eggs and larvae of fish and crustaceans, as at these stages of development high levels of oxygen in the water are required for growth to support high metabolic growth rates.

The 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 most fisheries 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. The predicted 10th-percentile depth-averaged DO levels at both the Project site and Wong Wan FCZ are below the corresponding assessment criterion. Such episodes of low DO levels were also observed at Wong Wan FCZ in the past years without affecting the mariculture operation which are typically driven by low bottom DO levels in summer months, and the situation at the Project site is

(78) References cited in BCL (1994) Marine Ecology of the Ninepin Islands including Peddicord R and McFarland V (1996) Effects of suspended dredged material on the commercial crab, Cancer magister. in PA Krenkel, J Harrison and JC Burdick (Eds) Dredging and its Environmental Effects. Proc. Speciality Conference. American Society of Engineers.

(79) Alabaster JS & Lloyd R (1984) Water Quality Criteria for Freshwater Fisheries. Butterworths, London.

(80) City University of Hong Kong (2001) Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment. Prepared for AFCD.

worse than that of the existing Wong Wan FCZ given the higher water depth. Mariculture operation at the Project site and other proposed FCZs would result in some change in the mean and 10^{th}-percentile depth-averaged DO levels. In response to lowered DO levels, mariculturists could consider providing aeration onsite to improve DO levels at the fish farm by observing changes in fish behaviour due to low DO levels, and real-time water quality monitoring device set up by AFCD onsite will also help to detect signs of low DO levels and inform mariculturists. Additional modelling scenario has been conducted for the provision of aeration and results indicated that aeration would be able to replenish DO levels consumed by mariculture operation. Therefore, the predicted reduction in DO levels at the Project site is expected to be controlled by aeration as necessary and impacts from DO depletion due to fish farm operation are considered to be of minor significance. Outside of the Wong Chuk Kok Hoi embayment, no unacceptable change in water quality is predicted at other fisheries 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 fisheries 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. As discussed above, reduced levels of DO can impact the eggs and larvae of fish and crustaceans which require high levels of oxygen for development. Significantly low levels of DO may also result in fish mortality.

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 fisheries 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 fisheries 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 fish mortality.

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. There is no change of predicted levels of chlorophyll-a at the Project site and the levels are below the corresponding assessment criterion. Outside of the Wong Chuk Kok Hoi embayment, predicted levels of chlorophyll-a of all fisheries 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 fisheries are not expected to occur.

5.5.2.5 Fish Diseases

Fishes are kept in close proximity at individual cages in fish farms compared to the open marine waters which will increase the chance of disease transmission once developed.

It is expected that good mariculture practices shall be implemented by the fish farmers and preventive measures, such as quarantine newly stocked fish / fry, using uncontaminated fish feed, regular monitoring and control of fish density, etc., as specified in ***Appendix 2A***. As mentioned in ***Section***

5.5.2.4, if the use of pharmaceuticals for fish is required, it will be limited on site and stored at secured locations, discharge of such chemicals is not expected from daily operations. Mariculturists at the Project site would be required to strictly observe the requirement under *Cap. 529 Veterinary Surgeons Registration Ordinance* and have strict control on prescription drugs, therefore, adverse impacts on fisheries are not anticipated. The implementation of the fish health surveillance program would also be vital to maintain the health of these maricultured fish species in the new FCZ [(81)], therefore, AFCD has implemented the Fish Health Inspection Programme by conducting regular visits to fish farms, to identify early outbreaks of fish diseases and advice on good mariculture practices and prevention measures to fish farmers as specified in ***Appendix 2A*** [(82)]. Unacceptable impacts on fisheries are expected to be minor.

5.6 Impact Evaluation

From the information presented above, the fisheries impacts associated with the Project are not considered to be significant. An evaluation of the impacts according to *Annex 9* of the *EIAO-TM* is presented in ***Table 5.4***.

(81) Chong R, Bousfield B, Brown R (2011) *Op. cit*.

(82) AFCD (2021) Technical Support and Financial Assistance.

Table 5.4 Evaluation of Fisheries Impacts in accordance with the Criteria described in Annex 9 of the EIAO-TM

Potential Impact	Nature of Impact	Size of Affected Area	Loss of Fisheries Resources / Production	Destruction and Disturbance of Nursery and Spawning Grounds	Impact on Fishing Activity	Impact on Aquaculture Activity	Overall Impact Significance	Mitigation Measures Required
Construction Phase								
Habitat disturbances and loss of access to fishing grounds	Temporary and short term (a few weeks) in the active works area.	Loss of access to fishing grounds would cover the whole Project site (35 ha).	Project site is of low to moderate levels of fisheries production and the majority of fisheries resources is of low commercial value. Considering that the impacts are temporary, impacts on fisheries resources / production is minor.	The Project site is located within the recognised spawning ground and nursery area. No destructive constructing method are used. The magnitude of disturbance is considered to be low.	Moderate to high fishing operations have been recorded at the Project site. Considering the temporary nature of construction impact, the impacts on fishing activity are considered to be of minor significance.	No adverse impact is expected on Wong Wan, O Pui Tong, Sai Lau Kong and Tap Mun FCZs.	Minor	No
Underwater sound from marine construction activities and marine vessels	Temporary and short term (a few weeks) in the active works area.	Localised to sound-generating activities, e.g. assembly of fish rafts, installation of mooring system, marine vessels.	Avoidance and habituation by fish are expected. Loss of fisheries resources / production are considered negligible.	Underwater sound is expected to have negligible impact on spawning ground and nursery area.	Underwater sound is expected to have negligible impact on fishing operations.	No adverse impact is expected on Wong Wan FCZ located at ~0.8 km away. Other FCZs are located >5 km away from the Project site and are considered far away.	Minor	No
Operation Phase								
Change in fisheries habitat and loss of access to fishing grounds	Long term over Project operation but reversible.	Loss of access to fishing grounds would cover the whole Project Site (35ha)	The fish farm structures only occupy a section of the water column and a small area of seabed confined to a thin surface layer. Considering that the majority of fisheries resources is of low commercial value in the Project site, impacts on fisheries resources / production is minor. Potential positive effect on fisheries resources due to the colonisation of marine organisms on fish farm structures is expected.	The fish farm structures only occupy a section of the water column and a small area of seabed confined to a thin surface layer, impacts was considered of minor significance. Fish farm structures may potentially provide spawning and nursery habitats, the magnitude of disturbance is therefore considered to be low.	The loss of access to fishing ground is also considered to be small compared to the availability of fishing grounds elsewhere in northeastern Hong Kong waters available for fishing activities. Suitable fishing grounds outside of these structures can allow similar fishing activities to take place. The overall impact is therefore considered to be minor.	No adverse impact is expected on Wong Wan, O Pui Tong, Sai Lau Kong and Tap Mun FCZs.	Minor	No
Temporary relocation of fish rafts/ cages	Temporary.	Localised to the immediate vicinity of the area of fish rafts / cages relocation.	Avoidance by fish is expected, and negligible loss of fisheries resources when re-anchoring occurs.	Impacts are localised with negligible impact on nursery and spawning grounds when re-anchoring occurs.	Impacts are localised with negligible impact on fishing operations when re-anchoring occurs.	Impact is variable depending on the location in which the fish rafts / cages will be relocated (i.e. distance with other existing FCZs). Considering that the impact is temporary and the rafts / cages shall be relocated back into the Project site afterwards, overall no unacceptable impact is expected.	Minor	No
Underwater sound from marine vessels	Long term over Project	Localised to the immediate vicinity of the sound-generating	Avoidance and habituation of fish is expected. Loss of fisheries resources or production are considered negligible.	Underwater sound is expected to have negligible impact on spawning ground and nursery area.	Underwater sound is expected to have negligible impact on fishing operations.	Daily fish farm operations and marine traffic are present at the Wong Wan	Minor	No

Potential Impact	Nature of Impact	Size of Affected Area	Loss of Fisheries Resources / Production	Destruction and Disturbance of Nursery and Spawning Grounds	Impact on Fishing Activity	Impact on Aquaculture Activity	Overall Impact Significance	Mitigation Measures Required
and daily operations	operation but reversible.	activities e.g. maintenance of the fish rafts / cages and marine vessel movement.				FCZ. Small increase of underwater sound from the Project site is expected to have no unacceptable impact.		
Changes in water quality due to fish farm operational activities	Long term over Project operation but reversible.	Localised to the immediate vicinity of the fish farm.	Water quality compliance expected with no unacceptable impact.	Water quality compliance expected with no unacceptable impact.	Impacts are localised with negligible impact on fishing operations.	No unacceptable water quality impact expected at FCZs.	Minor	Water quality mitigation measures would further reduce impacts.
Fish diseases	Infrequent outbreaks. Occur when source of pathogens stressors are present.	Specific fish rafts / cages or waters in the vicinity of the Project site.	Magnitude of impact would depend on the type of disease induced. Proper treatment will be implemented at the infected sites, therefore the magnitude of impact is considered to be low.	Magnitude of impact would depend on the type of disease induced. Proper treatment will be implemented at the infected sites, therefore the magnitude of impact is considered to be low.	Impacts are localised with negligible impact on fishing operations.	Good mariculture practices will be implemented, therefore, impact on fish stock will be minor.	Minor	No

5.7 Cumulative Impacts

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 fisheries resources are not predicted to occur.

Potential operational impacts presented in ***Section 5.5.2*** 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:

- Change of Fisheries Habitat and Loss of Access to Fishing Grounds: The change of fisheries habitat and loss of access to fishing grounds in the context of fisheries operation would be approximately 600 ha in total, including the Project site (35 ha), the proposed Outer Tap Mun FCZ (55 ha), the proposed Mirs Bay FCZ (410 ha), and the proposed Po Toi (Southeast) FCZ (100 ha). Although the fishing areas affected covers a certain extent of Hong Kong waters, loss of fisheries resources and habitats due to all the proposed FCZs would be minimal. Furthermore, the provision of the proposed FCZs would support more mariculture operations in Hong Kong and thus providing more mariculture production for local and global consumption. Considering that the overall impact of the Project is minor, and it is unlikely that the construction and operation of the Project and the other proposed FCZs would exert an unacceptable cumulative effect on fisheries.
- Changes in Water Quality: No marine works or other major source of pollution is expected from the construction phase of the Project, therefore, no unacceptable cumulative impact during the construction phase is expected. Water quality modelling results for the operation phase, including the pollution loading from existing and other proposed FCZs (i.e. Outer Tap Mun FCZ and Mirs Bay FCZ) also showed that no unacceptable cumulative impact during the operation phase is expected.
- Underwater Sound: This Project is located ~0.8 km away from Wong Wan FCZ and >5 km away from other existing and planned FCZs. The cumulative effect of underwater sound will therefore consider the impact from the nearby Wong Wan FCZ only as other FCZs are far away from the Project site. 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 Wong Wan FCZ and private mooring site. 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 fisheries 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 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 Wong Chuk Kok Hoi near Wong Wan FCZ and the private mooring area, 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 fishing operations are anticipated to be negligible.

5.8 Mitigation Measures

In accordance with the guidelines in the *EIAO-TM* on fisheries impact assessment, the approach adopted in this EIA includes:

- **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:** When all possible mitigation measures have been exhausted and there are still significant residual impacts or when the impacts are permanent and irreversible, consideration shall be given to off-site compensation. It may include enhancement of fisheries resources and habitats elsewhere.

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 fisheries sensitive receivers, such as the spawning ground and nursery area of the northeastern waters of Hong Kong, marine parks, ARs and nearby FCZs.

Impacts to fisheries have largely been avoided and minimised through proper planning and design of the works. The Project site is selected to be far from YCTMP, such that impact to the marine park is 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 fisheries habitat and fishing ground. 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. No heavy construction plant would be used. To minimise the impact on fisheries resources, 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 designs are expected to control and reduce potential impacts to fisheries resources, and no fisheries-specific mitigation measures are thus required during construction.

The mitigation measures designed to mitigate water quality impacts and proper fish farm management designated to mitigate marine ecological impacts shall be adopted. No fisheries-specific mitigation measures are thus required during operation.

5.9 Residual impacts

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 fisheries resources including sensitive receivers such as Wong Wan FCZ have been evaluated. Residual impacts occurring as a result of the proposed Project have been determined and are discussed as follows:

- 35 ha of fisheries habitat and fishing grounds 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 area and the overall low commercial value of fisheries resources, the impact due to the loss of access to fishing grounds is considered to be of minor significance. Furthermore, with the implementation of the proposed mitigation measures, the potential impact on fisheries will be further minimised. No unacceptable residual fisheries impacts during the construction and operation of the Project are therefore anticipated.
- In addition, the establishment of the proposed FCZ would have positive effects on fisheries resources. While the proposed FCZ would provide more fisheries resources to the local and global fisheries market, the fish farm structures would also provide artificial substrates, which could form habitat and shelter for juveniles or adult fisheries resources. Besides, the reduced

fishing pressure may also have potential positive effect on fisheries resources within and adjacent to the Project site.

5.10 Environmental Monitoring & Audit

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

5.11 Summary and Conclusions

A review of baseline information on commercial fisheries resources, habitats and fishing operations surrounding the waters of the proposed Project from available literature has been conducted. Results of the review indicated that although moderate to high levels of fishing operation with low to moderate levels of fisheries production were reported at the Project site, similar levels of fisheries operation and production were also reported elsewhere in the broad Assessment Area. Recent studies suggested that the northeastern waters supported fisheries resources that are mainly with low commercial value, with some commercially important families recorded in the area. It remains as an important spawning ground and nursery area for fisheries resources. Areas which supported fish families with higher commercial values, such as YCTMP and HHWMP are located at some distance away from the Project site. Within the Assessment Area, fisheries sensitive receivers, including spawning ground, nursery area, marine parks, ARs and existing FCZs have been identified. Based on the information reviewed, the Project site does not represent a unique fishing ground, spawning ground and nursery area for fisheries resources.

During the construction of the Project, direct impacts arising from the proposed marine works include disturbance to fisheries habitats and the loss of access to potential fishing grounds (35 ha). Considering the temporary nature of the disturbance and the majority of fisheries resources found in and around the vicinity of the Project site are of low commercial value, unacceptable impacts on fisheries are not expected. Moderate to high fishing operations have been recorded at the Project site. Considering the temporary nature of construction impact, the impacts on fishing activity are considered to be of minor significance. 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 Wong Wan FCZ and private mooring site. No fisheries-specific mitigation measures are required during FCZ construction.

During FCZ operation, there will be 35 ha loss of access to fishing grounds. 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 bring potential positive effect on fisheries resources. Considering the relatively small area affected in the context of surrounding similar habitat and the majority of fisheries resources found in and around the vicinity of the Project site are of low commercial value, unacceptable impacts on fisheries are not expected. The loss of access to fishing ground is also considered to be small compared to the availability of fishing grounds elsewhere in northeastern Hong Kong waters available for fishing activities. Suitable fishing grounds outside of these structures can allow similar fishing activities to take place. The overall impact on fishing activity is therefore considered to be minor. 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 Wong Wan FCZ and private mooring site. Temporary relocation of fish rafts 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. Although there are some changes to DO levels at the Project site due to mariculture operation, the provision of aeration at fish farms by mariculturists would be able to replenish DO levels consumed by mariculture operation at the Project site. Outside of the Wong Chuk Kok Hoi embayment, no unacceptable change in water quality is predicted at other fisheries sensitive receivers under both baseline and project scenarios. The management of fish health will be conducted regularly to prevent fish disease outbreaks, including the Fish Health Inspection Programme to be conducted regularly by AFCD and the implementation of good mariculture practices by fish farm owners. No fisheries-specific mitigation measures are required during FCZ operation.

Overall, no unacceptable impacts to fisheries are expected to occur. All of the potential construction and operational fisheries impacts identified are deemed acceptable.

6. WASTE MANAGEMENT

6.1 Introduction

This ***Section*** identifies the potential waste management implications arising from the construction and operation of the Project and the potential environmental impacts associated with the storage, handling, transportation and disposal of the wastes with reference to the criteria and guidelines as stated in the requirements in *Clause 3.4.6* and *Appendix E Requirements for Assessment of Waste Management Implications* of the Study Brief, as well as *Annex 7* and *Annex 15* of the *EIAO-TM*.

6.2 Legislation Regulations and Evaluation Criteria

The criteria for evaluating waste management implications are stated in *Annex 7* of the *EIAO-TM*. *Annex 15* of the *EIAO-TM* prescribes the general approach and methodology for assessing the waste management implications caused by a project or proposal.

The following legislation covers the handling, treatment and disposal of wastes in Hong Kong which are relevant to the types of waste to be generated from the Project, and has been considered in the assessment.

- *Waste Disposal Ordinance (WDO) (Cap 354);*
- *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C);*
- *Marine Fish Culture Ordinance (Cap 353);*
- *Land (Miscellaneous Provisions) Ordinance (Cap 28);*
- *Public Health and Municipal Services Ordinance - Public Cleansing and Prevention of Nuisances Regulation (Cap 132BK);*
- *Merchant Shipping (Prevention and Control of Pollution) Ordinance (Cap 413); and*
- *Waste Disposal (Charging for Municipal Solid Waste) (Amendment) Ordinance 2021.*

6.2.1 Waste Disposal Ordinance (WDO) (Cap 354)

The *WDO* prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Under the *WDO*, wastes can only be disposed of at licensed waste disposal sites. A breach of these regulations can lead to the imposition of a fine and/or a prison sentence. The *WDO* also provides for the issuing of licences for the collection and transport of wastes.

The *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* defined construction waste as any substance, matters or things that are generated from construction work and abandoned, whether or not it has been processed or stockpiled before being abandoned, but does not include any sludge, screening, or matter removed in or generated from any desludging, desilting or dredging works.

The *Construction Waste Disposal Charging Scheme* came into operation on 1 December 2005. Processing of account applications by the EPD started on the same day. A Contractor who undertakes construction work with value of HK$1 million or above is required to open a billing account solely for the contract. Charging for the disposal of construction waste started on 20 January 2006.

Depending on the percentage of inert materials in the material, construction waste can be disposed of at public fill reception facilities, construction waste sorting facilities, landfills and outlying islands transfer facilities, where differing disposal costs would be applied. This scheme encourages waste reduction and hence minimise the costs of the Contractor or the Project Proponent.

Table 6.1 summarises the Government waste disposal facilities for construction waste and various charge levels.

Table 6.1 Government Waste Disposal Facilities for Construction Waste

Government Waste Disposal Facilities	Type of Construction Waste Accepted	Charge per Tonne [(a)]
Public fill reception facilities	Consisting entirely of inert construction waste [(b)]	HK$71
Sorting facilities	Containing more than 50% by weight of inert construction waste [(b)]	HK$175
Landfills [(c)]	Containing not more than 50% by weight of inert construction waste [(b)]	HK$200
Outlying Islands Transfer Facilities [(c)]	Containing any percentage of inert construction waste [(b)]	HK$200

Notes:

(a) Except for the Outlying Islands Transfer Facilities, the minimum charge load is 1 tonne, i.e. if a load of waste weighs 1 tonne or less, it will be charged as 1 tonne. A load of waste weighing more than 1 tonne will be charged at 0.1 tonne increment. For Outlying Islands Transfer Facilities, the charge is $20 per 0.1 tonne and the minimum charge load is 0.1 tonne.

(b) Inert construction waste means rock, rubble, boulder, earth, soil, sand, concrete, asphalt, brick, tile, masonry or used bentonite.

(c) If a load of waste contains construction waste and other wastes, that load will be regarded as consisting entirely of construction waste for the purpose of calculating the applicable charge.

6.2.2 Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)

Chemical waste as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1 of the Regulation*, if such a substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

Chemical waste producers shall register with the EPD. Any person who contravenes this requirement commits an offence and is liable to a fine and imprisonment. Producers of chemical wastes must treat their wastes, utilising on-site plants licensed by the EPD or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The system is designed to allow the transfer of wastes to be traced from cradle-to-grave.

The *Regulation* prescribes the storage facilities to be provided on site including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. He/she must also provide employees with training in such procedures.

6.2.3 Marine Fish Culture Ordinance (Cap 353)

Under *Section 10* of the *Marine Fish Culture Ordinance*, the Director of Agriculture, Fisheries and Conservation could provide instructions to licensees in writing regarding the disposal or destruction of any fish within any site found or suspected to be suffering from any infectious disease, or the disposal of any noxious or waste matter resulting from the fish collection or fish harvest. It is the existing practice/license condition for marine fish culture licensees under Cap. 353 to dispose of the anticipated waste arising (e.g. general refuse, floating refuse, organic wastes, etc.) at Food and Environmental Hygiene Department (FEHD)'s refuse collection points during construction and operation phases.

6.2.4 Land (Miscellaneous Provisions) Ordinance (Cap 28)

The inert portion of construction waste [(83)] (also called public fill) may be taken to public fill reception facilities. Public fill reception facilities are operated by the Civil Engineering and Development Department (CEDD). *The Land (Miscellaneous Provisions) Ordinance* requires that individuals or companies who deliver public fill to the public fill reception facilities need to obtain Dumping Licences. The licences are issued by the CEDD under delegated authority from the Director of Lands.

Under the licence conditions, public fill reception facilities will only accept inert earth, soil, sand, rock, boulder, rubble, brick, tile, concrete, asphalt, masonry or used bentonite. In addition, in accordance with paragraph 11 of *Development Bureau (DevB) Technical Circular (Works) (DevB TC(W)) No. 6/2010),* the Public Fill Committee will advise on the acceptance criteria (e.g. no mixing of construction waste, nominal size of the materials less than 250mm, etc). The material should, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical wastes, animal and vegetable matter and any other materials considered unsuitable to the public fill reception facility.

6.2.5 Public Cleansing and Prevention of Nuisances Regulation (Cap 132BK)

This Regulation provides further control on the illegal dumping of wastes on unauthorized (unlicensed) sites. The illegal dumping of wastes can lead to a fine and/or imprisonment.

6.2.6 Merchant Shipping (Prevention and Control of Pollution) Ordinance (Cap 413)

The Merchant Shipping (Prevention and Control of Pollution) Ordinance and its subsidiary regulations prohibit the discharge of wastewater and garbage from vessels.

Hong Kong has implemented the International Convention for the Prevention of Pollution from Ships 1973 as amended by the 1978 Protocol (universally known as MARPOL) and the MARPOL related requirements are mainly implemented under the Merchant Shipping (Prevention and Control of Pollution) Ordinance. Under the requirements, liquid oil waste or any other mixtures which contain oil and noxious liquid substances or any such residues shall not be discharged into the sea. In Hong Kong, the Chemical Waste Treatment Centre (CWTC) is the reception facility for oily waste discharged from vessels.

6.2.7 Waste Disposal (Charging for Municipal Solid Waste) (Amendment) Ordinance 2021

This Ordinance served to amend the Waste Disposal Ordinance and the Waste Disposal (Refuse Transfer Station) Regulation to establish the quantity-based charging scheme for the disposal of municipal solid waste in Hong Kong. The Ordinance also describes the production, sale, supply and the mandatory use of designated bags or designated labels for disposal of municipal solid waste.

6.2.8 Other Relevant Guidelines

Other relevant guidance documents, which detail how the Project Proponent or the Operator should comply with the local regulations, are as follows:

- *Waste Disposal Plan for Hong Kong* (December 1989), Planning, Environment and Lands Branch Government Secretariat, HKSAR Government;

(83) "Construction waste" refers to materials arising from any land excavation or formation, civil/building construction, road works, building renovation or demolition activities. It includes various types of reusable materials, building debris, rubble, earth, concrete, timber and mixed site clearance materials. When sorted properly, materials suitable for land reclamation and site formation (known as public fill) should be re-used at public fill reception facilities. The rock and concrete can be crushed and processed to produce aggregates for various civil and building engineering applications. The remaining construction waste (comprising timber, paper and plastics) are to be disposed of at landfills.

- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* (1992), EPD, HKSAR Government;
- *Hong Kong Planning Standards and Guidelines* (2021), Planning Department, HKSAR Government;
- *WBTC No. 2/93 - Public Dumps,* Works Branch, HKSAR Government;
- *WBTC No. 2/93B - Public Filling Facilities,* Works Branch, HKSAR Government;
- *WBTC No. 16/96 - Wet Soil in Public Dumps,* Works Branch, HKSAR Government;
- *Waste Reduction Framework Plan, 1998 to 2007*, Planning, Environment and Lands Bureau, Government Secretariat, 5 November 1998;
- *WBTC No. 4/98 and 4/98A - Use of Public Fill in Reclamation and Earth Filling Projects*, Works Bureau, HKSAR Government;
- *WBTC No. 12/2000 - Fill Management,* Works Bureau, HKSAR Government;
- *WBTC No. 19/2001 - Metallic Site Hoardings and Signboards*; Works Bureau, HKSAR Government;
- *WBTC No. 12/2002 - Specifications Facilitating the Use of Recycled Aggregates*, Works Bureau, HKSAR Government;
- *Project Administration Handbook for Civil Engineering Works, Section 4.1.3 of Chapter 4 - Management of Construction and Demolition Material Including Rock*, HKSAR Government; and
- *DevB TC(W) No. 6/2010 - Trip Ticket System for Disposal of Construction & Demolition Materials*, Development Bureau, HKSAR Government.

It should be noted that the establishment of FCZ is not categorised as a public works contract. As such, *ETWB TC(W) No. 19/2005 - Environmental Management on Construction Sites* is not applicable for this Project.

6.3 Expected Waste Arisings during the Construction Phase

During the construction phase, no barging points, conveyor system and stockpiling areas would be used. The main activities include on-site assembly and anchoring of fish rafts/ cages, and installation of auxiliary facilities, such as storages and shelters for contractor(s) [84] on some of the fish rafts. These activities will potentially result in the generation of wastes.

The typical waste types associated with these activities include:

- General refuse from construction workforce; and
- Floating refuse entrapment.

The fish rafts/ cages will be manufactured off-site and thus no on-site construction of the fish rafts / cages will be involved. The fish rafts / cages will be towed to the FCZ directly by tug boats for on-site assembly and anchoring, no heavy construction plant would be used, and as such no construction and demolition (C&D) materials (both inert and non-inert) and chemical waste are anticipated to be generated at the Project site. Non-inert C&D materials (e.g. wooden pallets, bamboo, timber, packaging wastes, metals, etc.) would not be anticipated from the Project construction works. The general refuse and floating refuse as discussed in detail below will be generated during the construction phase which normally last about a few weeks for each fish raft and is expected to commence in 2024, subject to the application and approval of the new marine fish culture licence.

(84) Contractor(s) refer to licensee(s) or the contractor(s) supporting the construction of fish raft structures.

6.3.1 General Refuse

General refuse, such as food waste, aluminium cans, plastic bottles, waste paper and glass bottles, will be generated from the licensed contractor(s) during the construction and anchorage of fish rafts and cages which require off-site disposal. The storage of general refuse has the potential to give rise to adverse environmental impacts, if not properly managed. These include odour if the general refuse is not collected frequently, floating / windblown litter and visual impact.

Assuming there will be no more than 20 licensed contractor(s) and workers participated in the construction of the FCZ area each day, with a general refuse generation rate of 0.65 kg per worker per day, the maximum amount of general refuse to be generated will be approximately 13 kg per day. It is anticipated that the duration of construction of each fish raft, including towing the fish rafts / cages to the Site, assembly and anchoring of the fish rafts/ cages and provision of auxiliary facilities, are expected to be completed within a few weeks.

To reduce the quantity of general refuse to be disposed of at landfill, recyclable materials (i.e. paper, plastic bottles, aluminium cans and glass bottles) will be segregated on-site and delivered to recyclers, as far as practicable. Adequate number of enclosed waste containers will be provided on the marine vessels to avoid over-spillage of waste / recyclable materials and accidental spillage of waste / recyclable materials to the sea. The non-recyclable general refuse will be collected and transported to the nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353, for example, Wong Shek Pier via marine vessels (1 trip per day), and ultimately sent to NENT landfill for disposal. As the quantity of general refuse to be disposed of at landfill is small, no adverse impact on the operation of the landfill is anticipated.

The waste disposal arrangement will follow the requirements stipulated under Marine Fish Culture Ordinance (Cap. 353) as appropriate. With the implementation of the mitigation measures recommended in ***Section 6.5***, no adverse environmental impacts (including potential hazard, dust and odour emissions, noise and wastewater discharge) caused by storage, handling, transport and disposal of general refuse are expected.

6.3.2 Floating Refuse

As the Project site is located in sheltered water area, floating refuse entrapment [85] may occur during the anchorage of fish cages, fish rafts and the auxiliary facilities. Floating refuse may be trapped on the surface of the anchored fish cages, fish rafts and vessels within the Project site, which will require collection and off-site disposal. Similar to general refuse, the storage of floating refuse has the potential to give rise to adverse environmental impacts, if not properly managed. These include odour if the floating refuse is not collected frequently, floating / windblown litter and visual impact.

The amount of floating refuse, i.e. not generated by this Project as licensed fish farmers and workers are not allowed to dump rubbish into the sea, is highly variable and influenced by the strength and direction of water currents. Since none of the shorelines surrounded the Project site is considered vulnerable to accumulation of floating refuse under both wet and dry seasons [86], the likelihood of entrapment of floating refuse within the Project site is expected to be low. It is expected that the amount of floating refuse requiring disposal is approximately 10 kg per week [87]. Floating refuse will be collected regularly and disposed of as general refuse. The floating refuse collected will be

(85) Floating refuse entrapment refers to those marine refuse that were washed to, and trapped in the Project site by water current. They are not generated by the Project as licensed contractor(s) are not allowed to dump rubbish into the sea.

(86) Based on the EPD's Study Report of Investigation on the Sources and Fates of Marine Refuse in Hong Kong issued in April 2015.

(87) It should be noted that minimal amount of floating refuse is collected regularly from the existing FCZs. For conservative assessment, it is assumed that a fish cage/ fish raft may trap up to 1 kg per week floating refuse requiring disposal during construction. The Project site is approximately 35 hectares and may support ~10 fish cages/ fish rafts. Therefore, the amount of floating refuse collected is estimated to be approximately 10 kg per week.

transported to the nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353, for example, Wong Shek Pier via marine vessels (1 trip per day), and ultimately sent to NENT landfill for disposal. As the quantity of floating refuse to be disposed of at landfill is small, no adverse impact on the operation of the landfill is anticipated.

For the case that the floating refuse contains recyclable materials (i.e. paper, plastic bottles, aluminium cans and glass bottles), the contractor(s) will divert these materials from landfill disposal using the same waste segregation, storage and recycling approach as that for recyclable materials from general refuse as described in ***Section 6.3.1***, as far as practicable.

The waste disposal arrangement will follow the requirements stipulated under Marine Fish Culture Ordinance (Cap. 353) as appropriate. With the implementation of the mitigation measures recommended in ***Section 6.5***, no adverse environmental impacts (including potential hazard, dust and odour emissions, noise and wastewater discharge) caused by storage, handling, transport and disposal of floating refuse are expected.

6.3.3 Summary of Transportation Routings

The tentative transportation routings for the disposal of general refuse (including the floating refuse collected) generated during the construction phase are shown in ***Table 6.2***. The transportation routings may change subject to the actual traffic conditions. It should be noted that public transport will not be used for handling (including stockpiling, labelling, packaging & storage), collection, transportation and re-use / disposal of wastes generated under the Project. Thus, impacts to public transport is not expected and specific mitigation measure for public transport is considered not necessary.

Table 6.2 Tentative Transportation Routings for Waste Disposal of General Refuse during Construction Phase

Type of Waste	Disposal Outlet	Tentative Transportation Routing
General Refuse (including floating refuse)	Refuse Collection Point at Wong Shek Pier	Wong Chuk Kok Hoi → Wong Shek Pier

6.4 Expected Waste Arisings during the Operation Phase

During the operation phase of the Project, no barging points, conveyor system and stockpiling areas would be used. The major waste types to be generated potentially from the licensed area within the Project site include:

- Organic waste, such as fish feed wastage, fish excretions and fish carcasses;
- Chemical waste;
- General refuse from site operation; and
- Floating refuse entrapment.

As it is expected that mariculture activities would not require maintenance dredging or removal of sediments, generation of marine sediments is not anticipated during the operation phase. Organic waste, chemical waste, general refuse and floating refuse as discussed in detail below will be generated during the operation phase (i.e. during operation of the FCZ).

6.4.1 Organic Waste

Organic waste mainly consists of solid organic materials or debris including uneaten fish feed, fecal waste from marine organisms, fish carcasses and dead fish arising from the fish culture operation.

These waste could potentially be harmful to fish species as they are easily decomposed which boost the nutrient level of water. Hence, these waste should be removed from the licensed area to avoid affecting the health conditions of cultured fish, as well as nutrients enrichment within the Project site and to the adjacent water.

The quantity of fish feed wastage generated from each fish raft is highly variable depending on a number of factors, including feed type and composition, fish stocking density, feeding method and feeding rates. The quantity of fish fecal waste, fish carcasses and dead fish will also be varied with the type and quality of fish feed applied, cultured species of fish stock and stocking intensity. In any case, it is expected that the quantity of organic waste generated from the Project site would be no more than 42 kg per day on average (88). The licensed contractor(s) should remove these waste from the licensed area regularly, especially after the fish feed was added. In the unlikely case that significant amount of dead fish occur, the licensed fish farmers would inform AFCD immediately. AFCD will then liaise with relevant Government departments (e.g. Food and Environmental Hygiene Department, Marine Department) to collect the dead fish from the Project site directly as necessary.

The collected marine debris and dead fish will be treated with disinfectant or other pharmaceutical drugs, and will be placed in enclosed waste containers or garbage bags located within the Project site. These organic waste will be transported to the nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353, for example, Wong Shek Pier via marine vessels (a few trips per day), and ultimately sent to NENT landfill for disposal.

The waste disposal arrangement will follow the requirements stipulated under Marine Fish Culture Ordinance (Cap. 353) as appropriate. With the implementation of the mitigation measures recommended in ***Section 6.5***, no adverse environmental impacts (including potential hazard, dust and odour emissions, noise and wastewater discharge) caused by storage, handling, transport and disposal of organic waste are expected.

6.4.2 Chemical Waste

It is anticipated that a small amount of chemicals, including pharmaceutical drugs / antibiotics / vaccines and chemical disinfectant, will be stored and used for treating diseased fish and disinfection of operation waste and equipment, resulting in generation of chemical wastes such as empty chemical containers and syringes. Chemical waste, such as lubricant oil, may also be generated due to maintenance of powered mechanical equipment. The amount of chemical waste generated will depend on the frequency of chemical usage and number of equipment used on site. Nevertheless, the quantity of chemical waste to be generated is expected to be insignificant (about a few cubic metres per month). These chemical wastes will be collected by a licensed chemical waste collector regularly (about 1-2 trips per month) and delivered to the licensed chemical waste treatment facilities (i.e. CWTC) at Tsing Yi via marine vessels for disposal. With the incorporation of suitable arrangements for the storage, handling, collection and transportation and disposal of chemical waste under the requirements stated in the *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*, no adverse environmental (including air and odour emissions, noise and waste water discharge) impacts and hazards are anticipated.

6.4.3 General Refuse

General refuse will arise from the licensed contractor(s) and occasional visitors during site operation. General refuse may consist of food waste, plastics, aluminium cans, papers and glass bottles, which require proper storage for off-site disposal. The storage of general refuse has the potential to give rise to adverse environmental impacts, if not properly managed. These include odour if the general refuse is not collected frequently, floating / windblown litter and visual impact.

(88) The quantity of organic waste is estimated based on the mariculture operation at the existing FCZs. With the use of advanced mariculture operation at the Project site, it is expected that the organic waste generated will be much lowered.

It is expected there will be no more than 20 contractor(s) supporting the mariculture operation as well as occasional visitors at the Project site at any one time. With a general refuse generation rate of 0.65kg per worker per day, the total amount of general refuse generated from the licensed area is estimated to be approximately 13 kg per day.

To reduce the quantity of general refuse to be disposed of at landfill, recyclable materials (i.e. paper, plastic bottles, aluminium cans and glass bottles) will be segregated on-site and delivered to landside recyclers, as far as practicable. Adequate number of enclosed waste containers will be provided on site (e.g. marine vessels, communal rafts) to avoid over-spillage of waste / recyclable materials and accidental spillage of waste / recyclable materials to the sea. The non-recyclable general refuse will be collected and transported (together with the organic waste) to the nearest suitable refuse collection point(s), for example, Wong Shek Pier via marine vessels (1 trip per day), and ultimately sent to NENT landfill for disposal. Given that the quantity of general refuse to be disposed of at landfill is low, no adverse impact on the operation of the landfill is anticipated.

The waste disposal arrangement will follow the requirements stipulated under Marine Fish Culture Ordinance (Cap. 353) as appropriate. With the implementation of the mitigation measures recommended in ***Section 6.5***, no adverse environmental impacts (including potential hazard, dust and odour emissions, noise and wastewater discharge) caused by storage, handling, transport and disposal of general refuse are expected.

6.4.4 Floating Refuse

Floating refuse may be trapped on the surface of fish cages, fish rafts and vessels within the Project site. However, since none of the shorelines surrounded the Project site is considered vulnerable to accumulation of floating refuse under both wet and dry seasons, the quantity of floating refuse trapped within the Project site during the operation stage is expected to be low (~ 20 kg per week) [(89)]. Floating refuse will be collected regularly (1 trip per day), handled, stored, recycled and disposed of as general refuse as described in ***Section 6.4.3***.

Given that the quantity of floating refuse to be disposed of at landfill is low, no adverse impact on the operation of the landfill is anticipated.

The waste disposal arrangement will follow the requirements stipulated under Marine Fish Culture Ordinance (Cap. 353) as appropriate. With the implementation of the mitigation measures recommended in ***Section 6.5***, no adverse environmental impacts (including potential hazard, dust and odour emissions, noise and wastewater discharge) caused by storage, handling, transport and disposal of floating refuse are expected.

6.4.5 Summary of Transportation Routings

The tentative transportation routings for the disposal of organic waste, general refuse (including the floating refuse collected) and chemical waste generated during the operation phase are shown in ***Table 6.3***. The transportation routings may change subject to the actual traffic conditions. It should be noted that public transport will not be used for handling (including stockpiling, labelling, packaging & storage), collection, transportation and re-use / disposal of wastes generated under the Project. Thus, impacts to public transport is not expected and specific mitigation measure for public transport is considered not necessary.

(89) It should be noted that minimal amount of floating refuse is collected regularly from the existing FCZs. For conservative assessment, it is assumed that a fish cage/ fish raft may trap up to 2 kg per week floating refuse requiring disposal during operation. The Project site is approximately 35 hectares and may support ~10 fish cages/ fish rafts. Therefore, the amount of floating refuse collected is estimated to be approximately 20 kg per week.

Table 6.3 Tentative Transportation Routings for Waste Disposal of Various Waste during Operation Phase

Type of Waste	Disposal Outlet	Tentative Transportation Routing
Organic Waste	Refuse Collection Point at Wong Shek Pier	Wong Chuk Kok Hoi → Wong Shek Pier
General Refuse (including floating refuse)		
Chemical Waste	Chemical Waste Treatment Centre (CWTC)	Wong Chuk Kok Hoi → Licensed Chemical Waste Collector → Mirs Bay → Tathong Channel → Victoria Harbour → CWTC

6.5 Mitigation Measures

6.5.1 Waste Management Hierarchy

The various waste management options are categorised in terms of preference from an environmental viewpoint. The options considered to be most preferable have the least environmental impacts and are more sustainable in the long term. The hierarchy is as follows:

- Avoidance and reduction;
- Re-use of materials;
- Recovery and recycling; and
- Treatment and disposal.

The above hierarchy has been used to evaluate and select waste management options. The aim has been to reduce waste generation and reduce waste handling and disposal costs. The contractor(s) shall implement the following control measures:

Under Marine Fish Culture Ordinance (Cap. 353):

- Submit an Environmental Management Plan under the Fish Farm Operational Plan (see ***Appendix 2A*** for details) on the control of environmental impacts from the mariculture activities for agreement with AFCD;
- Disposal or destruction of any fish within any site found or suspected to be suffering from any infectious disease;
- Disposal of any noxious or waste matter resulting from the fish collection or fish harvest.

Under Merchant Shipping (Prevention and Control of Pollution) Ordinance (Cap. 413):

- Liquid oil waste or any other mixtures which contain oil and noxious liquid substances or any such residues shall not be discharged into the sea;
- Oily waste from vessels should be discharged to CWTC.

They will also consult AFCD for the final disposal of wastes and, as appropriate, implement the good site practices and mitigation measures recommended in this EIA Report and those given below.

- Nomination of approved personnel (e.g. environmental officer of the contractor(s), representative of the project proponent) to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility of all wastes generated at the site;
- Training of site personnel in proper waste management and handling procedures by AFCD;
- Provision of sufficient waste disposal points and regular collection for disposal;

- Appropriate measures to reduce windblown / floating litter and dust during transportation of waste by transporting wastes in enclosed containers; and
- A recording system (e.g. log book for mariculture operation) for the amount of wastes generated, recycled and disposed of and the disposal sites for checking by AFCD.

6.5.2 Construction Phase

The assessment indicates that with the implementation of the waste management practices at the Project site, no adverse environmental impacts are envisaged for the handling, collection and disposal of waste arising during the construction phase of the Project.

This ***Section*** further describes the good construction site practices to avoid or further reduce the potential environmental impacts associated with the handling, collection and disposal of general refuse and floating refuse arising from the construction works.

The contractor(s) must ensure that all the necessary waste disposal permits or licences are obtained prior to the commencement of the construction works.

6.5.2.1 Measures for Management of General Refuse and Floating Refuse

General refuse (including the floating refuse collected) will be stored in enclosed bins. The garbage bins will be placed at appropriate locations to facilitate disposal by the contractor(s) on site. The contractor(s) will be prohibited from throwing rubbish into the sea and adequate bins will be provided on the Project site and marine vessels. General refuse will be delivered for offsite disposal on a regular basis to reduce odour, pest and litter impacts. General refuse will be collected and disposed of at the nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353 (e.g. Wong Shek Pier via marine vessels), and ultimately sent to NENT landfill for disposal. General refuse requiring disposal will be collected in designated garbage bags after the official implementation of MSW charging scheme.

Recycling bins with proper labelling will be provided at appropriate locations to facilitate collection of recyclable materials (including aluminium can, plastic bottles and paper) from the Project site. Materials recovered will be sent to authorised recyclers.

To avoid entrapment of floating refuse within the Project site, the fish cages / rafts and vessels should be properly designed such that there are no sharp turns or abrupt indentation in order to avoid or minimise any trapped or accumulated refuse. With the proper design of fish cages / rafts and vessels, entrapment of floating refuse and the need for its subsequent disposal can be minimised.

Public transport will not be used for handling (including stockpiling, labelling, packaging & storage), collection, transportation and re-use / disposal of wastes generated under the Project. Thus, impacts to public transport is not expected and specific mitigation measure for public transport is considered not necessary.

6.5.2.2 Staff Training

Prior to the commencement of the construction works, AFCD will provide training to the contractor(s) on the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, re-use and recycling. In particular, the training will emphasize no dumping of waste into the sea is allowed, particularly within the licensed area and on marine vessels.

6.5.3 Operation Phase

6.5.3.1 Measures for Management of Organic Waste

Effective management of feed with the application of modern feeding practices and technologies can minimise fish feed wastage and the subsequent negative impacts to the environment. Good quality feed, such as pellet feed, should be used for feeding instead of trash fish as it effectively reduces the feed conversion ratio, and thus the quantity of uneaten feed wastage. Depending on the cultured species and the stocking intensity, optimal feed input should be implemented while the fish feed should be even distributed within the licensed area. The feed will also be sieved to remove broken pieces and dust before feeding. The contractor(s) will keep detailed operational records for each licensed area including the type and quantity of feed used, estimated number of fish stock and biomass, water temperature and growth rates of cultured organisms to allow more accurate estimation of fish feed input and to minimise unnecessary wastage of feeds. The contractor(s) and other personnel are also required to take all precautions to prevent spillage during the delivery of feed to the Project site. The uneaten feeds should be cleaned up immediately, especially during summer times when the decomposition of organic waste is more rapid, so as to minimise leaching to the adjacent water. The quantity of feed delivered to the licensed area will also be recorded in order to ensure an appropriate quantity of feed stock is procured. Feed will be stored in covered areas on the fish rafts within the licensed area to avoid exposure to external climatic and weather conditions that might result in unnecessary spillage and spoilage.

Organic waste including residue feed, fish carcasses, fecal waste and dead fish will be removed from the licensed area after each feeding process and the waste will be stored in enclosed bins. The treated organic waste will be securely sent offsite to the nearest accessible FEHD refuse collection points with public pier suitable refuse following the existing practice under Cap. 353, for example, Wong Shek Pier via marine vessels, and ultimately to NENT landfill for disposal. Designated garbage bags will be used to collect the organic waste after the official implementation of MSW charging scheme.

Public transport will not be used for handling (including stockpiling, labelling, packaging & storage), collection, transportation and re-use / disposal of wastes generated under the Project. Thus, impacts to public transport is not expected and specific mitigation measure for public transport is considered not necessary.

In case of large quantity of organic waste generated as a result of extensive fish deaths, for example, due to algal bloom or fish diseases, the contractor(s) will report to AFCD in due course, and AFCD, Food and Environmental Hygiene Department (FEHD), Marine Department (MD) and other relevant departments will provide assistance to the contractor(s) to transport the organic waste directly to NENT landfill for disposal.

6.5.3.2 Measures for Management of Chemical Waste

The contractor(s) will register as a chemical waste producer with the EPD. Chemical waste will be handled in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* as listed below.

Containers used for storage of chemical wastes will:

- Be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;
- Have a capacity of less than 450L unless the specifications have been approved by the EPD; and
- Display a label in English and Chinese in accordance with instructions prescribed in *Schedule 2* of the *Regulations*.

The storage area for chemical wastes will:

- Be clearly labelled and used solely for the storage of chemical waste;
- Be enclosed on at least 3 sides;

- Have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest;
- Have adequate ventilation;
- Be covered to prevent rainfall entering (water collected within the bund must be tested and disposed of as chemical waste, if necessary); and
- Be arranged so that incompatible materials are appropriately separated.

Chemical waste will be disposed of:

- Via a licensed waste collector; and
- To a facility licensed to receive chemical waste, such as the CWTC which also offers a chemical waste collection service, and can supply the necessary chemical waste storage containers.

6.5.3.3 Measures for Management of General Refuse and Floating Refuse

The management of general refuse (including the floating refuse collected) from the Project site during the operation phase will be similar to that in the construction phase (see ***Section 6.5.2.1***). General refuse will be stored in enclosed bins and disposed offsite to the nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353, for example, Wong Shek Pier via marine vessels, on a regular basis for avoidance of pest and odour nuisance. Designated garbage bags will be used to collect general refuse after the official implementation of MSW charging scheme. Recycling bins with proper labelling will be placed at the fish rafts to collect recyclables which will be transported off-site for recycling via vessels on a regular basis.

To avoid entrapment of floating refuse within the Project site, the fish cages / rafts and vessels should be properly designed such that there are no any sharp turns or abrupt indentation in order to avoid or minimise any trapped or accumulated refuse. With the proper design of fish cages / rafts and vessels, entrapment of floating refuse and the need for its subsequent disposal can be minimised.

Public transport will not be used for handling (including stockpiling, labelling, packaging & storage), collection, transportation and re-use / disposal of wastes generated under the Project. Thus, impacts to public transport is not expected and specific mitigation measure for public transport is considered not necessary.

6.5.3.4 Staff Training

Prior to the commencement of the operation phase, AFCD will provide on-farm training to all staff working at the Project site on the concepts of sustainable mariculture practice, site cleanliness and appropriate waste management procedures, including waste reduction, re-use and recycling. In particular, the training will emphasize no dumping of waste into the sea is allowed.

6.6 Residual Environmental Impacts

With the implementation of mitigation measures specified in ***Section 6.5***, no adverse residual waste management impact is envisaged during the construction and operation phases of the Project.

6.7 Environmental Monitoring and Audit

No adverse waste management impact is anticipated during the construction and operation phases of the Project. To ensure the waste management performance during construction phase of the Project, EM&A is recommended to be conducted during construction phase. Site inspections at the Project site (on marine vessels) are recommended on a regular basis at bi-weekly interval during the time of construction activities by the Environmental Team (ET) to check if wastes are being managed in accordance with good site practices and the mitigation measures as recommended in ***Section 6.5*** during the construction phase as part of the EM&A. All aspects of waste management will be investigated during the regular inspections, including waste generation, storage, handling, recycling, transportation and disposal, to prevent any dumping of waste into the sea or malpractice of waste disposal.

During operation phase, the waste management issues of the Project will be controlled by licensing under the Marine Fish Culture Ordinance (Cap. 353). EM&A is not required to be conducted during operation phase of the Project. AFCD will conduct regular inspections at monthly interval and review on FCZ operation to check if wastes are being managed in accordance with good site practices and the mitigation measures as recommended in ***Section 6.5*** during the operation phase. All aspects of waste management will be investigated during the regular inspections, including waste generation, storage, handling, recycling, transportation and disposal, to prevent any dumping of waste into the sea or malpractice of waste disposal.

6.8 Conclusions

With the implementation of good site practices, adverse environmental impacts (including potential hazards, air and odour emissions, noise and wastewater discharge) arising from the management and disposal of waste during the construction and operation phases are not anticipated.

The estimated waste arising and the recommend waste management arrangements during the construction phase and operations phase of the Project are summarised in ***Table 6.4***.

Table 6.4 Summary of Estimated Waste Arisings and Recommended Waste Management Arrangements

Types of Waste	Approximate Quantity	Disposal Locations
Construction Phase		
General refuse	~ 13 kg per day	Recyclable materials: on-site sorting and off-site recycling. Non-recyclable refuse: Nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353 (e.g. Wong Shek Pier), and then transported to NENT landfill for disposal.
Floating refuse	~ 10 kg per week	Recyclable materials: on-site sorting and off-site recycling. Non-recyclable refuse: Nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353 (e.g. Wong Shek Pier), and then transported to NENT landfill for disposal.
Operation Phase		
Organic waste	< 42 kg per day	Nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353 (e.g. Wong Shek Pier), and then transported to NENT landfill for disposal.
Chemical waste	A few cubic metres per month	CWTC
General refuse	~ 13 kg per day	Recyclable materials: on-site sorting and off-site recycling. Non-recyclable refuse: Nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353 (e.g. Wong Shek Pier), and then transported to NENT landfill for disposal.

Types of Waste	Approximate Quantity	Disposal Locations
Floating refuse	~ 20 kg per week	Recyclable materials: on-site sorting and off-site recycling. Non-recyclable refuse: Nearest accessible FEHD refuse collection points with public pier following the existing practice under Cap. 353 (e.g. Wong Shek Pier), and then transported to NENT landfill for disposal.

7. VISUAL

7.1 Introduction

In accordance with *Clause 3.4.7* and *Appendix F* Requirements for Visual Impact Assessment (VIA) of the EIA Study Brief, a VIA has been conducted based on mapping with a Geographic Information System (GIS) and field surveys to help identify the existing conditions so as to be able to assess the potential visual impacts during construction and operation and glare associated with the light sources of the Project. The VIA presented here covers the elements of the Project that are located above sea level.

7.2 Legislative Requirements and Evaluation Criteria

This VIA has been prepared according to *Clause 2.1 (vi), Clause 3.2.1 (vi), Clause 3.4.7* and *Appendix F* of the EIA Study Brief.

Environmental Impact Assessment Ordinance (*EIAO*) legislation (Cap.499, S.16) and the Technical Memorandum on EIA Process (*EIAO-TM*), particularly *Annexes 10 (Criteria for Evaluating Visual and Landscape Impact, and Impact on Sites of Cultural Heritage*) and *18 (Guidelines for Landscape and Visual Impact Assessment)* have been referred to in carrying out this assessment.

In addition, the following standards and guidelines have been referred to for assessing the visual impacts associated with the Project:

- Environmental Impact Assessment Ordinance Guidance Note 8/2010 (Preparation of Landscape and Visual Impact Assessment under the Environmental Impact Assessment Ordinance);
- Hong Kong Planning Standards and Guidelines (HKPSG) issued by the Planning Department (November 2015), in particular Chapter 11 Urban Design Guidelines;
- Study on Landscape Value Mapping of Hong Kong.

7.3 Review of Existing Planning and Development Control Framework

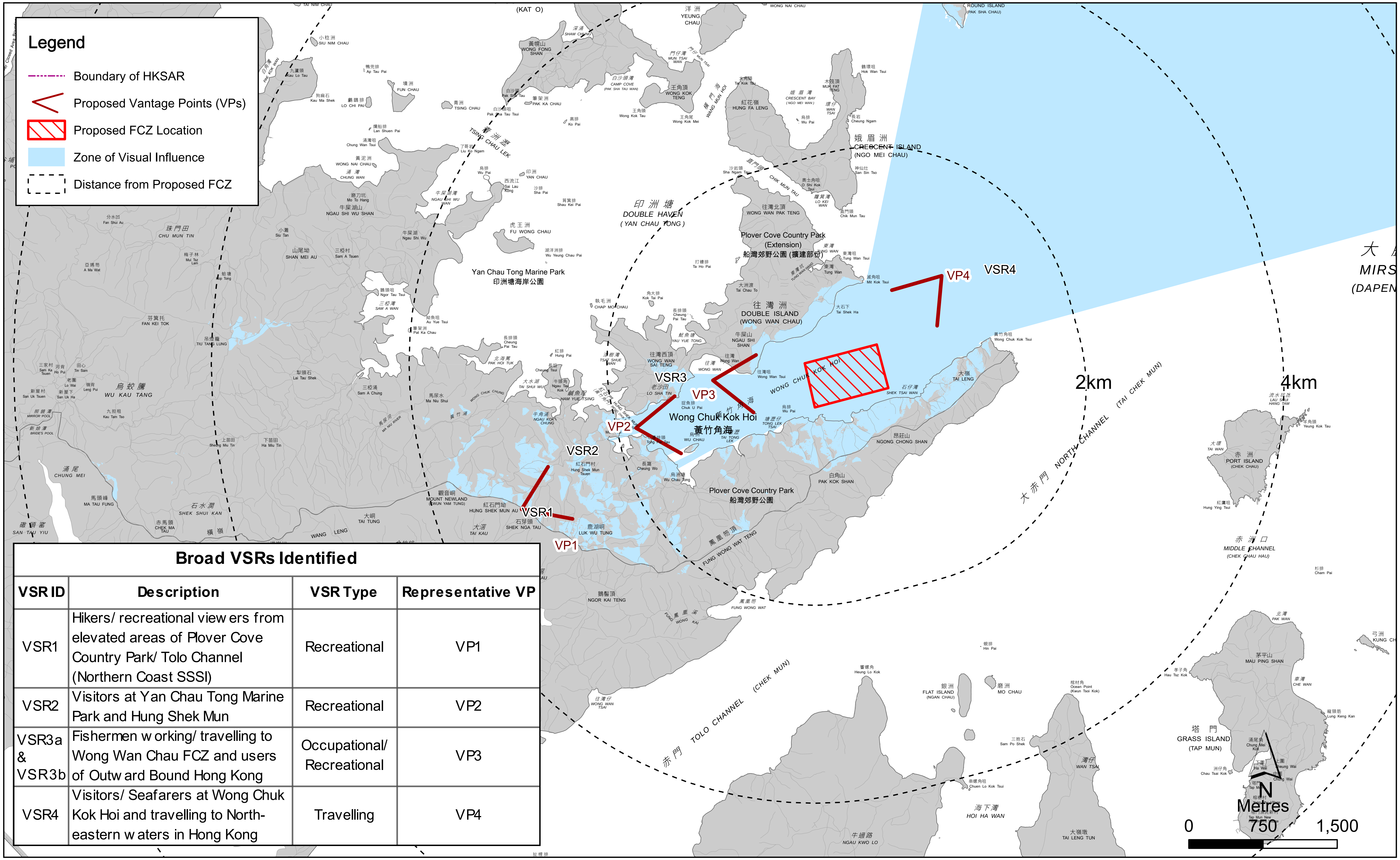
The Project site is located at the waters of Wong Chuk Kok Hoi in the Northeast New Territories (***Figure 7.1***). It is located within the Geopark (Northeast New Territories Sedimentary Rock Region) and is adjacent to Yan Chau Tong Marine Park (***Figure 7.2***).

7.4 Methodology

7.4.1 Baseline

The Assessment Area for visual impact assessment shall be defined by the Visual Envelope of the Project. A Visual Envelope is an area within which views of the Project will be possible. Identification of the visual envelope has been achieved by site visit and desk-top study of topographic maps and photographs, and GIS analysis, to determine potential visibility of the Project from various locations. GIS analysis uses known data regarding the proposed built structures to model the area that can potentially see the developments. It should be noted that GIS analysis uses topographic data as a baseline, disregarding existing built forms and vegetation which reduce the actual visual envelope. ***Figure 7.1*** illustrates the GIS Visual Envelope for this Project.

The visual envelope of the Project site is determined based on its potential dimensions of 750 m x 450 m across the horizontal plane, with FCZ facilities no higher than 3 m in height above water (except during maintenance). Considering that the visual impact of this Project would be mainly associated with the horizontal field of view of fish farms, it is proposed to use the horizontal field of view of individual fish farms within the whole FCZ area when assessing the visual extent of impact for this Project.



Broad VSRs Identified

VSR ID	Description	VSR Type	Representative VP
VSR1	Hikers/ recreational viewers from elevated areas of Plover Cove Country Park/ Tolo Channel (Northern Coast SSSI)	Recreational	VP1
VSR2	Visitors at Yan Chau Tong Marine Park and Hung Shek Mun	Recreational	VP2
VSR3a & VSR3b	Fishermen working/ travelling to Wong Wan Chau FCZ and users of Outward Bound Hong Kong	Occupational/ Recreational	VP3
VSR4	Visitors/ Seafarers at Wong Chuk Kok Hoi and travelling to North-eastern waters in Hong Kong	Travelling	VP4

ERM

Figure 7.1

VIA Assessment Area and Locations of Proposed Vantage Points (VPs) for Wong Chuk Kok Hoi FCZ

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Date: 24/5/2022

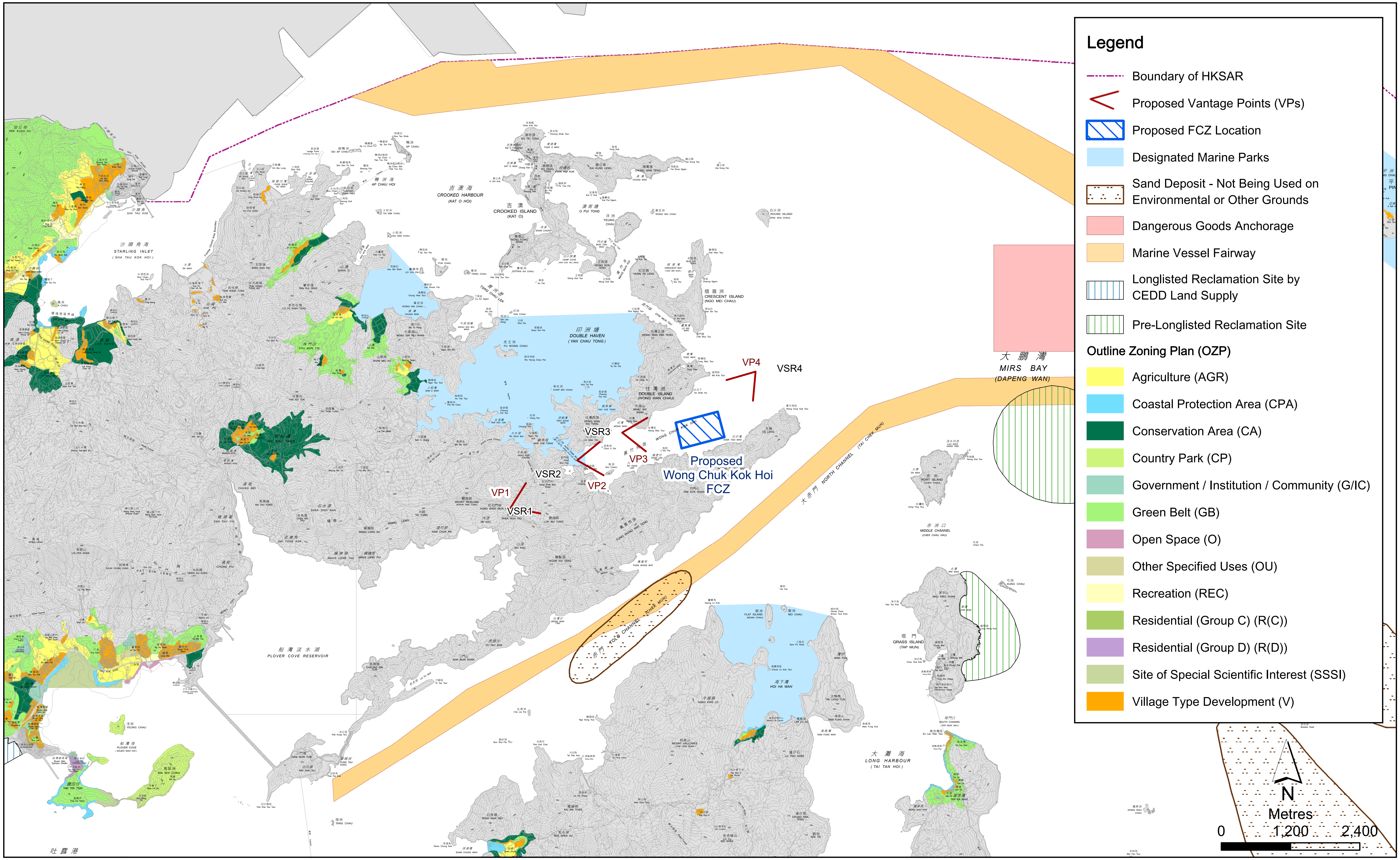

Figure 7.2

Planning & Development Context near Proposed Wong Chuk Kok Hoi FCZ

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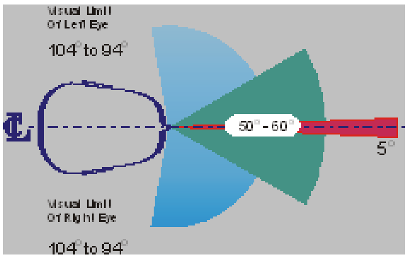
Date: 25/5/2022

Figure 7.1 also gives an indication of how far viewers are from the Project site. As a viewer moves further away from the Project site, the visual impact decreases until it is no longer visible. However, before the point of invisibility is reached, the FCZ would have reduced in scale such that it no longer has a significant visual effect on the view.

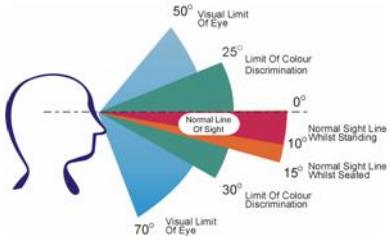
Boxes 1 and 2 below show that for an individual fish farm, the horizontal field of view will be visually dominant for distance <170 m and insignificant further than 2.3 km away, whereas the vertical field of view will be visually evident for distance <70m and insignificant for distance >340 m. Therefore, the maximum distance which the fish farm is considered insignificant will be at >2.3 km.

Box 1 - EXTENT OF HUMAN VISION

The visual impact of a development can be quantified by reference to the degree of influence on a person's field of vision. The following diagrams illustrate the typical parameters of human vision and are based on anthropometric data (*Human Dimension & Interior Space – A Source Book of Design Reference Standards, Julius Panero and Martin Zelnik, The Architectural Press Ltd. London, 1979*). This data provides a basis for assessing and interpreting the impact of a development by comparing the extent to which the development would intrude into the central field of vision (both horizontally and vertically).



Horizontal Field of View



Vertical Field of View

Horizontal Cone of View - The central field of vision for most people covers an angle of between 50^{O} and 60^{O}, within which both eyes observe an object simultaneously within this 'bionocular field' images are sharp, depth perception occurs and colour discrimination is possible. These physical parameters are illustrated in the images above.

The visual impact of a development will vary according to the proportion to which the development consumes the central field of vision. Developments, which take up less than 5% of the central binocular field, are usually insignificant in most landscapes (5% of 50^{O} = 2.5^{O}).

Vertical Field of View - A similar analysis can be undertaken based upon the vertical line of sight for human vision. A person's natural or normal line of sight is normally a 10^{O} cone of view below the horizontal and, if sitting, approximately 15^{O}. Objects which take up 5% of this cone of view (5% of 10^{O} = 0.5^{O}) would only take up a small proportion of the vertical field of view, and are only visible when one focuses on them directly. Objects that take up such a small proportion of the vertical view cone are not dominant, nor create a significant change to the existing environment when placed within a disturbed or man-modified landscape. They may, however, be more noticeable in a pristine environment.

Box 2 – DISTANCE FROM WHICH PROJECT WILL BE VISIBLE

In assessing the visual impact of the proposed FCZ it is assumed that the largest horizontal component is the longest dimension of the FCZ layout, which is approximately 1.63 km wide and a maximum height of 3 m. However, as the fish culture zone is comprised of multiple fish farms of the same dimensions with a separation distance of ~100m in between, therefore, it would not be accurate to examine the entire width of the FCZ when reviewing the horizontal field of view. This effect can also be demonstrated by the example of a farm fence that may be many kilometres in width, yet as one moves further away it becomes less apparent, until at some distance it is not possible to separate this element from the horizontal plane of the landscape. In essence, as soon as one fish farm becomes visually insignificant, so do all of the fish farms in the entire FCZ. In assessing the visual impact of the fish farms it is therefore assumed that the largest horizontal component is the diameter of a fish farm. Considering that on fish farm will be ~1 ha, its maximum width would be of 100 m wide.

The tables below show the calculations for horizontal and vertical fields of view respectively.

Horizontal Field of View	Impact	Distance from an observer to a fish farm of 1 ha
		100 m wide
$<2.5^{\circ}$ of view	*Insignificant* The development will take up less than 5% of the central field of view. The development, unless particularly conspicuous against the background, will not intrude significantly into the view. The extent of the vertical angle will also affect the visual impact.	>2.3 km
2.5° – 30° of view	*Potentially noticeable* The development may be noticeable and its degree of visual intrusion will depend greatly on its ability to blend in with its surroundings and how far someone is from the terminal.	170 m–2.3 km
$>30^{\circ}$ of view	*Potentially visually dominant* Developments that fill more than 50 percent of the central field of vision will always be noticed and only sympathetic treatments will mitigate visual effects.	<170 m

Vertical Line of Sight	Impact	Distance from an observer to a facility that is
		3m high
$< 0.5^{\circ}$ of vertical angle	*Insignificant* A thin line in the landscape.	>340m
$0.5^{\circ} – 2.5^{\circ}$ of vertical angle	*Potentially noticeable* The degree of visual intrusion will depend on the development's ability to blend in with the surroundings.	70m – 340m
$> 2.5^{\circ}$ of vertical angle	*Visually evident* Usually visible, however the degree of visual intrusion will depend on the width of the object and its placement within the landscape.	<70m

7.4.2 Identification of Visual Sensitive Receivers (VSRs) and Vantage Points (VPs)

Having determined the Assessment Area for the VIA, VSRs have been broadly identified within the visual envelope. VSRs may include the people who would reside, work, play within, or travel through the Assessment Area and be potentially under the impact of the proposed Project.

Subsequently Vantage Points, or Viewpoints (VPs), were selected. VPs are positions selected to represent some potential VSRs from where the proposed Project can be viewed, and are selected to help illustrate the visual change that would be brought about by the proposed Project. The VPs have been selected to ensure that in combination they give a good overall representation of how the

Project will appear to different types of VSRs, both near and far and at sea level as well as lower and higher ground elevations.

7.4.3 VSR Sensitivity

Assessment of the sensitivity of VSRs is influenced by a number of factors including the following:

- Type of VSR. VSRs are categorized according to whether the viewer is at home, at work or school, at play or leisure, or travelling (ranked by the major VSR types, as described below):

  - *Occupational VSRs* – These VSRs are people working or in education in the area, who view the proposed Project from their workplace or education centre. Visual amenity is in general not considered a top priority within the average workplace and these VSRs are considered to be relatively less sensitive than residential VSRs as their view will have a less important, although still material, effect on their perception of quality of life. The degree to which this applies to workers depends on whether their location is industrial, retail or commercial. The VSRs in industrial areas, such as factories, are generally considered to be the least sensitive, due to the relatively low quality of their existing view in an industrial area.

  - *Recreational VSRs* – These VSRs are people engaging in recreational activities such as hikers on established trails and footpaths, recreational fishers near the coast and outlying islands. Sensitivity of these VSRs depends on duration of stay, nature of the activity and how enclosed the location is.

  - *Travelling VSRs* – These VSRs are people travelling on marine vessels. They have varying sensitivity depending on the speed, nature and frequency of travel, but are generally considered to be transitory to the area with less regard for the surrounding views and with low sensitivity.

- Number of individuals (ranked as very many, many, few or very few);
- Quality of existing view (ranked as good, fair or poor);
- Availability of alternative views (ranked as yes or no);
- Degree of visibility (ranked as full, partial or glimpse);
- Duration of view (ranked as long, medium or short); and
- Frequency of view (ranked as frequent, occasional or rare).

The sensitivity of each VSR is based on the values of all the above factors in totality and classified as follows:

- **High:** The VSR is highly sensitive to any change in their viewing experience.
- **Medium:** The VSR is moderately sensitive to any change in their viewing experience.
- **Low:** The VSR is only slightly sensitive to any change in their viewing experience.

7.4.4 Identification and Assessment of Impacts

The magnitude of change caused by a visual impact is quantified according to a number of factors including the following:

- Distance between the closest source of impact and the VSR (given in meters);
- Scale of the development. This is assessed using a number of factors, including: absolute dimensions of new built structures visible to the VSR; relative dimensions of the new built structures compared to other structures visible to the VSRs in their existing view (ranked as small, medium or large);

- Potential blockage of view (ranked as full, partial or nil);
- Duration of the impacts (ranked as temporary or permanent);
- Compatibility of the Project and associated works with the existing and planned landscape in the vicinity (ranked as good, fair or poor); and
- Reversibility of change (ranked as reversible or irreversible).

The magnitude of change caused by visual impacts on each VSR is based on the values of all the above factors in totality and classified as follows:

- **Large**: VSRs would suffer a major change in their viewing experience.
- **Intermediate:** VSRs would suffer a moderate change in their viewing experience.
- **Small**: VSRs would suffer a small change in their viewing experience.
- **Negligible:** VSRs would suffer no discernible change in their viewing experience.

7.4.5 Ranking Significance of Impact

By understanding the magnitude of change caused by the various impacts and the sensitivity of the various sensitive receivers, it is possible to categorize impacts in a logical, well-reasoned and consistent fashion*.* ***Table 7.1*** shows the rationale for dividing the degree of significance into four thresholds, namely insignificant, slight, moderate, and substantial, depending on the combination of a magnitude of change and sensitivity of sensitive receiver.

Table 7.1 Relationship between receptor sensitivity and magnitude of change in defining impact significance

		Magnitude of Change			
		Negligible	**Small**	**Intermediate**	**Large**
Receptor Sensitivity (VSR)	**Low**	Insignificant	Slight	Slight / Moderate*	Moderate
	Medium	Insignificant	Slight / Moderate*	Moderate	Moderate / Substantial*
	High	Insignificant	Moderate	Moderate / Substantial*	Substantial

** In those instances where the lower level of impact is predicted, this will be justified in the description of the impact*

The four thresholds for the degree of significance are explained below. Noting impacts can be either adverse or beneficial, it should be noted that any impacts described in the text of the Report are assumed to be adverse unless specifically identified otherwise.

- **Substantial**: Adverse / beneficial impact where the proposed Project will cause significant deterioration or improvement in existing landscape quality.
- **Moderate**: Adverse / beneficial impact where the proposed Project will cause a noticeable deterioration or improvement in existing landscape quality.
- **Slight**: Adverse / beneficial impact where the proposed Project will cause barely perceptible deterioration or improvement in existing landscape quality.
- **Insignificant:** No discernible change in the existing landscape quality

7.4.6 Mitigation Measures

Having identified and ranked the significance of potential impacts, measures, if required, will be proposed to mitigate the impacts. Firstly, means by which impacts can be avoided will be considered, then possible means that might reduce the impact magnitude, and also measures that potentially enhance existing visual quality. To ensure their effectiveness throughout the construction and operation phases of the Project and associated works, the relevant responsible parties for the implementation and management / maintenance of the proposed mitigation measures will be identified as appropriate.

As outlined in ***Section 7.1***, the photomontages will illustrate options of design schemes as well as mitigation measures by showing baseline conditions, Day 1 with no mitigation measures, Day 1 with mitigation measures and Year 10 with mitigation measures.

7.4.7 Acceptability of Visual Impacts

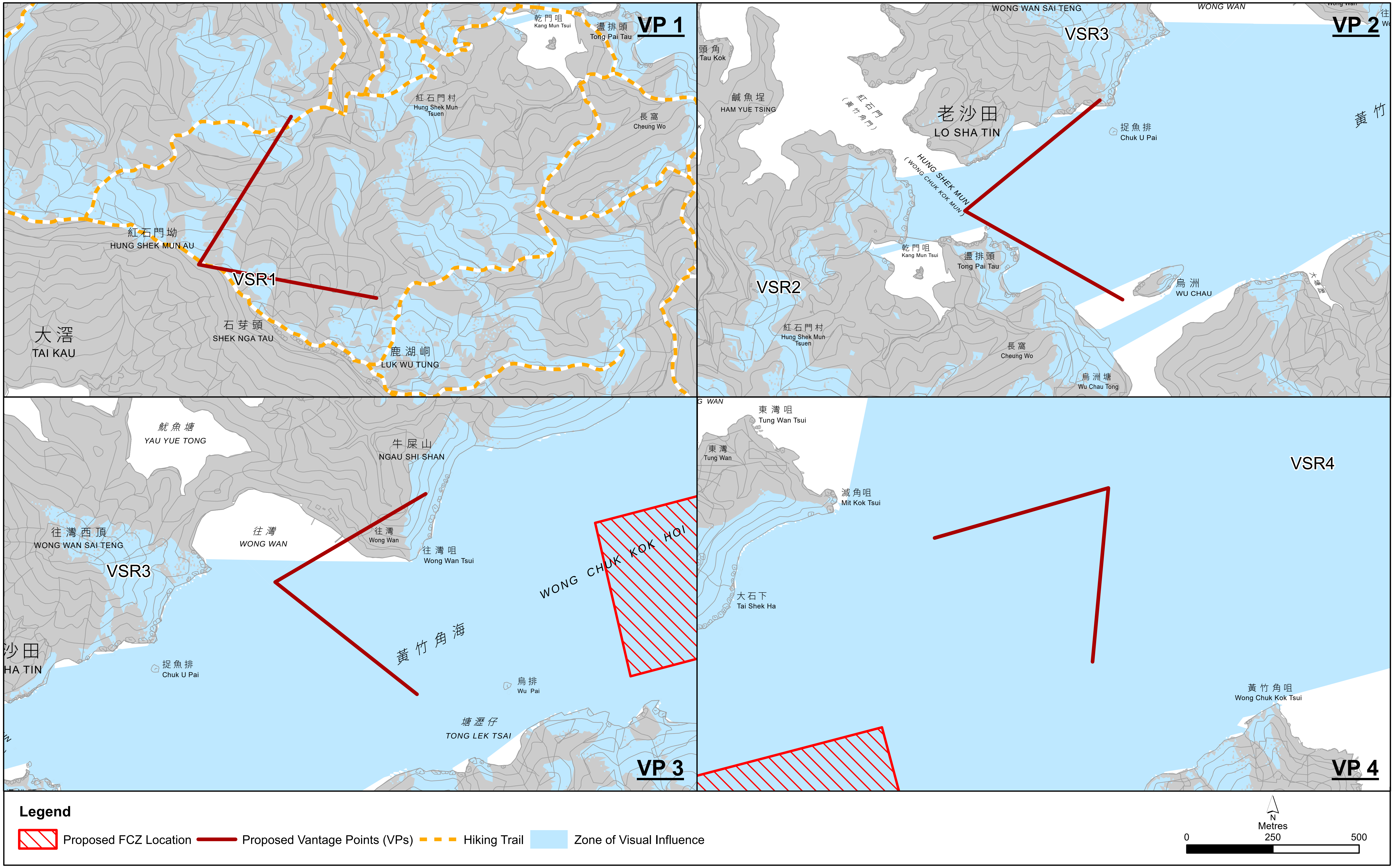
An overall assessment of the acceptability, or otherwise, of visual impacts in accordance with the five criteria set out in Annex 10 of the *EIAO-TM* will be provided, considering the guidelines in paragraph 3.11 of Environmental Impact Assessment Ordinance *GN No. 8/2010*.

7.5 Visual Baseline Conditions

As detailed in ***Figure 7.1***, ***Figure 7.3*** and ***Figure 7.4***, the indicative location of the Project site is about 2 km northeast of Plover Cove Country Park and 1.8 km southeast of Yan Chau Tong Marine Park. The Project is located in a relatively open sea area with high degree of visibility to a large area from a visual perspective.

The Project site will be visible to east facing coastline of Wong Chuk Kok Hoi, north facing coastline on Wong Wan Chau and elevated areas of Plover Cove Country Park. Visitors and hikers at Plover Cove Country Park, Yan Chau Tong Marine Park, and Wong Chuk Kok Hoi, and marine seafarers such as ferry passengers and fishermen, will have view to the Project site **(Figure 7.1**).

Overall, the VSRs have been identified within the predicted Visual Envelope, including three types as identified in the methodology: recreational, occupational and travelling. The VSRs include receivers at ground level, sea level and on elevated ground. The quality of most existing views for these VSRs affected by the FCZ, are generally good, respectively, with a high degree of visibility to natural views containing limited or no anthropogenic structures. The details of VSRs are summarised in ***Table 7.2*** which includes their sensitivity.



ERM

Figure 7.3

Detailed Locations of Vantage Points (VP1 to VP4) and Identified Zone of Visual Influence for Proposed Wong Chuk Kok Hoi FCZ

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_VP_Zoom-in_Wong_Chuk_Kok_Hoi_v2.mxd
Date: 25/11/2021

Legend

Proposed FCZ Location — Proposed Vantage Points (VPs) — Hiking Trail

N

Metres

0 250 500

ERM

Figure 7.4

Aerial View of Detailed Locations of Vantage Points (VP1 to VP4) for Proposed Wong Chuk Kok Hoi FCZ

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_VP_Zoom-in_Wong_Chuk_Kok_Hoi_Aerial.mxd
Date: 25/11/2021

Table 7.2 VSRs within the Predicted Visual Envelope

VSR ID / Representative VP	Representative VP	VSR Type	Distance with the FCZ (m)	Quality of Existing View	Alternative Views	Receiver Population	Duration of View	Frequency of View	Degree of Visibility	Sensitivity
VSR 1 – Hikers / recreational viewers from elevated areas of Plover Cove Country Park / Tolo Channel (Northern Coast SSSI)	VP1	Recreational	3,140	Good	Yes	Few	Short	Occasional	Full	Medium
VSR 2 – Visitors at Yan Chau Tong Marine Park and Hung Shek Mun	VP2	Recreational	1,810	Good	Yes	Few	Short	Occasional	Full	Medium
VSR 3a – Fishermen working / travelling to Wong Wan FCZ	VP3	Occupational	944	Good	Yes	Few	Long	Frequent	Full	Medium
VSR 3b – Users of Outward Bound Hong Kong		Recreational					Short	Occasional	Full	Medium
VSR 4 – Visitors / Seafarers at Wong Chuk Kok Hoi and travelling to Northeastern waters in Hong Kong	VP4	Traveling	955	Good	Yes	Few	Short	Occasional	Full	Medium

7.6 Selected VPs to Represent VSRs

As shown in ***Figure 7.1***, computer modelling suggests sections of coastal areas near Plover Cove Country Park, Double Island fall within the visible area for the Project site. Broad VSR areas and specific locations of VPs are illustrated in ***Figure 7.1*** and ***7.3***. It should be noted that Double Island to the north of the Project site is not accessible by public transport and there is no dedicated hiking trail on Double Island. Therefore, there is no additional viewpoint identified to the north of the Project site. In addition, the immediate southern part of the Project site is Plover Cove Country Park, which is represented by VSR1 (i.e. hikers / recreational visitors from elevated areas of Plover Cove Country Park / Tolo Channel). Therefore, there is no additional viewpoint identified to the south of the Project site.

Generally VPs have been selected to represent the most affected VSRs and a total of 4 nos. of VPs have been selected from which to develop photomontages. ***Figure 7.1*** and ***7.3*** show the suggested VP locations and their corresponding details are provided below. ***Figure 7.4*** shows the aerial photos of the suggested VP locations. ***Figure 7.5a&b – 7.8a&b*** show the existing conditions of VP1 – VP4.

<u>VPs selected to represent VSRs of the proposed Wong Chuk Kok Hoi FCZ</u>

Views from Marine Park, Country Park and Scenic Lookouts

VP1 – Viewpoint along Plover Cove Country Park Trail. VP1 is selected to represent hikers from elevated areas of Plover Cove Country Park. The selected VP is located at one of the popular hiking trails in Wong Chuk Kok Hoi that provides a panoramic view of the bay including the location of the proposed Wong Chuk Kok Hoi FCZ. It is located approximately 3,140 m southwest of the Project site. ***Table 7.2*** shows the value and quality of view of the sea from this VP is considered to be good. This VSR has alternative views to the sea. The number of VSRs is few due to the limited number of hikers visiting the country park. The duration and frequency of view is short and occasional as this VSR only spends a limited amount of time along the trail during holidays. This VSR has a full degree of visibility with a high altitude. Therefore, VSR 1 is considered to have medium sensitivity.

VP2 - Yan Chau Tong Marine Park and Hung Shek Mun. VP2 is located within the Yan Chau Tong Marine Park and in the vicinity of Hung Shek Mun. This VP is selected to represent visitors that will travel within the marine park and near the Hung Shek Mun coastline dominated by red sedimentary rocks. It is located approximately 1,810 m west of the Project site. ***Table 7.2*** shows the value and quality of view of the sea from this VP is considered to be good. This VSR has alternative views to the sea. The number of VSRs is few due to the limited number of tourists visiting Yan Chau Tong Marine Park and Hung Shek Mun. The duration and frequency of view is short and occasional as this VSR only spends a limited amount of time along the trail during holidays. This VSR has a full degree of visibility. Therefore, VSR 2 is considered to have medium sensitivity.

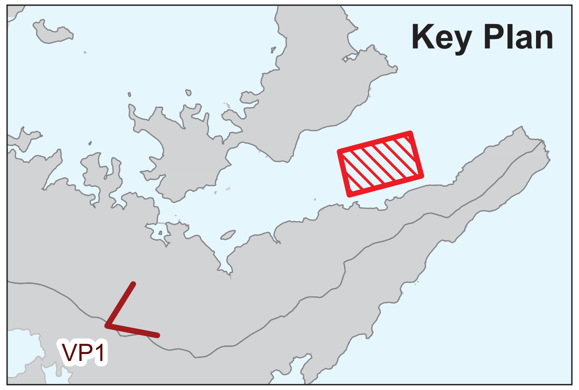
Views from Other FCZ and Marine Waters

VP3 – Wong Wan FCZ and areas in vicinity. VP3 is selected to represent fishermen travelling to or working at the Wong Wan FCZ (VSR 3a) and users of Outward Bound Hong Kong (VSR 3b). Water sports, such as kayaking are common at waters around Outward Bound Hong Kong and the nearby coastal area. It is located approximately 944 m west of the Project site. ***Table 7.2*** shows the value and quality of view of the sea from this VP is considered to be good. Both VSRs have alternative views to the sea. The number of both VSRs is few due to the limited number of fishermen travelling to or working at the Wong Wan, and users of Outward Bound Hong Kong. Both VSR have a full degree of visibility. For fishermen travelling to or working at the Wong Wan FCZ (VSR 3a), although they have long and frequent view of the Project, they are occupational VSR, who would mainly focus much on work, hence having medium sensitivity. For users of Outward Bound Hong Kong (VSR 3b), although they have short and occasional view of the Project, they are recreational VSR, who aim to enjoy the view, hence having medium sensitivity.

VP4 – Wong Chuk Kok Hoi Waters. VP4 is selected to represent viewers on the sea (e.g. recreational vessels, fishermen) travelling between Wong Chuk Kok Hoi and Hung Shek Mun, and

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.

Date Photograph Taken: November 2021



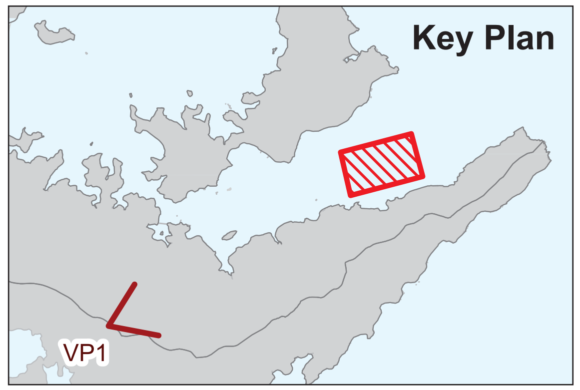
ERM

Figure 7.5a **Wong Chuk Kok Hoi Viewpoint 1 - View to Project Site from Plover Cove Country Park Trail**

FILE: 0549925_WCKH-VP1_v2.cdr DATE: 07/07/2022

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.

Date Photograph Taken: November 2021



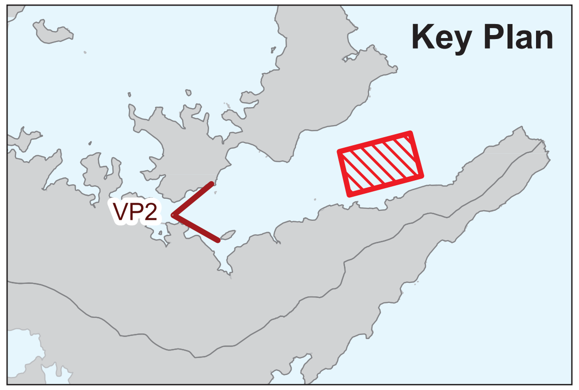
ERM

Figure 7.5b **Wong Chuk Kok Hoi Viewpoint 1 - View to Project Site from Plover Cove Country Park Trail**

FILE: 0549925_WCKH-VP1_v2.cdr DATE: 07/07/2022

Date Photograph Taken: October 2021

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.



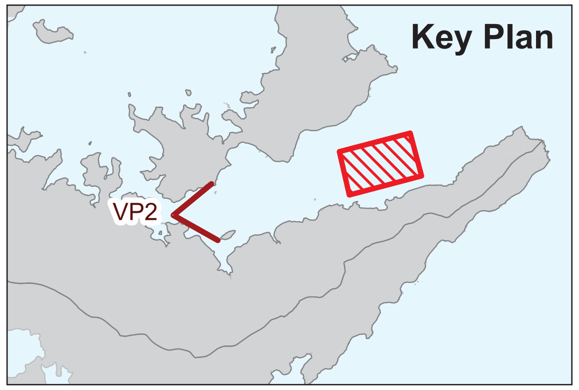
ERM

Figure 7.6a Wong Chuk Kok Hoi Viewpoint 2 - View to Project Site from Hung Shek Mun Coastline

FILE: 0549925_WCKH-VP2_v2.cdr DATE: 07/07/2022

Date Photograph Taken: October 2021

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.



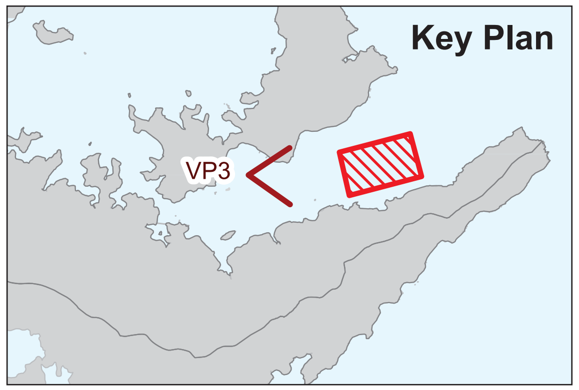
ERM

Figure 7.6b **Wong Chuk Kok Hoi Viewpoint 2 - View to Project Site from Hung Shek Mun Coastline**

FILE: 0549925_WCKH-VP2_v2.cdr DATE: 07/07/2022

Date Photograph Taken: October 2021

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.



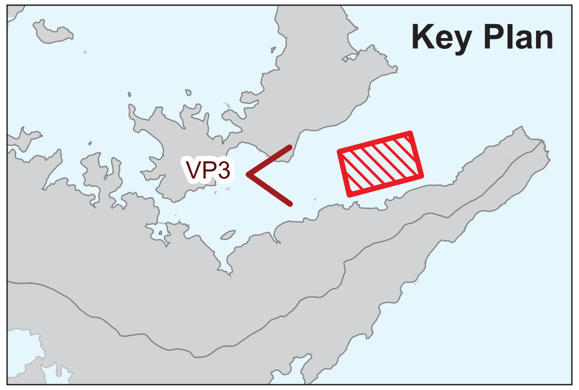
ERM

Figure 7.7a Wong Chuk Kok Hoi Viewpoint 3 - View to Project Site from Wong Wan Chau Fish Culture Zone

FILE: 0549925_WCKH-VP3_v2.cdr DATE: 07/07/2022

Date Photograph Taken: October 2021

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.



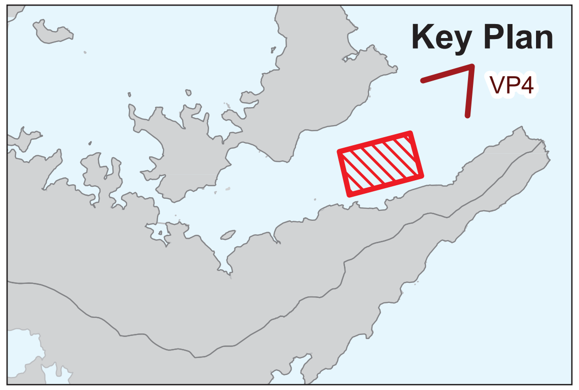
ERM

Figure 7.7b **Wong Chuk Kok Hoi Viewpoint 3 - View to Project Site from Wong Wan Chau Fish Culture Zone**

FILE: 0549925_WCKH-VP3_v2.cdr DATE: 07/07/2022

Date Photograph Taken: October 2021

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.



ERM

Figure 7.8a Wong Chuk Kok Hoi Viewpoint 4 - View to Project Site from Wong Chuk Kok Hoi Waters

FILE: 0549925_WCKH-VP4_v2.cdr DATE: 07/07/2022

Date Photograph Taken: October 2021

Remark: The structures on the sea within the Fish Culture Zone Area are fish cages (circular objects) / rafts (rectangular objects) / steel truss cage (yellow and white rectangular object) for illustration purpose only.

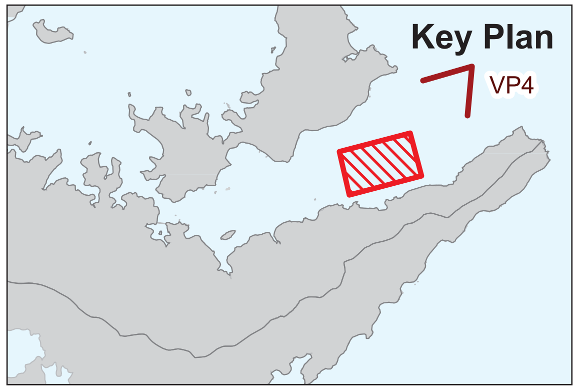


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Figure 7.8b **Wong Chuk Kok Hoi Viewpoint 4 - View to Project Site from Wong Chuk Kok Hoi Waters**

FILE: 0549925_WCKH-VP4_v2.cdr DATE: 07/07/2022

when visiting the Yan Chau Tong Marine Park. It is located approximately 955 m northeast of the Project site. ***Table 7.2*** shows the value and quality of view of the sea from this VP is considered to be good. This VSR has alternative views to the sea. The number of VSRs is few due to the limited number of visitors and seafarers at Wong Chuk Kok Hoi and travelling to Northeastern. The duration and frequency of view is short and occasional. This VSR has a full degree of visibility. Therefore, VSR 4 is considered to have medium sensitivity.

7.7 Identification of Impacts

Section 2 provides an overview of the Project. The key components which may cause visual impacts are listed below. Construction visual impacts are expected to be minimal and may be caused by:

- Setup of fish rafts / cages, which includes: on-site assembly and anchoring of the fish rafts/ cages, small number of marine vessels will be used as supporting vessels; and
- Provision of auxiliary facilities, such as storage and shelters for fish farmers.

Operational visual impacts are expected to be minimal and arise from:

- The presence and operation of the FCZ, including night time lighting for the sake of safety purpose.

The construction of the Project site, including towing the fish rafts / cages to the Site, assembly and anchoring of the fish rafts / cages and provision of auxiliary facilities would normally take a few weeks for each fish raft.

During operation phase, as mentioned in ***Section 2.6.2***, four types of advanced aquaculture technologies, i.e. floating gravity cage; submersible gravity cage; integrated multi-trophic aquaculture; and semi-submersible steel truss cage, are considered suitable for this Project. Since the materials adopted in the fish rafts / cages are durable compared to traditional cages, the operation of the fish rafts / cages in the Project site based on advanced aquaculture technologies would be more than 10 years without major repair.

7.8 Visual Impact Assessment Prior to Mitigation

As illustrated in ***Figures 7.1, 7.3 and 7.4***, the predicted Visual Envelope for the Project is relatively large and the VSR groups have been identified. Four representative VPs have been selected to represent these VSRs.

Photomontages have been prepared from the VPs to illustrate the existing conditions, as well as conceptual visual impacts, for all of: impacts at Day 1 of operation without implementation of mitigation / enhancement measures; impacts at Day 1 of operation with implementation of mitigation / enhancement measures and residual impacts at Year 10 of operation with implementation of mitigation / enhancement measures. The photomontages supplement the visual changes described in the text. Photomontages showing the presence of the FCZ help illustrate that the magnitude of visual change for all VSRs are negligible to intermediate. Those VSRs that are closer to the FCZ are expected to experience relatively higher magnitude of change. It should be noted that detailed information on the type of advanced aquaculture technologies as well as the number, size and separation distance of the fish rafts / cages is not available at the current stage. Such information will only be available during the later detailed design stage, subject to the mariculturists' proposals on the type of advanced technologies to suit their business need for agreement with AFCD. The photomontages are thus prepared for illustration purpose only.

7.8.1 VSR 1 – Hikers / Recreational Viewers from Elevated Areas of Plover Cove Country Park / Tolo Channel (Northern Coast SSSI) (VP1)

The construction of the Project will take a few weeks for each fish raft. Despite the considerable distance to the Project (3,140 m), since the viewpoint is at a high altitude, the construction activities will be noticeable, and the magnitude of change is considered small. The resulting significance during construction is considered slight.

The photomontage in ***Figure 7.5a&b*** shows the Project site from this viewpoint. Since the FCZ facilities will not be higher than 3 m in height above water (except during maintenance), only the upper part of the fish rafts / cages would be exposed above the water, they would only block part of the view, and the scale of development is small. As the fish rafts / cages will be noticeable on the open water, they have fair compatibility with the surrounding seascape. The duration of impact is temporary during construction phase and permanent during operation phase; and the impact is reversible for both phases. Despite the considerable distance to the Project (3,140 m), since the viewpoint is at a high altitude, the magnitude of change is considered small. The resulting significance during operation is considered slight.

7.8.2 VSR 2 – Visitors at Yan Chau Tong Marine Park and Hung Shek Mun (VP2)

The construction of the Project will take a few weeks for each fish raft. Due to the considerable distance (1,810 m) to the Project, the construction activities will not be noticeable, and the magnitude of change is considered negligible. The resulting significance during construction is considered insignificant.

The photomontage in ***Figure 7.6a&b*** shows the Project site from this viewpoint. Since the FCZ facilities will not be higher than 3 m in height above water (except during maintenance), only the upper part of the fish rafts / cages would be exposed above the water, and the scale of development is small. As the fish rafts / cages will be noticeable on the open water, they have fair compatibility with the surrounding seascape. The duration of impact is temporary during construction phase and permanent during operation phase; and the impact is reversible for both phases. Given there is a considerable distance to the Project (1,810 m), the viewpoint is horizontal to WCKH, and the FCZ facilities' above water heights are limited to 3 m (except during maintenance), the magnitude of change is considered negligible. The resulting significance during operation is considered insignificant.

7.8.3 VSR 3a and VSR 3b – Fishermen Working / Travelling to Wong Wan FCZ and Users of Outward Bound Hong Kong (VP3)

The construction of the Project will take a few weeks for each fish raft. Despite the short distance (944 m) to the Project, since the viewpoint is horizontal to WCKH and the construction activities will not be noticeable, and the magnitude of change is considered negligible. For fishermen working / travelling to Wong Wan FCZ (VSR 3a), although they have long and frequent view of the Project, they are occupational VSR, who would mainly focus much on work, hence having medium sensitivity. For users of Outward Bound Hong Kong (VSR 3b), although they have short and occasional view of the Project, they are recreational VSR, who aim to enjoy the view, hence having medium sensitivity. Therefore, the resulting significance during construction is considered insignificant for both VSRs.

The photomontage in ***Figure 7.7a&b*** shows the Project site from this viewpoint. Since the FCZ facilities above water will not be higher than 3 m in height (except during maintenance), only the upper part of the fish rafts / cages would be exposed above the water, and the scale of development is small. As the fish rafts / cages will be noticeable on the open water, they have fair compatibility with the surrounding seascape. The duration of impact is temporary during construction phase and permanent during operation phase; and the impact is reversible for both phases. Despite the short distance to the Project (944 m), since the viewpoint is horizontal to WCKH, and the FCZ facilities' above water heights are limited to 3 m (except during maintenance), the magnitude of change is considered negligible. As suggested in the previous section, fishermen working / travelling to Wong Wan FCZ and users of Outward Bound Hong Kong are considered to have medium sensitivity. Therefore, the resulting significance during operation is considered insignificant for both VSRs.

7.8.4 VSR 4 – Visitors / Seafarers at Wong Chuk Kok Hoi and travelling to Northeastern waters in Hong Kong (VP4)

The construction of the Project will take a few weeks for each fish raft. However, due to the short distance (955 m) to the Project, the construction activities will be noticeable, and the magnitude of change is considered small. The resulting significance during construction is considered slight.

The photomontage in ***Figure 7.8a&b*** shows the Project site from this viewpoint. Since the FCZ facilities will not be higher than 3 m in height above water (except during maintenance), only the upper part of the fish rafts / cages would be exposed above the water, they would only block part of the view, and the scale of development is small. As the fish rafts / cages will be noticeable on the open water, they have fair compatibility with the surrounding seascape. The duration of impact is temporary during construction phase and permanent during operation phase; and the impact is reversible for both phases. Due to the short distance to the Project (955 m), the magnitude of change is considered slight. The resulting significance during operation is considered small.

Table 7.3 details magnitude of change expected for each VSR. Based on the magnitude of change and the baseline sensitivities given to each VSR, a summary of the visual impacts prior to mitigation is provided in ***Table 7.4*** and impacts are considered to be adverse and acceptable unless stated otherwise.

Table 7.3 Magnitude of Change

VSR ID / Representative VP	Representative VP	Distance with the FCZ (m)	Blockage of View (Full / Partial / Nil)	Scale of Development (Large / Medium / Small)	Compatibility with Surrounding Seascape (Good / Fair / Poor)	Duration of Impact (Temporary / Permanent)	Reversibility of Impact (Reversible / Irreversible)	Magnitude of Change (Large / Intermediate / Small / Negligible)	
								Construction	Operation
VSR 1 – Hikers / recreational viewers from elevated areas of Plover Cove Country Park / Tolo Channel (Northern Coast SSSI)	VP1	3,140	Partial	Small	Fair	Construction phase: Temporary; Operation phase: Permanent	Reversible for both construction and operation phases	Small	Small
VSR 2 – Visitors at Yan Chau Tong Marine Park and Hung Shek Mun	VP2	1,810	Partial	Small	Fair	Construction phase: Temporary; Operation phase: Permanent	Reversible for both construction and operation phases	Negligible	Negligible
VSR 3a – Fishermen working / travelling to Wong Wan Chau FCZ VSR 3b – Users of Outward Bound Hong Kong	VP3	944	Partial	Small	Fair	Construction phase: Temporary; Operation phase: Permanent	Reversible for both construction and operation phases	Negligible	Negligible
VSR 4 – Visitors / Seafarers at Wong Chuk Kok Hoi and travelling to Northeastern waters in Hong Kong	VP4	955	Partial	Small	Fair	Construction phase: Temporary; Operation phase: Permanent	Reversible for both construction and operation phases	Small	Small

Table 7.4 Visual Impacts Prior to Mitigation

VSR ID / Representative VP	Representative VP	VSR Sensitivity	Magnitude of Change (Large / Intermediate / Small / Negligible)		Impact Significance threshold BEFORE Mitigation (Substantial/ Moderate/ Slight/ Insignificant)	
			Construction	Operation	Construction	Operation
VSR 1 – Hikers / recreational viewers from elevated areas of Plover Cove Country Park / Tolo Channel (Northern Coast SSSI)	VP1	Medium	Small	Small	Slight	Slight
VSR 2 – Visitors at Yan Chau Tong Marine Park and Hung Shek Mun	VP2	Medium	Negligible	Negligible	Insignificant	Insignificant
VSR 3a – Fishermen working / travelling to Wong Wan FCZ	VP3	Medium	Negligible	Negligible	Insignificant	Insignificant
VSR 3b – Users of Outward Bound Hong Kong		Medium	Negligible	Negligible	Insignificant	Insignificant
VSR 4 – Visitors / Seafarers at Wong Chuk Kok Hoi and travelling to Northeastern waters in Hong Kong	VP4	Medium	Small	Small	Slight	Slight

7.8.5 Night Lighting and Glare

The above analysis examined the visual impacts of the Project during daylight hours. Night-lighting will be used for safety purpose in this Project. Detailed night lighting specifications are not available at this preliminary design stage, however, a preliminary assessment can be made based on similar developments. It is assumed that the light sources will generally be of low intensity, the orientation of light will point towards to the fish rafts / cages, and will not be pointing horizontally and to any VSRs. In addition, no mirrors or polished materials will be installed on the fish rafts / cages, reflectance of light will be low. Therefore, the night lighting and glare impact is considered acceptable.

7.9 Suggested Mitigation Measures

The assessment made in ***Section 7.8*** shows that visual impacts arising from the Project without any mitigation or enhancement measures in place are between insignificant to slight. The following mitigation measures are proposed to minimise the visual impacts:

- **VM1 – Construction period**. Pre-construction and construction period for the Project site should be reduced as far as practical to lower visual impact;
- **VM2 – Sensitive design of the fish rafts / cages.** The new structures will be designed in accordance with relevant marine safety standards and regulations. Sensitive architectural design will be considered where practicable. This should take into account material texture, colour, finishes to structures to ensure the fish rafts/ cages blend into the existing context, cause least disturbance to the existing seascape, and are the most visually appealing. Please refer to Figure 7.5b, Figure 7.6b, Figure 7.7b and Figure 7.8b for the implementation of VM2;
- **VM3 – Reinstatement**. After operation, the open water occupied by the Project site will be reinstated to their former state, i.e. the ‘existing view’ (top photo) shown in Figure 7.5a, Figure 7.6a, Figure 7.7a and Figure 7.8a;
- **VM4 – Night-time lighting control**. Light intensity and beam directional angle should be controlled at the Project site at the design stage to reduce light pollution and glare (e.g. hooded lights, specific directional focus, etc.). In addition, lighting will be limited to auxiliary structures to reduce night-time impacts.

Table 7.5 Un-mitigated and Mitigated Impacts at the VSRs

VSR ID / Representative VP	Un-Mitigated Visual Impact		Recommended Mitigation Measure	Mitigated Impact (Substantial/ Moderate/ Slight/ Insignificant)		
	Construction	Operation		Construction	Operation Day 1	Operation Year 10
VSR 1 – Hikers / recreational viewers from elevated areas of Plover Cove Country Park / Tolo Channel (Northern Coast SSSI)	Slight	Slight	VM1-4	Insignificant	Insignificant	Insignificant
VSR 2 – Visitors at Yan Chau Tong Marine Park and Hung Shek Mun	Insignificant	Insignificant	VM1-4	Insignificant	Insignificant	Insignificant
VSR 3a – Fishermen working / travelling to Wong Wan FCZ	Insignificant	Insignificant	VM1-4	Insignificant	Insignificant	Insignificant
VSR 3b – Users of Outward Bound Hong Kong	Insignificant	Insignificant	VM1-4	Insignificant	Insignificant	Insignificant
VSR 4 – Visitors / Seafarers at Wong Chuk Kok Hoi and travelling to Northeastern waters in Hong Kong	Slight	Slight	VM1-4	Insignificant	Insignificant	Insignificant

7.10 Residual Impact Assessment

The assessment made in ***Section 7.7*** shows that visual impacts arising from the Project prior to any mitigation or enhancement measures in place, are between insignificant to slight.

By operation, auxiliary facilities will have been removed. Therefore with sensitive design of the new structures (materials, textures, colours) and careful design of lighting, impacts would further reduce at operation day 1 for the Project site. The new structures are expected to blend in to the seascape and residual visual impacts will be insignificant to VSR 1, VSR 2, VSR 3a, VSR 3b and VSR 4.

No unacceptable residual visual impact is expected.

7.11 Cumulative Impact Assessment

No existing or committed project is identified in the vicinity of the Project site. The Project may have the potential to interact with the proposed establishment of FCZs at Outer Tap Mun and Mirs Bay, subject to the timing of completion of legislative exercise to amend the *Schedule to the Fish Culture Zone (Designation) Order (Cap. 353B)*. Due to its considerable distance with Outer Tap Mun (~3.9 km) and Mirs Bay (~6.3 km), cumulative impacts are not expected from these projects.

7.12 Environmental Monitoring and Audit Requirements

A number of measures to be implemented during design and construction of the Project are recommended in ***Section 7.9***, to further enhance the visual elements associated with the Project. Design measures such as for the design of the new fish rafts / cages are recommended to be integrated into the design and construction stage of the Project as early as possible.

As no tree felling, transplanting or compensatory planting is required for the Project and visual enhancement measures would be provided during the construction phase, therefore no specific EM&A programme is required.

7.13 Conclusion

A visual impact assessment has been undertaken for the Project located at Wong Chuk Kok Hoi. The VSRs were identified and assessed based on their sensitivity and magnitude of change. Four visual mitigation measures are proposed to minimise the visual impacts. Given the sensitive design of the new structures, small scale of development and good compatibility with the surrounding seascape of the structures, residual visual impacts of the Project will be subsequently considered insignificant. No unacceptable residual visual impact is expected.

Cumulative visual impacts are not anticipated to be additional to the visual impacts of proposed establishment of FCZs at Outer Tap Mun and Mirs Bay.

According to Annex 10 of the *Technical Memorandum on the Environmental Impact Assessment* Process (*EIAO-TM*) the visual impacts are considered acceptable with mitigation measures.

8. NOISE

8.1 Introduction

This ***Section*** provides an evaluation of the potential noise impacts associated with the construction and operation of the Project, including the associated works and marine activities.

8.2 Legislative Requirements and Evaluation Criteria

8.2.1 Construction Phase

The principal legislation relating to the control of construction noise due to the Project is the *EIAO*. The *EIAO-TM*, issued under the *EIAO*, provides guidelines and noise criteria for evaluating noise impacts. The assessment criteria are defined in *Annex 5* of the *EIAO-TM* with reference made to *Annex 13* of the *EIAO-TM* for the guidelines of noise assessment.

The *Noise Control Ordinance (NCO)* (*Cap. 400)* also provides statutory controls on general construction works during restricted hours (i.e. 1900 – 0700 hours Monday to Saturday and at any time on Sundays and public holidays). A number of Technical Memoranda (TMs) have been issued under the *NCO* to stipulate control approaches and criteria. The *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (*GW-TM*), which provides the guidelines for controlling the construction noise from the use of powered mechanical equipment (PME) at the construction work sites, details the procedures that should be adopted for the assessment of noise from construction work other than percussive piling, the issuing of Construction Noise Permits (CNP), and for determining whether or not any such CNP is being complied with.

8.2.1.1 General Construction Works during Non-Restricted Hours

Under the *EIAO*, potential noise impact arising from general construction works during non-restricted hours (i.e. 0700 to 1900 hours on any day not being a Sunday or public holiday) at noise sensitive uses that rely on opened windows for ventilation, should be assessed in accordance with the noise criteria specified in the *EIAO-TM*. The *EIAO-TM* noise standards are presented in ***Table 8.1***.

Table 8.1 EIAO-TM Daytime Construction Noise Standards ($L_{eq(30min)}$ dB(A))

Uses	Noise Standards (dB(A))
Domestic Premises	75
Educational Institutions	70
Educational Institutions (during examination periods)	65

Notes:
(a) The above standards apply to uses which rely on opened windows for ventilation.
(b) The above standards shall be viewed as the maximum permissible noise levels assessed at 1m from the external façade.

8.2.1.2 Construction Works during Restricted Hours

When assessing a CNP application for the use of PME during the restricted hours (i.e. 1900 to 0700 hours of the next day and any time on Sundays and public holidays), the Noise Control Authority will compare the Acceptable Noise Levels (ANLs), as promulgated in *GW-TM*, and the Corrected Noise Levels (CNLs) (i.e. after accounting for factors such as barrier effects and reflections) associated with the proposed PME operations. The ANLs are related to the noise sensitivity of the area in question and different Area Sensitivity Ratings (ASRs) have been established to reflect the background characteristics of different areas. The appropriate ASR for the noise sensitive receiver (NSR) is determined with reference to ***Table 8.2***.

Table 8.2 Area Sensitivity Ratings (ASRs)

Types of Area Containing NSR	Degree to which NSR is affected by Influencing Factor (IF)		
	Not Affected	Indirectly Affected	Directly Affected
Rural area, including Country Parks or village type developments	A	B	B
Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
Urban area	B	C	C
Area other than those above	B	B	C

Notes:

The following definitions apply:

(a) "Country Park" means an area that is designated as a country park pursuant to Section 14 of the *Country Parks Ordinance*;

(b) "Directly affected" means that the NSR is at such a location that noise generated by the IF is readily noticeable at the NSR and is a dominant feature of the noise climate of the NSR;

(c) "Indirectly affected" means that the NSR is at such a location that noise generated by the IF, whilst noticeable at the NSR, is not a dominant feature of the noise climate of the NSR;

(d) "Not affected" means that the NSR is at such a location that noise generated by the IF is not noticeable at the NSR; and

(e) "Urban area" means an area of high density, diverse development including a mixture of such elements as industrial activities, major trade or commercial activities and residential premises.

The relevant ANLs are shown in ***Table 8.3.***

Table 8.3 Acceptable Noise Levels of General Construction Works

Time period	$L_{Aeq\ 5min}$ (dB(A))		
	ASR "A"	ASR "B"	ASR "C"
All days during the evening (i.e. 1900-2300 hours) and general holidays (including Sundays) during the day and evening (i.e. 0700-2300 hours)	60	65	70
All days during the night-time (i.e. 2300-0700 hours of the next day)	45	50	55

The Noise Control Authority will consider a well-justified CNP application, for construction works within restricted hours as guided by the relevant TMs issued under the NCO. The Noise Control Authority will take into account the adjoining land uses and any previous complaints against construction activities at the site before making a decision. Nothing in this EIA Report shall bind the Noise Control Authority in making its decision. The Noise Control Authority may include any conditions in a CNP that it considers appropriate. Failure to comply with any such conditions may lead to cancellation of the CNP and prosecution action under the NCO.

8.2.2 Operation Phase

The *EIAO-TM* and the Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places or Construction Sites (IND-TM) issued under the NCO specify the applicable ANLs for the operation of Project. The ANLs are dependent on the Area Sensitivity Rating (ASR) and the time of the day as presented in ***Table 8.4***. Each NSR is assigned an ASR based on its predominant land use and the presence, if any, of Influencing Factors (IFs) such as nearby industrial areas, major roads or airports.

Table 8.4 Acceptable Noise Levels (ANLs) of Operational Noise

Time Period	$L_{Aeq\ 30min}$ (dB(A))		
	ASR "A"	ASR "B"	ASR "C"
Daytime: 0700-1900 hrs & Evening: 1900-2300 hrs	60	65	70
Night-time: 2300-0700	50	55	60

Fixed plant noise is controlled under Section 13 of the *NCO* and the predictions will be undertaken in accordance with the *IND-TM*. The noise criteria for planning and design of planned fixed noise sources under Designated Projects are set out in the *EIAO-TM* as follows:

- the noise level at the facade of the nearest NSR is at least 5 dB(A) lower than the appropriate ANL (as shown in ***Table 8.4***) as specified in the *IND-TM*; or
- the prevailing background noise level (for quiet areas with a noise level 5 dB(A) below the appropriate ANL).

8.3 Description of the Noise Environment

8.3.1 Assessment Area

In accordance with the requirements given in Section 3.4.8.2 and *Clauses 2.2.1(a)* and *3.2.1(a)* in *Appendix G* of the EIA Study Brief, the Assessment Area for the noise impact assessment should generally cover a distance of 300 m from the boundary of the Project and the works of the Project. The Assessment Area considered in the assessment is shown in ***Figure 8.1***.

8.3.2 Baseline Conditions

The Project site is located about 200 m northeast of Plover Cove Country Park. The Project is located in a relatively open sea area. Background noise at the Project site and the surrounding environment is dominated by the prevailing general background including sea waves.

8.3.3 Noise Sensitive Receivers

The statutory Outline Zoning Plans (OZP) and other relevant development plan available from Lands Department or Town Planning Board have been reviewed with regard to the Assessment Area. There is no existing OZP in the Assessment Area for the Project site. There is no committed and planned NSR identified within the defined Assessment Area. The identified representative NSRs are listed in ***Table 8.5*** and shown in ***Figure 8.1***. Photographs of the representative NSRs are shown in ***Appendix 8A***.

Table 8.5 Identified Representative NSRs

NSR ID	Description	Use	Approximate Distance to nearest Project Site Boundary (m)
N1	Outward Bound Hong Kong – Wong Wan Chau Base	Existing Educational	710
N2	Plover Cove Country Park	Country Park	87 [a]
N3	Plover Cove (Extension) Country Park	Country Park	273 [a]

Note:
(a) The areas of Plover Cove and Plover Cover (Extension) Country Parks within 300 m of the Project are not accessible by any hiking trail due to steep slope. The nearest accessible hiking trail is more than 300 m from the Project.

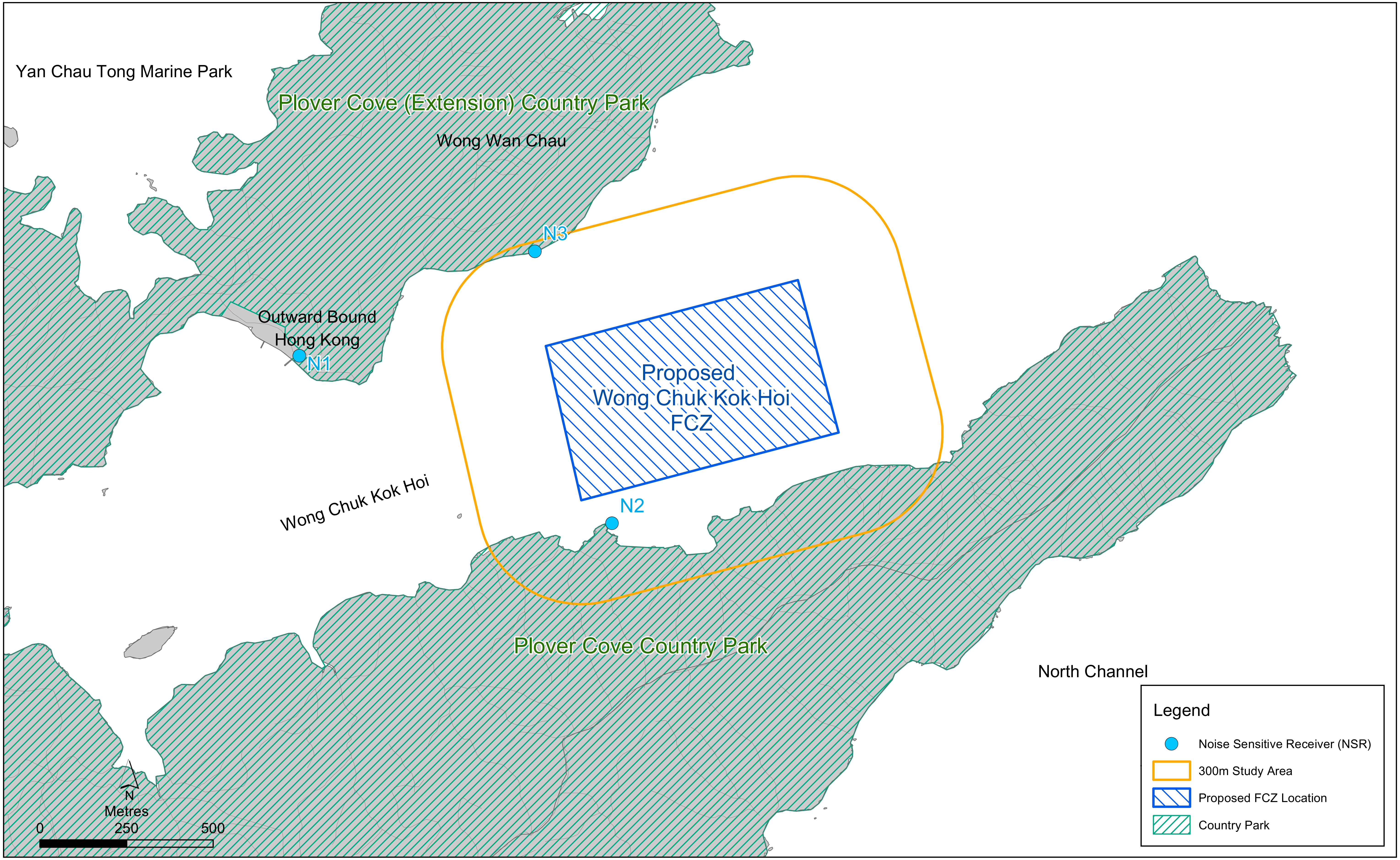

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Figure 8.1

Locations of Noise Sensitive Receivers for Proposed Wong Chuk Kok Hoi FCZ

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8.4 Potential Sources of Impact

8.4.1 Construction Phases

As mentioned in ***Section 2***, the construction of the Project would take a few weeks for the assembly and anchoring of each fish raft. No heavy PME is required and no noisy activities will take place during the construction phase. All construction works will be carried out during non-restricted hours only. The main components of the fish rafts and cages will be manufactured off-site. The construction of the Project site will mainly involve the following:

- Towing of existing fish rafts from other location(s) to the new FCZ using tug boat for a few trips a day and anchoring; and
- Assembly and anchoring of fish rafts by winch;

Small marine vessels such as sampans and speed boats could be present and used as supporting vessels during the construction. Anchoring of marine vessels could be required when positioning the fish raft. The installation of the fish raft mooring system would be conducted by attaching the anchor lines from the fish rafts to anchoring points on the seabed. No dredging works are required during the construction phase. Auxiliary facilities, such as storage and shelters for fish farmers may be installed on some of the fish rafts. Details of the construction plant inventory are presented in ***Appendix 8B***. and it will be subject to further design at later stage.

8.4.2 Operation Phase

Mariculture activities, such as management of fish raft / cages and fish stocks within the Project site will be undertaken during operation phase. Limited numbers of small power generators will be used on fish raft to support the daily mariculture activities. The transportation of fish stock, fish feed, fish raft equipment and workforce as well as occasional visitors will occur with the use of small marine vessels such as sampans and speed boats for a few trips a day. No PA system or loudspeaker will be used on-site during operation of the Project. No maintenance dredging or sediment removal is anticipated during FCZ operation under the Project.

8.5 Evaluation of Impact

8.5.1 Construction Phases

As mentioned in ***Section 8.4.1***, the construction of the Project would take a few weeks for the assembly and anchoring of each fish raft. No heavy PME is required and no noisy activities will take place during the construction phase. The main components of the fish rafts and cages will be manufactured off-site. The construction works are marine-based with limited air-borne noise impact, i.e. installation of the fish raft mooring system and anchoring on the seabed.

NSRs N2 and N3 for Country Parks are identified within the 300 m Assessment Area, however, specific noise limit for Country Parks is not available from the relevant legislation and guidelines, including *EIAO-TM* and *GW-TM*. The Country Parks only consist of limited transient hikers, and the nearest designated campsite is more than 4 km away from the Project Site. NSR N1 is located at least 700 m away from the Project Site. In view of the small scale of the Project with limited numbers of PME required for the construction and noisy activities are not required, adverse noise impact during construction phase is not anticipated.

8.5.2 Operation Phase

As mentioned in ***Table 8.5***, the areas of Plover Cove and Plover Cover (Extension) Country Parks within 300 m of the Project are not accessible by any hiking trail due to steep slope. The nearest accessible hiking trail is more than 300 m from the Project. The Country Parks only consist of limited transient hikers, and the nearest designated campsite is more than 4 km away from the Project Site. There is no specific operation phase noise criteria for Country Parks in the relevant guidelines and

TMs. NSR N1 is located at least 700 m away from the Project Site. With small number of marine vessel trips/day for transportation, limited numbers of small power generators and no noisy operational activities within the Project site, adverse noise impact due to operation of the Project is not anticipated.

8.6 Mitigation Measures and Residual Impacts

In view of no adverse noise impact is anticipated due to the construction and operation of the Project, mitigation measures are therefore not required for both construction and operation phases. Adverse residual impacts are not anticipated.

Although adverse construction noise impact is not expected, *Recommended Pollution Control Clauses for Construction Contracts* issued by EPD will be included in the Contract for future contractor(s) to follow. Good construction site practice and noise management could also be considered to reduce the noise impact from the construction activities as follows:

- Only well-maintained plant will be operated on-site and plant will be serviced regularly during the construction phase;
- Silencers or mufflers on construction equipment will be utilised and will be properly maintained during the construction phase;
- Mobile plant, if any, will be sited as far away from NSRs as possible;
- Machines and plant that may be in intermittent use will be shut down between work periods or will be throttled down to a minimum;
- Plants known to emit noise strongly in one direction will, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and
- Other structures will be effectively utilised, wherever practicable, in screening noise from on-site construction activities.

8.7 Cumulative Impact

No existing or committed project is identified in the vicinity of the Project site. Cumulative impacts are therefore not expected during both construction and operation phases of the Project.

8.8 Environmental Monitoring and Audit

No adverse noise impacts are anticipated during construction and operation of the Project. No environmental monitoring and audit (EM&A) requirements related to noise are considered necessary during both construction and operation phases.

8.9 Conclusion

The areas of Plover Cove and Plover Cove (Extension) Country Parks within 300 m from the Project site are not accessible by any hiking trail due to steep slope. The nearest accessible hiking trail is more than 300 m from the Project. No specific construction noise limit for Country Parks is available from the relevant legislation and guidelines, including *EIAO-TM* and *GW-TM*. The nearest representative NSR is located at more than 700 m from the Project site. In view of the small scale of the Project with limited numbers of marine vessel trips / day and noisy activities are not required, adverse noise impacts associated with the construction and operation of the Project are not anticipated. Mitigation measures are therefore not considered to be required.

9. CULTURAL HERITAGE

9.1 Introduction

This Section presents the cultural heritage impact assessment (CHIA) associated with the construction of the proposed Project. In accordance with Clause 3.4.9 of the EIA Study Brief No. ESB-324/2019, a Marine Archaeological Investigation (MAI) including impact assessment was undertaken by the qualified marine archaeologist (Dr. William Jeffery) and the findings of the MAI are presented herein.

9.2 Legislative Requirements and Evaluation Criteria

The following legislations/standards/guidelines/requirements are applicable to the assessment of archaeological and historic resources in Hong Kong.

- Environmental Impact Assessment Ordinance (Cap. 499) and the associated Technical Memorandum on the EIA Process (*EIAO-TM*);
- Antiquities and Monuments Ordinance (Cap. 53) (AM Ordinance);
- Hong Kong Planning Standards and Guidelines; and
- Requirements for Marine Archaeological Investigation (MAI) (Appendix H of EIA Study Brief).

9.2.1 Environmental Impact Assessment Ordinance (Cap 499)

Annex 10 of the *EIAO-TM* outlines the criteria for assessment of impact on sites of cultural heritage. The general presumption is in favour of the protection and conservation of all sites of cultural heritage. In addition, adverse impacts on sites of cultural heritage shall be kept to the absolute minimum.

Annex 19 of the *EIAO-TM* outlines the approaches required in investigating and assessing the impacts on sites of cultural heritage. There is no quantitative standard in deciding the relative importance of these sites, but in general, sites of unique archaeological, historical or architectural value will be considered as highly significant. Preservation in totality is preferred. If, due to site constraints and other factors, only preservation in part is possible, this must be fully justified with alternative proposals or layout designs, which confirm the impracticability of total preservation.

9.2.2 Antiquities and Monuments Ordinance (Cap 53)

The Antiquities and Monuments Ordinance (Cap. 53) (AM Ordinance) provides statutory protection against the threat of development on Declared Monuments to enable their preservation for posterity. The AM Ordinance also establishes the statutory procedures to be followed in making such a declaration.

Any person who discovers an antiquity, or supposed antiquity, is required to report the discovery to the Antiquities Authority.

9.2.3 Hong Kong Planning Standards and Guidelines (HKPSG)

The Chapter 10, Conservation, of the HKPSG provides general guidelines and measures for the conservation of historical buildings, sites of archaeological interest and other antiquities.

9.2.4 Requirements for Marine Archaeological Investigation (MAI)

Requirements for MAI provided in *Appendix H* of the EIA Study Brief details the standard practice, procedures and methodology which must be undertaken in determining marine archaeological baseline and potential, presence of archaeological artefacts, evaluating the potential impact and establishing suitable mitigation measures.

9.3 Assessment Methodology

9.3.1 Introduction

The CHIA follows the criteria and guidelines in *Annexes 10* and *19* of the *EIAO-TM*. It also follows the Requirements for MAI as stated in Appendix H of the EIA Study Brief. It should be noted that the Project is marine-based and thus potential impacts on built heritage and terrestrial archaeological resources are not anticipated. Findings of the MAI of this Project are presented in the following sections.

9.3.2 Assessment Area

As the construction works of the proposed Wong Chuk Kok Hoi Fish Culture Zone (FCZ) would mainly be the assembly and anchorage of fish rafts / cages that will be carried out by the fish farmers who obtain marine fish culture licences in this new FCZ which is limited to marine area, no built heritage impact assessment and terrestrial archaeological impact assessment will be conducted for the Cultural Heritage Impact Assessment (CHIA). Therefore, the CHIA will only cover the Marine Archaeological Investigation (MAI).

The Assessment Area for the MAI includes an area to be affected by the marine works associated with the anchoring system of fish rafts/cages as shown in the proposed FCZ location in ***Figure 9.1***.

9.3.3 Baseline Review

A baseline review was conducted to collate existing information to identify the archaeological potential and their likely character, extent, quality and value. The baseline review will focus on known sources including:

a) Civil Engineering and Development Department, Geotechnical Engineering Office – The Department holds extensive seabed survey data collected from previous geological research;

b) Marine Department, Hydrographic Office – the Department holds a substantial achieve of hydrographic data and charts;

c) The Royal Naval Hydrographic Department in the UK – the Department maintains an archive of all survey data collected by naval hydrographers;

d) Relevant Government departments such as Antiquities and Monuments Office, Environmental Protection Department etc. to obtain information on dredging history on the proposed FCZ locations; and

e) Internet and libraries sources of relevant studies.

The findings will provide historical records and more detailed geological analysis of submarine features which may have been subsequently masked by more recent sediment deposits and accumulated debris.

9.3.4 Marine Geophysical Survey

A marine geophysical survey of the proposed Wong Chuk Kok Hoi FCZ was conducted with side scan sonar, multi bean and single beam echo sounding and seismic sub-bottom profiling. The data received from the survey were analysed in detail to provide:

- Exact definition of the areas of greatest archaeological potential;
- Assessment of the depth and nature of the seabed sediments to define which areas consist of suitable material to bury and preserve archaeological material;
- Detailed examination of survey records to map anomalies in and on the seabed which may be archaeological material; and

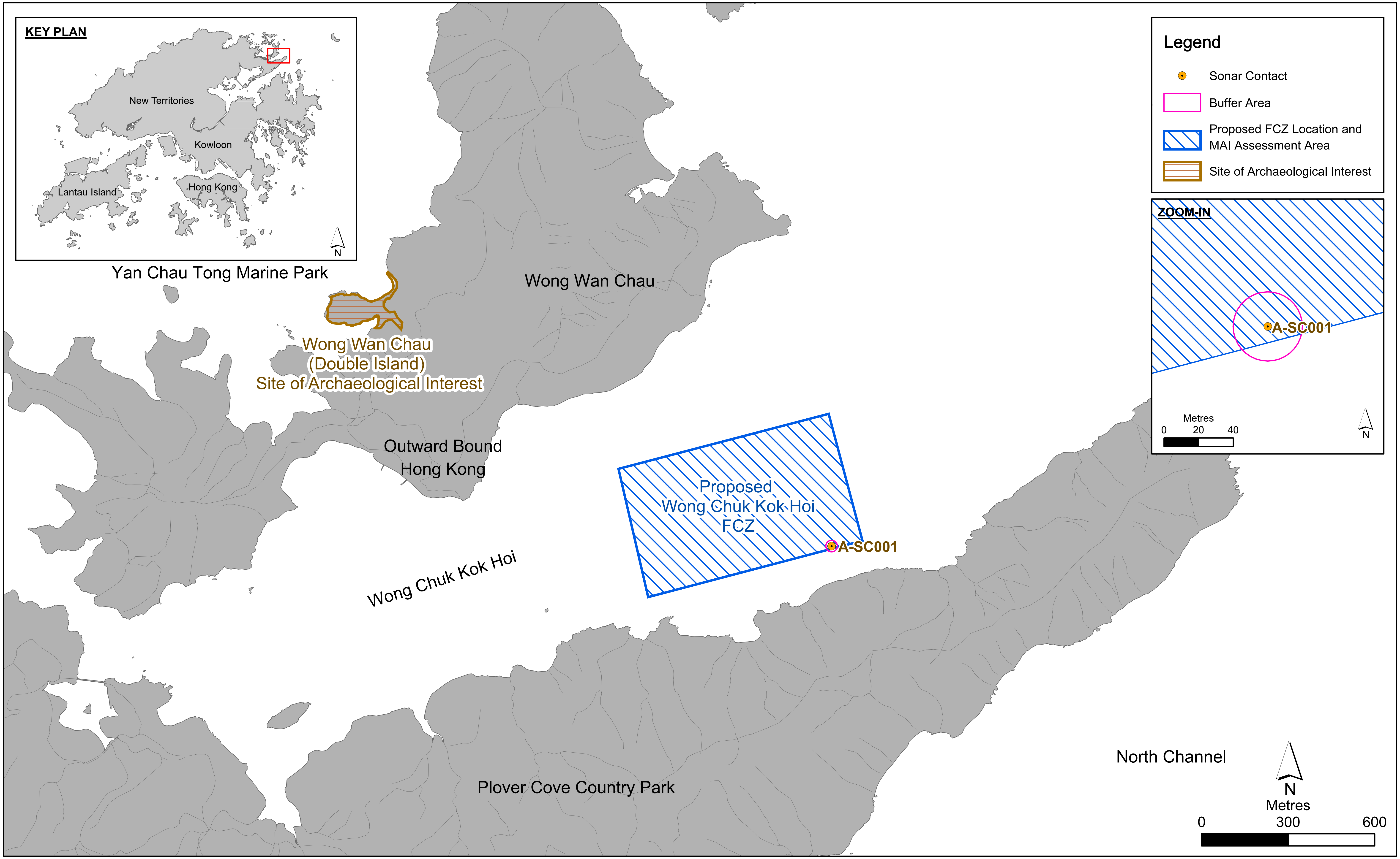

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Figure 9.1

Location of Sonar Contact at the Proposed FCZ at Wong Chuk Kok Hoi

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Date: 8/2/2022

- Detailed examination of the multi beam sonar data to assess the archaeological potential of the sonar contact.

9.3.5 Establishing Marine Archaeological Potential

The data examined during baseline review and marine geophysical survey data review were analysed to provide an indication of the likely character and extent of archaeological resources within the assessment area. The results are presented in below sections.

9.3.6 Further Archaeological Actions (Provisional)

Subject to the results of establishing archaeological potential, accepted marine archaeological practices could be recommended to acquire more detailed data on areas with archaeological potential that may potentially be impacted by the proposed FCZ at Wong Chuk Kok Hoi. These may include further detailed marine geophysical surveys of potential areas, including Remote Operated Vehicle, visual diver survey, or employing a watching brief. If it is considered necessary, the detailed plan and scope will be agreed with AFCD, EPD and Antiquities and Monuments Office (AMO).

9.3.7 Impact Assessment and Recommendations

Based on the findings and analysis of the baseline conditions and results of the evaluation of the marine archaeological potential, an impact assessment was conducted to evaluate the potential marine impacts of the Project on marine archaeological resources / sites, and recommend necessary marine archaeological actions or mitigation measures.

9.4 Marine Archaeological Review

9.4.1 Baseline Review

9.4.1.1 Review of Historical Documents

The Assessment Area is located south of Double Island and west of Wong Chuk Kok Tsui in Wong Chuk Kok Hoi at the northeastern New Territories of Hong Kong. The Wong Wan Chau (Double Island) Site of Archaeological Interest is located over 600 m at the middle east coast of the island facing Double Heaven (see ***Figure 9.1***) where Neolithic period and Bronze Age archaeological deposits had been found.

Before the evacuation of the coast in the 17th century, most of the inhabitants were Cantonese. Hakka started moving into southern China after the Mongol invasions of the Song dynasty and prided themselves on their reputation for strength and endurance (Faure, 1986). They were often associated with stonemasonry, farming and building rather than seafaring and maritime trade. They engaged in fishing and the principal routes to market for their products were by sea due to the very basic and steep unpaved paths that connected Hakka villages until late in the 20th century (ARUP, 2020).

The Assessment Area is located at the east of the old villages of the Northeastern New Territories (including the villages north of Tiu Tang Lung and Fan Kei Tok, south of Starling Inlet and Kat O Hoi; and west of Double Haven such as Lai Chi Wo, So Lo Pun, Yung Shue Au and Kuk Po) that could trace back their history to over 300 years ago (AFCD, 2005).

Sea bandits and pirates were a periodic scourge especially in the years 1790-1810 when large piratical fleets caused havoc in the Pearl River Delta. Coastal dwellers themselves were not above resorting to piracy or receiving stolen goods. The region was also notorious for its inter lineage and inter village wars, sometimes conducted along ethnic lines. In the late 19th century the coastal regions of the new territories had long acquired a reputation for unruliness (ARUP, 2020).

The maritime history of the coastal Hakka villages of the New Territories is not widely explored but it is evident that fishing and maritime transport plus maritime deities like Tin Hau (Matsui) were an essential part of the culture and economy of village life and formed the links with neighbouring villages and the wider economy and official administration cantered around Shenzhen (ARUP, 2020).

9.4.1.2 Geological Conditions

The solid geology of the Assessment Area consists of Hang Hau Formation with shallow marine sediments comprising beach sand, intertidal (mud and sand) and estuarine deposits (mud, clayey silt and sand) (EGS, 2021).

9.4.1.3 Review of Charts

A review of admiralty charts covering the Assessment Area did not identify any sites of potential marine archaeological interest. Chart number 2593 “Hong Kong to Mirs Bay” from the United States Hydrographic Office was compiled from British surveys until 1906, and no sites/shipwrecks were found to be in the Assessment Area.

9.4.1.4 United Kingdom Hydrographic Office ‘Wreck’ Files

The United Kingdom Hydrographic Office in Taunton maintains a database of known shipwrecks / undefined sites in the HKSAR. This is the same data held by the Hong Kong Marine Department, Hydrographic Office. The review showed that no wrecks were found to be within the MAI Assessment Area.

9.4.1.5 Summary of Marine Archaeological Potential

Based on the historical review, the human activities have occurred since the Neolithic period around the area. Evidence shows that fishing and maritime transport associated with the old villages has been the major maritime activities at the adjacent area. While on this basis the waters of the Assessment Area may have marine archaeological potential, no shipwrecks of marine archaeological potential could be identified from the Charts and the Wreck Databases.

9.4.2 Marine Geophysical Survey Result

A marine geophysical survey as part of the site investigations of the Project was conducted in March 2021 to study the seabed features and to locate anomalous features in the surveyed area. The survey covered the areas to be affected by marine works associated with the anchoring system of fish rafts. The survey findings were processed by the geophysicists and reviewed by the qualified marine archaeologist, Dr William Jeffery, and cultural heritage specialist, Ms Peggy Wong. ***Figure 9.1*** show the marine geophysical survey. The survey track plots are shown in ***Appendix 9A***. Details of survey types with objectives and survey spacing are shown in ***Table 9.1***, and the equipment list is shown in ***Table 9.2***. The seabed is primarily covered with fine sediment with numerous seabed scars (from trawling and anchoring). An example is illustrated in ***Figure 9.2***.

Review of the survey findings identified one sonar contacts (A-SC001). It is located at a water depth of 14.1m and its dimension is shown in ***Table 9.3***. It is interpreted to be debris. Its location is shown in ***Figure 9.1*** and the sonar contact image is illustrated in ***Figure 9.3***. No sub-bottom anomalies of marine archaeology potential were observed.

Table 9.1 Survey Types with Objectives and Survey Spacing

Survey Type	Objective	Survey Spacing
Multi-beam echo sounding (MBES)	To provide detailed seabed level variations	50m, infill lines in shallow areas
Single beam echo sounding (SBES)	For cross check of MBES data	50m, infill lines in shallow areas
Side scan sonar (SSS)	To locate anomalous features and map sediment types on the seabed	50m, infill lines along the coast
Seismic sub-bottom profiling (SBP)	To identify sub-bottom features and stratigraphy	50m x 200m grid

Table 9.2 Equipment List

Type	Equipment
Survey Vessel	Class II licenced survey vessel *Wing Hung 2*
Horizontal positioning	C-Nav Globally Corrected Global Positioning System (GcGPS) Model 3050M
Single beam echo sounding	Knudsen 320M dual frequency Single-beam Echo Sounder
	TSS 320B Motion Sensor
Multi-beam echo sounding	R2Sonic SONIC2024 Multi-beam Echo Sounder
Side scan sonar	EdgeTech 4200 (100kHz & 400kHz)
Seismic sub-bottom profile	C-Boom Low Voltage high-resolution Boomer system
	C-Phone hydrophone system
Software	C-Nav computerized navigation suite
	C-View digital recording and processing system
	3-D seismic interpretation environment
Others	A/C generators, computers and bar check equipment

Table 9.3 Sonar contact Summary Table

Contact number	Latitude Longitude	Easting Northing	Water depth (m)	Dimensions (m)	Description
A-SC001	22° 30.396' N 114° 19.364' E	851275.6E 840781.9N	14.1	1.8 x 1.5 x <0.5	Debris

Figure 9.2 Example of Side Scan Sonar (SSS) Rectified Image Showing Numerous Seabed Scar (Trawling Scar) and Fine Sediment Seabed

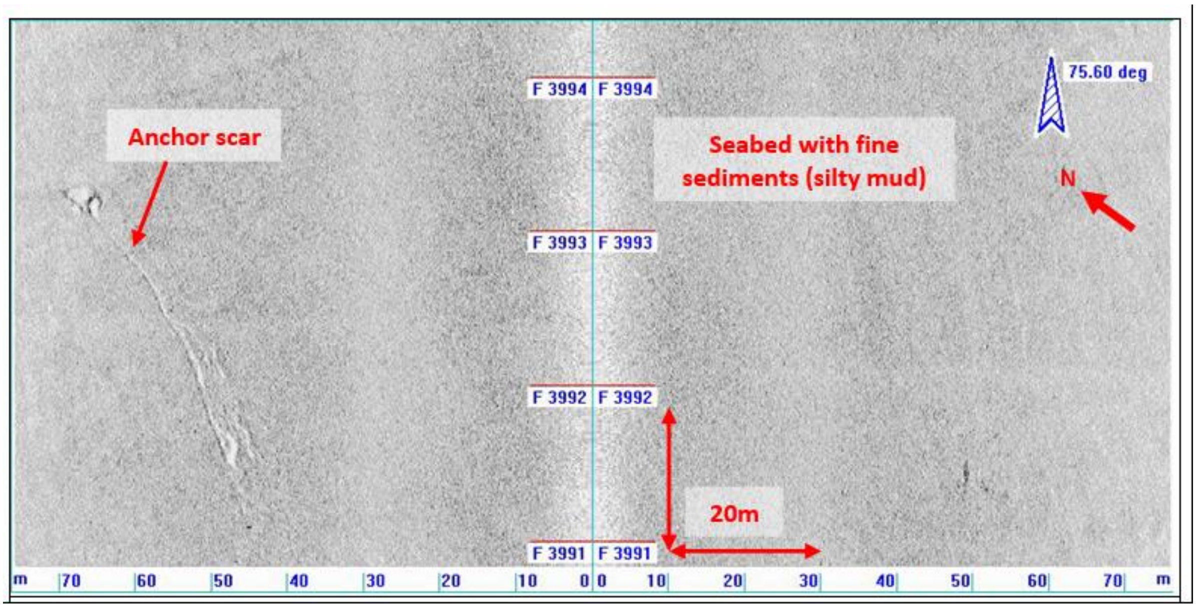
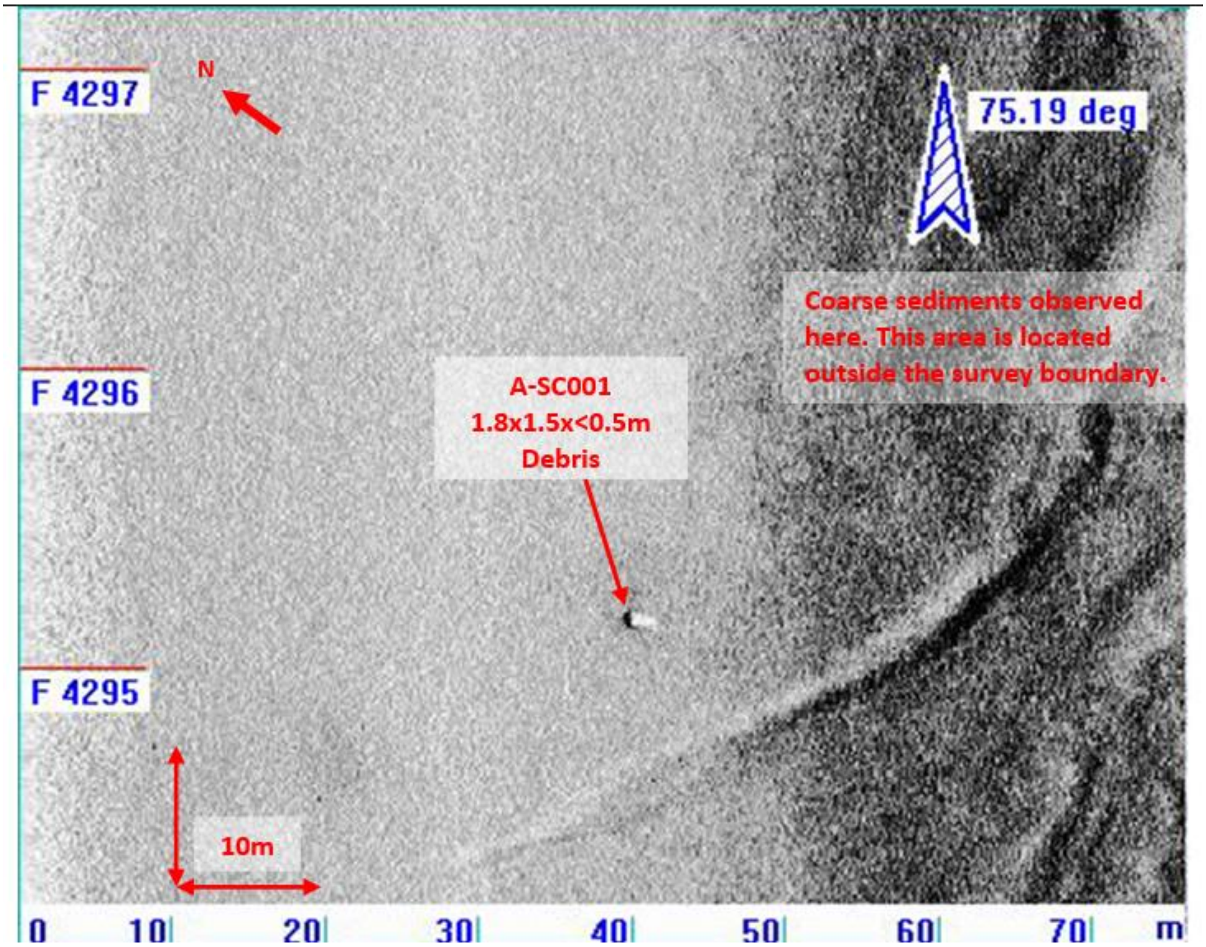


Figure 9.3 SSS Rectified Image Showing Sonar Contact A-SC001



9.4.3 Establishment of Marine Archaeological Potential

There is one sonar contact (A-SC001) at the edge of the Assessment Area interpreted as debris that may be of archaeological potential. Nevertheless, because of the muddy/silty seabed, objects such as cannon would sink into the seabed, the sonar contact is most likely to be modern, recently deposited debris that would not be of high archaeological potential. There are no wrecks/obstructions found in the UKHO Wrecks database for the MAI Assessment Area.

Except A-SC001, the remaining Assessment Area is concluded to have no marine archaeological potential.

No sub-bottom anomalies of marine archaeology potential were observed.

9.5 Potential Sources of Impact

The construction works of the proposed Wong Chuk Kok Hoi FCZ, would mainly be on-site assembly and anchorage of fish rafts/cages within the Project Area, and will be carried out by the fish farmers who obtain marine fish culture licences in this new FCZ. Maintenance dredging or removal of sediments is not anticipated during FCZ operation under the Project.

Potential impacts arising from these activities include:

- Direct loss of potential marine archaeological deposits due to seabed disturbance works during anchorage of the fish rafts/cages;
- Indirect impact on access for future archaeological surveys; and
- Permanent access disturbance to marine archaeological deposits if they are found to be within the Project Area.

9.6 Impact Assessment

The desktop review found no sites of archaeological interest, declared monuments, proposed monuments, graded historic sites/buildings/structures; and Government historic sites identified by the AMO fall within the Assessment Area. No construction phase and operation phase impact to these cultural heritage resources is anticipated. However, a sonar contact A-SC001 that may be of marine archaeological potential has been identified from marine geophysical survey. The impacts are discussed below.

9.6.1 Construction Phase

The construction of fish rafts / cages will simply involve the use of tug boats to tow the main part of the fish rafts/cages to within the Project site, and to be assembled and anchored therein. No major marine construction works, such as dredging or works with significant seabed disturbance, is expected. The fish rafts / cages will generally be gravity cages and the four corners of each cage will be anchored using weights and ropes and it is expected that the seabed to be disturbed by anchoring will be confined to a thin vertical surface layer (<0.5 m), and <2 m horizontally. Geophysical survey identified one sonar contact A-SC001 located at the edge of the Assessment Area as in ***Figure 9.1***. It is interpreted as debris that may be of archaeological potential. Nevertheless, because of the muddy / silty seabed, objects such as cannon would sink into the seabed, the sonar contact is most likely to be modern, recently deposited debris that would not be of high archaeological potential. Potential direct impact on sonar contact A-SC001 that may be of marine archaeological potential due to anchorage of fish rafts / cages and tug boat anchorage is possible.

9.6.2 Operation Phase

Potential direct impact on sonar contact A-SC001 that may be of marine archaeological potential during operation phase of the Project is possible.

9.7 Mitigation Measures

As no impacts to sites of archaeological interest, declared monuments, proposed monuments, graded historic sites/buildings/structures; and Government historic sites identified by AMO are expected, no construction phase and operation phase mitigation measure for terrestrial cultural heritage is required. However, the mitigation measures recommended for sonar contact A-SC001 is discussed below.

9.7.1 Construction Phase

According to *Annex 10* of *EIAO-TM*, the general presumption is in favour of the protection and conservation of all sites of cultural heritage, the potential direct impact on sonar contact A-SC001 that may have marine archaeological potential will be avoided by isolating it with a 20 m radius buffer area from any tug boat anchoring and anchoring of the fish rafts/cages as shown in ***Figure 9.1***. The locations and relocations of fish rafts/cages are regulated by the *Marine Fish Culture Ordinance (Cap. 353)*, and AFCD will ensure the locations of anchoring of vessels and fish rafts/cages will not be located within the buffer area. Site inspections on a regular basis by the Environmental Team are recommended to check if any seabed disturbance work is conducted in the buffer area.

9.7.2 Operation Phase

The buffer area as shown in ***Figure 9.1*** with 20 m radius from A-SC001 should be implemented during the operation phase of the Project. AFCD will maintain the record of the buffer area and the locations of the fish rafts / cages. The locations and relocations of fish rafts / cages are regulated by the *Marine Fish Culture Ordinance (Cap. 353)*, and AFCD will ensure the locations of anchoring of vessels and fish rafts/cages will not be located within the buffer area. AFCD will conduct regular site inspections to check if any seabed disturbance work is conducted in the buffer area.

9.8 Cumulative Impacts

At present, there are no planned projects within the Assessment Area that could have cumulative cultural heritage impacts with the proposed Project. No cumulative impact or adverse residual impacts on marine archaeological resources are expected.

9.9 Conclusion

The desktop review supplemented with the results of marine geophysical survey conducted for the Project identified one sonar contact, A-SC001, within the Project Area boundary that may be of archaeological potential. Nevertheless, because of the muddy/silty seabed, objects such as cannon would sink into the seabed, the sonar contact is most likely to be modern, recently deposited debris that would not be of high archaeological potential. A buffer area with 20 m radius from A-SC001 is recommended to avoid any tug boat anchoring and anchoring of the fish rafts/cages in the area so as to avoid any impact to A-SC001 during both the construction and operation phases of the Project. The locations and relocations of fish rafts/cages are regulated by the *Marine Fish Culture Ordinance (Cap. 353)*, and AFCD will ensure the locations of anchoring of vessels and fish rafts/cages will not be located within the buffer area. Site inspections on a regular basis by the Environmental Team are recommended to check if any seabed disturbance work is conducted in the buffer area during construction phase of the Project. AFCD will conduct regular inspections to check if any seabed disturbance work is conducted in the buffer area during operation phase of the Project.

9.10 Bibliography

9.10.1 English

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Ove Arup & Partners Limited (ARUP), 2020, Pier Improvement at Lai Chi Wo – Environment Impact Assessment Report for Civil Engineering and Development Department, Hong Kong.

9.10.2 Chart

Chart number 2593 “Hong Kong to Mirs Bay” from the United States Hydrographic Office was compiled from British surveys until 1906.

10. ENVIRONMENTAL MONITORING AND AUDIT

10.1 Introduction

This EIA study has focused on the assessment and mitigation of the potential impacts associated with the construction and operation of the Project. One of the key outputs has been the identification of mitigation measures to be undertaken so that residual impacts comply with regulatory requirements including the *EIAO-TM*. To confirm effective and timely implementation of the mitigation measures, it is considered necessary to develop Environmental Monitoring and Audit (EM&A) procedures and mechanisms by which the Implementation Schedule (***Appendix 10A***) may be tracked and its effectiveness assessed.

10.2 Objectives of EM&A

The objectives of carrying out EM&A for the Project include:

- Providing baseline information against which any short or long term environmental impacts of the Project can be determined;
- Providing an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- Monitoring the environmental performance of the Project and the effectiveness of the recommended mitigation measures;
- Verifying the environmental impacts identified in this EIA;
- Determining Project compliance with regulatory requirements, standards and Government policies;
- Taking remedial action(s) if unexpected results or unacceptable impacts arise; and
- Providing data to enable an environmental audit to be undertaken at regular intervals.

The following ***Sections*** summarise the recommended EM&A requirements for the Project. Further details are provided in the ***EM&A Manual***.

10.3 Water Quality

With the implementation of proposed mitigation / precautionary measures (detailed in ***Appendix 10A***), the construction and operation of the Project would not result in unacceptable change water quality at and around the proposed site at Wong Chuk Kok Hoi. Baseline monitoring shall be done prior to the commencement of the Project construction of any licenced fish raft. Environmental monitoring is considered not necessary for construction of the Project. For project operation, water quality monitoring is recommended when the standing stock is expected to achieve 75% of the carrying capacity [(90)] (i.e. 755.2 ton x 75% = 566.4 ton) or when the standing stock is expected to achieve 95% of the carrying capacity (i.e. 755.2 ton x 95% = 717.4 ton) for at least a month in a fish farming cycle to ensure no unacceptable change in water quality at the nearby water sensitive receivers. Detailed recommendations would be provided in the stand-alone ***EM&A Manual***.

(90) From the modelling results, the 95th-percentile safety margin of the carrying capacity, which is a conservative estimate taking into account possible fluctuations in the weather, hydrodynamic and environmental conditions as well as the farming practices, is about 75% of the estimated carrying capacity under typical average condition. Therefore, it is considered representative to conduct operational water quality monitoring at 75% of the maximum allowable standing stock level to monitor potential water quality at the surrounding sensitive receivers during project operation.

10.4 Marine Ecology

This EIA Study concluded that unacceptable construction and operation phase impacts are not expected to occur to marine ecological resources. Consequently, no marine ecology-specific EM&A measures are considered necessary. During the operation phase, water quality impacts will be monitored through the implementation of water quality monitoring programme as presented in the ***EM&A Manual****.* The monitoring and control of water quality impacts will also serve to avoid unacceptable impacts to marine ecological resources. The recommended operational phase mitigation measures are summarised in the Implementation Schedule provided in ***Appendix 10A***.

10.5 Fisheries

This EIA Study concluded that unacceptable construction and operational phase impacts are not expected to occur to fisheries. Consequently, no fisheries-specific EM&A measures are considered necessary for the construction and operation phases. Water quality impacts will be monitored through the implementation of water quality monitoring programme as presented in the ***EM&A Manual****.* The monitoring and control of water quality impacts will serve to avoid unacceptable impacts to fisheries resources. The recommended operational phase mitigation measures are summarised in the Implementation Schedule provided in ***Appendix 10A***.

10.6 Waste Management

This EIA study concluded that with the implementation of good site practices, adverse environmental impacts arising from the management and disposal of waste during the construction and operation phases are not anticipated. To ensure the waste management performance during construction phase of the Project, EM&A is recommended to be conducted during construction phase. Site inspections at the Project site (on marine vessels) are recommended on a regular basis at bi-weekly interval during the time of construction activities by the Environmental Team (ET) to check if wastes are being managed in accordance with good site practices and the recommended mitigation measures during the construction phase as part of the EM&A.

During operation phase, the waste management issues of the Project will be controlled by licensing under the Marine Fish Culture Ordinance (Cap. 353). EM&A is not required to be conducted during operation phase of the Project. AFCD will conduct regular inspections at monthly interval and review on FCZ operation to check if wastes are being managed in accordance with good site practices and the recommended mitigation measures. The site inspections will include all aspects of waste management including waste generation, storage, handling, recycling, transport and disposal. The waste management measures as recommended in ***Section 6.5*** during construction and operation phases are summarised in the Implementation Schedule provided in ***Appendix 10A***.

10.7 Visual

This EIA Study concluded the visual impacts from the Project are acceptable with mitigation measures. A number of measures to be implemented during design, construction and operation of the Project are recommended in ***Section 7.9***, to further enhance the visual elements associated with the Project. These are summarised in the Implementation Schedule provided in ***Appendix 10A***.

10.8 Noise

This EIA study of the Project concluded that no adverse noise impact will be associated with the construction or operation of the Project. No noise mitigation measures are required during construction and operation phase of the Project such that construction and operational noise monitoring is not required. Nevertheless, good construction site practice and noise management could be considered to reduce the noise nuisance from the construction activities. These are summarised in the Implementation Schedule provided in ***Appendix 10A***.

10.9 Cultural Heritage

This EIA study identified no sites of archaeological interest, declared monuments, proposed monuments, graded historic sites / buildings / structures; and Government historic sites identified by Antiquities and Monuments Office within the Assessment Area and therefore no impact to these cultural heritage resources are expected. No construction and operation phase mitigation measure for terrestrial cultural heritage is required.

However, potential impact to a sonar contact A-SC001 that may have marine archaeological potential identified. A buffer area of 20 m radius from A-SC001 is recommended to avoid any tug boat anchoring and anchoring of the fish rafts/cages in the area so as to avoid any impact to A-SC001 during both the construction and operation phases of the Project. The locations and relocations of fish rafts/cages are regulated by the *Marine Fish Culture Ordinance (Cap. 353)*, and AFCD will ensure the locations of anchoring of vessels and fish rafts/cages will not be located within the buffer area. Site inspections on a regular basis by the Environmental Team (ET) are recommended to check if any seabed disturbance work is conducted in the buffer area during construction phase of the Project. AFCD will conduct regular inspections to check if any seabed disturbance work is conducted in the buffer area during operation phase of the Project. This is summarised in the Implementation Schedule provided in ***Appendix 10A***.

11. SUMMARY OF ENVIRONMENTAL OUTCOMES

11.1 Introduction

An assessment of the potential environmental impacts associated with the construction and operation phases of the Project has been conducted in accordance with the requirements of the Study Brief and *EIAO-TM*. This EIA study predicted that the Project would be environmentally acceptable with the implementation of the recommended mitigation measures. The key environmental outcomes, taking into account estimated population protected from various environmental impacts, environmentally sensitive areas protected, environmentally friendly options considered and incorporated in the preferred option, environmental designs recommended, key environmental problems avoided, compensation areas included and the environmental benefits of environmental protection measures recommended, are summarised in the following sections.

11.2 Estimated Population and Environmentally Sensitive Areas Protected from Various Environmental Impacts

Environmentally friendly options and designs as well as various mitigation / control measures were considered to avoid and / or minimise environmental impacts due to the construction and operation of the Project. The following populations and environmentally sensitive areas have been protected:

- Areas near Wong Chuk Kok Hoi have limited access to public transportation and mainly working and transient populations at nearby country parks and marine parks, Wong Wan FCZ, Outward Bound Hong Kong, existing and future users of the marine waters in the vicinity of Wong Chuk Kok Hoi are subject to less potential noise and visual impacts by the selection of the currently proposed Project site; and
- All sensitive uses of marine waters, marine ecological resources and fisheries resources in the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ have been protected from the potential change in water quality during construction phase and operation phase.

11.3 Environmentally Friendly Options Considered and Incorporated in the Preferred Option

Environmentally friendly options which have been considered for the Project to minimise potential environmental impacts include the followings and each of them is described below:

- Migration to environmentally friendly modernised mariculture;
- Site selection to avoid encroachment onto environmental sensitive areas; and
- Site sitting at deeper waters to avoid organic accumulation and the need of sediment removal.

11.3.1 Migration to Environmentally Friendly Modernised Mariculture

AFCD has been actively supporting the modernization and sustainable development of the local fisheries industry and enhancing their competitiveness through a multi-pronged approach. Amongst the various measures that have been recommended, the designation of new FCZs and the promotion of the adoption of advanced and environmentally friendly culture practices are practical means to promote mariculture development. The sustainable development of mariculture and the designation of new FCZs can have the following benefits:

- Increase local mariculture production to support local demand for live marine fish, with a quality, healthy, safe, diversified and stable supply with low carbon footprint;
- Provide an avenue for capture fishermen, who face various operational challenges, to switch to a sustainable operation mode, which in turn alleviates local fishing pressure and promotes the conservation and recovery of fisheries resources and preservation of the marine environment;

- Allow mariculturists of the existing FCZs to consider pursuing modernised and sustainable modes of operation in the new FCZs, such that the marine environment of the existing FCZs can improve when the level of mariculture activities there decreases;
- Larger production scale enabled with technology can allow operating costs to be optimised, and hence improving cost-efficiency and competitiveness;
- Provide high value-added fisheries products and assists the fisheries sector to seize the opportunities in the Greater Bay Area (GBA) and other places;
- Attract new entrants and business opportunities to further grow the sector and related trades organically, also providing employment opportunities.

Overall, the sustainable development of mariculture in Hong Kong, by means of designating new FCZs, plays a critical role in fostering support for the fisheries industry which is an important local cultural asset with a long history and valuable contributions to Hong Kong's economy and society. A sustainable fisheries industry will help establish and maintain marine biodiversity such that our future generations can enjoy a diverse and rich marine ecological environment.

11.3.2 Site Selection to Avoid Encroachment onto Environmentally Sensitive Areas

The criteria for the site selection of sustainable mariculture were reviewed with reference to international guidelines (e.g. the Food and Agriculture Organization (FAO)), which include minimum water depth, wave exposure, water quality and the compatibility with the existing usage and environment. A site search using constraint mapping was conducted to identify suitable locations in Hong Kong waters for the development of new FCZs considering these site selection criteria. The Project site is one of the selected sites that have avoided encroaching key marine ecological habitats, including marine parks and marine reserve, country parks and special areas, SSSIs, coral communities with high ecological value. The Project is also at some distance away from key marine ecological habitats, including marine parks and marine reserve, country parks and special areas, SSSIs, coral communities with high ecological value, mangroves, horseshoe crabs, marine mammal habitats, wintering or nesting grounds for birds (including White-Bellied Sea Eagles). Impacts to these marine ecological sensitive receivers from the potential change in water quality due to mariculture operation are minimized.

In addition, the Project is at some distance away from existing, planned / potential marine usages, including existing FCZs, artificial reefs, coastal protection areas, seawater intake points, designated areas of marine dredging and mud disposal, existing anchorages, marine vessel fairways, restricted areas, submarine cables, pipelines and outfalls, private moorings, planned / potential coastal developments & reclamation, beaches and diving hotspots, thus potential environmental nuisance from mariculture operation to these marine usages is minimized.

The Project is at some distance away from air quality, noise and visual sensitive receivers and thus environmental impacts to these sensitive receivers are also minimized.

11.3.3 Site Sitting at Deeper Waters to Avoid Organic Accumulation and the Need of Sediment Removal

The Project site is located at deeper waters with water depth of -10 m to -15 m and higher water flushing rate. Sufficient distance between the bottom of the fish cage and the seabed as well as among fish cages can be maintained to minimise water quality impact. This setting together with the open sea environment allows adequate water dispersion and prevents the build-up of organic content and degradation of the nearby marine environment. Consequently, organic content is also not built up on the seabed and maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided.

11.4 Environmental Designs Recommended, Key Environmental Problems Avoided

Environmental designs have been recommended to further minimise the identified environmental impacts. The designs include the followings and each of them is discussed below:

- Control maximum standing stock level to safeguard water quality;
- Adopt modern prefabricated fish culture raft to minimise on-site construction works and chemical uses;
- Adopt modern fish farm designs to lower carbon footprint and waste generation, minimise potential fish escape and introduction of foreign species to local marine ecological environment; and
- Adopt fish farm designs and layout to maintain adequate water flushing.

11.4.1 Control Maximum Standing Stock Level

Carrying capacity (i.e. maximum standing stock) of the Project site has been determined with well-established modelling system to ensure environmental sustainability. The modelling system takes into account factors such as tidal flushing rate of the site, organic and nutrients loading from fish farms, and the statutory/indicative water quality objectives applicable to the local waters to determine the carrying capacity of FCZs, thus providing an objective and scientific assessment on the environmental acceptability of FCZs. AFCD will limit the number of marine fish culture license issued to control mariculture operation at the Project site within the maximum allowable standing stock level. Impacts on water quality as well as marine ecological and fisheries resources will therefore be minimised.

11.4.2 Adopt Modernised Prefabricated Fish Culture Raft to Minimise On-site Construction Works and Chemical Uses

A majority of the framework of the fish cages will be prefabricated off-site, and then tow the fish farm framework to the Project site for assembly and anchorage. Prefabrication work off-site can minimize the construction activities and work duration on-site and hence reducing the duration when potential impacts to the environment can occur. It is expected to avoid the generation of C&D materials and chemical wastes, and potential water quality impact from construction site run-off during the construction of the Project. Generation of underwater sound is minimised in this method, with less disturbance to marine and fisheries habitats. Also, less labour input required on site would result in reduction of waste generated from human activities.

11.4.3 Adopt Modernised Fish Farm Designs and Advanced Mariculture Technologies

Unlike traditional fish farm designs which are mainly simple designs made of timber, modernised fish farm designs and the use of advanced mariculture technologies would minimise environmental impacts. Modernised fish farm designs are built of weather-resistant materials, such as high-density polyethylene (HDPE) and the use of steel truss cages are more durable, which would be less likely to get damaged or repaired and result in less waste generation. The design of submersible / semi-submersible fish cage would also be less susceptible to adverse weather conditions. Advanced mariculture technologies (e.g. real-time surveillance and water quality monitoring, renewable energy sources such as solar and wind) and automation (e.g. fish feeder) can reduce labour intensive activities, hence reduce potential disturbance to ecology and environment from feed wastage, workforce wastes, vessel trips, etc.

With the more durable fish farm building materials, weather-resistant designs and application of advanced technologies, the impact on marine ecological resources will be minimised. The introduction of invasive species and escape of cultured fish are not anticipated with use of durable fish net / cages, together with the regular maintenance of fish farm equipment, unacceptable impacts on local ecology and fisheries resources are therefore not anticipated. Lower carbon footprint from mariculture operation and less waste generation are also expected with the use of advanced mariculture technologies.

Commercial pellet feed or alternative feed with better FCR will be adopted as the major fish feed at the new FCZ. Pellet feed generally floats on the water surface that could minimise feed wastage to seabed, thus reducing the potential pollution loading and minimising impacts to water and sediment quality. On the other hand, pellet feed contains less moisture (~10%) that can be easily stored at FCZ and minimise the potential transmission of parasitic and infectious disease to fishes, thus reducing potential organic waste generation due to feed wastage and fish carcasses and dead fish arising from the fish culture operation.

11.4.4 Adopt Fish Farm Designs and Layouts to Maintain Adequate Water Flushing

Sufficient separation distance between fish cages and between the cage bottom and seabed will be maintained to allow adequate water flow in between and reduce impacts on water quality such as changes in flow regime and build-up of organic content, reducing the subsequent ecological and fisheries impacts in the vicinity and degradation of the nearby marine environment. The sizable fish farm cages can also avoid overcrowding of fish stock and with good mariculture practice and dispersion by the open sea, organic content is not built up on the seabed. Maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided.

11.5 Summary of Key Environmental Problems Avoided and Sensitive Areas Protected

A summary of the key environmental problems avoided with the environmentally friendly options (***Section 11.3***) and recommended environmental designs (***Section 11.4***) of the Project is provided in ***Table 11.1***.

Table 11.1 Key Environmental Problems Avoided, Sensitive Areas Protected and Environmental Outcomes achieved

Design Approach	Key Environmental Problems Avoided, Sensitive Areas Protected and Environmental Outcomes Achieved
Migration to environmentally friendly modernised mariculture	▪ Adverse impacts from mariculture activities to water quality, marine ecology, fisheries and waste management would be avoided.
Site selection to avoid encroachment onto environmental sensitive areas	▪ Direct impact from anchorage, assembly and operation of FCZ to marine ecological resources such as artificial reefs, coastal protection area are avoided. ▪ Adverse impacts to marine ecology and fisheries due to encroachment onto environmental sensitive areas would be avoided.
Site sitting at deeper waters to avoid organic accumulation and the need of sediment removal	▪ Adverse impacts from maintenance dredging and sediment removal works to water quality, marine ecology and fisheries would be avoided.
Control maximum standing stock level	▪ Adverse impacts from mariculture activities to water quality, marine ecology and fisheries would be avoided.

Design Approach	Key Environmental Problems Avoided, Sensitive Areas Protected and Environmental Outcomes Achieved
Adopt modern prefabricated fish culture raft	▪ Adverse impacts from on-site construction to water quality, marine ecology, fisheries and waste management would be avoided.
Adopt modern fish farm designs and advanced mariculture technologies	▪ Adverse impacts from mariculture activities to water quality, marine ecology, fisheries and waste management would be avoided.
Adopt fish farm designs and layout to maintain adequate water flushing	▪ Adverse impacts from mariculture activities to water quality, marine ecology, fisheries and waste management would be avoided.

11.6 Environmental Benefits of Environmental Protection Measures

Appropriate environmental protection measures and mitigation measures have been recommended to reduce environmental impacts due to the construction and operation of the Project. The key measures are summarised in ***Table 11.2***.

Table 11.2 Key Recommended Environmental Protection / Mitigation Measures and their Associated Benefits

Aspect	Key recommended environmental protection / mitigation measures	Associated Benefits
Water Quality	▪ Standing stock should not exceed 755.2 ton at any given time. AFCD will ensure the production scale of the Project site will not exceed the maximum standing stock level by controlling the mariculture production scale permitted under individual license. ▪ The licensees will adopt the operational measures and best practice for mariculture activities (see ***Appendix 2A***). ▪ Proper storage and disposal of solid wastes, sewage / wastewater, chemical wastes and organic wastes shall be carried out under the relevant Ordinances. ▪ AFCD and mariculturists should be aware of potential occurrence of low dissolved oxygen at the Project Site by self-monitoring and the mariculturists will apply suitable control measures (e.g. aeration) as necessary. ▪ In case of 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.	▪ Protect the neighbouring water sensitive receivers in particular coral communities.

Aspect	Key recommended environmental protection / mitigation measures	Associated Benefits
Marine Ecology	▪ The mitigation measures designed to mitigate water quality impacts through proper fish farm management shall be adopted.	▪ Minimise impacts to marine ecological sensitive receivers in the vicinity to the Project site, such as coral communities.
Fisheries	▪ The mitigation measures designed to mitigate water quality impacts and proper fish farm management designated to mitigate marine ecological impacts shall be adopted.	▪ Minimise impacts to fisheries sensitive receivers in the vicinity to the Project site, such as spawning ground and nursery area of commercial fisheries resources.
Waste Management	▪ Nomination of approved personnel (e.g. environmental officer of the contractor(s), representative of the project proponent) to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility of all wastes generated at the site. ▪ Training of site personnel in proper waste management and handling procedures by AFCD. ▪ Provision of sufficient waste disposal points and regular collection for disposal. ▪ Appropriate measures to reduce windblown / floating litter and dust during transportation of waste by transporting wastes in enclosed containers. ▪ A recording system (e.g. log book for mariculture operation) for the amount of wastes generated, recycled and disposed of and the disposal sites for checking by AFCD. ▪ Prior to the commencement construction phase and operation phase, training should be provided to contractor(s) and all staff working at the Project site respectively. ▪ Proper collection, storage and disposal of solid wastes, chemical wastes and organic wastes shall be carried out under the relevant Ordinances. ▪ To avoid entrapment of floating refuse within the Project site, fish cages / rafts and vessels should be properly designed to avoid or minimise any trapped or accumulated refuse. ▪ Use of good quality feed, i.e. pellet feed, to reduce uneaten feed wastage.	▪ Minimise waste generation. ▪ Ensure proper handling of wastes by site staff and contractors.

Aspect	Key recommended environmental protection / mitigation measures	Associated Benefits
	▪ The fish farmers will keep detailed operational records to allow more accurate estimation of fish feed input and to minimise unnecessary wastage of feeds. ▪ The uneaten feeds should be cleaned up immediately to minimise leaching to the adjacent water.	
Visual	▪ Pre-construction and construction period for the Project site should be reduced as far as practical. ▪ Sensitive architectural design will be considered where practicable. ▪ Light intensity and beam directional angle should be controlled at the Project site at the design stage to reduce light pollution and glare (e.g. hooded lights, specific directional focus, etc.). In addition, lighting will be limited to auxiliary structures to reduce night-time impacts.	▪ Minimise impacts to visual sensitive receivers in the vicinity to the Project site. ▪ Enhance visual appearance of fish farm during operation.
Cultural Heritage	▪ Implement a buffer area of 20 m radius from the sonar contact (A-SC001) to avoid tug boat anchoring, and anchoring of the fish rafts/cages in the areas. ▪ The locations and relocations of fish rafts / cages are regulated by the Marine Fish Culture Ordinance (Cap. 353), and AFCD will ensure the locations of anchoring of vessels and fish rafts/cages will not be located within the buffer area.	▪ Minimise impacts to sites of marine archaeological interest within the Project site.

11.7 Compensation Area

As the Project has adopted environmentally friendly options and environmental designs as well as various environmental mitigation/ control measures, adverse impacts on water quality, marine ecology, fisheries, waste management, visual and cultural heritage are not anticipated. Thus, compensation area is considered not necessary for the Project.

12. CONCLUSION

12.1 General

This Environmental Impact Assessment (EIA) Report has been produced in accordance with the requirements of the EIA Study Brief (ESB-324/2019) for the Establishment of Fish Culture Zone at Wong Chuk Kok Hoi and the Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO).

Potential environmental impacts that have been assessed for the Project include the following aspects and are summarised in the sections below.

- Water quality;
- Marine ecology;
- Fisheries;
- Waste management;
- Visual;
- Noise; and
- Cultural heritage.

12.2 Summary of Environmental Impacts

The summaries of environmental impacts are structured as follows for each of the technical assessment completed under this EIA study:

- Sensitive receivers / assessment points;
- Assessment Methodology and Criteria;
- Key Construction Impacts;
- Key Operation Impacts;
- Key Mitigation Measures;
- Residual Impacts; and
- Compliance with the guidelines and criteria of the *EIAO-TM*.

12.2.1 Water Quality

Table 12.1 presents a summary of the key findings of the assessment of potential impacts to water quality as a result of the construction and operation of this Project. Full details of the assessment and mitigation measures are presented in ***Section 3*** of this EIA Report.

Table 12.1 Summary of Environmental Assessment and Outcomes – Water Quality

Item	Description
Water Sensitive Receivers (WSRs)	WSRs were identified under this Project, covering: ■ Recreational areas, such as secondary contact recreation subzones of WCZs; ■ Marine Parks and Artificial Reef deployed within; ■ Existing FCZs, proposed FCZs and spawning ground and nursery area of fisheries resources; ■ Ecological habitats for marine organisms including coral and benthic communities, and Finless Porpoise at / near the Project site; ■ Intertidal area; ■ Site of Special Scientific Interest; and ■ Non-gazetted beaches.
Assessment Methodology and Criteria	■ The potential impacts due to the construction and operation of the Project were assessed following the *EIAO-TM Annex 6* guidelines and the impacts evaluated based on the criteria in *EIAO-TM Annex 14*. Water quality impacts on WSRs were evaluated according to the Water Quality Objective (WQO) criteria of the corresponding WCZ, additional suspended solids criterion for coral in the Tolo Harbour and Channel WCZ and chlorophyll-a criterion for FCZs in the Mirs Bay WCZ. ■ Construction phase of this Project will only involve towing; on-site assemble and anchorage of fish raft. The corresponding impacts were assessed qualitatively. ■ Impacts due to increase pollution load from mariculture activities at the Project site at Wong Chuk Kok Hoi were assessed quantitatively using Delft3D suite of model. First, the carrying capacity of the Project site at Wong Chuk Kok Hoi was estimated following methodology by *Wong et. al. 2012*. Project WATERMAN - Carrying Capacity of Fish Culture Zones in Hong Kong. Then the corresponding pollution load from the Project site based on the derived carrying capacity, as well as all the pollution load of fish culture zones were estimated based on the updated methodology established by *Wong et. al. 2012*. This stream of pollution load, together with other sources of pollutants in HK and the Guangdong side of the Mirs Bay, were than taken into account in the Delft3D WAQ modelling simulation to predict the change in water quality at water sensitive receivers. ■ The predicted water quality was then assessed against the relevant criteria of WQOs and / or specific water quality criterion for mariculture for compliance.
Key Construction Impacts	Impacts during construction phase of the Project is expected to be very limited. Limited and localised elevation of suspended solids from anchoring activities will have transient impact on the water quality because suspended sediment will settle shortly close to the anchor. The Project site is deep enough so propeller wash would not be a concern. Construction phase would likely involve the use of modular form and pretreated materials so onsite works and use of chemicals would be minimal. This also means there would not be significant presence of workforce onsite. Any sewage / wastewater generated should be collected by the associated transportation / work boats for disposal at appropriate facilities on land.
Key Operation Impacts	■ Water quality simulation indicated that the predicted change in water quality due to the mariculture operation at the estimated carrying capacity of the Project site would be limited. No additional exceedance of WQO was predicted at any water sensitive receivers. ■ Low dissolved oxygen level was predicted at the Project Site under the baseline scenario. To remediate the potential reduction in dissolved oxygen level at the Project Site as a result of project operation, the model has taken into account mariculturists' response to low dissolved

Item	Description
	oxygen in the wet season period in form of aeration at individual mariculture operation. Modelling result indicated the provision of aeration at the months when dissolved oxygen levels were predicted to be the lowest would allow 10^{th}-percentile dissolved oxygen level remain similar to the baseline levels and avoid any aggravation of baseline non-compliance.
Key Mitigation Measures	Construction: ■ Any sewage / wastewater generated should be collected at the transportation / work vessel(s) for disposal at appropriate facilities on land. Operation: The following precautionary measures should be implemented to minimise water quality impact from the proposed mariculture operation at the Project site: ■ Standing stock should not exceed 755.2 ton at any given time. AFCD will ensure the production scale of the Project site will not exceed the maximum standing stock level by controlling the mariculture production scale permitted under individual license. ■ AFCD and mariculturists should be aware of potential occurrence of low dissolved oxygen at the Project Site by self-monitoring and the mariculturists will apply suitable control measures (e.g. aeration) as necessary. ■ In case of 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. ■ Only pellet feed or alternative feed with better feed conversion ratio will be permitted within the proposed FCZ. ■ No chemically-laden solution from culture gears disinfection should be discharged into the sea. ■ Onsite storage of chemicals should be controlled and minimised as practicable. Excess chemicals as well chemical waste generated should be removed from the site at appropriate facilities or by licensed contractor as soon as possible. ■ Fuel storage onsite should be minimised, and if needed, be located at sheltered and secure location. ■ Littering of the sea should be prohibited.
Residual Impacts	Construction: ■ No marine work or other major source of pollution is expected from the construction phase of the Project. No unacceptable construction phase water quality impact is expected. Operation: ■ Modelling results indicated no additional exceedance or aggravation of existing condition would be expected from the operation phase of the Project with suitable control measure (e.g. aeration) in place as necessary. No unacceptable operation phase water quality impact is expected.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 6* and *14* and applicable assessment standards / criteria.

12.2.2 Marine Ecology

Table 12.2 presents a summary of the key findings of the assessment of potential impacts to marine ecology as a result of the construction and operation of this Project. Full details of the assessment and mitigation measures are presented in ***Section 4*** of this EIA Report.

Table 12.2 Summary of Environmental Assessment and Outcomes – Marine Ecology

Item	Description
Marine Ecological Sensitive Receivers	In accordance with the Study Brief Section 3.4.4.2 of the Project, the marine ecological sensitive receivers were identified and detailed in ***Section 4***. ■ The Assessment Area is the same as the water quality impact assessment, which covers the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ. ■ Known marine ecological important habitats and species in the vicinity of the Project within the Assessment Areas include existing Country Parks, Sites of Special Scientific Interest (SSSI), Special Area, existing marine parks, mangroves, coral communities, marine benthos of conservation interest, and ecological important species including Amphioxus and White-bellied Sea Eagle.
Assessment Methodology and Criteria	■ A literature review was supplemented by a programme of field surveys that covered subtidal (benthic and coral) communities. ■ The potential impacts due to the construction and operation of the proposed Project were assessed following the *EIAO-TM Annex 16* guidelines and the impacts evaluated based on criteria in *EIAO-TM Annex 8* and *Guidance Notes*.
Key Construction Impacts	■ Impacts from temporary habitat disturbance (~35 ha) and underwater sound from marine construction activities and marine vessels on marine ecology and marine parks is considered minor and acceptable, therefore the implementation of mitigation measures is not required.
Key Operation Impacts	■ Impacts from changes in marine habitats (<35 ha), temporary relocation of rafts under typhoons or algal blooms, underwater sound from daily operations and marine vessels, changes in water quality parameters during fish farm operation and potential introduction of invasive species on marine ecology and marine parks is considered to be minor and acceptable. ■ Water quality impacts arising from the operation of fish farms will be reduced through implementation of the recommended water quality mitigation measures. ■ The operation measures and practices presented in ***Appendix 2A*** would prevent the potential introduction of invasive species.
Key Mitigation Measures	The mitigation measures designed to mitigate impacts to water quality during construction and operation and through proper fish farm management are expected to mitigate impacts to marine ecological resources.
Residual Impacts	The following residual ecological impacts have been identified: ■ <35 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,

Item	Description
	would provide positive effects on marine ecological resources within and adjacent to the Project Site.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 8* and *16* and applicable assessment standards / criteria.

12.2.3 Fisheries

Table 12.3 presents a summary of the key findings of the assessment of potential impacts to fisheries as a result of the construction and operation of this Project. Full details of the assessment and mitigation measures are presented in ***Section 5*** of this EIA Report.

Table 12.3 Summary of Environmental Assessment and Outcomes – Fisheries

Item	Description
Fisheries Sensitive Receivers	The identified fisheries sensitive receivers are: ■ Recognised spawning ground and nursery area of commercial fisheries resources in northeastern waters located within the Project site; ■ FCZ at Wong Wan and other FCZs (located at ~0.8 km and >5 km by sea distance respectively from Project site); ■ Yan Chau Tong Marine Park and ARs deployed within; and ■ Hoi Ha Wan Marine Park and ARs deployed within.
Assessment Methodology and Criteria	A literature review was conducted to establish the fisheries importance of the area surrounding the Project. The potential impacts due to the construction and operation of the Project and associated developments were assessed following the *EIAO-TM Annex 17* guidelines and the impacts evaluated based on the criteria in *EIAO-TM Annex 9*.
Key Construction Impacts	■ Temporary disturbance to fisheries habitat and loss of access to fishing grounds within an area of ~35 ha at the Project site is considered to be minor and acceptable given the small size of the affected areas and the majority of fisheries resources found in and around the vicinity of the Project site are of low commercial value. ■ The impact from the construction works on fishing activity is of temporary nature. Furthermore, although part of the project site is located in an area with high level of fishing activities, the loss of access to fishing ground is considered to be small compared to the availability of fishing grounds elsewhere in northeastern Hong Kong waters available for fishing activities. Overall, the impacts on fishing activity are of minor significance and no unacceptable impacts are expected. ■ Due to the presence of low to high background levels of underwater sound in the vicinity of the Project site, unacceptable impacts on fisheries due to the generation of underwater sound from increased marine traffic during FCZ construction is not expected.
Key Operation Impacts	■ Changes in fisheries habitat and loss of access to fishing grounds will not fully occupy all of the Project area with the estimated affected area 35 ha. The impact on fisheries resources and fisheries habitat is considered to be minor and acceptable given the small size of the affected areas and the majority of fisheries resources found in and around the vicinity of the Project site are of low commercial value. ■ Relocation of fish rafts / cages would occur only temporarily and corresponding impacts would be similar to the construction phase. The impact is considered to be minor and unacceptable impacts on fisheries resources and habitats are not expected. ■ Due to the presence of the low to high background levels of underwater sound in the vicinity of the Project site, unacceptable impacts due to the

Item	Description
	generation of underwater sound from increased marine traffic during fish farm operation is not expected. ■ Unacceptable impacts at all fisheries sensitive receivers due to changes in water quality from fish farm operation is not expected. ■ The implementation of good mariculture practices and measures presented in ***Appendix 2A***, such as fish health surveillance program would reduce the outbreak of fish disease, unacceptable impacts on fisheries are expected to be minor.
Key Mitigation Measures	The mitigation measures designed to mitigate impacts to water quality during construction and operation with proper fish farm management designated to mitigate marine ecological impacts are expected to mitigate impacts to fisheries resources.
Residual Impacts	■ 35 ha of fisheries habitat and fishing grounds 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 area and the overall low commercial value of fisheries resources, the impact due to the change in fisheries habitat and loss of access to fishing grounds is considered to be of minor and acceptable. Furthermore, with the implementation of the proposed mitigation measures, the potential impact on fisheries will be further minimised. No unacceptable residual fisheries impacts during the construction and operation of the Project are therefore anticipated. ■ In addition, the establishment of the proposed FCZ would have positive effects on fisheries resources. While the proposed FCZ would provide more fisheries resources to the local and global fisheries market, the fish farm structures would also provide artificial substrates, which could form habitat and shelter for juveniles or adult fisheries resources. Besides, the reduced fishing pressure may also have potential positive effect on fisheries resources within and adjacent to the Project site.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 9* and *17* and applicable assessment standards / criteria.

12.2.4 Waste Management

Table 12.4 presents a summary of the key findings of the assessment of the waste management implications associated with the construction and operation of this Project. Full details of the assessment and mitigation measures are presented in ***Section 6*** of this EIA Report.

Table 12.4 Summary of Environmental Assessment and Outcomes – Waste

Item	Description
Assessment Methodology and Criteria	The study methodology follows the criteria and guidelines as stated in *Annexes 7* and *15* of the *EIAO-TM* and the Requirements stated in *Appendix E* of the Study Brief.
Key Construction Impacts	General refuse will be produced by contractor(s) and floating refuse may be trapped on the surface of the anchored fish cages, fish rafts and vessels within the Project site during the construction phase. Unacceptable waste management impact arising from construction of the Project is not anticipated.
Key Operation Impacts	Operation waste are mainly comprised of organic waste, chemical waste, general refuse and floating refuse from site operation. Operation impacts are expected to be acceptable with the adoption of appropriate mitigation measures.
Key Mitigation Measures	▪ Nomination of approved personnel (e.g. environmental officer of the contractor(s), representative of the project proponent) to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility of all wastes generated at the site. ▪ Training of site personnel in proper waste management and handling procedures by AFCD. ▪ Provision of sufficient waste disposal points and regular collection for disposal. ▪ Appropriate measures to reduce windblown / floating litter and dust during transportation of waste by transporting wastes in enclosed containers. ▪ A recording system (e.g. log book for mariculture operation) for the amount of wastes generated, recycled and disposed of and the disposal sites for checking by AFCD. ▪ Prior to the commencement construction phase and operation phase, training should be provided to contractor(s) and all staff working at the Project site respectively. ▪ Proper collection, storage and disposal of solid wastes, chemical wastes and organic wastes shall be carried out under the relevant Ordinances. ▪ To avoid entrapment of floating refuse within the Project site, fish cages / rafts and vessels should be properly designed to avoid or minimise any trapped or accumulated refuse. ▪ Use of good quality feed, i.e. pellet feed, to reduce uneaten feed wastage. ▪ The fish farmers will keep detailed operational records to allow more accurate estimation of fish feed input and to minimise unnecessary wastage of feeds. ▪ The uneaten feeds should be cleaned up immediately to minimise leaching to the adjacent water.
Residual Impacts	No adverse residual impacts are expected.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 7* and *15* and applicable assessment standards / criteria.

12.2.5 Visual Impact

Table 12.5 presents a summary of the key findings of the assessment of potential visual impact as a result of the construction and operation of the Project. Full details of the assessment and mitigation measures are presented in ***Section 7*** of this EIA Report.

Table 12.5 Summary of Environmental Assessment and Outcomes – Visual Impact

Item	Description
Visual Sensitive Receivers (VSRs)	A total of three VSR groups have been identified. They included recreational, occupational and travelling users. Four viewpoints have been selected to assess the visual impacts.
Assessment Methodology and Criteria	▪ The methodology of the visual impact assessment was based on *Annexes 10* and *18* in the *EIAO-TM* under the *EIA Ordinance* and associated *Guidance Notes*. ▪ The visual assessment examined the impact of the proposed development on the existing views and the visual amenity, particularly from the VSRs within the viewshed. ▪ In order to illustrate the visual impacts of the proposed Project structures, photomontages prepared from selected viewpoints compare the existing conditions with the view after construction. The residual impacts are evaluated qualitatively, in accordance with the requirements of *Annex 10* of the *EIAO-TM*.
Key Construction Impacts	Visual impacts during construction of the Project are considered acceptable with mitigation.
Key Operation Impacts	Operational impacts are expected to be acceptable and arise from the operation of the new structures of the Project site. Night-time lighting for night-time navigation and glare impact is considered acceptable.
Key Mitigation Measures	▪ Pre-construction and construction period for the Project site should be reduced as far as practical to lower visual impact. ▪ The new structures will be designed in accordance with relevant marine safety standards and regulations. Sensitive architectural design will be considered where practicable. This should take into account material texture, colour, finishes to structures to ensure the fish rafts / cages blend into the existing context, cause least disturbance to the existing seascape, and are the most visually appealing. ▪ After operation, the open water occupied by the Project site will be reinstated to their former state. ▪ Light intensity and beam directional angle should be controlled at the Project site at the design stage to reduce light pollution and glare (e.g. hooded lights, specific directional focus, etc.).
Residual Impacts	No significant adverse visual impacts are expected.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 10* and *18* and applicable assessment standards / criteria.

12.2.6 Noise

Table 12.6 presents a summary of the key findings of the assessment of potential impacts to ambient noise level as a result of the construction and operation of this Project. Full details of the assessment and mitigation measures are presented in ***Section 8*** of this EIA Report.

Table 12.6 Summary of Environmental Assessment and Outcomes – Noise

Item	Description
Noise Sensitive Receivers (NSRs)	In accordance with Section 3.4.8.2 and *Clauses 2.2.1(a)* and *3.2.1(a)* in *Appendix G* of the Study Brief, the Assessment Area for the noise impact assessment covers areas within 300 m of the Project boundary. Two NSRs for country park were identified within the Assessment Area. A total of three NSRs were identified and are illustrated in ***Figure 8.1***. Other NSR are located at more than 700 m from the Project boundary.
Assessment Methodology and Criteria	The methodology for the noise impact assessment is in accordance with Clause 3.4.8 of the Study Brief and the procedures outlined in the *GW-TM*, which is issued under the Noise Control Ordinance (NCO) and the *EIAO-TM*.
Key Construction Impacts	Two NSRs for Country Park are identified within the Assessment Area, however, specific noise limit for Country Parks is not available from the relevant legislation and guidelines, including *EIAO-TM* and *GW-TM*. The Country Parks only consist of limited transient hikers, and the nearest designated campsite is more than 4 km away from the Project Site. No adverse construction noise impact is anticipated.
Key Operation Impacts	In view of the insignificant noise impact arising from the operation of the Project, no adverse noise impact associated with the operation of the Project is anticipated.
Key Mitigation Measures	In view of the insignificant noise impact arising from the proposed Project, mitigation measures are therefore not required for both construction and operation phases. Good construction site practice and noise management could be considered to reduce the noise impact from the construction activities as follows: ▪ Only well-maintained plant will be operated on-site and plant will be serviced regularly during the construction phase; ▪ Silencers or mufflers on construction equipment will be utilised and will be properly maintained during the construction phase; ▪ Mobile plant, if any, will be sited as far away from NSRs as possible; ▪ Machines and plant that may be in intermittent use will be shut down between work periods or will be throttled down to a minimum; ▪ Plants known to emit noise strongly in one direction will, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and ▪ Other structures will be effectively utilised, wherever practicable, in screening noise from on-site construction activities.
Residual Impacts	No adverse residual impact is anticipated.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 5* and *13* and applicable assessment standards / criteria.

12.2.7 Cultural Heritage

Table 12.7 presents a summary of the key findings of the assessment of potential impacts to cultural heritage as a result of the construction and operation of this Project. Full details of the assessment and mitigation measures are presented in ***Section 9*** of this EIA Report.

Table 12.7 Summary of Environmental Assessment and Outcomes – Cultural Heritage

Item	Description
Cultural Heritage Sensitive Receivers	One sonar contact A-SC001 that may be of marine archaeological potential identified at the edge of the Assessment Area. Nevertheless, because of the muddy / silty seabed, objects such as cannon would sink into the seabed, the sonar contact is most likely to be modern, recently deposited debris that would not be of high archaeological potential.
Assessment Methodology and Criteria	The study methodology follows the criteria and guidelines as stated in *Annexes 10* and *19* of the *EIAO-TM* and the Requirements for MAI as stated in *Appendix H* of the Study Brief.
Key Construction Impacts	Potential direct impact on sonar contact A-SC001 that may be of marine archaeological potential is identified due to tug boat anchoring and anchoring of fish rafts / cages as the seabed will be disturbed by the anchoring but confined to a thin vertical surface layer (<0.5 m), and <2 m horizontally.
Key Operation Impacts	Potential direct impact on sonar contact A-SC001 due to relocation of fish cages / rafts that may be of marine archaeological potential is possible.
Key Mitigation Measures	A buffer area of 20 m radius from A-SC001 to avoid any tug boat anchoring, and anchoring of the fish rafts / cages in the area during construction phase. The locations and relocations of fish rafts/ cages are regulated by the *Marine Fish Culture Ordinance (Cap. 353)*, and AFCD will ensure the locations of anchoring of vessels and fish rafts/cages will not be located within the buffer area during construction phase. AFCD will conduct regular site inspections during operation phase to check if any seabed disturbance work is conducted in the buffer area.
Residual Impacts	No adverse residual impacts are expected.
Compliance with *EIAO-TM*	The assessment and the potential impacts are in compliance with the *EIAO-TM Annexes 10* and *19* and applicable assessment standards / criteria.

12.3 Documentation of Key Assessment Assumptions, Limitation of Assessment Methodology and Related Prior Agreement(s)

A summary of key assessment assumptions, limitation of assessment methodologies and related prior agreements with relevant Government Departments is presented in ***Table 12.8***.

Table 12.8 Key Assessment Assumptions, Limitation of Assessment Methodologies and related Prior Agreement(s) with the Relevant Authorities

Environmental Aspect	Key Assessment Assumptions	Limitation of Assessment Methodologies	Prior Agreement(s) with the Director of Environmental Protection or other Authorities
Water Quality	Water quality baseline developed based on available EPD water quality monitoring data within Assessment Area in 1986-2020. Pollution loading inventory in Hong Kong was developed based on available planning data, latest information for sewerage and other infrastructure and followed the established approach adopted in previous Hong Kong studies. Future year of 2023 was chosen to develop baseline scenario as the future pollution loading from the Guangdong Province of China. Pollution load from the Guangdong Province is expected to decrease continuously and therefore the estimated loading in 2023 are assumed for conservative assessment (***Section 4*** of ***Appendix 3A*** referred). Pollution load from mariculture practice was estimated based on accepted methodology from previous fish culture zone studies. A conservative feed conversion ratio of 2 was adopted for estimation of pollution load.	Potential change in pollution loading from Guangdong side of Mirs Bay and potential change in mariculture practice which leads to different level of pollution loading from fish farms. Conservative assumptions were adopted to ensure these uncertainties are properly covered. Modelling exercise simulates only typical conditions of dry season and wet season, which is generally considered acceptable.	In accordance with *Clause 3.4.3* and *Appendix B* of the Study Brief, a Water Quality Modelling Plan was submitted for agreement by the Director of EPD. Agreement was received from EPD on 17 October 2022.
Marine Ecology	Assessment was conducted based with literature review supplemented with focussed field surveys within the Assessment Area, including subtidal (benthic and coral) surveys.	N/A	Methodology Paper for Marine Ecological Survey was submitted to AFCD for agreement prior to the survey. Agreement was received from AFCD on 25 September 2020.
Fisheries	Assessment was conducted based on literature review of past fisheries studies, AFCD's Port Survey and recent fisheries surveys of the approved EIA studies.	N/A	Methodology Paper for Fisheries Impact Assessment was submitted to AFCD for agreement prior to conducting the literature review. Agreement was received from AFCD on 25 September 2020.

Environmental Aspect	Key Assessment Assumptions	Limitation of Assessment Methodologies	Prior Agreement(s) with the Director of Environmental Protection or other Authorities
Waste Management	Volume of general construction and operational waste were estimated based on the latest design information available from AFCD at the time of reporting.	N/A	N/A
Visual	Photomontages were prepared with reference to the typical fish farm. Colours of fish farm structures may be subject to change at detailed design stage.	Assessment of magnitudes of change caused by the Project works to visual sensitive receivers are inherently subjective.	N/A
Noise	The methodology for the noise impact assessment is in accordance with the procedures outlined in the *GW-TM*, which is issued under the *NCO*. The construction activities and PME inventory of the Project are based on latest Project design information provided by project proponent.	N/A	In accordance with *Clause 3.4.8* and *Appendix G* of the Study Brief, Methodology Paper for Noise Impact Assessment was submitted to EPD for agreement prior to the assessment. Agreement was received from EPD on 29 November 2021.
Cultural Heritage	The Marine Archaeological Investigation (MAI) was conducted based on the literature review of past projects and supplemented by a marine geophysical survey within the Assessment Area to fill in information gaps.	N/A	N/A

12.4 Summary of Development Options and Alternative Mitigation Measures Considered

Viable sites of the Project have been considered during the Project's Feasibility Study, based on the environmental benefits and dis-benefits for the construction and operation of the new FCZs. Various development options are reviewed and considered in this EIA study. The environmental benefits and dis-benefits of the development options and alternative mitigation measures are summarised in ***Table 12.9***. Wong Chuk Kok Hoi is one of the proposed sites which met the selection criteria for new FCZs and is sited to avoid encroaching sensitive receivers (e.g. ecologically important habitats, areas of high fisheries importance). To further minimise potential impacts, the Project site will adopt modernized and advanced type of aquaculture technologies and operate within the maximum standing stock as identified in this EIA study.

Table 12.9 Summary of Environmental Benefits and Dis-benefits of the Development Options and Alternative Mitigation Measures Considered for the Project

Development Options	Benefits	Dis-benefits
Project Siting		
Preferred Option Site selection of sustainable mariculture with reference to international guidelines, which include minimum water depth, wave exposure, water quality and the compatibility with the existing usage and environment	▪ Avoid encroaching into ecological sensitive receivers e.g. marine reserves, coral habitats of high ecological value and areas of high fisheries importance, thus avoid impacts to marine ecology and fisheries ▪ Better water flushing rate for mariculture to allow adequate water dispersion and prevent the build-up of organic content and degradation of the nearby marine environment. Consequently, organic content is also not built up on the seabed and maintenance dredging and sediment removal are therefore not required for FCZ in deep waters, and the associated water quality impacts and related ecological and fisheries impacts can be avoided ▪ Remote area at Wong Chuk Kok Hoi minimises impacts on air quality, noise, and visual sensitive receivers	▪ May pose potential environmental impacts to newly affected areas. However, careful site selection and fish farm design have been done to avoid / minimise potential impacts
Alternative Option Expanding existing FCZs	▪ Limit environmental impacts to areas that are already affected by existing FCZs	▪ Development constrained by existing marine usage and nearby ecological sensitive receivers. Water flushing rate is generally lower due to inshore and shallow waters of the existing FCZs. Impacts to water quality, including restricted dispersion and accumulation of organic loading due to FCZ operation, are likely to occur when more mariculture production is necessary to support the development of mariculture in Hong Kong. ▪ Sediment removal may be required periodically to maintain a suitable environment for mariculture. The environmental impacts are likely to be more detrimental

Development Options	Benefits	Dis-benefits
		for FCZs in inshore areas with shallow water depths. Alternative mitigation measures such as deployment of silt curtain and control of dredging rate, etc would be required to minimise the water quality and marine ecology impact.
Project Size / Scale		
Preferred Option Establishment of smaller FCZ at different locations	▪ Establishment of smaller FCZs to reduce the organic loading at individual site, to minimise impact to coral communities and habitat for marine ecological and fisheries resources. ▪ With sufficient clearance to navigation routes, accidents / collision of marine vessels with fish farm facilities, and potential risk of fish escape and introduction of invasive species to the marine environment can be minimised.	▪ Affect more areas with potential environmental impacts but better control of impact intensity to within relevant criteria
Alternative Option Establishment of a single larger FCZ	▪ Limit environmental impacts to single location but with higher intensity	▪ The pollution loading from mariculture operation will concentrate in a particular area. The potential impacts to water quality, marine ecology and fisheries of the surrounding waters are expected to increase.
Fish Farm Layout and Design		
Preferred Option Use of advanced mariculture fish farm designs (e.g. HDPE cages, steel stuss cages)	▪ Durable and weather-resistant material would less likely to get damaged or repaired and result in less waste generated. ▪ Less susceptible to damage during adverse weather condition, such as typhoons, and minimise potential risk of fish loss / escape, and subsequent impact on local ecology and fisheries; and also minimise impact due to fish cage relocation.	▪ Higher setup cost

Development Options	Benefits	Dis-benefits
	▪ Adequate water flow and dispersion of organic content between cages / rafts, and along the water column is allowed. Adequate clearance from seabed will also be maintained. Water quality impacts such as changes in flow regime and build-up of organic content are minimised. Subsequent ecological and fisheries impacts in the vicinity and degradation of the nearby marine environment could be reduced. The need for maintenance dredging and sediment removal during construction and operation of the Project is also avoided. ▪ Use of green technology and automation could reduce feed wastage and physical labour, hence reduce potential disturbance to water quality, ecology and environment from feed wastage, workforce wastes, vessel trips, etc.	
<u>Alternative option</u> Use of traditional fish farm designs (e.g. made of timber supported by floating units made of empty plastic drums or polystyrofoam floats)	▪ Lower setup cost	▪ Non-weather resistant materials and easy to get damaged or repaired. More wastes are expected to be generated. ▪ Susceptible to damage from adverse weather conditions such as typhoons. Potential risk of fish loss / escape is higher, and subsequent impact on local ecology and fisheries; and also impact due to fish cage relocation would increase. ▪ Potential impact on water flow and dispersion of organic content between cages / rafts, and along the water column might be present, and result in the build-up of organic content on seabed. Maintenance dredging and sediment removal may be required periodically and water quality impacts would arise. Subsequent ecological and fisheries impacts in the vicinity and

Development Options	Benefits	Dis-benefits
		degradation of the nearby marine environment would also increase. Other mitigation measures will be required to control and minimise impacts to water quality, such as the use of silt curtains, closed grab dredger, etc. ▪ Require more labour input and hence increase potential disturbance to ecology and environment from feed wastage, workforce wastes, vessel trips, etc.
Construction Methods and Sequence of Works for the Project		
<u>Preferred option</u> Fish farm framework are pre-fabricated off-site, then assemble and anchored on-site	▪ Minimisation of construction duration on-site and hence reducing the duration when potential impacts to the environment can occur. ▪ No generation of C&D materials on-site and potential water quality impact from construction site run-off during the construction of the Project is avoided. The use of silt curtain and construction boats for silt curtain deployment are therefore not required, the subsequent impacts to marine and fisheries habitats such as underwater sound from marine vessels are minimised ▪ Less labour input required on site would result in reduction of waste generated from human activities	▪ N/A
<u>Alternative option</u> No alternative option applicable as the fish farm framework used for advanced type of mariculture is large in scale, and could not be constructed from raw materials on site.	▪ N/A	▪ N/A

12.5 Environmental Monitoring and Audit

The construction and operation activities of the proposed Project has been demonstrated in this EIA Report to comply with the *EIAO-TM* requirements. Actual impacts during the construction and operation activities will be monitored through a detailed Environmental Monitoring and Audit (EM&A) programme. Full details of the EM&A programme are presented in the ***EM&A Manual*** attached to this EIA Report. This programme will provide management actions and mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the construction and operation activities of this Project.

12.6 Environmental Outcomes

No unacceptable residual impacts have been predicted for the construction and operation activities of this Project. It must be noted that for each of the components assessed in the EIA Report, the assessments and the residual impacts have all been shown to be acceptable and in compliance with the relevant assessment standards/criteria of the *EIAO-TM* and the associated *Annexes*.

APPENDIX 1A STAKEHOLDER ENGAGEMENT ACTIVITIES

1A STAKEHOLDER ENGAGEMENT ACTIVITIES

1A.1 Objectives of Stakeholder Engagement

The objectives of the stakeholder engagement carried out for the Project include the following:

- To build an understanding of the need for the Project and explain the key elements of the Project to stakeholders, to actively seek their views and, address their concerns related to the future Project development and implementation; and
- To ensure transparent, responsive and responsible communications with stakeholders.

1A.2 Engagement Period

Project Profile No. PP-590/2019 was exhibited to the public for comments on 16 October 2019. Comments were received from the public during the 14-day public inspection period of the Project Profile stage. During this EIA Study, engagement with selected stakeholder groups commenced in June 2021 and was continued throughout the study period.

1A.3 Key Comments and Summary of Responses on the Project Profile

A summary of the key comments received from the public on the Project Profile and the responses are listed in ***Table 1A.1.1***.

Table 1A.1.1 Key Comments Received from the Public and Responses

Aspect	Key Comments	Responses
General	■ Commenters showed their concern on the environmental impact from the relocation of the fish rafts during adverse weather. Commenters recommended to include the associated environmental impacts of such relocation in the environmental impact assessment.	■ Impact due to the relocation of fish rafts under adverse weather, such as typhoons or algal blooms would be temporary and the associated impacts have been assessed in ***Sections 3.8.1.7, 4.5.2.2*** and ***5.5.2.2*** of this EIA Study.
Marine Ecology	■ Concern was raised on the risk of introducing invasive alien species during the operation phase of the fish culture zone at Wong Chuk Kok Hoi. Commenter suggested to carry out risk assessment on the invasive species and provide mitigation measures in the EIA.	■ Measures on preventing the introduction of invasive species will be managed by AFCD, and has been presented in ***Appendix 2A*** of this EIA report.
Marine Ecology	■ Commenters showed their concern on the impacts of the fish rafts and the associated use of vessels during construction and operation phase on Finless Porpoise. Mitigation measures such as limitation of vessel type and boat speed shall be recommended.	■ According to AFCD's Marine Mammal Monitoring Report 2021/22, the long-term study on marine mammals in Hong Kong shows that, there are no records of Finless Porpoises within and in the vicinity of the Project site. It is also reported that Finless Porpoises are mostly distributed in the southern and eastern waters of Hong Kong. With the Project site located at the

Aspect	Key Comments	Responses
		northeastern waters in Wong Chuk Kok Hoi, the impact of the Project on marine mammals is not anticipated. Mitigation measures for Finless Porpoises are therefore not required. Relevant description is provided in ***Section 4.3.3.6*** of this EIA Study.
Fisheries	■ Commenters showed their concern on the environmental impact of the proposed fish culture zone on spawning and nursery grounds of fish and marine creatures and the impact of using additive and drug for fish disease treatment. These were suggested to be assessed in the environmental impact assessment.	■ Impacts on spawning and nursery grounds of fish and marine creatures and the impact of using additive and drug for fish disease treatment due to the operation of the proposed fish culture zone have been assessed in ***Section 3*** and ***Section 5*** of this EIA Study.
Marine Ecology and Fisheries	■ Commenters suggested that the ecological impact assessment of proposed neighbouring fish culture zones and existing fish culture zones shall be considered.	■ Assessment on cumulative and residual impacts of the Project site and other proposed and existing FCZs have been mentioned under ***Sections 4.7*** and ***4.9*** and ***Sections 5.7*** and ***5.9*** of this EIA Study.
Water Quality	■ In view of the existing fish culture zone, marine park and SSSI in vicinity of the proposed fish culture zone at Wong Chuk Kok Hoi, concern was raised on the generation of additional pollution sources from the proposed fish culture zone which may impose adverse impact to the nearby sensitive marine environment.	■ Potential water quality impact from the Project to nearby sensitive marine environment has been assessed in ***Sections 3.7 and 3.8*** of the EIA Study.
Water Quality and Waste	■ Commenters showed their concern on the environmental impact from human activities on the fish rafts and additional structures on the fish rafts. It was suggested to be assessed in the environmental impact assessment.	■ Impacts from human activities on water quality and waste management have been reviewed and assessed in ***Sections 3.7, 3.8.4, 3.8.5, 6.3.1, 6.4.3, 6.5.2, 6.5.3.3*** and ***6.5.3.4*** of this EIA Study respectively.
Waste	■ Commenters showed their concern about the disposal of wastes related to fish farm construction and operation activities. It was suggested to impose effective measures to avoid illegal and inappropriate disposal of wastes.	■ Control on illegal dumping has been discussed in ***Section 6.2.5*** of this EIA Study.
Visual	■ Commenters showed their concern about the potential adverse visual	■ Visual impacts of the Project site on recreational users have been assessed in ***Section 7.8*** of this EIA Study, and the

Aspect	Key Comments	Responses
	impact of the Project on hikers and tourists travelling in the vicinity.	Study showed that there is no significant adverse visual impact.

1A.4 Key Comments and Summary of Responses during EIA Stage

1A.4.1 *Key Stakeholders*

Since June 2021, a series of briefings and meetings have been arranged with interest groups and stakeholders as listed in ***Table 1A.1.2***.

PowerPoint presentations were used as tools to inform the stakeholders and enhance their understanding of the Project.

Table 1A.1.2 Types of Stakeholder Consulted

Stakeholder Type
■ Fishermen Groups
■ Mariculture Groups
■ Green Groups
■ Legislative Councillors
■ Rural Committee Representatives

1A.4.2 *Comments and Responses*

This section provides a summary of the key comments and suggestions relating to the Project made by those stakeholders consulted.

1A.4.2.1 *Water Quality*

Stakeholders were concerned about the potential impacts to water quality from the Project, in particular, the generation of wastewater, carrying capacity and water quality monitoring of the Project site.

The key views relating to water quality, and responses are summarised in ***Table 1A.1.3***.

Table 1A.1.3 Key Views and Responses Relating to Water Quality

Key Views	Responses
■ Domestic wastewater produced by personnel during future operation on the fish farm should be treated properly with modern technology to minimise potential impacts of water pollution.	■ Impact of domestic wastewater production by personnel has been assessed in ***Section 3.8.4*** of this EIA Study. As the Project operation would be typically manned minimally onsite and relies mostly on automated / remote control, generation of domestic wastewater would be limited.
■ High turbidity of water conditions is observed at the Project site in general and potential algal bloom might occur.	■ Water quality conditions and associated impacts have been assessed in ***Section 3*** of the EIA Study.

Key Views	Responses
■ How should the carrying capacity of the Project site be interpreted?	■ The carrying capacity of the Project site should be considered as the maximum standing stock of fish that can be kept under sustainable environmental conditions within the Project site area.
■ Water flow in sheltered areas would have low flushing rate and could potentially retain pollutants generated from the fish farms.	■ Impact of the Project on water quality has been assessed in ***Section 3*** of the EIA Study and mariculture operation within the FCZ
■ Will the water quality monitoring data of the Project site will be available to the public?	■ Water quality monitoring data of existing FCZ (e.g. Tung Lung Chau FCZ) has been published online for public's reference and the same arrangement would be applied to the Project site.

1A.4.2.2 *Marine Ecology and Fisheries*

Stakeholders were concerned with the potential impacts to marine ecological and fisheries resources, and the cumulative impacts from concurrent operation of nearby existing and proposed FCZs.

The key views relating to marine ecology and fisheries, and responses are summarised in ***Table 1A.1.4***.

Table 1A.1.4 Key Views and Responses Relating to Marine Ecology and Fisheries

Key Views	Responses
■ Impacts of the Project on nearshore capture fisheries and mariculture stakeholders, particularly near the Project site should be considered.	■ Impacts which are related to environmental aspects of fisheries have been evaluated in ***Section 5*** of this EIA Study.
■ Have the coral habitats, including rare coral species in the vicinity of the Project site been assessed?	■ Coral habitats, including uncommon coral species have been assessed in ***Sections 4.3.3.9, 4.3.4, 4.3.5, 4.5*** and ***4.6*** of this EIA study.
■ Are there any plans to deal with issues arising from marine fouling with the establishment of the FCZ?	■ Good mariculture practices will be implemented at the FCZ, such as regular fish net maintenance to prevent and minimise impacts from marine fouling. Also, new methods of cleaning fish nets are currently being explored in the Tung Lung Chau FCZ and will be considered at the Project site if applicable.
■ Will there be any cumulative impacts of the proposed FCZs on nearby oyster reef restored in Tolo Harbour Channel?	■ Cumulative impacts have been assessed in ***Sections 3.11, 4.7*** and ***5.7*** of this EIA study. The water quality modelling results indicated that the proposed FCZ operation would not result in unacceptable change in water quality at the identified WSRs. The oyster reef restored in

Key Views	Responses
	Tolo Harbour Channel is located further away from the identified WSRs and hence unacceptable cumulative impacts are not anticipated.
■ Will the harvesting of mariculture products cause potential impact on nearby tern colonies or seabirds of concern during their breeding season?	■ A review on the impacts to the White-Belled Sea Eagle (WBSE) has been provided in ***Section 4.3.3.12***. 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. Fish cages or nets that would be used in the new FCZ would be properly secured and maintained in the fish farm and the harvesting of mariculture products would not result in free floating nets or other equipment that could pose threats to the seabirds e.g. entanglement. The presence of fish farm is not expected to pose threats to seabirds.

1A.4.2.3 *Waste Management*

Some stakeholders were concerned about the treatment of potential waste generated by the Project.

The key views relating to waste management and responses are summarised in ***Table 1A.1.5***.

Table 1A.1.5 Key Views and Responses Relating to Waste Management

Key Views	Responses
■ What will be the waste treatment arrangements of fish farms, such as general waste produced by fish farm workers?	■ New mariculture facilities are expected to be mostly automated, with minimal manual support. Proper-labelled enclosed waste containers will be provided to store general refuse, floating waste, recyclables and operation wastes generated at the Project site to avoid waste being thrown into the sea. The collected waste will also be regularly transported to landside refuse collection points / authorised recyclers via marine vessels.

1A.4.2.4 *Visual*

Some stakeholders were concerned about the potential visual impact during the construction and operation of the Project.

The key views relating to visual, and responses are summarised in ***Table 1A.1.6***.

Table 1A.1.6 Key Views and Responses Relating to Visual

Key Views	Responses
■ Will the potential impact of glare associated with light sources generated from the Project considered in this EIA Study?	■ The potential impact of night lighting and glare has been assessed in ***Section 7.8.5*** of this EIA Study.

1A.4.2.5 *Noise*

Some stakeholders were concerned about the potential impact of noise during the construction and operation of the Project.

The key views relating to noise, and responses are summarised in ***Table 1A.1.7***.

Table 1A.1.7 Key Views and Responses Relating to Noise

Key Views	Responses
■ Will the potential impact of noise generated from the Project considered in this EIA Study?	■ The potential impact of noise has been reviewed in ***Section 8*** of this EIA Study.

APPENDIX 2A OPERATION MEASURES AND PRACTICES

2A OPERATION MEASURES AND PRACTICES

2A.1 Operational Arrangements to be Managed by AFCD

The following operation measures and practices have been considered during the design of the new FCZ management. AFCD will manage these measures and practices for the new FCZs to minimise impacts to the surrounding environment. These measures and practices have been considered in the impact assessment.

2A.1.1 *Control of Standing Stock Capacity*

AFCD will limit the number of fish farm licenses issued to control the standing stock of the Project site within its maximum allowed carrying capacity as identified in this EIA study.

2A.1.2 *Specifications of Fish Farm Layout*

A sufficient separation distance (e.g. around 100 m) will be provided between each fish farm unit (1) with typical size around one hectare of sea area to allow sufficient space for operation around the fish rafts / cages and with this separation distance, changes in hydrological and flow regime of the marine environment are not anticipated. The detailed number, size and separation distance of the fish rafts / cages would be determined during a later stage. A clearance of at least 200 m is typically required from established coral communities when designating locations of fish rafts / cages for each licensee. Also, at least 2 m of clearance from the seabed should be maintained at all times, except for integrated multi-trophic aquaculture (IMTA) when certain part of the mariculture setup might stay at / near bottom of the water column.

2A.1.3 *Fish Farm Operational Plan*

Fish farm owners are required to submit a fish farm operational plan during the licence application to allow a more stringent control of fish farm operation and minimise environment impacts. AFCD shall inspect the plan and provide recommendations to fish farm owners. The fish farm operational plan may include but not limited to:

- An overview of the mode of mariculture to be conducted;
- Area required for the operation;
- An overview of the layout of the farm;
- A description of the culture equipment required;
- List of species proposed for culture;
- Estimated annual production;
- Fish escape plan (such as the reporting procedures, etc.);
- Environmental management plan (such as the identification of potential environmental impacts and mitigation measures, etc.);
- Environmental monitoring plan (such as water quality monitoring schedule and procedures, etc.); and
- Mitigation actions to be taken in response to specific events or incidents.

The operational plan will be evaluated by AFCD considering at least the following components as listed in ***Table 2A.1*** to minimise impact of FCZ operation on fisheries resources and the marine environment:

(1) Each fish farm unit can consist of multiple fish rafts / cages.

Table 2A.1 FCZ Management Requirements

Monitoring and Control Measures	Frequency	Personnel Involved
Checking and maintaining appropriate stocking density	Weekly	Fish farm owner and / or worker
Regular cleaning of fish raft / cages	Weekly	Fish farm owner and / or worker
Feeding fish stock using pellet feed / alternative feed with better feed conversion ratio	Daily	Fish farm owner and / or worker
Appropriate disposal of dead fish and garbage	Daily	Fish farm owner and / or worker
Disinfection and maintenance of fish farm facilities	Weekly	Fish farm owner and / or worker and professional personnel e.g. scuba divers
Monitoring of health condition of fish stock and implement proper treatment for sick fish	Daily	Fish farm owner and / or worker and professional personnel e.g. veterinarian
Regular water quality monitoring	Daily	Fish farm owner and / or worker

2A.1.4 *Biosecurity and Disease Management*

Biosecurity should be implemented for all fish stocks imported, and ensure fish stock has undergone quarantine procedures to ensure the health of cultured fish and prevent the spread of diseases if identified. More frequent monitoring of fish farms might be needed during summer time as a majority of fish diseases are related to elevated water temperature and any infections, if observed, should be reported to AFCD.

In the event of a disease outbreak, the licensee should report the outbreak to AFCD within 24 hours. The diseased fish should be isolated and any therapeutics (e.g. antibiotics) that are used should be certified and approved by relevant authorities and administered in accordance with the recommended dosage and withdrawal period. Equipment must be disinfected prior to the movement out of licensed area. Other mariculture operators within the FCZ must be informed immediately. The licensee should also keep record of the event for submission to AFCD upon request.

Fish mortality of a significant number may also lead to the spread of disease and cause deterioration in water quality within FCZ, thus, these fish should be removed from the water immediately and disposed of at the nearest refuse collection point on land. In the unlikely case that significant amount of dead fish occur, the licensed fish farmers would inform AFCD immediately. AFCD will then liaise with relevant Government departments (e.g. Food and Environmental Hygiene Department, Marine Department) to collect the dead fish from the Project site directly as necessary. Dumping of fish carcasses in the water is not permitted.

2A.1.5 *Fish Escape*

Escaped farmed fish have a potential to out-compete wild population for habitat and food. Biosecurity risks may be resulted as the fish may spread disease and pathogens to the wild population. Cage nets must be inspected regularly to ensure the nets are in good condition to avoid unexpected escapes. It is also important to have a response plan in relation to potential fish escape. The licensee should take immediate action to control any escape and report any suspected escape from a fish farm to AFCD. The scale of fish escape and species of escape should be reported. Circumstances which give rise to significant risk of fish escape should also be reported to AFCD.

2A.1.6 *Use of Pellet Feed*

Trash fish is variable in freshness and susceptible to spoilage due to its high moisture content (~70%); it also favours the transmission of parasitic and infectious disease, therefore creating fish feed wastage and water pollution if not stored properly. Given the potential environmental impact to the surroundings, trash fish will not be permitted as fish feed within the Project site.

Dry pellet fish feed in contrast contains less moisture (~10%), which is mainly made of fishmeal, protein from other animal or plant origin, fish oil or other kinds of lipids, vitamin premix, minerals and binders bounded into pellet form. Only commercial pellet feeds or alternative feed with better feed conversion ratio should be used within the Project site.

2A.1.7 *Waste Management*

Waste management is important to reduce the potential impact of mariculture operation to the marine environment. Wastage material (such as fish carcasses, residual feed and operational waste) must be placed in sealed waste containers on site and securely disposed at refuse collection point on land. To avoid water contamination and spreading of germs, fish carcasses on the water surface must be collected and disposed of immediately in sealed waste containers for delivery to the nearest refuse collection point. Application of pharmaceutical drugs / antibiotics / vaccines on fish should be performed on the fish raft within enclosed tanks / containers. All pharmaceutical waste should be disposed of properly using relevant waste containers. Disposal of chemicals should follow regulations stated under the *Waste Disposal Ordinance Cap (354)*.

2A.1.8 *Cleaning of Fish Farming Equipment*

Nets should be cleaned thoroughly before each production cycle and no nets or other equipment should be dropped to the sea for the purpose of storage or cleaning. Disinfection of equipment could be conducted by bleaching, streaming or drying under sunlight on the mariculture raft off the waters to avoid pollution to the surrounding waters by disinfectants.

2A.1.9 *Water Quality Regulation and Control*

Currently, AFCD conduct regular water quality monitoring at all FCZs in Hong Kong with one of the real-time water quality monitoring systems located at Tap Mun FCZ to report water quality continuously for early detection of abnormality and issuance of alerts to mariculturists. For this Project, in addition to the water quality monitoring to be conducted in Environmental Monitoring and Audit (EM&A) exercise and reported in the Water Quality Monitoring Reports under EIAO (details are provided in the ***EM&A Manual***), real-time water quality monitoring stations will be installed by AFCD at the Project site after its establishment and the nearby real-time monitoring station of Tap Mun FCZ will also help to provide useful information on water quality in vicinity of the Project site. Weekly sampling of seawater for analysis of phytoplankton will be conducted by AFCD at Tap Mun FCZ for maricultural condition monitoring purpose and sampling frequency will be increased when harmful algal species or abnormally high phytoplankton populations are detected. Prompt alerts will be issued to mariculturists where required and would provide valuable information to the new FCZ of the Project site as well.

All the workers and mariculturists working in the FCZ will be required to implement practical measures (e.g. regular sewage collection by licensed collectors, etc.) to comply with the relevant environmental control in handling sewage and wastewater under the *Water Pollution Control Ordinance (Cap. 358)*.

2A.2 Recommended Best Practices

With the proposed Project design and implementation of the specific mitigation measures proposed in the report to mitigate the potential impact from the Project, no unacceptable environmental impact is anticipated. Nonetheless, the following best practices would also be adopted as necessary at the proposed fish culture zone under the modern mariculture for environmental benefits.

2A.2.1 *Optimal Feed Input*

Optimal feed input (i.e. the amount of fish feed required for the cultured fish to support optimal growth without feed wastage) shall be implemented to reduce nutrient enrichment to the surroundings. In addition, this will improve the feed conversion rate for the stock, reduce feed wastage, and mitigate environmental pollution caused by feed residue.

Suitable feeding practices should be adopted to avoid the use of excessive feeds and impact to the seabed under the cages. These practices include:

- Amount of feed given to the fish should be based on biomass of fish contained in the cage and environmental conditions present;
- Feeding should be reduced or stopped during low temperature, low dissolved oxygen, strong currents, or bad weather;
- Feeding operations and fish feeding behaviour should be closely monitored by the operator;
- The use of underwater video cameras to monitor the feeding activity is recommended for all FCZs as far as visibility permits;
- The amount of feed input should be reduced or stopped when changes in fish behaviour (e.g. reduction in feeding rate) are observed;
- Feeding should be conducted in a manner to ensure an even distribution and reduce the amount of wasted feed;
- Detailed records should be kept and provided upon request for each cage. The record should include the amount of feed and type used, estimated number of fish and biomass, water temperature and growth rates, etc. to ensure optimal feed conversion rates could be achieved;
- Size of feed pellets should match the size of fish to ensure that the feed pellets are effectively consumed by the fish stocks; and
- Modern feeding practices and technologies should be used, where practical, to minimise feed wastage and impact to the environment.

Operator and other personnel should take all precautions to reduce spills during delivery of feed to the site. The untaken feeds should be cleanup immediately to minimise the loss of feed into the adjacent water. Record of the amount of feed delivered to the farm should be kept to monitor feed use during operation. Feeds should be stored in covered areas and should not be left exposed or uncovered to minimise spills and spoilage.

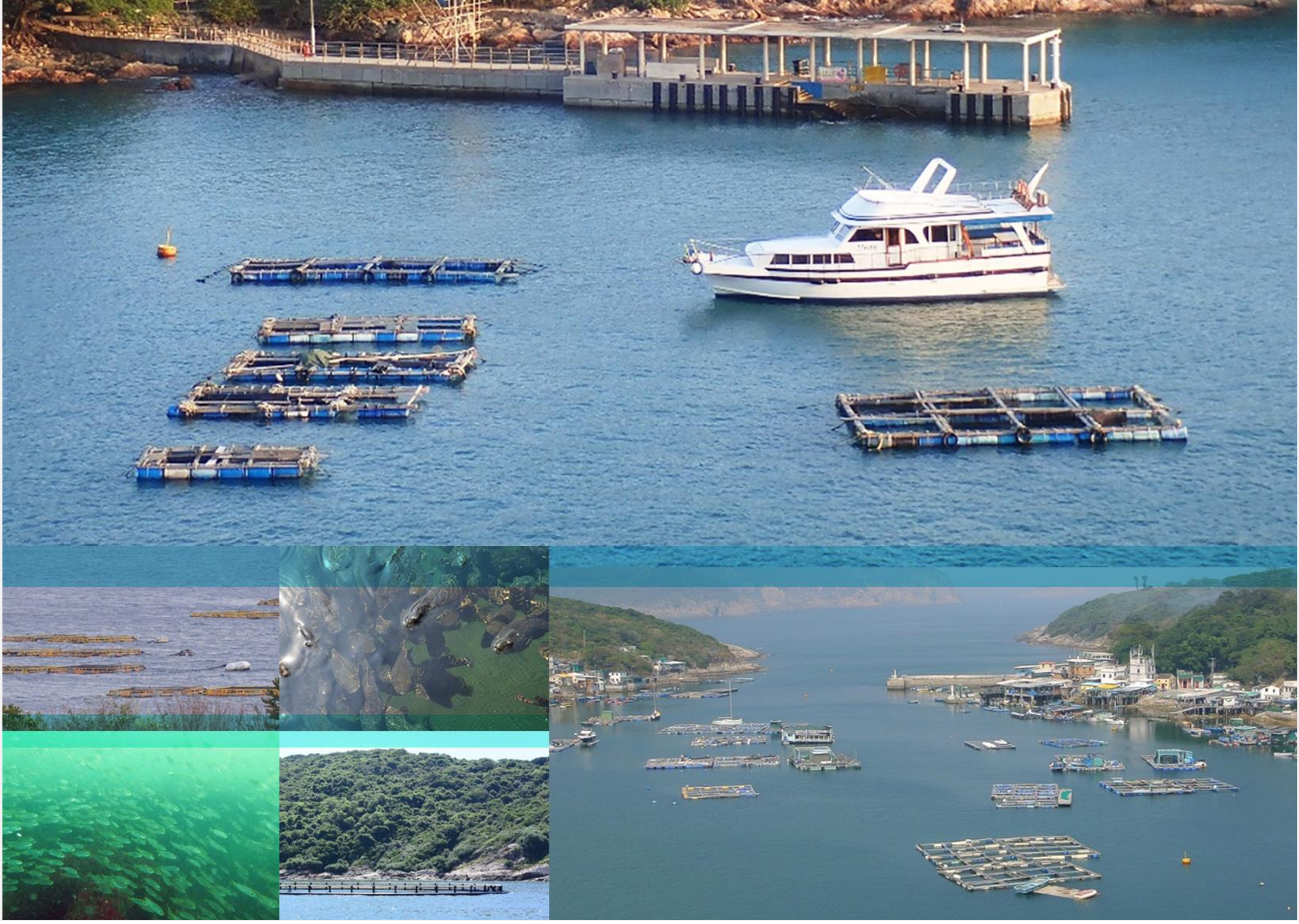
2A.2.2 *Fallowing*

Fallowing could be conducted by the movement of cages within the licensed area or de-stocking to allow recovery of sediments under the cage and manual recovery of sediments is not required. The movement of stocks to culture tanks or by partial harvesting is another measure to reduce impacts on water or sediment quality from fallowing. The operators should reduce stocking densities by separating cages or selective harvest to allow time for recovery of the surrounding environment.

2A.2.3 *Further Engagement in Water Quality Monitoring*

In order to further engage mariculturists with monitoring the water quality of the new FCZ, technical seminars and regular farm visits are also held regularly by AFCD to share water quality monitoring and management techniques with fish farmers for the proper use of basic water testing equipment e.g. oxygen meters to encourage proactive management of their fish stocks.

APPENDIX 3A WATER QUALITY MODELLING PLAN FOR WONG CHUK KOK HOI FISH CULTURE ZONE



漁農自然護理署
Agriculture, Fisheries and Conservation Department

Contract Ref.: AFCD/FIS/02/2019 Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

Water Quality Modelling Plan for Wong Chuk Kok Hoi Fish Culture Zone

October 2022

Project No.: 0549925

The business of sustainability

ERM

Signature Page

12 October 2022

Contract Ref.: AFCD/FIS/02/2019 Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

Water Quality Modelling Plan for Wong Chuk Kok Hoi Fish Culture Zone

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Appendix

1. INTRODUCTION

1.1 Background

To pave the way for facilitating the sustainable development of the local mariculture sector, the Agriculture, Fisheries and Conservation Department (AFCD) proposed to lift the moratorium by designating new fish culture zones (FCZs) to create room for the mariculture sector to grow further, including allowing capture fishermen to switch to this sustainable mode of operation, and attracting new entrants. In 2014, the AFCD commissioned a consultancy study (1) to explore suitable sites as new FCZs and Wong Chuk Kok Hoi FCZ is one of the four Shortlisted Sites.

The designation of a FCZ of more than 5 hectares in size is classified as a designated project under Item M.1, Part I of Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499), and a statutory EIA is required before designation. In accordance with the EIAO, a Project Profile for application for an Environmental Impact Assessment (EIA) Study Brief has been prepared and submitted to Environmental Protection Department (EPD) on 15 October 2019. The EIA Study Brief (ESB-324/2019) (hereafter referred to as "the Study Brief") was issued by EPD on 27 November 2019.

AFCD has commissioned ERM to undertake the "*Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones*" ("the Study"). In accordance with *Clause 3.4.3* of the EIA Study Brief, a water quality impact assessment shall be conducted to evaluate and assess potential impacts on water quality for the construction and operation of the Wong Chuk Kok Hoi FCZ ("the Project").

1.2 Purpose of the Modelling Plan

This Modelling Plan presents information on the approach for numerical modelling and assessment works for water quality and hydrodynamic aspects of the EIA, for agreement by EPD before proceeding with the modelling works. It is important to note that at the time of writing this Modelling Plan, the detailed information for the scale of mariculture is yet to be determined; this would in fact be covered by the water quality modelling exercise conducted under this Study.

Note that this Modelling Plan covers only water quality issues which requires modelling assessment. Water quality issues to be addressed qualitative will not be discussed in detail in this document. These are described in detail in *Section 1.4*.

1.3 Assessment Area

In accordance with the Study Brief, the Study Area for water quality impact assessment covers the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ. The model adopted covers the entirety of the Tolo Harbour and Channel WCZ and the majority of the Mirs Bay WCZ. For modelling assessment, water sensitive receivers (WSRs), including important marine ecological and fisheries resources, within about 5 km from the Project Site would be considered. The size of licensed raft area within the proposed FCZ will take into account the carrying capacity of the FCZ and the outcome of the water quality impact assessment.

1.4 Key Issues for Modelling

1.4.1 Construction Phase

The construction works for this Project will not involve civil or marine works. Most of the construction works would be the assembly of parts to form fish rafts for the mariculture operation, as well as the towing and anchoring of existing fish rafts from other location(s) to the new FCZ using tug boat.

(1) ERM (2018) Consultancy Ref. AFCD/FIS/01/14 Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study.

Potential water quality impact from the assembly of parts to form fish rafts would include spill, construction waste, as well as sewage from construction workforce. These potential impacts are deemed minor and will be assessed qualitatively in the EIAs.

Towing and anchoring of fish rafts is a normal part of mariculture activities. While the anchoring and de-anchoring of fish rafts could lead to transient, localised elevation of suspended solids near seabed, such elevation is expected to be minimal and would not have notable impact on the water column. In view of this, qualitative assessment is deemed sufficient for the EIA studies.

1.4.2 Operation Phase

The presence of mariculture activities at the proposed site would result in the increase in water quality pollutants from fish feed, feed wastage, fish excretion, dead fish, waste from human activities and faecal pollution from dogs and cats living on fish rafts. The increase in pollution load would result in a change in water quality in the receiving waters, affecting the water quality at nearby sensitive receivers, such as other existing FCZs, marine ecological as well as fisheries resources. This would be assessed quantitatively using computational model in the EIA.

There are other daily routines for the operation of fish farms that could result in a change in water quality. Operational activities would involve the removal of fouling organisms of the rafts as well as fish cages. Fouling organisms are usually removed mechanically (e.g. using pressurised water jet) so chemical is generally not required. Dislodged fouling biomass falling into the sea would not constitute additional pollution load because such biomass has fed on the original pollution source from the fish farm operation. It is anticipated that for this new FCZ, power supply would be provided by generator on supply vessels for individual mariculturists or other sources, supplemented by renewable energy system onsite. Storage of fuel for electricity would be minimal for the unlikely scenario of an outage. According to AFCD, there has been no record of major fuel spillage events (2) in the recent 3 years despite of fuel storage is required for mariculture operation in most FCZs that has no existing power supply by cable. Better control on fuel storage would be expected for newer fish farm design in the new FCZ. Given the rarity of such event and better control at the proposed new FCZ, the risk of an oil spillage event from the proposed new FCZ is considered minimal. Similarly, minimum amount of storage of chemicals were observed during regular inspection in the recent years. Major spillage of these chemicals are not anticipated. It is deemed sufficient to assess these potential impact qualitatively.

The use and storage of chemicals would be limited to pharmaceuticals for fish, as well as those required to maintain equipment for the fish farm operation. In general, pharmaceuticals for fish would be applied to fish when needed and in isolated cages to minimise the use of the pharmaceuticals, and thus there will not be massive discharge of water containing pharmaceuticals from daily operation. In AFCD's regular inspection of existing fish culture zones in the recent 3 years, there was no identified case of excessive storage of drugs or pharmaceuticals. It should be highlighted that for the proposed new fish culture zone, even stricter control on the use and storage of drugs or pharmaceuticals would be implemented. The mariculturists at the proposed news zone would be required to strictly observe the requirement under *Cap. 529 Veterinary Surgeons Registration Ordinance* and have strict control on prescription drugs. Given the stricter control as well as small scale of use and storage, the potential impact from any potential spillage would be small as well. It is deemed sufficient to assess this potential impact qualitatively.

Unlike spillage of chemical, spilled/ excess fish feed generally does not persist for considerable amount of time as the presence of fish feed would attract existing fish population to feed on the excess feed. For floating type fish feed, the majority of feed can simply be recovered by the mariculturists to feed their fish stock. Commercially available fish feed comes in tough fabric bags. In

(2) Underreporting of oil spill at fish farm is highly unlikely as oil spill could lead to fish kills and great financial loss to the mariculturists in the vicinity. Thus mariculturists close to the fish farm where spillage occur have strong incentive to report.

case of such bags of feed drop into the sea during storage or transportation, they are likely recovered by the crew member (or else they are littering in the sea which is punishable of a fine of HK$10,000 and 6 months imprisonment). Even if such bags are not recovered, the bag would limit the exchange materials such that the nutrient content would unlikely be released all at once and result in significant water quality impact. In view of this, the risk and consequence of such scenario are deemed minimal and is considered appropriate to assess this potential impact qualitatively.

The proposed location for the selected Site is generally deeper than existing FCZs and maintenance dredging is not anticipated. Therefore, there is no impact from suspended solids nor change in flow regime due to change in seabed profile. No operation phase quantitative assessment for maintenance dredging is deemed necessary.

Structures of fish raft would generally be highly porous to allow water flow and removal of waste. Fish rafts would generally be spaced apart for better fish growth. Therefore the presence of floating structures of fish rafts will not exert significant drag on the tidal stream and no notable change in flow regime due to the presence of floating structures would be expected. This issue would be assessed qualitatively in the EIA.

During the operation of the proposed new FCZ, there would be increased marine traffic and boating at the site. Typically commuting and transfer of supplies (e.g. feed) and products (e.g. fish) is generally done with small boats that do not require separate anchorage. Therefore, potential change in water quality associated with anchoring is not expected. Also, the water depth at the proposed site is considered sufficient to avoid propeller wash from disturbing the bottom sediment. No notable change in water quality is expected from the increase marine traffic and boating.

Key water quality issues listed under *Appendix B* of the Study Brief are summarised in ***Table 1.1***. Most of the identified issues would be addressed qualitatively with the exception of the change in water quality associated with operation phase pollution loadings from fish feed, feed wastage, fish excretion, dead fish, waste from human activities and faecal pollution from dogs and cats living on fish rafts.

Table 1.1 Key Water Quality Issues Listed under Appendix B of the Study Briefs

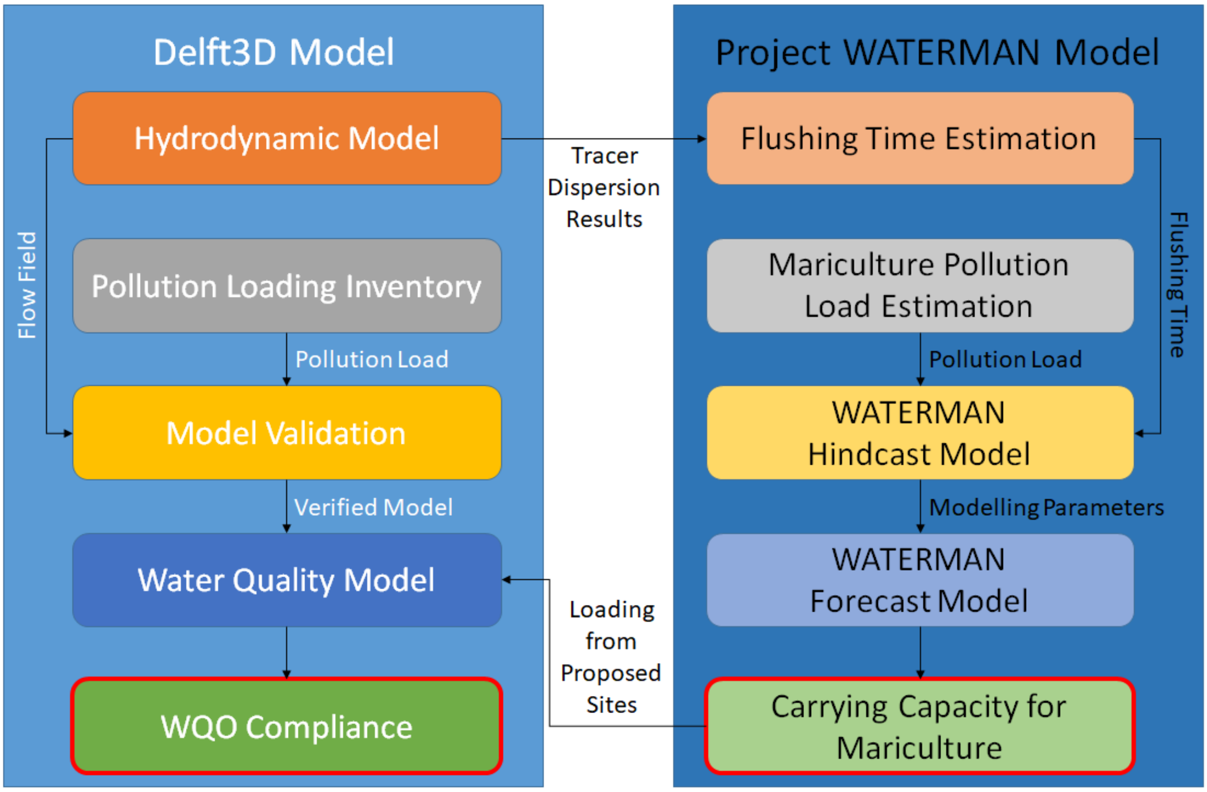
#	Potential Issue	Proposed Approach for this Assessment
	Construction Phase	
C1	Construction of new mariculture facilities	Qualitative
C2	Towing and anchoring of fish rafts, including change in hydrology, flow regime, water quality, release of sediments and other contaminants	Qualitative
	Operation Phase	
O1	Floating of permeable cages, including change in hydrology and flow regime	Qualitative
O2	Changes in water quality from pollution loadings from fish feed, feed wastage, fish excretion, dead fish, waste from human activities and faecal pollution from dogs and cats living on fish rafts	Quantitative, Delft3D and WATERMAN
O3	Fish drugs or other pharmaceutical chemicals, feed additives, disinfection of culture gears, sewage from workforce	Qualitative
O4	Maintenance dredging or removal of sediments shall include change in hydrology, flow regime, sediment erosion and deposition patterns, morphological change of seabed profile, water quality and sediment quality, and contaminant release and sediment release or resuspension	Maintenance dredging and sediment removal not required
O5	Increased marine traffic, boating and visitor activities, and release of sediments	Qualitative

1.5 Overview on Modelling Methodology

The water quality modelling would be conducted using the Delft3D suite of models, following typical arrangement of other water quality modelling exercise under EIAO. Additional modelling tools, developed under Project WATERMAN, would be adopted to estimate the carrying capacity of mariculture operation at the proposed FCZ site.

The water quality modelling assessment using Delft3D would be conducted in a typical manner: compilation of pollution loading inventory, followed by model validation (Appendix B referred) and then actual run of model. For the estimation of carrying capacity for mariculture activities and the associated sensitivity test, specific modelling tools developed under Project WATERMAN would be adopted. There are two modelling tools required to carry out this task. The first tool carries out hindcast modelling based on selected sets of loading from mariculture at FCZ sites near the proposed site (as a surrogate), system-wide flushing time of the surrogate site, background pollution level and meteorology conditions, etc., to derive the appropriate modelling kinetics and equilibrium parameters specific to the selected site. The required system-wide flushing time would be determined using the Delft3D model. The second tool carries out forecast modelling based on the selected set of modelling kinetics and equilibrium parameters, and predict the water quality conditions for a specific level of mariculture activities at the proposed FCZ site. The overall methodology for water quality modelling under this EIA study is illustrated in ***Figure 1.1***.

Figure 1.1 Overview on Modelling Methodology



The purposes and expected outcomes for each of the modelling tools / modules are:

- Delft3D FLOW: (1) verify hydrodynamic model; (2) provide flow field for modelling simulation under Delft3D WAQ; (3) estimate flushing time of FCZ (as input to WATERMAN Hindcast and Forecast Model);
- WATERMAN Hindcast Model: establish rate kinetics and equilibrium conditions specific to the FCZ (as input to WATERMAN Forecast Model);
- WATERMAN Forecast Model: estimate carrying capacity of FCZ (as input for FCZ loading to Delft3D WAQ); and
- Delft3D WAQ: predict water quality impact on the identified WSRs, for assessment of compliance with assessment criteria.

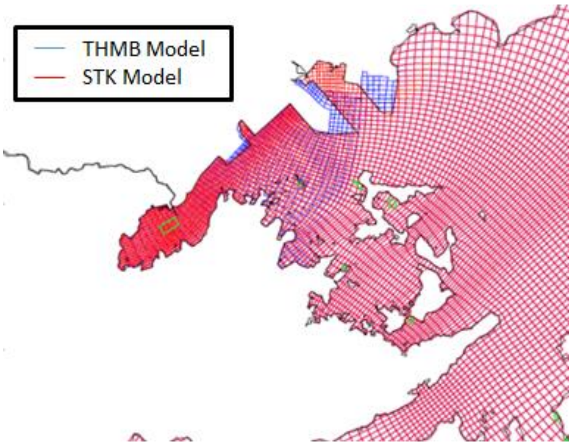
1.6 Model Selection – Delft3D

Preliminary study at the proposed FCZ site has been conducted under *Agreement AFCD/FIS/01/14 Identification of New Fish Culture Zones in Hong Kong – Feasibility Study* using the Delft3D suite of model. For the proposed FCZ site at Wong Chuk Kok Hoi, a Delft3D model (the STKDD Model), based on the previous Tolo Harbour-Mirs Bay (THMB) Model and Sha Tau Kok (STK) Model was developed to investigate the flushing time (further defined under *Section 3.1.3*) of the FCZ site. The THMB Model was developed by EPD under Agreement No. WP01-27 and was adopted in a number of approved EIAs including *AEIAR-081/2004 - Tai Po Sewage Treatment Works Stage V* and *AEIAR-202/2016 - Sha Tin Cavern Sewage Treatment Works* as well as other non-EIA modelling studies. The STK Model was adopted in the approved EIA of *AEIAR-207/2017 - Expansion of Sha Tau Kok Sewage Treatment Works*. The STKDD model is proposed to be adopted for the modelling studies for the EIA for the proposed FCZ at Wong Chuk Kok Hoi.

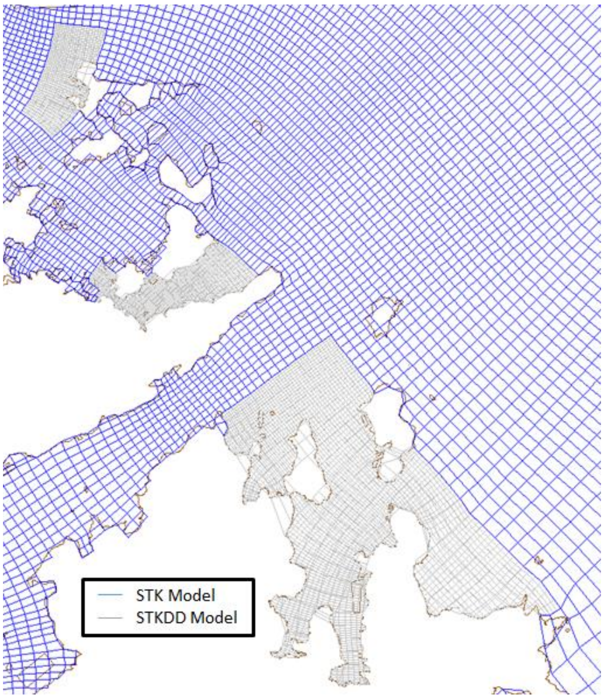
Note that the STKDD Model has previously been verified against its predecessor STK Model under *Consultancy Ref. AFCD/FIS/01/14 Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study* and was demonstrated to reproduce similar model prediction as the STK Model. Given the minor update of removing an unnecessary subdomain for the STKDD Model, additional model verification would be provided at a later stage of the EIA study.

The STKDD Model was developed from the STK Model, which itself was developed based on the THMB Model. When compared with the THMB Model, the STK Model has significantly more refined representation within Starling Inlet (i.e. Sha Tau Kok Hoi) and northern Mirs Bay. When compared with the STK Model, the STKDD Model included additional refinement at a number of selected locations, including the proposed FCZ site. These three model grids share the same coverage, land boundary, open boundary as well as bathymetry. These three models are shown in ***Figure* 1.2**.

Figure 1.2 Comparison of Model Grids



(Zoomed to Starling Inlet and northern Mirs Bay)

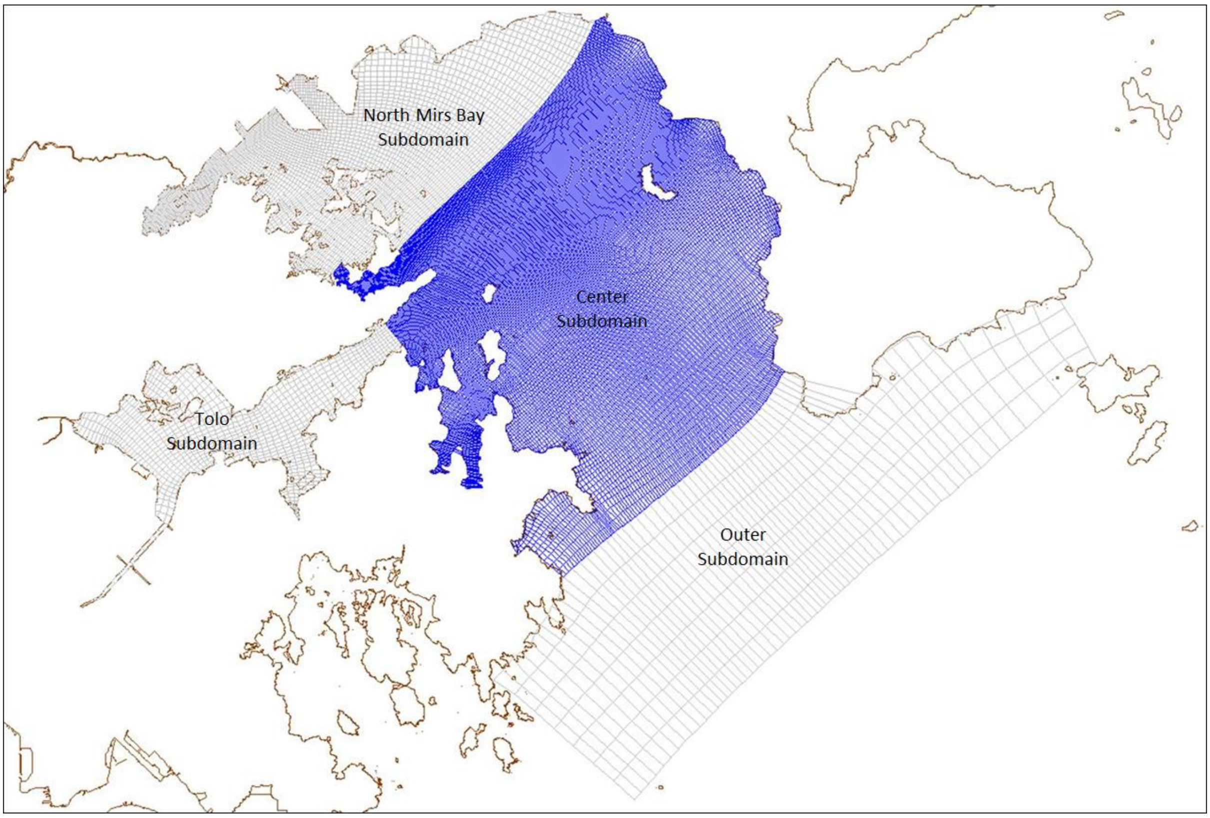


(Zoomed to the Tolo Channel, Long Harbour and Yan Chau Tong)

For this EIA study, amendment to the STKDD would be done by removing the subdomain at the northwest of the Island of Ap Chau as that specific subdomain is no longer needed. Also the subdomains at Hoi Ha Wan and Wong Chuk Kok Hoi extended significantly and fused together. For the rest of the model domain, no other amendment except update of bathymetry would be required. The adopted Modified STKDD Model is shown in *Figure 1.3*.

The model resolution of the Center subdomain at Wong Chuk Kok Hoi is around 80 m near its NE opening, and is around 40 m around the proposed FCZ site. Model resolution is around 80 m within Hoi Ha Wan, with resolution up to 150 m towards the relatively open Mirs Bay waters to the east of Wong Mau Chau.

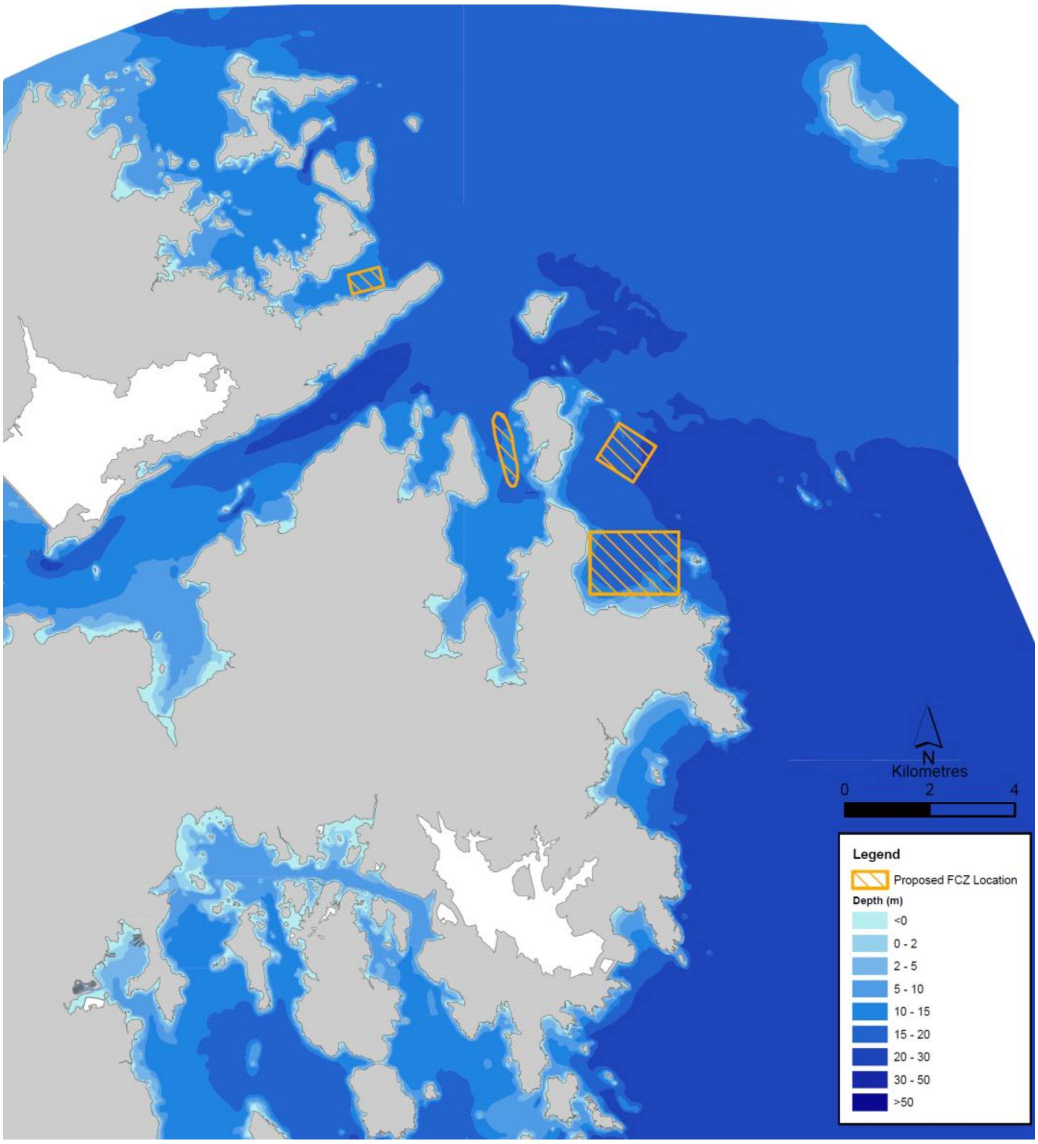
Figure 1.3 Schematization of the Modified STKDD Model



1.7 Coastline Configurations and Bathymetry

The latest coastline configuration 2019/2020 will be adopted in model simulations in this EIA study. There is no notable change in coastline configuration within the coverage of the STKDD Model in recent future based on approved EIAs as of May 2020. One potential future reclamation within the coverage of STKDD Model is the potential reclamation at Ma Liu Shui, which is around 15 km (geodesic distance) from the proposed FCZ site at Wong Chuk Kok Hoi and is not expected to result in notable change in flow regime and water quality. In view of the uncertainties in its implementation as well as vast distance from proposed site, the Ma Liu Shui Reclamation is not taken into account in this EIA study. Modelled bathymetry would be based on electronic nautical chart (ENC) published by the Marine Department in 2020, as shown in ***Figure 1.4***.

Figure 1.4 Modelled Bathymetry



1.8 Boundary conditions

As discussed in *Section 1.6*, the STKDD Model would share the same hydrodynamic boundary as its predecessors THMB Model and STK Model, which is driven by harmonic tide components. The water quality boundary conditions of the STKDD Model would be generated from the Update Model which takes into account pollution load from the entirety HK as well as the Pearl River Delta and Mirs Bay.

1.9 Ambient Environmental Conditions – background Temperature, Solar Radiation and Wind

The ambient environmental conditions are closely linked to the processes of hydrodynamic changes. The wind conditions applied in the hydrodynamic simulation are 5 m/s NE for dry season and 5 m/s SW for the wet season. The same average wind speed and direction were adopted in the Update Model [(3)].

(3) Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool (1998)

1.10 Simulation Periods

For Delft3D hydrodynamic modelling for estimation of flushing time (further discussed in *Section 3.1.3*), modelling spin-up will be included in the model. For each model, at least two 15-days (i.e. length of a typical spring-neap cycle in Hong Kong) of spin-up periods have been provided. The conditions after the two 15 days spin-up periods would be adopted as the initial condition of a 15-days model run. This 15-days run will generate initial conditions to start seven actual runs that have different start time covering an entire spring neap cycle. The simulation periods for these seven actual runs may varies but will be sufficiently long to allow tracer level be reduced to 1/e at the proposed sites.

For Delft3D hydrodynamic modelling to provide flow field for subsequent water quality modelling, the actual 15-days model run would be precede by two 15-days spin-up periods. Model run Delft3D water quality modelling would be run for a complete year driven by the hydrodynamic of the 15-days actual hydrodynamic model of the dry and wet season, taking into account seasonal variations in Pearl River discharges, monthly variations in solar radiation, water temperature and wind velocity.

1.11 Uncertainties in Assessment Methodologies

The uncertainties associated with the operation phase water quality modelling and carrying capacity estimation include:

- Potential change in pollution loading in China in future; and
- Potential change in mariculture practice which leads to different level of pollution loading from fish farms.

As discussed in *Section 3.2*, future year of 2023 was chosen because the future loading from the Guangdong Province of China is expected to decrease continuously and therefore the estimated loading in 2023 is would be conservative.

In terms of change in mariculture practice, the overall trend of mariculture practice has been heading towards the more environmental friendly direction in the past decades. The wider adoption of pellet feed has decreased feed conversion ratio, thus reduced wastage. Improved fish farming practice has reduced overfeeding, disease and fish mortality. Future improvement in technology and fish farming practice is expected to further the trend on small environmental footprint for mariculture, and thus the current assumptions are considered conservative.

2. WATER SENSITIVE RECEIVERS

The water sensitive receivers (WSRs) have been identified in accordance with *Annex 14* of the *Technical Memorandum on EIA Process* (*EIAO, Cap.499, S.16*) and the Study Brief. These WSRs are illustrated in ***Figure 2.1*** and listed in ***Table 2.1***. Key WSRs include:

- Recreational areas, such as secondary contact recreation subzones of WCZs [(4)];
- Yan Chau Tong Marine Park (MP1), as well as the Hoi Ha Wan Marine Park (MP2);
- Existing FCZs at Wong Wan and other nearby areas (F1 to F4);
- Proposed FCZs at Outer Tap Mun and Mirs Bay (Site B and Site C, respectively);
- Ecological habitats for marine organisms including coral and benthic communities, and Finless Porpoise [(5)] at / near the Project site (CR1 to CR3, CR8 to CR16, M1 to M5);
- Spawning ground and nursery areas of commercial fisheries resources [(6)];
- Artificial reefs in Yan Chau Tong Marine Park (MP1) and Hoi Ha Wan Marine Park (MP2);
- Intertidal area of Plover Cove Country Park (M1 to M5);
- Hoi Ha Wan SSSI (SSSI1); and
- Non-gazetted beaches (B1).

There is no seawater intake identified within 5 km from the Project Site, and other WSRs outside of 5 km from the Project Site is expected to be too far away to be impacted by the proposed mariculture operation. Also, the Tolo Channel (Northern Coast) Site of Special Scientific Interest was listed under EIA Study Brief section 3.4.3.2 as a sensitive receiver for this Project. Yet it is identified to be of land-based geological interest and is not expected to the affected by change in water quality. Therefore, it is not further considered for water quality impact assessment for this Study.

In accordance with the Study Brief, the Project site itself is also considered as a sensitive receiver for assessment.

(4) The entirety of the Tolo Harbour and Channel WCZ as well as the nearshore waters of the Mirs Bay are categorized as Secondary Contact Recreation Subzone. The predicted water quality at these areas are represented by other WSRs and thus do not have the respective WSRs for Secondary Contact Recreation Subzone only. Specifically, all WSRs identified under this Study except Site C and CR3 are located within Secondary Contact Recreation Subzone.

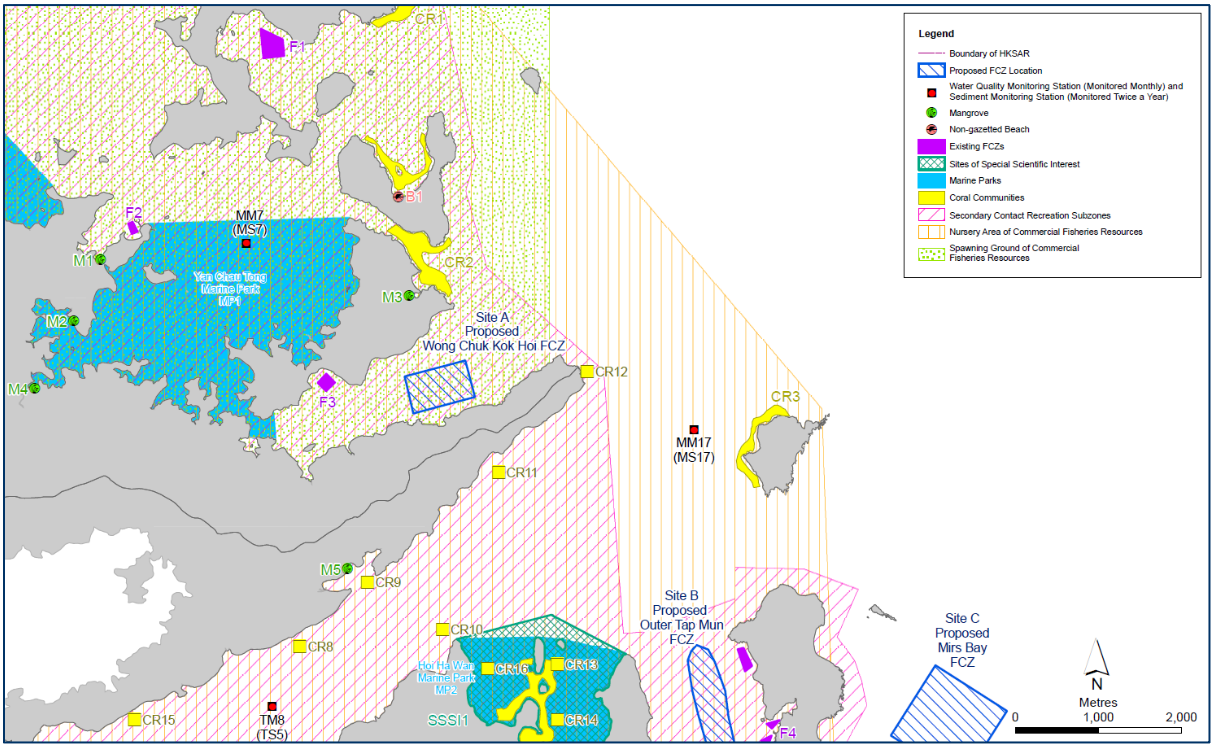
(5) Similar to the case of Secondary Contact Recreation Subzone, ecological habitat for finless porpoise is an areal WSR with wide coverage. The predicted water quality at these areas are represented by other WSRs and thus do not have the respective WSRs for ecological habitat for finless porpoise only. Note that according to the latest AFCD Marine Mammal Monitoring Report 2021/22, no records of finless porpoise were recorded in the assessment area.

(6) Similar to the case of Secondary Contact Recreation Subzone and ecological habitat for finless porpoise, spawning ground and nursery area of commercial fisheries resources is an areal WSR with wide coverage. The predicted water quality at these areas are represented by other WSRs and thus do not have the respective WSRs for spawning ground and nursery area of commercial fisheries only. Specifically, all WSRs identified under this Study except Site C are located within nursery area of commercial fisheries resources. WSRs located within spawning ground of commercial fisheries resources include M1-M4, F1-F3, CR1-2, MP1 and the Project Site itself.

Table 2.1 Water Sensitive Receivers (WSRs) in the Vicinity of the Proposed FCZ Site at Wong Chuk Kok Hoi

WSR ID	WSR	Distance to the Proposed FCZ site at Wong Chuk Kok Hoi (km)
B1	Non-gazetted beach of Crescent Bay	2.0
CR1	Coral at NE Crooked Island	4.1
CR2	Coral at Crescent Island and Double Island	0.8
CR3	Coral at Port Island	3.3
CR8	Coral at Wong Wan Tsui	3.1
CR9	Coral at Fung Wong Wat	2.1
CR10	Coral at Gruff Head	2.6
CR11	Coral at South Wong Wan Tsui	0.9
CR12	Coral at Wong Chuk Kok Tsui	1.3
CR13	Coral at Hoi Ha Wan Moon Island	3.4
CR14	Coral at Hoi Ha Wan Coral Beach	4.0
CR15	Coral at Sam Mun Shan	4.9
CR16	Coral at Heung Lo Kok	3.1
F1	O Pui Tong Fish Culture Zone	4.0
F2	Sai Lau Kong Fish Culture Zone	3.7
F3	Wong Wan Fish Culture Zone	0.9
F4	Tap Mun Fish Culture Zone	4.4
M1	Mangrove Stand / Intertidal at Ngau Shi Wu Wan	4.1
M2	Mangrove Stand / Intertidal at Ngor Tau Tsui	4.5
M3	Mangrove Stand / Intertidal at Tung Wan	1.0
M4	Mangrove Stand / Intertidal at Sam A Chung	4.5
M5	Mangrove Stand / Intertidal at Fung Wong Wat	2.3
MP1	Yan Chau Tong Marine Park and Artificial Reef within the Marine Park	1.1
MP2	Hoi Ha Wan Marine Park and Artificial Reef within the Marine Park	2.7
SSSI1	Hoi Ha Wan SSSI	2.8
Site A	Proposed Wong Chuk Kok Hoi FCZ	Project Site
Site B	Proposed Outer Tap Mun FCZ	3.9
Site C	Proposed Mirs Bay FCZ	6.3

Figure 2.1 Water Sensitive Receivers



As discussed in ***Table 1.1***, the potential impact on water quality that requires quantitative assessment using computational modelling is the change in water quality from the pollution loadings from fish feed, feed wastage, fish excretion, dead fish, waste from human activities and faecal pollution from dogs and cats living on fish rafts at the proposed FCZ site.

The following details the proposed methodology for the computational modelling exercise. The methodology has been based on the following three focus areas:

- Model Selection;
- Input Data; and
- Scenarios.

It is noted that some potential sources of water quality impacts are expected to be managed within acceptable levels based on preliminary design. These potential sources of water quality impact would be assessed qualitatively, with due consideration of control in mariculture practice and other control measures. As this Methodology presents information on the approach for numerical modelling and assessment for the EIA study, the potential sources of water quality impact requiring qualitative assessment are therefore considered beyond the scope of this Methodology and will not be further discussed.

3. ASSESSMENT OF CARRYING CAPACITY OF THE PROPOSED FCZ

As discussed in *Section 1.5* above, the modelling assessment required under this Study by the Study Brief will require the use of both the Delft3D suite of model as well as the modelling tools developed under Project WATERMAN. The modelling exercise would first estimate the carry capacity of the proposed FCZ site with the combined use of Delft3D FLOW and Project WATERMAN tools, and then the water quality impact from the proposed site would be assessed using Delft3D WAQ based on the pollution loading generated from mariculture at the estimated carrying capacity.

3.1 Flushing Time Estimation

The estimation of carrying capacity using Project WATERMAN tools requires the flushing time of the proposed FCZ site. The Delft-3D hydrodynamic and transport model will be used to determine the system-wide flushing time of a stratified water body via a numerical tracer experiment. The modelling method is based on *Choi and Lee (2004)*, the *Environmental Study for Establishment of Yim Tin Tsai Fish Culture Subzone* (YTT FCZ Subzone environmental study) [7] and *Agreement AFCD/FIS/01/14*. A unit hypothetical conservative tracer is instantaneously introduced into a region of interest such as a fish farm or an entire bay. The subsequent transport of the tracer mass by tidal currents and turbulent dispersion is computed numerically and the time variation of tracer inside the region is tracked. The ‘‘system-wide’’ flushing time will be used to estimate the long-term average water quality and it will be determined by tracking the tracer mass removal from a much larger water body that is connected to an adjoining ‘‘clean’’ ocean. In such a wide system, the removed pollutant will unlikely return. The “system-wide” flushing time will be obtained by analysing the computed time variation curve of tracer mass for the region of interest based on the numerical tracer experiment from the following equations:

$$\frac{M}{M_0} = \gamma e^{-k_1 t} + (1-\gamma)e^{-k_2 t} \quad (1)$$

$$T_f = \frac{\gamma}{k_1} + \frac{1-\gamma}{k_2} \quad (2)$$

The three fitted coefficients γ, k_1 and k_2 are related to the region volumes and tidal exchange flows (*Choi* and *Lee, 2004*) [8].

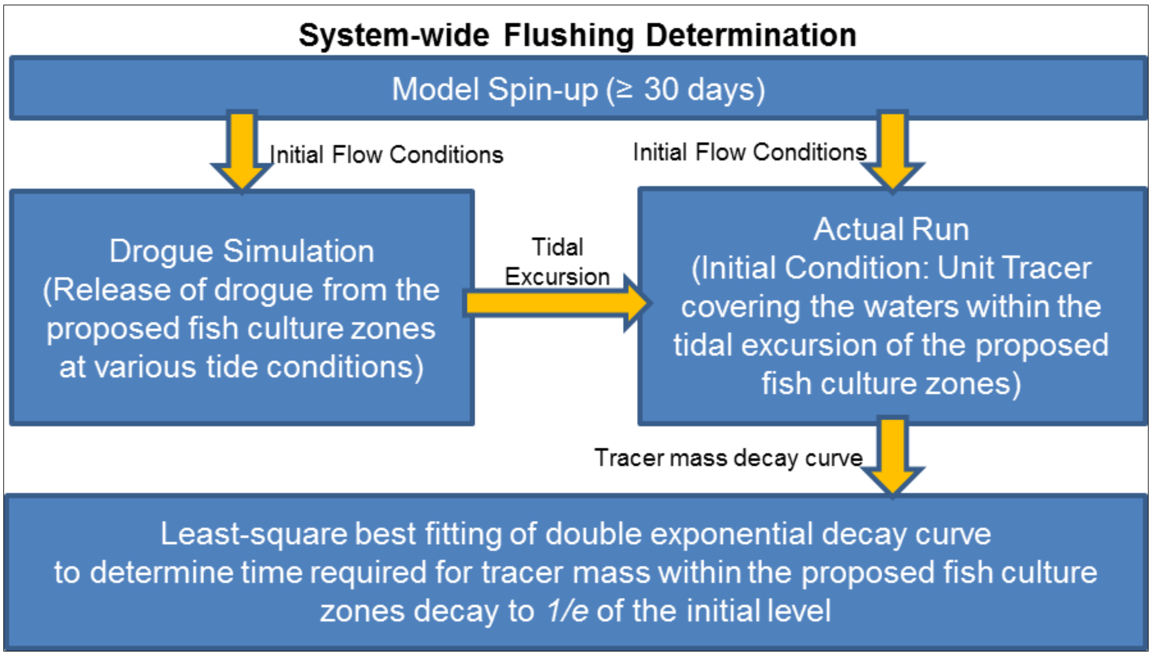
To compute system-wide flushing time, one-off release of conservative tracers (resulting unit concentration) within the model grid cells covering the waters within the tidal excursion of the proposed FCZ site (thereafter “initial dye area”) will be assumed at the start of the model, while no conservative tracer will be assumed for the rest of model domain, including the boundary conditions. For local flushing time computation, one-off release of conservative tracers will be assumed only at the model grid cells covering the proposed FCZ site.

Following the approach adopted under *Agreement AFCD/FIS/01/14*, the extent of which the one-off conservative tracer release would be determined through a drogue release modelling. Reference would be made to the drogue release modelling results under *Agreement AFCD/FIS/01/14*. For all flushing time calculation, at least 30-day spin-up period from “cold start” would be used before the tracer mass simulation starts. At the end of spin-up period, mass of conservative tracer within the proposed FCZ site would be plotted against time and best fitting curves of the tracer mass within the proposed FCZ site would be generated using least-square method assuming double exponential decay function. The system-wide flushing time of the proposed FCZ site is defined as the time required for the best fitting curves to reach *1/e* (i.e. *e* is the base of natural logarithm) of the initial tracer mass. The procedures for determination of system-wide flushing time are schematized in ***Figure 3.1***.

(7) ERM, 2015. Environmental Study for Establishment of Yim Tin Tsai Fish Culture Subzone for AFCD. Contract Ref. AFCD/SQ/182/13/C

(8) Choi, K.W., Lee, J.H.W., 2004. Numerical determination of flushing time for stratified waterbodies. Journal of Marine Systems 50, 263-281.

Figure 3.1 Procedures for Determining System-wide Flushing Time



Following the approach adopted under *Agreement AFCD/FIS/01/14*, the hydrodynamic model adopted for both the drogue and tracer simulations would be based on existing STK Model which take into account multiple harmonic tide components (O1, P1, K1, N2, M2, S2, K2, M4 and MS4).

3.1.1 Modelling Assessment Scenarios – Delft3D FLOW

Hydrodynamic modelling scenarios would be conducted using Delft3D FLOW to achieve the following:

- Verification of hydrodynamic model;
- Determination of initial dye area;
- Estimation of flushing time of the proposed FCZ site; and
- Generate flow field for the subsequent water quality modelling using Delft3D WAQ.

For the verification of hydrodynamic model, one (1) modelling scenario, consisting of at least 15 days of actual run preceded by at least another 15 days of model spin-up, would be conducted for each of the wet season and dry season.

For the determination of initial dye area, one (1) modelling scenario would be conducted for each of the wet season and dry season. Drogue would be released continuously throughout a 15 days period, and each drogue would have a life time of 12 hours (around double of a 6-hour average tide window). The path covered by the drogue track would be considered to be the area of initial mixing and be set up for initial dye area for the flushing time estimation.

For the estimation of flushing time of the proposed FCZ site, seven (7) modelling scenarios would be conducted for each of the wet season and dry season. The start time of these seven modelling scenarios would be spaced evenly within the 15 days spring-neap tide cycle to ensure the difference in start time has been taken into account already. Model run time may varies among different sites, but would be sufficiently long to ensure the inert tracer would be sufficiently diluted for the calculation of flushing time.

For generation of flow field for water quality modelling using Delft3D, model run would be conducted covering the a spring neap cycle for each of typical dry and wet season to allow the synthesis of typical flow field for an entire year with seasonal variation.

3.1.2 Determination of Initial Dye Area

As discussed in the previous section, the system-wide flushing time will be used to estimate the long-term average water quality and it will be determined by tracking the tracer mass removal from a much larger water body that is connected to an adjoining ‘‘clean’’ ocean. The extent of water body that is of concern to the proposed FCZ site is assumed to be confined within the area covered by the flooding and ebbing tide (i.e. one tidal excursion from the proposed FCZ site). Based on this assumption, any pollutant (released from the maricultural activities at proposed site) within one tidal excursion from the proposed site has a high chance of returning to the proximity of the proposed site and may affect local water quality, while any pollutant released beyond one tidal excursion from the proposed site would likely be washed away and be diluted by clean marine water. In view of the above, the area covered within the tidal excursion from the proposed FCZ site would be considered in calculation of system-wide flushing time.

The “Drogue” functionality of the Delft3D FLOW model would be used in this exercise. Floating drogue tracers are assumed to be released at the surrounding of the proposed FCZ site at the mid-ebb, mid-flood, high water and low water tide conditions. The drogue tracks up to a full flood-ebb cycle of each drogue release would be plotted on a map to determine the extent of tidal excursion, which would be the initial dye area.

3.1.3 Determination of Flushing Time via Delft3D Tracer Simulation

Following the approach of Wong *et al.* (2012) [9] as discussed above in *Section 3.1*, tracer dispersion modeling would be conducted to determine the flushing time of the proposed FCZ site. Initial unit tracer concentration (i.e. 1 g/L) will be set for the waters in the immediate proximity of the proposed FCZ site, indicated by the area covered by the tidal excursion determined by drogue release modelling described under *Section 3.1.1*, and then allowed to disperse through diffusion and tidal flushing. The system-wide flushing time of the proposed site would be determined by the decay constant k_1 and k_2 of the double-exponential decay curve obtained by least-square best fitting of remaining tracer mass within the proposed site. In all model runs, the values of the assumed background horizontal and vertical diffusivity would be 1 m^2/s and 5×10^{-5} m^2/s respectively. The settings are the same as the original models (the Update Model and the THMB Model) which the existing model derived from / built upon.

Wong *et al.* (2012) adopted only the M2 tide component for boundary condition of the tracer dispersion modelling. For this Study, real tide consists of all major tide components inherited from the Update Model would be included. For each season, a total of 7 tracer dispersion modelling scenarios would be conducted, which are distributed evenly across a spring-neap cycle of 15 days. This is to ensure the modelled dispersion of inert tracer takes into account various tide conditions throughout a spring-neap cycle.

3.2 Carrying Capacity Estimation

The estimated flushing time from Delft3D FLOW simulation would be adopted for carrying capacity estimation using the WATERMAN’s Hindcast and Forecast Modelling Tool.

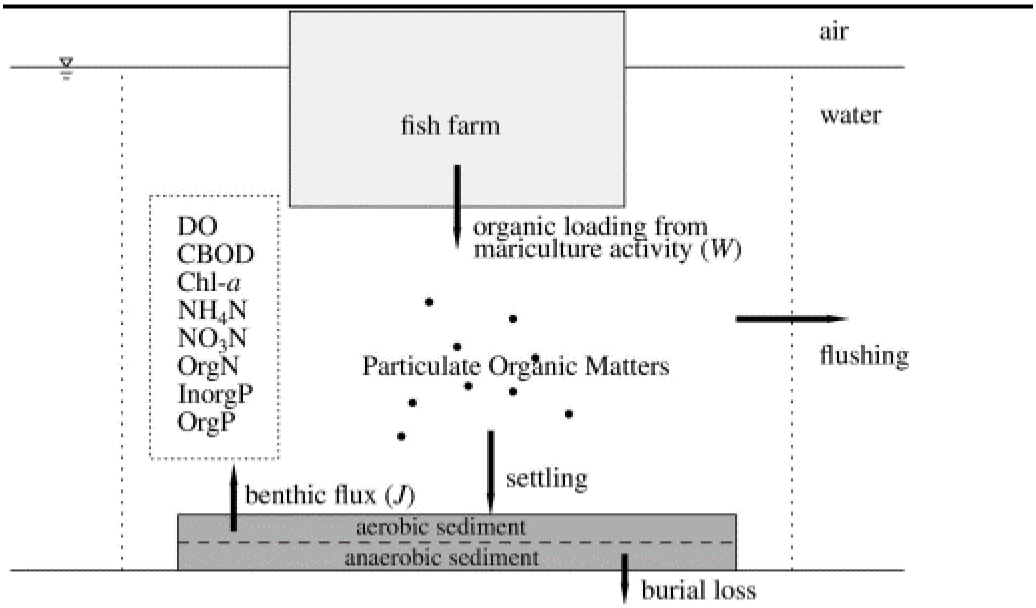
3.2.1 Model Selection – WATERMAN’s Hindcast and Forecast Modelling Tools

The WATERMAN’s hindcast and forecast modelling tools would be used to quantify the impacts of fish farm activities on local water quality and ecosystem. Eutrophication and associated processes are considered in the water quality model based on the framework shown in ***Figure 3.2*** and ***Figure 3.3***. The WATERMAN model has been fully tested and validated against field data as well as

(9) Wong *et.al.* 2012. Project WATERMAN Carrying Capacity of Fish Culture Zones in Hong Kong - Technical Note TN-2012-02

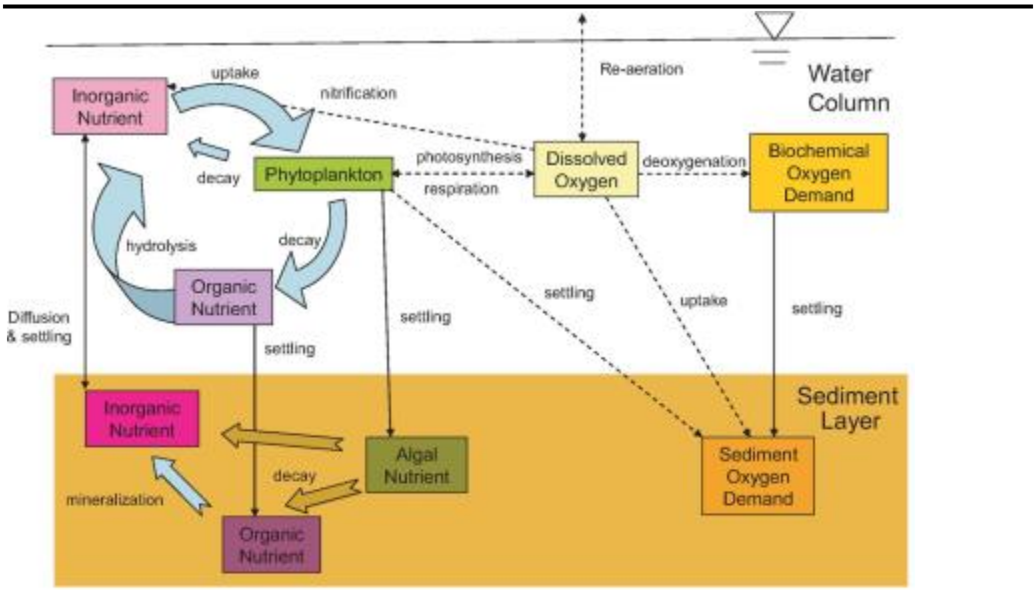
comparison with 3D model results. Details of water quality model process and validation could be found in the final report of Project WATERMAN.

Figure 3.2 Schematic Diagram of the Water Quality Model for the Fish Farm



Source: Project WATERMAN

Figure 3.3 Schematic Diagram of Eutrophication Kinetics and Processes Included in the Water Quality Model for the Fish Farm



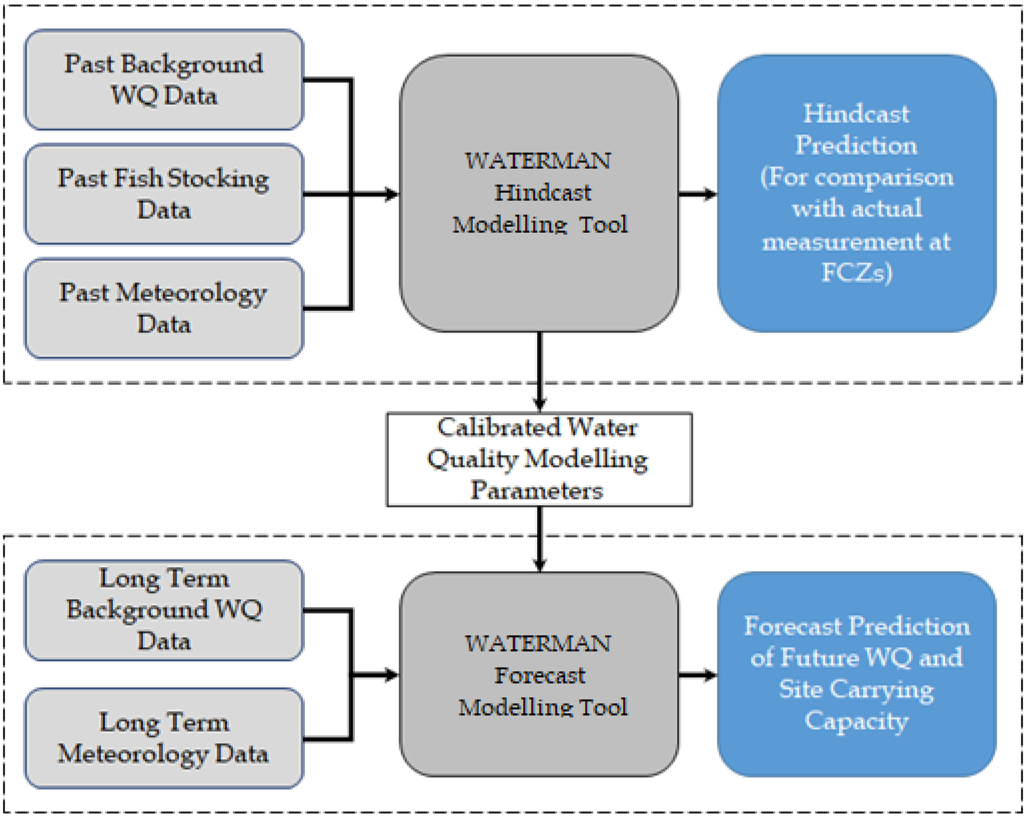
Source: Project WATERMAN

3.2.2 *Hindcast Modelling for Calibration of Modelling Parameters*

To ensure the water quality modeling parameters selected for modeling prediction by the WATERMAN system provide reasonable estimation on actual conditions, calibration of water quality modeling parameters would first be conducted using the WATERMAN hindcast modelling tool. The hindcast modelling tool makes use of past meteorology data, FCZ operation data, background water quality data, etc. to conduct back test (i.e. hindcast) for the ability of a specific set of water quality modeling parameters to simulate the water quality conditions at the FCZ. The calibrated set of water quality modeling parameters would then be adopted in the forecast modelling tool of the WATERMAN system, which conduct forecast of water quality condition at the same FCZ for a given fish stock level, based on the same set of algorithm for water quality calculation.

Since this modeling exercise aims at estimating the potential carrying capacity of the proposed FCZ site where there is no existing mariculture activity, there is a need to use nearby surrogate sites for calibration of water quality modeling parameters with existing mariculture activity. The surrogate sites are selected based on physical proximity. For the proposed FCZ site at Wong Chuk Kok Hoi, the existing Wong Wan FCZ would be adopted as surrogate site. The relationship between the hindcast and forecast modelling tool of the WATERMAN system is presented in ***Figure 3.4***. The following section presents a summary of major considerations on the calibration of water quality modeling parameters at each surrogate site.

Figure 3.4 Relationship of the WATERMAN Hindcast and Forecast Modelling Tool



For all the calibration exercise under this EIA study, data of background water quality (from EPD) for the latest three years, together with water quality data at existing FCZs, fish stocking data (from AFCD) and meteorology data (from HKO) of the same years would be used.

3.2.3 Modelling Assessment Scenarios – WATERMAN's Hindcast Modelling Tool

The WATERMAN's hindcast modelling tool would be used to determine the appropriate modelling parameters locally for the proposed FCZ site. The purpose is to calibrate the modelling parameters of the hindcast modelling tool to reproduce the observed water quality conditions at the surrogated site. Modelling would be conducted for multiple years at the surrogated site as identified under *Section 3.2.2*.

3.2.4 Forecast Modelling for Carrying Capacity Estimation

After obtaining a set of modelling parameters which allow reproduction of water quality conditions at the surrogated site, the same set of modelling parameters would be adopted for the forecast model. Based on the calibrated modelling parameters, together with long term background water quality data as well as meteorological data, the forecast model will estimate the water quality condition at the proposed site based on different level mariculture activity. The carrying capacity would be determined from the borderline case of mariculture scale which one of the water quality criteria for maricuture zone has been exceeded at the proposed site.

3.2.5 Modelling Assessment Scenarios – WATERMAN's Forecast Modelling Tool

Based on the appropriate modelling parameters determined using the hindcast modelling tool, carrying capacity would be estimated using the WATERMAN's forecast modelling tool. To ensure there would be sufficient safety margin in terms of carrying capacity, sensitivity tests would be conducted taking into account variations in three key input parameters for the WATERMAN's forecast modelling tool, namely flushing time, stock to production ratio and maximum algal growth rate. Three (3) sensitivity test settings (by increasing or decreasing each of these parameters by 20%, i.e. 80%, 100% and 120% of the original values) for each of the above parameters would be considered and a total of 3 × 3 × 3 would be conducted for each season for the proposed FCZ site. The carrying capacities with safety margin of 90th- and 95th-percentile will be estimated accordingly based on these 27 tests estimated for each season.

3.3 Assessment Criteria

Water Quality Objectives (WQOs) in the Mirs Bay and Tolo Harbour and Channel WCZs will be used to assess water quality impacts on DO, TIN, UIA, chlorophyll-a and *E.coli* during Project operation.

Table 3.1 Summary of Assessment WQO Criteria

Parameters	Mirs Bay WCZ	Tolo Harbour and Channel WCZ
Dissolved Oxygen (Bottom) (mg/L)	Not less than 2 mg/L for 90% of samples for all WCZs	Not less than 2 mg/L for the Harbour subzone. Not less than 3 mg/L for the Buffer subzone. Not less than 4 mg/L for the Channel subzone.
Dissolved Oxygen (Depth-averaged) (mg/L)	Not less than 4 mg/L for 90% of samples for all WCZs	Not less than 4 mg/L.
Suspended Solids (mg/L)	Change ≤ 30% due to waste discharge	Not applicable
Total Inorganic Nitrogen (mg/L)	≤ 0.3	Not applicable
Unionized Ammonia (mg/L)	≤ 0.021 mg/L for all WCZs	Not applicable
Chlorophyll-a (μg/L)	Not applicable	5-day running average not more than 20 μg/L for the Harbour subzone. 5-day running average not more than 10 μg/L for the Buffer subzone. 5-day running average not more than 6 μg/L for the Channel subzone.
E.coli (no./100mL)	≤ 610 no./100mL for the Secondary contact recreation subzone and the Fish culture subzones	≤ 610 no./100mL for the Secondary contact recreation subzone and the Fish culture subzones

For the proposed FCZ at Wong Chuk Kok Hoi, the following water quality criteria as shown in ***Table 3.2*** would be applicable for estimation of carrying capacity.

Table 3.2 WQ Criteria for Estimation of Carrying Capacity at Project Site

Parameters	Assessment Criteria
Dissolved Oxygen (Depth-averaged) (mg/L)	5 mg/L
Unionized Ammonia (mg/L)	0.021 mg/L
Total Inorganic Nitrogen (mg/L)	0.3 mg/L
Inorganic Phosphate (mg/L)	0.018 mg/L
Chlorophyll-a (µg/L)	20 µg/L
5-Day Biochemical Oxygen Demand (mg/L)	5 mg/L

4. COMPILATION OF POLLUTION LOADING INVENTORY

Estimation of pollution loading from mariculture activities would be conducted based on the methodology provided by AFCD (***Appendix A***). This estimated pollution loading would be adopted for both the water quality modelling exercise using Delft3D as well as the carrying capacity estimation using the WATERMAN modelling tools.

Estimation of pollution loading from other sources would be conducted following the established method from *Update on Cumulative Water Quality and Hydrological Effect of Coastal. Developments and Upgrading of Assessment Tool (1998)*. Pollution loading would be estimated for 2016 (for model validation) and 2023 (for project scenario). These years are selected because:

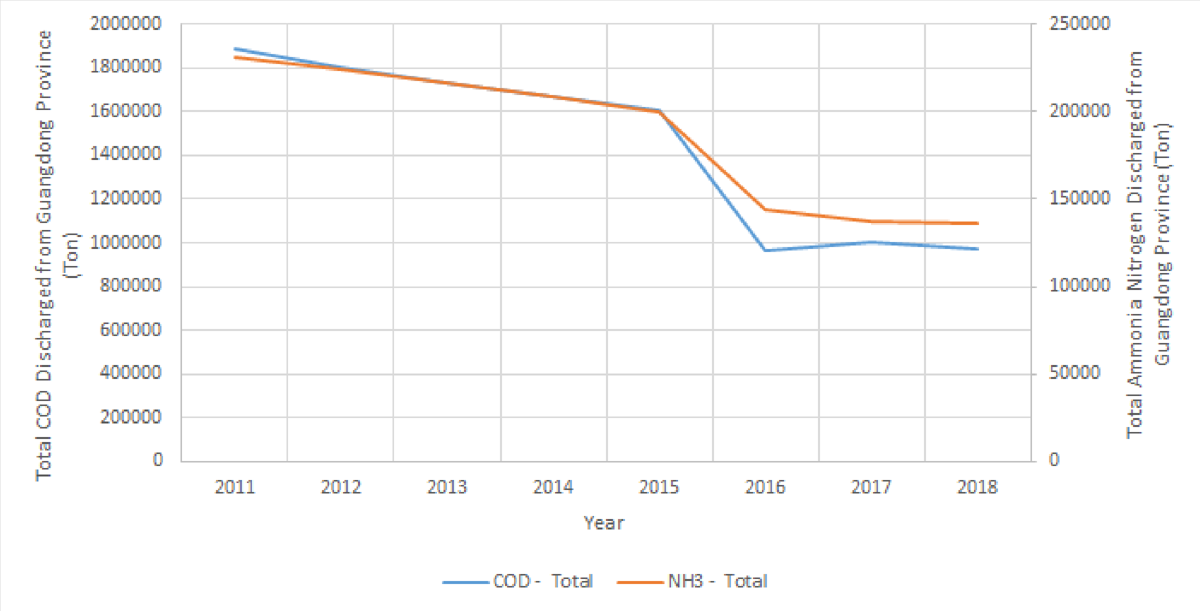
<u>For 2016:</u>

- This is the nearest base year for the 2016-based Territorial Population and Employment Data Matrix (TPEDM) in the past, thus avoid interpolation of population between different base years and the associated uncertainties.

<u>For 2023:</u>

- This is likely the year of designation of the proposed FCZ.
- Given there are multiple sewerage upgrade and expansion projects being planned and / or implemented which will be completed by 2023 and beyond (please refer to *Section 4.5*), 2023 would likely represent the worst case in terms of local loading after the designation of the proposed FCZ.
- The proposed FCZ site is relatively remote from the developed area of Hong Kong. When the wider region is considered, pollution contributions from the Guangdong province of China (GD) is shown to be decreasing over recent years as a result of increasingly stringent discharge standards and the provision of sewage treatment facilities (***Figure 4.1***). Thus modelling based on estimated pollution loading in 2023 would likely be more conservative than based on those in more distant future.

Figure 4.1 Estimated Sewage Chemical Oxygen Demand and Total Ammonia Nitrogen Load in GD by Department of Ecology and Environment of GD



Source: Department of Ecology and Environment of GD, Environmental Statistics. Available at: http://gdee.gd.gov.cn/tjxx3187/

4.1 Sources of Population Data

The projected population data of 2016 and 2023 would be based on the 2016-based TPEDM from the Planning Department. The latest forecast data give projected population breakdown by a total of 454 Planning Data Zones (PDZ), and on residential population by three categories, employment data by 19 categories and number of school places by four categories. These categories are summarised in ***Table 4.1***.

Table 4.1 Categories of Population Data

Residential population	Employment Data	Education Data
Usual Residents	S1: Agriculture, forestry and fishing, mining and quarrying	Kindergarten
Mobile Residents With Regular Residence in HK	S2: Manufacturing	Primary
Mobile Residents Without Regular Residence in HK	S3: Electricity and gas supply, water supply, sewerage and waste management	Secondary
	S4: Construction	Post-secondary
	S5: Import and export trade	
	S6: Wholesale	
	S7: Retail trade	
	S8: Transportation, storage, postal and courier services	
	S9: Short term accommodation activities	
	S10: Food and beverage service activities	
	S11: Information and communications	

Residential population	Employment Data	Education Data
	S12: Financial and insurance activities	
	S13: Real estate activities	
	S14: Professional, scientific/technical, administrative and support service activities	
	S15: Public administration	
	S16: Education	
	S17: Human health activities	
	S18: Other social and personal services	
	S19: Work activities within domestic households	

To estimate sewage generated from domestic, commercial and industrial sources, population and employment data are handled as follows to obtain the required metrics:

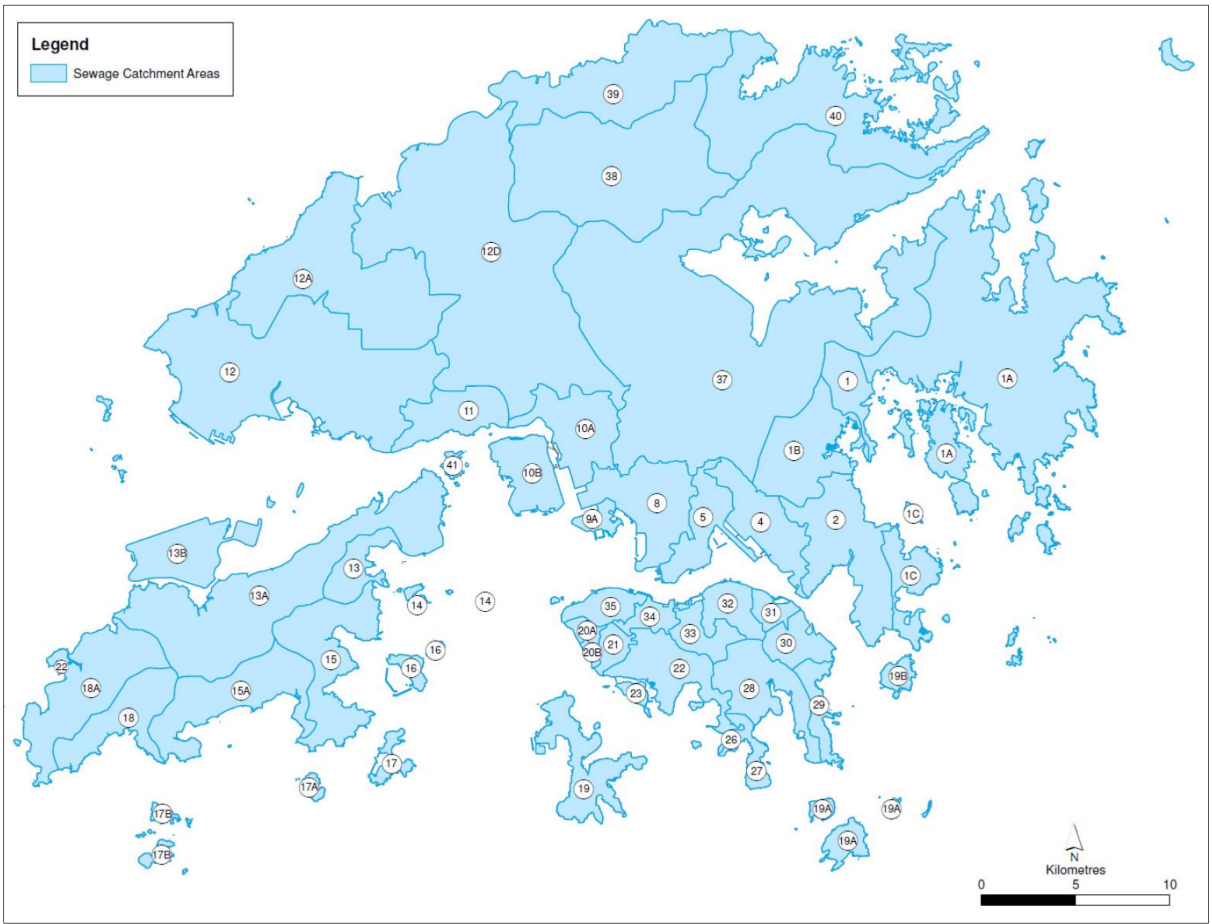
- **Residential population** = Sum of (Usual residents), (Mobile residents with regular residence in HK) and (Mobile residents without regular residence in HK)
- **Transient population** = Sum of (Total Employment [Employment S1+S2+…+S19]) and (Total Number of Full-time School Places in HK [from Kindergarten to Post-Secondary])
- **Number of employees in commercial sector** = Sum of Employment (S3, S4, S6 - S11, S17 – S18) (10)
- **Number of employees in manufacturing sector** (S2) by six sub-categories, namely food, textiles, leather, paper, manufacturing and machinery.

4.2 Spatial Aspect

Following the approach adopted in the Update Study and the Harbour Area Treatment Scheme (HATS) Studies, population in each of the sewage catchment areas (SCAs) are calculated based on the estimated population data for each of the PDZs using the pro-rata method. Plan of sewage catchment areas from the approved EIA of HATS 2A will be adopted for this EIA study and is shown in ***Figure 4.2***.

(10) In the approved EIA of HATS 2A, the job type categories consist of 12 job types (compared with 19 in the latest TPEDM). Similar composition of employees in the commercial sector with 19 job types has been adopted in the approved EIA of the Sha Tin Cavern Sewage Treatment Works (AEIAR-202/2016). These 10 commercial sectors listed are particular sectors where additional sewage / wastewater would be generated from their work nature.

Figure 4.2 Sewage Catchment Area



Note: Ma Wan was originally included as part of the SCA of North Lantau under the approved EIA of HATS 2A. However, Ma Wan has a separate sewage treatment works and it is considered as a separate sewage catchment areas under this Study. Sewage collected within this catchment would be diverted to the Ma Wan Sewage Treatment Works for treatment.

In general, when compiling population data in each of the SCAs, it is assumed population (residential, transient, employed and students) are distributed evenly spatially. The percentages of land area of PDZs within each of SCAs are calculated based on available GIS plans. The total population of each SCAs are then calculated as a summation of the percentage of land area of each PDZs within the corresponding SCAs multiplied by the population of each PDZs. Numerically, the calculation is illustrated below:

$$k_j = \sum p_{ij} K_i$$

where k_j = Estimated population (residential, transient, employed and students) in SCA j

Ki = Population (residential, transient, employed and students) in PDZ i

p_{ij} = Percentage of land area of PDZ i located within SCA j

4.3 Unit Factor for Flow and Load

Total sewage flow and load for each SCA are estimated based on the estimated population (residential population, employees and students) and the corresponding unit flow and load factors for each pollutant. The same unit flow and load factors from *Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (Version 1.0), EPD, March 2005* (referred as GESF hereafter) (adopted in the approved EIA of HATS 2A) will be assumed. These flow and load factors are summarised in ***Table 4.2***.

Sewage flow from residential population can be estimated based on either catchment-specific or housing type-specific flow factor. Catchment-specific flow factor is adopted because it would result in higher overall sewage flow, for a more conservative assessment.

4.4 Industrial Effluent

Following the approach adopted in the Update Study and the HATS Studies, industrial effluent from six sub-categories of the manufacturing sectors, namely food, textiles, leather, paper, manufacturing and machinery, will be estimated based on the corresponding number of employees and unit load factors for industrial activities. Since then, the classification has been replaced by the Hong Kong Standard Industrial Classification Version 2.0 (HSIC 2.0). There is no available update employment data (in TPEDM, 2011 Census or 2016 By-census) which provide detailed breakdown sufficient for the purpose of this EIA study.

Given the lack of employment data at the desired level of geographical and industrial sub-divisions, estimation of number of employee in the selected manufacturing industry is based on geographical and industrial sub-divisions assumed in Table 11 of Working Paper No. 6 of the Environmental and Engineering Feasibility Assessment Studies in Relation to the Way Forward of the Harbour Area Treatment Scheme (EEFS of HATS), scaled up to the population in the manufacturing industry in 2016 and 2023.

Estimated number of employees in each relevant manufacturing industry under the EEFS WP6 are provided in ***Table 4.4***

Table 4.2 Unit Flow and Load Factors for Domestic, Commercial and Industrial Flows

Description	Flow [1] m^3/d/head	SS [2] g/d/head	BOD5 [2] g/d/head	TKN [2] g/d/head	NH_3-N [2] g/d/head	TP [3] g/d/head	Cu [3] g/d/head	*E.coli* [2] no./d/head
Usual residents (catchment specific)								
Sandy Bay	0.350							
Stanley, Discovery Bay	0.290							
Shek O	0.350							
Outlying Islands, Sai Kung	0.270							
Yuen Long, Mui Wo	0.250							
Aberdeen, Wan Chai, North Lantau	0.230	40	42	8.5	5.0	1.33	0.0065	4.3×10^{10}
Sha Tin, Tai Po	0.220							
San Wai	0.230							
Wah Fu, Shek Wu Hui	0.210							
Northwest Kowloon, Tuen Mun, Central, North Point	0.200							
Ap Lei Chau, Chai Wan, Shau Kei Wan, Central Kowloon, East Kowloon, Kwai Chung, Tsing Yi, Tseung Kwan O	0.190							
Usual residents (housing type specific)								
Public rental	0.190							
Private R1	0.190							
Private R2	0.270							
Private R3	0.370							
Private R4	0.370	40	42	8.5	5.0	1.33	0.0065	4.3×10^{10}
Traditional village	0.150							
Modern village	0.270							
Institutional and special class	0.190							
Temporary and non-domestic	0.150							
General- Other housing (for catchment wide planning)	0.175	40	42	8.5	5.0	1.33	0.0065	4.3×10^{10}
Mobile residents	0.190	40	42	8.5	5.0	1.33	0.0065	4.3×10^{10}
Employed population	0.08	34	34	6.7	4	1.06	0.0052	3.5×10^{10}
Students	0.04	34	34	6.7	4	1.06	0.0052	3.5×10^{10}
Commercial Activities								
S3: Electricity and gas supply, water supply, sewerage and waste management	0.25							

Description	Flow [1] m^3/d/head	SS [2] g/d/head	BOD5 [2] g/d/head	TKN [2] g/d/head	NH_3-N [2] g/d/head	TP [3] g/d/head	Cu [3] g/d/head	*E.coli* [2] no./d/head
S8: Transportation, storage, postal and courier services & S11: Information and communications	0.10							
S6: Wholesale & S7: Retail trade	0.20	25	53	2.5	0.8	0.53	0	0
S4: Construction	0.15							
S9: Short term accommodation activities & S10: Food and beverage service activities	1.50							
S15: Public administration, S16: Education, S17: Human health activities & S18: Other social and personal services	0.2							
S2 Manufacturing								
Food	N/A (4)	632	898	44	0	0	0	0
Textiles	N/A (4)	2095	3680	67	0	0	4.4	0
Leather	N/A (4)	432	288	44	11	0	0.1	0
Paper	N/A (4)	2228	2150	33	0	0	0	0
Manufacturing	N/A (4)	355	931	0	0	0	2.4	0
Machinery	N/A (4)	89	133	33	22	0	0.9	0

Note:
1. Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (Version 1.0), EPD, March 2005
2. Table 4 of DSD Sewerage Manual
3. EPD Update Study
4. Catchment Specific; please refer to ***Table 4.3***.

Table 4.3 Flow Factors for Industrial Activities

Catchment	Flow (1) (m^3/head/d)
Hong Kong Island (except Aberdeen & Ap Lei Chau), San Po Kong	0.25
North West Kowloon, East Kowloon, Sha Tin, Lantau Island (except Mui Wo)	0.45
Central Kowloon, North District, Aberdeen, Ap Lei Chau	0.55
Tsuen Wan, Kwai Chung	0.65
Tai Po	0.75
Tuen Mun, Tseung Kwan O, Yau Tong, Cheung Chau, Mui Wo	1
Tsing Yi	1.5
Sai Kung, Yuen Long	2

Table 4.4 Estimated Number of Employees working in Manufacturing Sectors from EEFS WP6

Catchment	Food	Textiles	Leather	Paper	Manufacturing	Machinery	Total Manufacturing
Sai Kung	112	1	0	5	139	44	426
Sai Kung Country Park	19	0	0	0	0	1	64
Pak Sha Wan	50	0	0	0	7	9	142
Clear Water Bay	0	0	0	0	0	0	2
Tsuen Kwan O	1,174	191	0	430	2,497	306	16,808
Yau Tong	142	135	0	21	64	154	1,738
East Kowloon	932	1,035	83	448	330	2,328	26,527
North Kowloon	1,240	386	8	46	39	206	9,964
Central Kowloon	177	84	32	11	70	209	5,209
South Kowloon	29	5	2	17	41	97	2,910
Yau Ma Tei	348	127	19	56	119	915	8,473
Sham Shui Po	705	376	28	98	41	711	8,019
Lai Chi Kok	122	134	6	25	23	126	2,671
Stonecutters Island and West Kowloon Reclaimed Area	372	55	202	20	226	253	1,491
Kwai Chung and Tsuen Wan East	1,435	1,991	154	314	958	2,855	42,149
Tsing Yi	321	489	2	15	860	433	14,666
Tsuen Wan West (Rural Area)	1,144	0	0	0	7	1	1,171
Tuen Mun	1,350	723	39	41	777	954	15,263
Yuen Long and Tin Shui Wai	3,762	313	0	139	952	1,361	12,700
Deep Bay Streams	34	0	0	0	22	51	128
Yuen Long New Town	77	12	0	7	34	35	336
Kam Tin	91	0	3	0	27	41	427
Discovery Bay	0	0	0	0	0	0	15
North Lantau	0	0	0	0	0	0	94
Chei Lap Kok	0	0	0	0	12,713	0	12,713
Peng Chau	0	0	0	0	0	0	4
Mui Wo	0	0	0	0	0	2	19
South Lantau	0	0	0	0	0	6	72
Hei Ling Chau	3	0	2	0	2	2	12
Cheung Cheung	49	7	0	5	1	17	197
Shek Kwu Chau	1	0	0	0	0	0	3
Tai A Chau	1	0	1	0	1	1	5
Shek Pik	36	0	0	0	0	0	36
Tai O	36	0	0	0	0	0	64
Lamma Island	19	0	0	2	23	0	44
Po Toi Islands	0	0	0	0	0	0	0
Tung Lung	0	0	0	0	0	0	0
Pokfulam	426	6	3	32	90	30	1,335
Wah Fu Estates and Mt. Kellet	0	0	0	0	7	0	23

Catchment	Food	Textiles	Leather	Paper	Manufacturing	Machinery	Total Manufacturing
Aberdeen	528	12	3	134	318	122	3,832
Ap Lei Chau	804	4	0	14	624	185	3,999
Shouson Hill and Repulse Bay	0	0	0	0	0	37	196
South Bay	0	0	0	0	0	0	44
Chung Hom Kok	0	0	0	0	0	0	9
Stanley	0	0	0	1	0	0	74
Tai Tam	0	0	0	0	0	1	3
Shek O	1	0	0	0	0	0	1
Chai Wan	728	149	36	643	344	609	9,579
Shau Kei Wan	178	10	3	160	144	472	3,790
North Point	417	20	6	955	455	325	7,686
Wan Chai East	181	55	0	409	119	140	3,101
Wan Chai West	206	9	0	343	257	572	3,994
Western and Central	1,129	27	22	236	376	153	6,796
Green Island	97	14	53	5	59	66	388
Tolo Harbour Catchment	6,823	192	24	316	1,215	2,534	45,634
Sheung Shui and Fanling	476	48	11	31	252	312	3,274
North New Territories	131	16	24	18	328	408	2,155
Sha Tau Kok	45	1	0	25	10	9	115

4.5 Sewage Flow Interception

Sewage flow and load generated from domestic, commercial and industrial activities will be assumed to be either (1) discharged into the sewerage system, treated in sewage treatment works and discharged into marine waters (referred as “collected stream” hereafter) or (2) released into marine waters, either directly or via rivers / drainage system (referred as “released stream” hereafter). Percentage of pollution load ended up in the released stream depends on the availability (high percentage of pollution load for unsewered area), maintenance (sewerage collection system may be faulty if not properly maintained) and remaining capacity (overflow may occur more frequently as sewage flow approaches the capacity of its collection system) of public sewer, presence of expedient connections or illegal discharges. The amount of sewage received by the sewage treatment works is the sum of all collected stream of sewage flow within the SCA of the sewage treatment works. The percentage of collected stream to the entirety of sewage generated within the SCA, also known as sewage interception rate, are based on the approved EIA of HATS 2A, with updates based on approved sewage treatment works EIAs since 2008, as well as other STW- / catchment-specific information provided by DSD. Notable updates based on approved EIAs include:

- EIA-219/2013 Outlying Island Sewerage Stage 2 - Upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities: The project involves the upgrading of i) existing Cheung Chau STW (primary treatment with design capacity of 4,000 m^3/day) to secondary treatment with capacity of 9,800 m^3/day; and ii) Pak She Sewage Pumping Station (SPS) (increase peak pumping capacity from 29,000 m^3/day to about 42,000 m3/day). This project also involves the provision of public sewer to currently unsewered area. Cheung Chau STW and Pak She SPS upgrading are estimated to commence in 2019 for completion by 2025.
- EIA-240/2016 Sha Tin Cavern Sewage Treatment Works: This project involves the relocation of the existing Sha Tin Sewage Treatment Works (STSTW) into caverns located at Nui Po Shan. No major change in discharge rate, quality and location was proposed. Project operation is

expected to be beyond 2023. It was assumed in this approved EIA that sewage loss to storm water would 5% within the Tolo Harbour SCA. The same value is adopted for this EIA study.

- EIA-243/2016 Outlying Islands Sewerage Stage 2 - Upgrading of Tai O Sewage Collection, Treatment and Disposal Facilities: This project involves the upgrading of the existing Tai O Sewage Treatment Works (TOSTW) to secondary treatment and expanding treatment capacity to 2,750 m^3/day. As of early 2021, construction works for this Project has not been commenced. Project operation is expected to be beyond 2023.
- EIA-246/2016 Outlying Islands Sewerage Stage 2 - South Lantau Sewerage Works: This project involves the provision of sewerage collection and treatment facilities for the currently unsewered villages of South Lantau. The proposed San Shek Wan STW (SSWSTW, capacity of 5,800 m^3/day) will provide secondary treatment for sewage collected from the said region and the treated sewage effluent will be discharged via a submarine outfall. Given the project is still in its planning and design stage (https://www.dsd.gov.hk/EN/Our_Projects/All_Projects/4331DS.html), project operation are not expected in year 2023.
- EIA-245/2016 Expansion of Sha Tau Kok Sewage Treatment Works: This project involves the expansion of the existing Sha Tau Kok Sewage Treatment Works (STKSTW, design average dry weather flow = 1,660 m^3/day) to 5,000 m^3/day in 2023 and ultimately to design capacity of 10,000 m3/day. The percentage of pollution load discharge into stormwater is adjusted accordingly to reflect the provision of sewer connection to previously unsewered villages within the region. Sewage outfall would be relocated to location out of the Starling Inlet (i.e. Sha Tau Kok Hoi). A slight increase in sewage interception rate is assumed for 2023.

Table 4.5 summarised the assumed percentage of sewage not collected in each SCA and the corresponding sewage treatment works in each SCA.

Table 4.5 Percentage Pollution Load into Stormwater and Foul Interception Arrangement

SCA	ID	2016		2023	
		Assumed % of Load in the Storm System	**Foul Interception**	**Assumed % of Load in the Storm System**	**Foul Interception**
Sai Kung (1)	1	10%	Sai Kung STW	10%	Sai Kung STW
Sai Kung Country Park (1)	1a	65%		**65% (1)**	
Pak Sha Wan (1)	1b	95%		95%	
Clear Water Bay	1c	100%	-	100% (2)	-
Tseung Kwan O	2	5%	HATS	5%	HATS
Yau Tong, East Kowloon	4	10%		10%	
North Kowloon, Central Kowloon, South Kowloon	5	10%		10%	
Northwest Kowloon	8	10%		10%	
Stonecutters	9a	10%		10%	
Kwai Chung and Tsuen Wan East	10a	10%		10%	
Tsing Yi	10b	10%		10%	
Tsuen Wan West (Rural Area)	11	10%	Sham Tseng STW	10%	Sham Tseng STW
Tuen Mun	12	10%	Pillar Point STW	10%	Pillar Point STW

SCA	ID	2016		2023	
		Assumed % of Load in the Storm System	**Foul Interception**	**Assumed % of Load in the Storm System**	**Foul Interception**
Yuen Long and Tin Shui Wai and Deep Bay Streams	12a	10%	San Wan STW	10%	San Wan STW
Kam Tin and Yuen Long New Town	12b	80%	Yuen Long STW	80%	Yuen Long STW
Discovery Bay	13	0%	Siu Ho Wan STW	0%	Siu Ho Wan STW
North Lantau	13a	10%		10%	
Chek Lap Kok	13b	0%		0%	
Peng Chau (3)	14	30%	Peng Chau STW	20%	Peng Chau STW
Mui Wo (4)	15	40%	Mui Wo STW	30%	Mui Wo STW
South Lantau	15a	100%	-	100% (6)	-
Hei Ling Chau	16	0%	Hei Ling Chau STW	0%	Hei Ling Chau STW
Cheung Chau	17	30%	Cheung Chau STW	**10%**	Cheung Chau STW (7)
Shek Kwu Chau	17a	100%	-	100%	-
Tai A Chau	17b	0%	Tai A Chau PTW	0%	Tai A Chau PTW
Shek Pik	18	10%	Shek Pik STW	10%	Shek Pik STW
Tai O	18a	50%	Tai O STW	30%	Tai O STW
Lamma Island (7)	19	80%	Yung Shue Wan STW and Sok Kwu Wan STW	40%	Yung Shue Wan STW and Sok Kwu Wan STW
Po Toi Islands	19a	100%	-	100%	-
Tung Lung	19b	100%	-	100%	-
Pokfulam Sandy Bay	20a	10%	HATS (8)	10%	HATS
Cyber Port	20b	10%		10%	
Wah Fu Estates and Mt. Kellet	21	10%		10%	
Aberdeen, Shouson Hill and Repulse Bay, South Bay	22	10%		10%	
Ap Lei Chau	23	10%		10%	
Chung Hom Kok	26	10%	Stanley STW	10%	Stanley STW
Stanley	27	10%		10%	
Tai Tam	28	10%		10%	
Shek O	29	10%	Shek O PTW	10%	Shek O PTW
Chai Wan	30	10%	HATS (8)	10%	HATS
Shau Kei Wan	31	10%		10%	
North Point	32	10%		10%	
Wan Chai East	33	10%		10%	
Wan Chai West	34	10%		10%	
Western and Central, Green Island	35	10%		10%	
Tolo Harbour	37	5%	Sha Tin STW and Tai Po STW	5%	Sha Tin STW and Tai Po STW

SCA	ID	2016		2023	
		Assumed % of Load in the Storm System	**Foul Interception**	**Assumed % of Load in the Storm System**	**Foul Interception**
			(Disposal via THEES)		(Disposal via THEES)
Sheung Shui and Fanling	38	10%	Shek Wo Hui STW	10%	Shek Wo Hui STW
North New Territories	39	95%		90%	
Sha Tau Kok	40	30%	Sha Tau Kok STW	20%	Sha Tau Kok STW
Ma Wan (9)	41	20%	Ma Wan STW	20%	Ma Wan STW

Note:

(1) Review of existing sewerage plan from DSD indicated that SCA1B is generally unsewered. Therefore, a minimal of 5% sewage collection will be assumed to account for potential sewage discharge via hygienic service tankers from households with septic tank or similar facilities. For SCA1A, a higher sewage collection rate of 35% were assumed, given the SCA is partially served by public sewer and the population density is higher at sewered area (which is also closer to SCA1).

(2) According to EIA-244/2016 Port Shelter Sewerage, Stage3 - Sewerage Works at Po Toi O, sewerage system including the proposed Po Toi O Sewage Treatment Works would be provided to handle sewage generated in the Po Toi O area. According to the approved EIA, the proposed sewerage would provide coverage to area with population of 425 (based on Appendix 5.2 of the approved EIA), while the total population of the same SCA in 2011 is about 8000, therefore a small decrease of pollution load to storm system by 5% is assumed. According to the approved EIA, the construction of the Po Toi O Sewage Treatment Works will last for 60 months. Given the project construction has not been started in early 2020 (EIA approved in 2016, planning application ongoing in 2018), the project would not be completed by 2023 and therefore would not be taken into account in this EIA Study.

(3) According to the latest information provided by the DSD, expansion works of sewerage system is being conducted on Peng Chau when this document is prepared (2020) and ultimately the sewerage system should cover over 90% of the island's population. Therefore, a conservative value 10% loss to stormwater system is assumed in 2023.

(4) The percentage of sewage collected by public sewer at these SCAs are updated in response to provision of public sewer to previously unsewered villages confirmed after the approved EIA of HATS2A.

(5) According to EIA-246/2016 Outlying Islands Sewerage Stage 2 - South Lantau Sewerage Works, sewerage system including the proposed San Shek Wan Sewage Treatment Works would be provided to handle sewage generated in 9 unsewered areas / villages within the South Lantau SCA, which represents the majority of the population within the SCA. Given the project is still in its planning and design stage (https://www.dsd.gov.hk/EN/Our_Projects/All_Projects/4331DS.html), project operation are not expected in year 2023.

(6) According to EIA-219/2013 Outlying Island Sewerage Stage 2 - Upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities, the project will provide further sewerage coverage to residents of Cheung Chau as well as upgrading the Cheung Chau Sewage Treatment Works to secondary treatment with treatment capacity of 9,800 m^3/day. Under this project, sewerage coverage would be extended to most of the populated area on the Island, with the exception of a small number of standalone / clustered housing which are remote from others. For this Study, the sewage interception rate of 90% was assumed, which reflected the level of sewage collection of Cheung Chau is close to the norm of the rest of Hong Kong.

(7) YSWSTW and SKWSTW was commissioned in 2015. Sewage interception rate was set to gradually increase to reflect the provision of sewerage in the YSW catchment.

(8) HATS Stage 2A was implemented by late 2015 and sewage collected at Sandy Bay PTW, Cyber Port STW, Wah Fu PTW, Aberdeen PTW, Ap Lei Chau PTW, North Point PTW, Wan Chai East PTW and Central PTW was diverted to SCISTW for treatment since then.

(9) Based on the DSD sewerage plan, over 80% of the residential area on Ma Wan is located within sewered area. The sewered area consists mostly of multi-storey residential buildings while the village-type residential area remains unsewered. Given the lack of further population breakdown within Ma Wan (Ma Wan is located within one PDZ (#338)), it is conservatively assumed population density per unit land area is the same for both types of residential areas. Therefore, the sewage interception rate is calculated to be 80%.

4.6 Rainfall Related Load

In the Update Study as well as all subsequent modelling studies derived from the Update Model, modelling were conducted based on two typical seasons, dry and wet. The rainfall related load for model runs under these two seasons were calculated to be the product of the daily runoff value (in m/day) for each season, the total impermeable area (in m^2) for each sewage catchment and the Mean Event Concentration of pollutants in stormwater runoff. The selection and handling of data from previous studies has been reviewed and updated for this EIA study based on the latest available information as well as the different need for water quality modelling inputs.

In the Update Study and the approved EIA of HATS 2A, the daily runoff value were calculated as follows:

Daily runoff value (m/day)

= 30-year long term average daily rainfall × Runoff percentage (for each season)

Runoff percentage (for each season)

= (Sum of rainfall for days [with total rainfall > 10 mm and with maximum rainfall intensity of > 2 mm/hr [(11)]]) ÷ Total runoff for the season × 100%

Unlike previous modelling studies which cover only the conditions for typical wet and dry seasons, water quality modelling of this EIA study would be conducted for the entire year of 2016 and 2023. To ensure pollution load for the water quality model reflects seasonality in Hong Kong, daily runoff values will be calculated for each month instead. This is because the verification of water quality model performance would be based on data from EPD's Marine Water Quality Monitoring Programme, which provide monitoring results at monthly interval; therefore calculation interval shorter than a month would not allow better comparison with the model verification exercise.

Based on the above, the method for calculation of daily runoff value is amended as follows:

Daily runoff value (m/day)

= Average daily rainfall of the month × Runoff percentage of the month

Runoff percentage of the month

= (Sum of rainfall for days [with total rainfall > 10 mm and with maximum rainfall intensity of > 2 mm/hr [(12)]]) ÷ Total runoff Runoff percentage of the month × 100%

The calculated daily runoff values for 2016 are shown in ***Table 4.6.*** For comparison, average daily runoff values for each month for the past 30 and 50 years are calculated and shown in ***Table 4.7*** and ***Figure 4.1*** in parallel with the values calculated for 2016. As shown, the 30-year and 50-year averages are similar while the monthly averages of the modelling years follow similar pattern with much larger variation, generally with higher values in wet season.

Table 4.6 Calculation of Daily Runoff Values from 2016

Year/Month (YYYY/MM)	Total Rainfall (mm)	Sum of Rainfall for Days with Total Rainfall > 10mm and max. Rainfall Intensity > 2mm/hr (mm)	Runoff %	Daily Runoff Value (m/day)
2016/01	267.24	241.43	90%	0.007788
2016/02	25.04	11.32	45%	0.000390
2016/03	149.06	125.36	84%	0.004044
2016/04	211.68	187.47	89%	0.006249
2016/05	233.79	222.08	95%	0.007164
2016/06	347.56	320.85	92%	0.010695
2016/07	176.05	138.64	79%	0.004472
2016/08	532.84	511.58	96%	0.016503

(11) Both conditions need to be satisfied.
(12) Both conditions need to be satisfied.

Year/Month (YYYY/MM)	Total Rainfall (mm)	Sum of Rainfall for Days with Total Rainfall > 10mm and max. Rainfall Intensity > 2mm/hr (mm)	Runoff %	Daily Runoff Value (m/day)
2016/09	323.24	284.55	88%	0.009485
2016/10	624.55	620.84	99%	0.020027
2016/11	131.44	112.71	86%	0.003757
2016/12	6.67	0.00	0%	0.000000

Table 4.7 Calculation of Daily Runoff Values from 2016 and Comparison with Past Data

Month	Daily Runoff Value (m/day)	30-Year Average (m/day)	50-Year Average (m/day)
	2016	1988-2017	1968-2017
January	0.007788	0.000718	0.000610
February	0.000390	0.000979	0.000982
March	0.004044	0.001744	0.001917
April	0.006249	0.004694	0.004756
May	0.007164	0.009021	0.009831
June	0.010695	0.014856	0.013545
July	0.004472	0.011501	0.010950
August	0.016503	0.012997	0.013049
September	0.009485	0.009318	0.009087
October	0.020027	0.003238	0.003821
November	0.003757	0.000956	0.000895
December	0.000000	0.000671	0.000715

Following the approach adopted in the Update Study and the EIA of HATS 2A, rainfall distribution at each of the SCAs are estimated based on the corresponding amount of paved, impermeable surface. In the Update Study, impermeable area were based on "Urbanized Area" indicated in the "*Hong Kong Vegetation Map*" by World Wide Fund Hong Kong. Since the *Vegetation Map* was compiled in 1993, more recent sources of data, in form of Geo-Information System (GIS) files was obtained for the estimation of impermeable area in each SCA. These GIS data information include layers for Country Park, Green Belt and Agriculture from the Town Planning Board Statutory Planning Portal 2 website [13], supplemented with digital orthophoto of 2016 from the Lands Department.

Table 4.8 Estimated Impermeable Area for Each SCAs

SCA#	SCA	Catchment Land Area (km^2)	Catchment Impermeable Area (km^2)
1	Sai Kung	7.864	2.202
1A	Sai Kung Country Park	103.697	7.176
1B	Pak Sha Wan	20.633	3.964
1C	Clear Water Bay	10.121	2.271
2	Tseung Kwan O	25.745	12.525
4	Yau Tong, East Kowloon	14.283	12.575
5	North Kowloon, Central Kowloon, South Kowloon	11.085	10.703
8	Northwest Kowloon	19.543	16.072
9A	Stonecutters	2.580	2.085
10A	Kwai Chung and Tsuen Wan East	16.346	11.764
10B	Tsing Yi	10.698	6.472
11	Tsuen Wan West (Rural Area)	12.333	1.876
12	Tuen Mun	78.116	22.528
12A	Yuen Long and Tin Shui Wai and Deep Bay Streams	52.034	24.793
12D	Kam Tin and Yuen Long New Town	111.537	47.406

([13]) Available at https://www2.ozp.tpb.gov.hk/gos/default.aspx?#

SCA#	SCA	Catchment Land Area (km^2)	Catchment Impermeable Area (km^2)
13	Discovery Bay	7.350	2.670
13A	North Lantau	54.933	11.074
13B	Chek Lap Kok	14.664	14.456
14	Peng Chau	1.270	0.436
15	Mui Wo	22.536	4.222
15A	South Lantau	22.606	2.958
16	Hei Ling Chau	2.555	0.373
17	Cheung Chau	2.471	1.351
17A	Shek Kwu Chau	1.191	0.004
17B	Tai A Chau	2.090	0.000
18	Shek Pik	14.872	0.486
18A	Tai O	26.075	2.027
19	Lamma Island	13.944	1.741
19A	Po Toi Islands	5.509	0.159
19B	Tung Lung	2.425	0.006
20A	Pokfulam Sandy Bay	1.812	1.032
20B	Cyber Port	0.812	0.610
21	Wah Fu Estates and Mt. Kellet	3.360	1.057
22	Aberdeen, Shouson Hill and Repulse Bay, South Bay	14.735	5.484
23	Ap Lei Chau	1.411	0.893
26	Chung Hom Kok	0.365	0.155
27	Stanley	4.067	2.740
28	Tai Lam	15.543	1.217
29	Shek O	5.350	1.128
30	Chai Wan	6.843	3.128
31	Shau Kei Wan	3.212	2.199
32	North Point	6.918	2.987
33	Wan Chai East	6.404	2.940
34	Wan Chai West	3.991	2.969
35	Western and Central, Green Island	5.773	3.567
37	Tolo Harbour	181.741	40.345
38	Sheung Shui and Fanling	61.348	23.688
39	North New Territories	35.445	12.234
40	Sha Tau Kok	55.709	4.712
41	Ma Wan	1.019	0.703

Total runoff is calculated based on the monthly runoff value shown in ***Table 4.6*** and estimated impermeable areas for each of the SCAs in ***Table 4.8.*** And the total rainfall related load is calculated accordingly based on the event mean concentration for stormwater runoff shown in ***Table 4.9.*** Such runoff and associated loading is then distributed evenly among major stormwater outfalls and rivers within the same SCAs in the model.

Table 4.9 Event Mean Concentrations for Stormwater Runoff

TSS mg/L	BOD_5 mg/L	NH_3-N mg/L	Cu mg/L	TP mg/L	Ortho-P mg/L	Silicate mg/L	TON mg/L	TKN mg/L
43.25	22.48	0.20	0.01	0.20	0.04	3.28	0.40	1.40

Source: EPD Pilot Study of Storm Pollution

TON: Total oxidized nitrogen

4.7 Pollution Loading from Bathing Beaches

The following pollution loading from various bathing beaches would be adopted based on information provided by LCSD regarding status of sewage collection and sewer connections. Bathing beaches which have existing local discharge arrangements, including discharge into septic tank / soakaway locally or local discharge after treatment, detailed pollution load is provided below. For other gazetted beaches that are not included in this list, it is expected there would not be discharge of pollution load from beach-goers into marine / inland water due to connection with public sewer, provision of chemical toilets, etc. Those pollution load would be taken into account in the corresponding sewage treatment works in the same catchment.

Estimation of pollution from beach-goers is done based on the average number of beach-goers in the peak month in the 2015-2019 to ensure conservative estimation. Sewage flow and load generated from beach-goers is estimated based on unit flow and load values adopted from *DSD's Sewerage Manual*. Pollution removal by local treatment and disposal options is then taken into account for each bathing beaches based on the specific local arrangements. For instance:

Sewage load at South Bay Beach (discharge at soakaway) is calculated as:

Sewage Generated = [5-year average number of beach-goers] × [Unit Sewage Generation Rate]

= 456 (head/day) × 0.0029 (m^3/head/day)

= 1.32 (m^3/day)

Sewage Discharged = [Sewage Generated] × (1 - [Treatment Removal Rate])

= 1.32 (m^3/day) × (1 – 70%)

= 0.40 (m^3/day)

SS Generated = [5-year average number of beach-goers] × [Unit SS Generation Rate]

= 456 (head/day) × 0.0012 (kg/head/day)

= 547 (g/day)

SS Discharged = [SS Generated] × (1 - [Treatment Removal Rate])

= 547 (g/day) × (1 – 70%)

= 164 (g/day)

Other parameters are calculated accordingly.

Sewage load at Hung Shing Yeh Beach is calculated as (discharge into inshore water after treatment):

Sewage Generated and Discharged = [5-year average number of beach-goers] × [Unit Sewage Generation Rate]

= 1314 (head/day) × 0.0029 (m^3/head/day)

= 3.81 (m^3/day)

SS Generated = [5-year average number of beach-goers] × [Unit SS Generation Rate]

= 1314 (head/day) × 0.0012 (kg/head/day)

= 1577 (g/day)

SS Discharged = [Sewage Generated and Discharged] × [WPCO Discharge Limit for SS]

= 3.81 (m^3/day) × 30 (mg/L)

= 114 (g/day)

Table 4.10 Estimated Pollution Loading for Bathing Beaches

Beach	Sewage Flow (m^3/day)	Pollution Load (g/day, except for no./day for *E.coli*) [values in square brackets are treated loading which would be discharged locally via soakaway pits or treatment plants]							Discharge Arrangement
		SS	BOD_5	TKN	NH_3-N	*E.coli*	TP	Ortho-P	
South Bay Beach	1 [0.40]	547 [164]	547 [164]	638 [191]	410 [123]	8.66E+12 [2.60E+12]	93 [28]	56 [17]	Discharge to soakaway pit; 30% loss to marine water assumed
Big Wave Bay Beach	2 [0.57]	786 [236]	786 [236]	917 [275]	590 [177]	1.24E+13 [3.73E+12]	134 [40]	80 [24]	Discharge to soakaway pit; 30% loss to marine water assumed (WPCO license no.: WT00018655-2014, WT00020233-2014)
Hung Shing Yeh Beach	4	1577 [114]	1577 [76]	1840 [381]	1183 [245]	2.50E+13 [5.72E+07]	269 [38]	160 [23]	Discharge into inshore water after treatment (Discharge quality follows WPCO license- SS: 30 mg/L, BOD_5: 20 mg/L, *E.coli*: 1500 no./100mL) (WPCO license no.: WT00030534-2018)
Pui O Beach	8 [2.45]	3375 [1013]	3375 [1013]	3938 [1181]	2532 [759]	5.34E+13 [1.60E+13]	577 [173]	343 [103]	Discharge to soakaway pit; 30% loss to marine water assumed
Lower Cheung Sha Beach	3 [0.89]	1229 [369]	1229 [369]	1434 [430]	922 [277]	1.95E+13 [5.84E+12]	210 [63]	125 [37]	Discharge to soakaway pit; 30% loss to marine water assumed
Upper Cheung Sha Beach	3 [0.82]	1136 [341]	1136 [341]	1326 [398]	852 [256]	1.80E+13 [5.40E+12]	194 [58]	116 [35]	Discharge to soakaway pit; 30% loss to marine water assumed
Casam Beach	0.4	170	170	199	128	2.70E+12	29	17	No sanitary facilities provided, assumed 100% loading enters marine water
Trio Beach	2 [0.64]	880 [264]	880 [264]	1027 [308]	660 [198]	1.39E+13 [4.18E+12]	150 [45]	89 [27]	Discharge to soakaway pit; 30% loss to marine water assumed
Kiu Tsui Beach	2	758 [55]	758 [37]	885 [37]	569 [24]	1.20E+13 [1.83E+07]	130 [15]	77 [9]	Discharge into inshore water after treatment (Discharge quality follows WPCO license- SS: 30 mg/L, BOD_5: 20 mg/L, TN: 20 mg/L, *E.coli*: 1000 no./100mL) (WPCO license no.: WT00031367-2018)
Hap Mun Bay Beach	4	1597 [116]	1597 [77]	1863 [77]	1198 [50]	2.53E+13 [3.86E+07]	273 [31]	162 [18]	Discharge into inshore water after treatment (Discharge quality follows WPCO license- SS: 30 mg/L, BOD_5: 20 mg/L, TN: 20 mg/L, *E.coli*: 1000 no./100mL) (WPCO license no.: WT00025109-2016)

Beach	Sewage Flow (m^3/day)	Pollution Load (g/day, except for no./day for *E.coli*) [values in square brackets are treated loading which would be discharged locally via soakaway pits or treatment plants] SS	BOD$_5$	TKN	NH_3-N	*E.coli*	TP	Ortho-P	Discharge Arrangement
Clear Water Bay First Beach	1 [0.43]	588 [176]	588 [176]	686 [206]	441 [132]	9.31E+12 [2.79E+12]	100 [30]	60 [18]	Discharge to soakaway pit; 30% loss to marine water assumed
Clear Water Bay Second Beach	19	8045 [583]	8045 [389]	9386 [1944]	6034 [1250]	1.27E+14 [2.92E+08]	1374 [156]	818 [93]	Discharge into inshore water after treatment (Discharge quality follows WPCO license- SS: 30 mg/L, BOD$_5$: 20 mg/L, *E.coli*: 1500 no./100mL) (WPCO license no.: WT00030844-2018)

Note:
(1) For sewage discharged into soakaway pit, a constant 30% loss rate was applied to all parameters including flow following assumption adopted in the Update Study). The corresponding flow and load reaching marine water is calculated accordingly. For sewage discharge into local treatment plants with specific WPCO license condition, the flow was assumed to remain unchanged and loading for parameters with specified standards were calculated based on flow and standard concentration. For parameters which are not stipulated in the corresponding license condition, relevant discharge levels stated in the *Chapter 358AK Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* were adopted. The corresponding load reaching marine water is calculated by estimated flow times the WPCO criteria.

4.8 Pollution Loading from Landfills

The following pollution loading from various landfill would be adopted based on information provided by relevant offices of EPD regarding leachate generation, treatment and disposal. Most existing or restored landfills have their leachate collection systems connected to public sewer or transfer the collected leachate in other means and thus do not have a separate discharge into the sea. The associated loading would be taken into account in the corresponding sewage treatment works in the same catchment.

Table 4.11 Estimated Pollution Loading from the Landfills in Hong Kong

Landfill	Estimated Loading BOD$_5$ (kg/d)	SS (kg/d)	Org-N (kg/d)	NH_3-N (kg/d)	*E.coli* (no./d)	Cu (g/d)	Loading Distributes to
WENT	34	174	26	231	1.25E+07	35	Northwest New Territory Sewage Outfall
Shuen Wan Landfill	19	65	30	177	1.78E+06	19	Marine Water

4.9 Pollution Loading from Livestock Farms

The following pollution loading from various livestock farms would be adopted based on information of livestock farm license as well as measures of handling livestock waste provided by EPD Regional Office (RO). Pollution loading from each livestock farm is distributed into the corresponding river catchment after taking into account the effect on onsite sewage treatment.

Table 4.12 Estimated Pollution Loading from Livestock in Hong Kong, Distributed to the Corresponding Rivers / Receiving Waters

River / Location	Number of Livestock		Flow (m^3/d)	BOD$_5$ (kg/d)	SS (kg/d)	TKN (kg/d)	NH_3-N (kg/d)	TP (kg/d)	*E.coli* (counts/d)
	Pig	Chicken							
Tseng Lan Shue River	350	0	5	0.2	0.2	0.1	0.0	0.0	1.68E+12

River / Location	Number of Livestock		Flow (m^3/d)	BOD_5 (kg/d)	SS (kg/d)	TKN (kg/d)	NH_3-N (kg/d)	TP (kg/d)	*E.coli* (counts/d)
	Pig	Chicken							
Ha Pak Nai Stream	5150	10000	72	3.6	3.6	1.1	0.6	0.5	2.48E+13
Shenzhen River (Including River Beas and River Ganges)	21500	236500	305	15.3	15.3	4.4	2.3	1.9	1.04E+14
Tin Shui Wai Nullah	0	102000	2	0.1	0.1	0.0	0.0	0.0	9.27E+10
Yuen Long Creek	34540	886000	506	25.3	25.3	7.2	3.8	3.1	1.67E+14
So Kwun Wat Stream	6000	0	84	4.2	4.2	1.2	0.6	0.5	2.89E+13
Tsim Bei Tsui (marine water)	2500	0	35	1.8	1.8	0.5	0.3	0.2	1.20E+13
Lau Fau Shan (marine water)	4600	48000	65	3.3	3.3	0.9	0.5	0.4	2.22E+13
Total	**74640**	**1282500**	**1075**	**53.7**	**53.7**	**15.4**	**8.1**	**6.7**	**3.61E+14**

4.10 Pollution Loading from Marine Population in Typhoon Shelters

The following pollution loading from marine population would be adopted based on 2016 information obtained from the Census and Statistics Department. Note that marine population has been in decline since 1986 from around 37,000 and remains at the level around 1,200 by 2011 and 2016. The estimated level of pollution loading from marine population from 2016 would be adopted also for the 2023 scenario as major increase in marine population is not expected in the future.

Table 4.13 Estimated Pollution Loading from Marine Population in Each Typhoon Shelter

Typhoon Shelter	Population	Flow (m^3/d/head)	SS (g/d/head)	BOD_5 (g/d/head)	TKN (g/d/head)	NH_3-N (g/d/head)	TP (g/d/head)	*E.coli* (no./d/head)
Unit Rate (Temporary Housing Area) (1)	**-**	**0.150**	**40**	**42**	**8.5**	**5.0**	**1.33**	**4.3E+10**
		Flow (m^3/d)	**SS (kg/d)**	**BOD_5 (kg/d)**	**TKN (kg/d)**	**NH_3-N (kg/d)**	**TP (g/d)**	***E.coli* (no./d)**
TS1: Shau Kei Wan	117	17.55	4.68	4.91	0.99	0.59	0.16	5.03E+12
TS2: Sam Ka Tsuen	31	4.65	1.24	1.30	0.26	0.16	0.04	1.33E+12
TS3: Kwun Tong	17	2.55	0.68	0.71	0.14	0.09	0.02	7.31E+11
TS4: Causeway Bay	141	21.15	5.64	5.92	1.20	0.71	0.19	6.06E+12
TS5: Yau Ma Tei	145	21.75	5.80	6.09	1.23	0.73	0.19	6.24E+12
TS6: Rambler Channel	28	4.2	1.12	1.18	0.24	0.14	0.04	1.20E+12
TS7: Aberdeen	304	45.6	12.16	12.77	2.58	1.52	0.40	1.31E+13
TS8: Tuen Mun	108	16.2	4.32	4.54	0.92	0.54	0.14	4.64E+12
TS9: Cheung Chau	130	19.5	5.20	5.46	1.11	0.65	0.17	5.59E+12
TS10: Shuen Wan	39	5.85	1.56	1.64	0.33	0.20	0.05	1.68E+12
TS11: Sai Kung	64	9.6	2.56	2.69	0.54	0.32	0.09	2.75E+12
TS12: Chai Wan	35	5.25	1.40	1.47	0.30	0.18	0.05	1.51E+12
TS13: To Kwa Wan	42	6.3	1.68	1.76	0.36	0.21	0.06	1.81E+12
Total	**1201**	180	48.04	50.44	10.21	6.01	1.60	5.16E+13

Note:
(1) DSD Sewerage Manual.

4.11 Pollution Loading from Mariculture Activities

Currently, there are a total of 26 FCZs in Hong Kong. Mariculture of fish requires feeding, which generates wastage and results in pollution. Dead fish and excretion from cultured fish are also sources of water pollution. Furthermore, working population in FCZs as well as dogs [14] kept on fish

(14) It is stated in the EIA Study Brief that pollution from cats kept on fish farms should also be taken into account. Yet it is observed in the regular inspections of fish farms in the recent years that cats are not common

rafts would also generate water quality pollutants. The following methodology for estimation of pollution loading from FCZs makes reference to the excerpt of methodology for estimation of pollution loading under Project WATERMAN (2012 (15)) provided by AFCD, which takes into account the following aspects of mariculture of fish:

- fish farming activity including feeding and fish excretions;
- human waste; and
- faecal pollution from dogs living on the fish farm.

It should be noted that the methodology provided by AFCD (adopted under Project WATERMAN) focuses on nutrients, eutrophication as well as the associated oxygen depletion and / or algal growth. Thus contribution of suspended solids from mariculture activities was not included in the methodology and would be considered separately for this EIA study.

The pollution loading in a FCZ varies with the fish farming practice including the feed type and culture fish type. The workers and dogs on the fish farms contribute a minor portion of the mariculture pollution. The cage cleaning activities are not considered as an additional pollution input as the fouling organisms grow on the existing organic waste. There is no nutrient input from the fouling organisms especially when the total amount of fouling organism remains constant. On the other hand, some of the fouling organisms, such as green mussels, might instead be considered as a pollution sink when harvested. Given the discussion above, the pollution loading from a fish farm can be estimated by summing that from individual component including nutrient leachage, feed wastage, fish excretory waste, illegal disposal of dead fish, waste from workers and dogs on the fish farm. The following equation outlines the components in estimating the pollution loading in a mariculture zone:

Pollution Loading (kg/ton fish production/year) = FCR (16) × (Leachage + %Wastage × Nutrient Concentration after Leachage) + Standing Stock to Production Ratio × Faecal & Excretion Rate + Illegal Dead Fish Disposal + People per Unit Fish Production × Human Waste Production Rate + Dogs per Unit Fish Production × Dog Waste Production Rate

Disposal of dead fish to the sea is illegal. With stricter enforcement in recent years, the disposal ratio has been reduced significantly and becomes negligible and a zero disposal rate is assumed.

It should be noted that there are also mariculture of oyster in Deep Bay. As a filter feeder, mariculture of oyster generally do not require feeding and extensive onsite management. Therefore, no significant contribution on pollution loading is expected from the mariculture of oyster. They are therefore not considered further in this EIA study.

Total pollution load per unit production of cultured fish is calculated as the summation of leached nutrient, wasted feed, fish faeces and excretion, as well as pollution from workers and dogs at fish farm (these are underlined in the corresponding tables below). The unit pollution loads from these sources are summarised in ***Table 4.14***.

on fish farms as cats do not serve any function (unlike dogs). For this Study, pollution load for cat is not further considered.

(15) Wong *et.al.* 2012. Project WATERMAN Carrying Capacity of Fish Culture Zones in Hong Kong - Technical Note TN-2012-02

(16) FCR: Feed conversion ratio.

Table 4.14 Total Pollution Loading from Fish Farm for Production Level of 1 ton/year at Existing FCZs

Sources	Leached Nutrient	Wasted Feed	Fish Faeces	Fish Excretion	From Workers and Dogs	Total
Oxidized-N (g/day)	0.0644	0.1049	1.205	-	-	**1.3738**
Ammonia-N (g/day)	1.8925	3.0839	0.371	235.6	3.860	**244.8073**
Org-N (g/day)	45.9993	123.8126	16.265	-	2.702	**188.7786**
TIP (g/day)	12.9946	1.7571	1.624	-	0.536	**16.9120**
TOP (g/day)	6.3888	12.6981	0.813	-	0.375	**20.2749**
BOD (g/day)	159.7156	429.5929	495.095	-	46.490	**1130.8930**
TSS (g/day)	241.6076	388.3486	-	-	46.490	**676.4462**

Based on the above unit pollution load, the pollution loading from mariculture activities at existing FCZs is estimated as follows:

Table 4.15 Estimated Pollution Loading from Mariculture Production in FCZs in Hong Kong

FCZ	2013-2017 Average Production (ton/year)	Pollution Load (g/d)						
		Oxidized-N	Ammonia-N	Org-N	TIP	TOP	BOD_5	TSS
Ap Chau	1.76	2.42	430.67	332.11	29.75	35.67	1989.50	1190.03
Cheung Sha Wan	41.52	57.04	10164.53	7838.19	702.20	841.83	46955.30	28086.42
Kai Lung Wan	22.06	30.31	5400.99	4164.88	373.12	447.31	24950.02	14923.91
Kat O	15.13	20.79	3704.40	2856.58	255.91	306.80	17112.58	10235.93
Kau Lau Wan	4.91	6.75	1202.65	927.40	83.08	99.60	5555.67	3323.14
Kau Sai	50.71	69.66	12413.45	9572.40	857.56	1028.08	57344.21	34300.57
Leung Shuen Wan	24.23	33.28	5931.28	4573.79	409.75	491.23	27399.67	16389.17
Lo Fu Wat	6.13	8.42	1500.22	1156.87	103.64	124.25	6930.32	4145.39
Lo Tik Wan	88.56	121.67	21681.29	16719.12	1497.81	1795.64	100157.21	59909.26
Ma Nam Wat	20.06	27.57	4912.02	3787.82	339.34	406.81	22691.21	13572.80
Ma Wan	51.71	71.04	12659.76	9762.34	874.57	1048.48	58482.07	34981.18
O Pui Tong	21.34	29.32	5224.19	4028.54	360.90	432.67	24133.28	14435.37
Po Toi	1.06	1.45	258.59	199.41	17.86	21.42	1194.58	714.54
Po Toi O	16.82	23.10	4116.58	3174.43	284.39	340.94	19016.65	11374.85
Sai Lau Kong	1.15	1.58	281.41	217.00	19.44	23.31	1299.98	777.59
Sha Tau Kok	67.28	92.42	16469.59	12700.21	1137.77	1364.01	76081.64	45508.40
Sham Wan	62.56	85.94	15314.54	11809.52	1057.97	1268.35	70745.89	42316.81
Sok Kwu Wan	103.10	141.64	25240.45	19463.71	1743.69	2090.41	116598.86	69743.87
Tai Tau Chau	48.81	67.05	11948.12	9213.57	825.41	989.54	55194.61	33014.78
Tap Mun	39.81	54.69	9745.49	7515.05	673.25	807.12	45019.51	26928.52
Tiu Cham Wan	4.27	5.87	1045.15	805.95	72.20	86.56	4828.11	2887.94
Tung Lung Chau	49.32	67.76	12074.04	9310.67	834.11	999.97	55776.32	33362.73
Wong Wan	6.85	9.41	1676.06	1292.46	115.79	138.81	7742.61	4631.26
Yim Tin Tsai	89.45	122.88	21896.97	16885.44	1512.71	1813.51	101153.56	60505.23
Yim Tin Tsai (E)	85.26	117.13	20872.56	16095.49	1441.94	1728.67	96421.28	57674.61
Yung Shue Au	171.73	235.92	42040.60	32418.83	2904.29	3481.80	194207.55	116165.68

Note that this approach assumes similar mariculture practice is adopted at various FCZs leading to similar level of (average) pollution load. Given the possible combinations of fish specified, fish feeds options and feeding strategies (which are not recorded information available to allow detailed calculation), this assumption is deemed suitable by capturing some of the more typical arrangements for regional study.

At the proposed FCZ, only pellet feeds will be allowed. As pellet feeds in general has a much better feed conversion ratio (i.e. less food to produce the same mass of fish) than that of mixed fish feed, feed input and the associated loss of nutrient to the water column would be reduced. Typical pellet feed nowadays can achieve FCR of close to 1. For this EIA study, FCR of 2 would be adopted. It is assumed these fish farms will be minimally manned and would not rely on dogs for security. Furthermore, strict control would be implemented to minimise other sources of pollution of mariculture operation from entering the water column and such control would likely be much more in the proposed new FCZs. Based on the same estimation method, the pollution load from each source for mariculture is summarized below in ***Table 4.16***.

Table 4.16 Total Pollution Loading from Fish Farm for Production Level of 1 ton at Proposed FCZs

Sources	**Leached Nutrient**	**Wasted Feed**	**Fish Faeces**	**Fish Excretion**	**From Workers and Dogs**	**Total**
Oxidized-N (g/day)	0.0583	0.0968	1.205	-	-	**1.3597**
Ammonia-N (g/day)	0.0250	0.0415	0.371	235.6	-	**236.0373**
Org-N (g/day)	0.0042	21.9176	16.265	-	-	**38.1865**
TIP (g/day)	0.0333	0.0394	1.624	-	-	**1.6969**
TOP (g/day)	0.0006	2.6986	0.813	-	-	**3.5119**
BOD (g/day)	0.0086	45.2051	495.095	-	-	**540.3082**
TSS (g/day)	2.0822	24.6477	-	-	-	**26.7298**

The appropriate levels of mariculture activities at the proposed FCZ site would be determined by the use of WATERMAN's forecasting tool and are not available by the time this methodology paper is being prepared.

The estimated pollution loading from the existing FCZs will be used in WATERMAN's hindcast modelling tool to derive the appropriate modelling kinetics and equilibrium parameters specific to the selected sites. The carry capacity at the proposed FCZ site (and thus the associated pollution loading) would be estimated using WATERMAN's forecast modelling tool. The estimated pollution loading from both the existing FCZs and the proposed new FCZ site would both be used in the water quality modelling using Delft3D.

5. ASSESSMENT OF FAR FIELD WATER QUALITY

After the estimation of carrying capacity, the pollution loading from the proposed site at Wong Chuk Kok Hoi as well as other proposed FCZs at Outer Tap Mun and Mirs Bay would be estimated based on methodology outlined in *Section 4.11*. The pollution loading would be adopted in the Delft3D WAQ modelling exercise to investigation the potential change in water quality on the surrounding water quality.

5.1 Modelling Assessment Scenarios – Delft3D WAQ

Water quality modelling scenarios would be conducted using Delft3D WAQ to achieve the following:

- Verification of water quality model; and
- Prediction on water quality condition for fish farm operation at the estimated carrying capacities.

For the verification of water quality model, a whole year run would be conducted with both the verified predecessor model and the newly developed refined models to allow comparison of model predictions between the old and new.

For prediction of water quality condition for fish farm operation at the estimated carrying capacities, a whole year run would be conducted using the verified new models in 2023 and with the estimate carrying capacities at the proposed FCZ site.

Table 5.1 Summary of Modelling Scenarios

Modelling Tools	Scenario ID	Year	Modelling Activities	Season
Delft3D FLOW	DF2016D DF2016W	2016	FLOW model for verification	Dry Season Wet Season
	DF2023D DF2023W	2023	FLOW model for Delft3D WAQ flow field	Dry Season Wet Season
	DF2023D_D DF2023W_D	2023	FLOW model for Drogue Release Modeling	Dry Season Wet Season
	DF2023D_T1 to DF2023D_T7, DF2023W_T1 to DF2023W_T7	2023	FLOW model for Tracer Dispersion Modelling	Dry Season Wet Season
WATERMAN Hindcast Modelling Tool	WH2016-2018	2016-2018	Hindcast modelling for mariculture at the surrogated site from 2016-2018	Whole Year
WATERMAN Forecast Modelling Tool	WFD_01 to WFD_27. WFW_01 to WFW_27	- (carrying capacity is not time-specific	Forecast modelling for carrying capacity estimation at proposed FCZ site	Dry Season Wet Season
Delft3D WAQ	DW2016	2016	WAQ model for verification	Whole Year
	DW2023B	2023	WAQ model for baseline (i.e. without project) scenario	Whole Year
	DW2023P	2023	WAQ model for project scenario	Whole Year

5.2 Cumulative Impacts

For modelling prediction using WATERMAN hindcast and forecast modelling tools, cumulative impacts would be taken into account by the use of historic background water quality data from EPD Marine Water Quality Monitoring data.

For modelling prediction using Delft3D suite of model, cumulative impact in terms of pollution loading from existing FCZs, sewage treatment works and other loadings in Hong Kong as well as outside of Hong Kong would be taken into account in the pollution loading inventory already. Other proposed FCZ sites being considered by AFCD would be taken into account as other sources of pollution and as WSRs.

Appendix A

Estimation of Pollution Loading from Fish Farms

Estimation of Pollution Loading from Fish Farms

Pollution loading into a fish culture zone (FCZ) directly determines the water quality within the FCZ and the fish farming activity is the major pollution source. Therefore the heavier the farming activity the more pollution and the poorer water quality will be generated in a FCZ. The fish farm loading studies have been reviewed and a robust method to estimate the pollution loading in the FCZ has been developed in the Project WATERMAN. The general methodology is outlined below. Additional laboratory analysis was conducted in September 2020 to obtain updated necessary chemical characteristics of existing fish feed in Hong Kong. Unless otherwise stated, the same formulations and parameters were adopted as those for the Project WATERMAN.

Pollution Source in a Fish Farm

Pollution generated in a fish farm comes mainly from three sources as shown below:

- fish farming activity including fish feed and fish excretions;
- human waste; and
- faecal pollution from dogs living in the fish farm.

Fish farming activity including fish feed and fish excretions is the major pollution source accounting for over 95% of the pollution loading. Unconsumed feed wastage has high organic content and fish excretion is in the form of inorganic waste, mainly ammonia. Therefore, it is possible to estimate the amount of pollution loading (without knowing the detailed organic-inorganic composition) by subtracting the fish production from feed input.

Assuming nutrient content of the adult cultured fish is similar to the trash fish, a rough estimate of the pollution loading can be obtained from the feed conversion ratio (FCR) (see below for the definition of FCR):

$$Pollution\ \ loading\ \ from\ \ farming\ \ activities = \frac{(FCR-1)}{FCR} \times Feed\ \ Input$$

where FCR means feed conversion ratio, an important parameter for pollution control and mariculture management.

<u>Feed Conversion Ratio (FCR)</u>

FCR is defined as the feed consumption (C_{NF}) per unit fish meat production (P_N):

$$FCR = \frac{C_{NF}}{P_N}$$

The FCR was found to be around 6.5 based on the 2009 AFCD field survey and it has quite significantly reduced from 10 - 15 in the past days. It was also found that although some fish farmers have tried using pellet feed, they are mostly used as supplements and amounted to only 0.3% of the total feed input (by weight). Trash fish remained the major feed used. Based on the feed input component (99.7% trash fish and 0.3% pellet fish), the weighted FCR for 2009 should be equal to 6.48 (6.5 × 99.7%) for trash fish feed and 0.0060 (2.0 × 0.3%) for pellet feed. If the feeding practice in fish farms have not changed significantly, the same values for FCR can be adopted. However, based on recent studies on pellet feed formulation, the FCRs for groupers, snappers and seabreams are now ranged between 1 and 2. If pellet feed will be the major food source in a fish farm, the FCR to be used for calculating pollution loading is assumed to be 2.0 for this Study.

Methodology of Pollution Loading Estimation

The pollution loading in a FCZ varies with the fish farming practice including the feed type and culture fish type. The human and dogs on the fish farms contribute a minor portion of the mariculture pollution. The cage cleaning activities are not considered as an additional pollution input as the fouling organisms grow on the existing organic waste. There is no nutrient input from the fouling organisms especially when the total amount of fouling organism remains constant. On the other hand, some of the fouling organisms, such as green mussels, might instead be considered as a pollution sink when harvested. Given the discussion above, the pollution loading from a fish farm can be estimated by summing that from individual component including nutrient leachage, feed wastage, fish excretory waste, illegal disposal of dead fish, waste from human and dogs on the fish farm. The following equation outlines the components in estimating the pollution loading in a mariculture zone:

Pollution Loading (kg/ton fish production/year)
= FCR × (Leachage + %Wastage × Nutrient Concentration after Leachage)
+ Standing Stock to Production Ratio × Faecal & Excretion Rate
+ Illegal Dead Fish Disposal
+ People per Unit Fish Production × Human Waste Production Rate
+ Dogs per Unit Fish Production × Dog Waste Production Rate

<u>*Total Feed Input*</u>

The total input food for FCZs can be calculated by:

Feed Input
= Fish Production
× (Weighted FCR for Trash Fish Feed × Nutrient Content of Trash Fish
+ Weighted FCR for Pellet Feed × Nutrient Content of Pellet Feed)

Pellet feed will be the major food source allowed in the new FCZs as one of the management measures. As such, the equation can be simplified to:

Feed Input = Fish Production × FCR for Pellet Feed × Nutrient Content of Pellet Feed

The nutrient contents are listed in *Table 1*. The 2020 laboratory data for pellet feed and 2010 laboratory data for trash fish would be adopted for this Study. As shown, the improvement in formulation of pellet feed result in significant increase in protein level (indicated by the much higher total organic nitrogen level), and thus allow a lower FCR for pellet feed.

Table 1 Nutrient Content of Trash Fish and Pellet Feed

Test parameters	**Pellet feed (from AFCD 2020 Laboratory Study)**	**Pellet feed (from AFCD 2010 Laboratory Study)**	**Trash fish (from AFCD 2010 Laboratory Study)**
Water content. %	8.5	7	73
Total Inorganic Nitrogen, g/kg	0.52	0.54	0.83
Total Organic Nitrogen, g/kg	80	14.3	30.50
Total Dissolved Phosphorus content, g/kg	0.15	1.32	1.13
Total Organic Phosphorus content, g/kg	9.85	N/A	N/A
Biochemical oxygen demand, BOD5, g/kg	165	284.8	105.90

N/A: Not available

Loading from Leachage

The loading from the leachage is computed following the equation below:

Leachage (for existing FCZs)
= Fish Production
× (Weighted FCR for Trash Fish Feed × Nutrient Leached from Trash Fish
+ Weighted FCR for Pellet Feed × Nutrient Leached from Pellet Feed)

Leachage (for proposed new FCZs)
= Fish Production × FCR for Pellet Feed × Nutrient Leached from Pellet Feed

The nutrient leach factors are listed in *Table 2*. The 2020 laboratory data for pellet feed and 1989 laboratory data for trash fish would be adopted for this Study.

Table 2 Nutrients Leached from 50g of Fish Feed after Passing through 1m Water Column

Parameter	**Pellet feed (from AFCD 2020 Laboratory Study)**	**Pellet feed (from AFCD 2010 Laboratory Study)**	**Trash fish (chopped) (from Ove Arup and Partners 1989)**
Inorganic phosphorous (mg-P)	0.30	6.98	36.67
Nitrate-N (mg-N)	0.53	N.D.	N.D.
Nitrite-N (mg-N)	N.D.	0.02	0.18
Ammonia-N (mg-N)	0.23	6.23	5.34
Total Organic Nitrogen (mg-N)	0.04	22.9	129.81
Total Nitrogen (mg-N)	0.65	29.15	135.33
Total Organic Matter (mg)	0.30	204.92	382.26
Total Suspended Solids (TSS) (mg)	19.00	354.67	681.76

Loading from Feed Wastage / Unconsumed Feed

The pollution loading from feed wastage comes from two sources:
- The soluble part and fine particulates of fish feed will leach out when feed is released into water; and
- Some of the feed dumped into a fish raft will not be consumed and will sink to the bottom.

With reference to Project WATERMAN, it was estimated that about 30% of the feed input in Hong Kong turn out to be wastage. The unconsumed feed waste loading can be estimated by multiplying the feed input with the percentage feed wastage and its nutrient content. Since the soluble nutrients are taken as leachage, they will be subtracted from unconsumed feed waste to avoid double counting.

Unconsumed feed waste loading = (Feed Input - Leachage) × %Feed Wastage

The percentage of feed wastage is about 25% for existing FCZs. For the proposed new FCZs where only pellet feed is allowed, wastage is expected to be significantly lower and wastage of 5% is assumed for this Study. It is worth noting that the percentage feed wastage is not constant but decrease with the apparent FCR when there is less overfeeding.

Fish Excretion and Faecal Production

Fish generates waste through excreta from metabolic waste and faecal production of undigested food. Fish excretion is the major component of pollution loading among which the urea excretion was negligible or rather small with reference with Project WATERMAN. It is assumed that only ammonia loading is generated from the fish excretion which is estimated by:

NH_3 loading from excreta = standing stock × fish excretion rate

There is high degree of uncertainties in fish excretion. The ammonia excretion rate of fish has been estimated to vary from 34 mg NH_3/d/kg-body-wt to 398 mg NH_3/d/kg-body-wt by Leung, 1996 (1) and Leung et. al, 1999(2). The excretion rate depends not only on the fish type but also on the status of the fish including different metabolic rates at different water temperature and the feeding status (ration size). Instead of using a parameter dependent rate, the fish excretion rate for this study was taken to be 0.2354 g/kg/day (about mid-range indicated by the literature) of fish which is same as the one adopted in Project WATERMAN.

Fish faecal pollution is relative small components and therefore it is assumed a constant faecal pollution loading rate. The loading from the fish faeces will depend of the types of fish raised. Chemical composition of grouper and bream, both rather popular among mariculturists in HK, were adopted for estimation of faeces loading according to the following equation (3):

Loading from Faeces
= Standing Stock × (%Grouper × Chemical Composition of Grouper Faeces
+ %Bream × Chemical Composition of Bream Faeces)

The standing stock is assumed to be same as the production and the chemical compositions of the fish faeces are listed in *Table 3* which was derived from the data provided in Ove Arup and Partners (1989).

Table 3 Chemical Compositions of Fish Faeces

mg/kg	Grouper	Bream
NH_3	0.418	0.303
TIN	1.919	1.081
TON	14.423	18.915
PO_4	1.684	1.538
TOP	0.586	1.139
BOD	528.642	446.819

Disposal of Dead Fish

Pollution loading from dead fish disposal is given by:

Loading from Dead Fish Dumped = Loading from Dead Fish × Disposal Rate

Loading from Dead Fish = Biomass of Dead Fish Dumped × Nutrient Content of Dead Fish

Biomass of Dead Fish
= Fish production × (Fish death Rate/(1 - Fish Death Rate))
× Dead Fish Weight to Live Fish Weight Ratio

The nutrient content of dead fish is assumed to the same as that for the trash fish as referenced from AFCD 2010 Laboratory Study (*Wong et al. 2012*). The weight of total live fish is about 7.8 times the dead fish, and hence the dead fish weight to live fish weight ratio is equal to 0.128. Dumping of dead fish was quite common in the 80s - 90s although to the sea is illegal. With stricter enforcement in

(1) Leung, K.M.Y., (1996). *The nitrogen budgets of the areolated grouper Epinephelus areolatus (Forskal) and the mangrove snapper Lutjanus argentimaculatus (Forskal) cultured in open sea cages*, MPhil thesis, City University of Hong Kong, Hong Kong.
(2) Leung, K.M Y., Chu, J.C.W., Wu, R.S.S., (1999). "Nitrogen budgets for the areolated grouper *Epinephelus areolatus* cultured under laboratory conditions and in open-sea cages".*Marine Ecology Progress Series*, 186, 271-281.
(3) Note that other specifies of fishes are farmed in the existing and proposed FCZs. Groupers and breams were chosen for them being common for mariculturing in HK.

recent years, the disposal ratio has been reduced significantly and becomes negligible and a zero disposal rate is assumed. Therefore, the loading from dead fish dumping was taken to be zero for the present study.

Workers and Dogs on the Fish Farm

It is assumed that the labor in fish farm operation is proportional to the fish production with reference to Ove Arup and Partners (1989) [(4)]. Hence, man-day was estimated as the following method:

Man-day per ton fish production

= 1782 operations × 50.524 man-day/year/operation / 3000 ton production

= 0.082 man-day/day/ton production

With the BOD and TON loading per man-day estimated to be 45 g and 11 g respectively, the BOD and TON loadings per tonne fish production due to worker presence were estimated to be 3.7 g and 0.9 g respectively. Similarly, the pollution loading from dogs per tonne fish production were estimated to be 42.8 and 1.8 g respectively. It is worth noting that the pollution loading from human and dogs only comprise a very small portion of the pollution loading (less than 3%). It should also be noted that the calculation is expected to represent a conservative estimate for new FCZs. As the new FCZs are located comparatively offshore and owing to advancements in operation and monitoring, it is expected that there will not be staff staying are fewer workers and dogs on the fish farm of the proposed FCZs than at traditional fish farm, hence pollution loading from human and dogs would be lowered.

(4) Ove Arup & Partners, (1989). *Assessment of the Environmental Impact of Marine Fish Culture in Hong Kong: Final Report*, Environmental Protection Department, Hong Kong Government, Hong Kong.

Appendix B

Hydrodynamic Model Validation

Figure 1 Locations of Observation Points for Validation

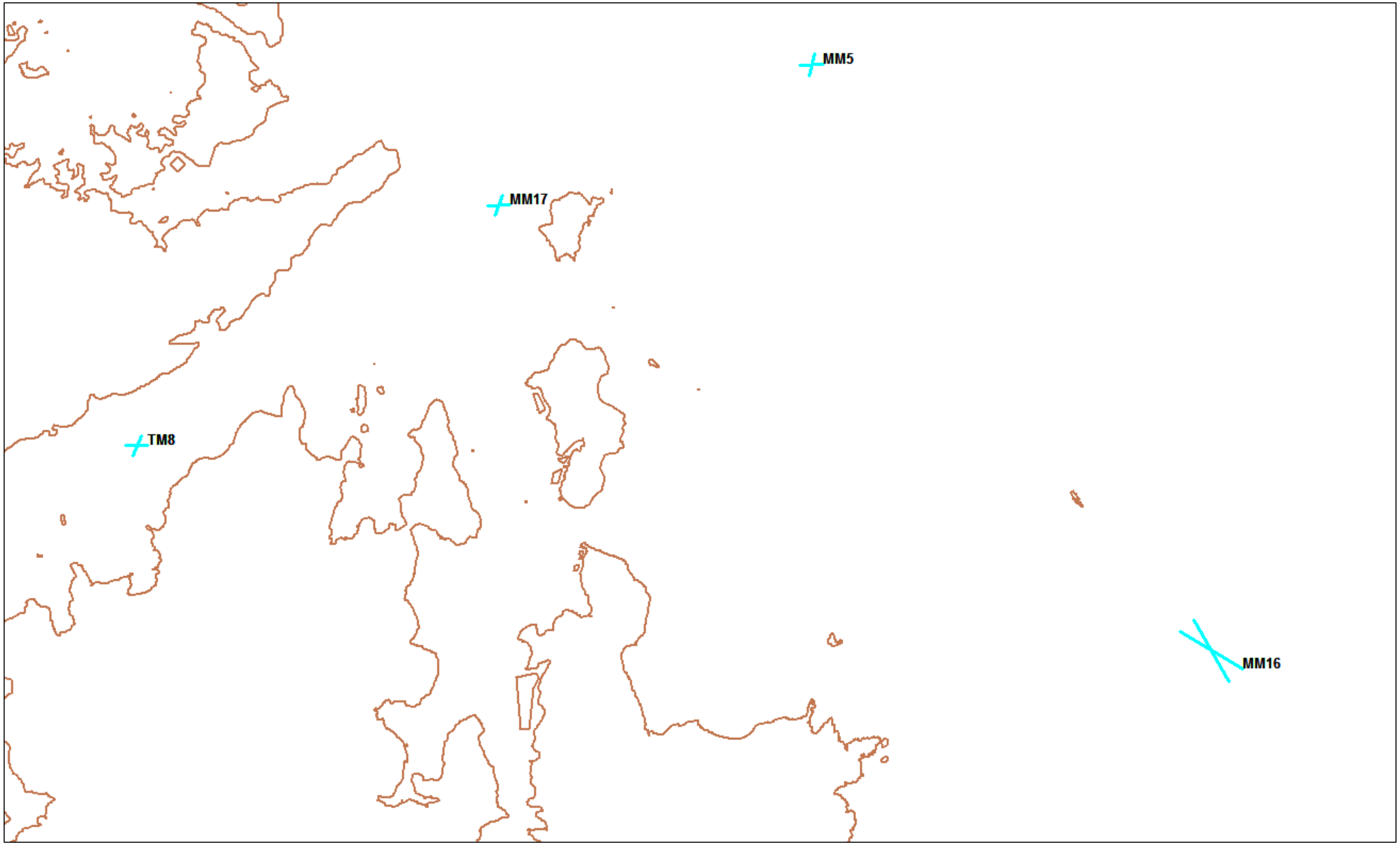
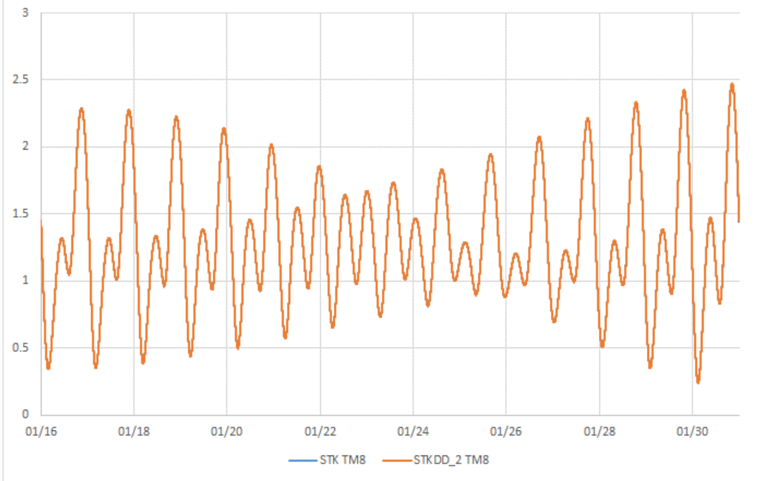
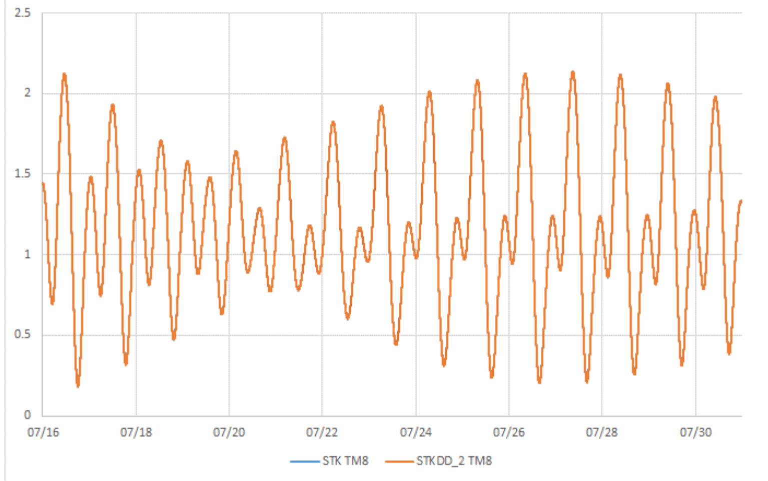
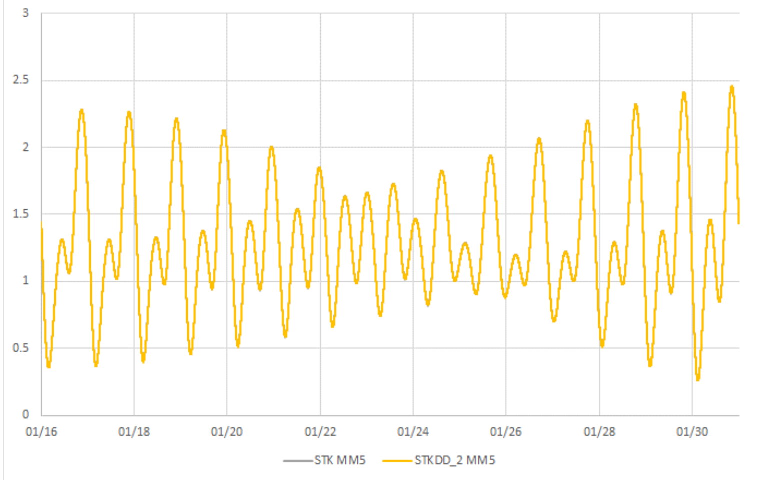
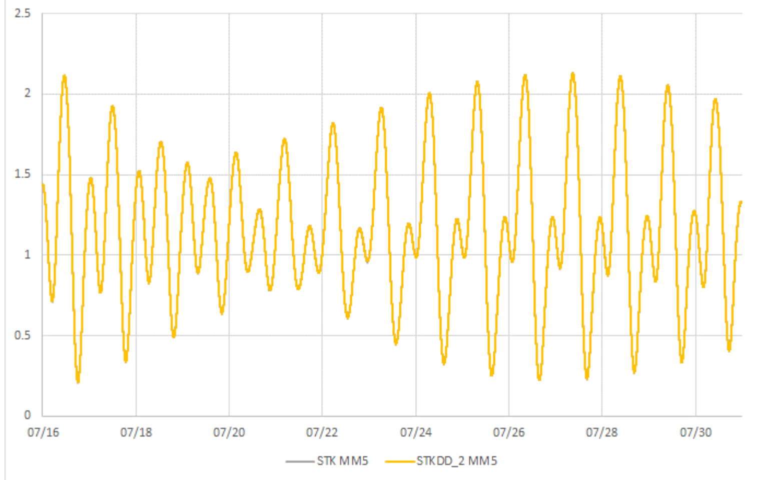
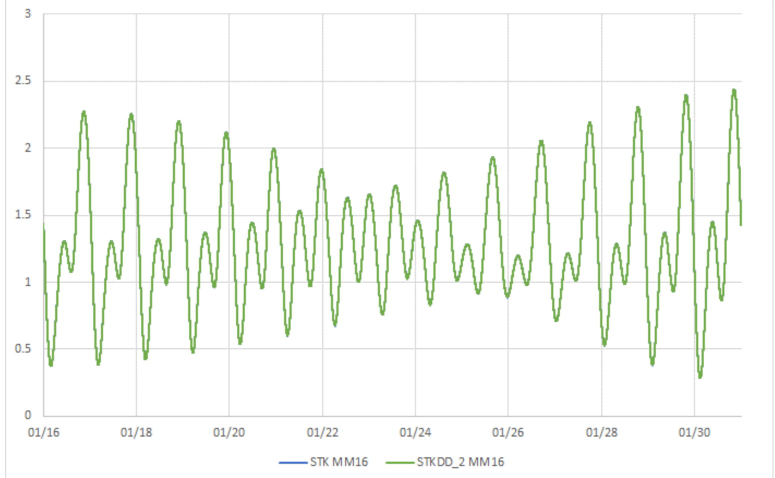
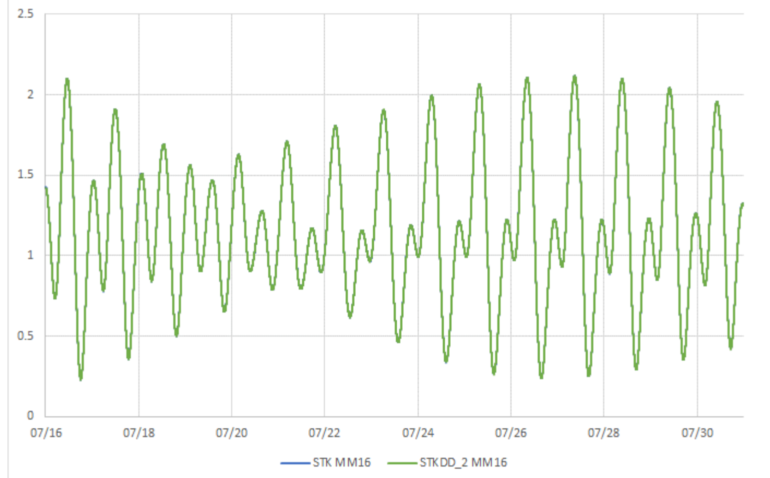
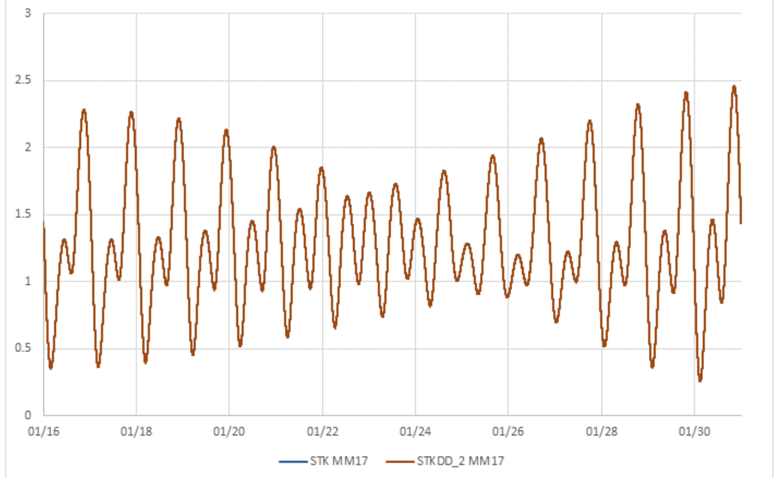
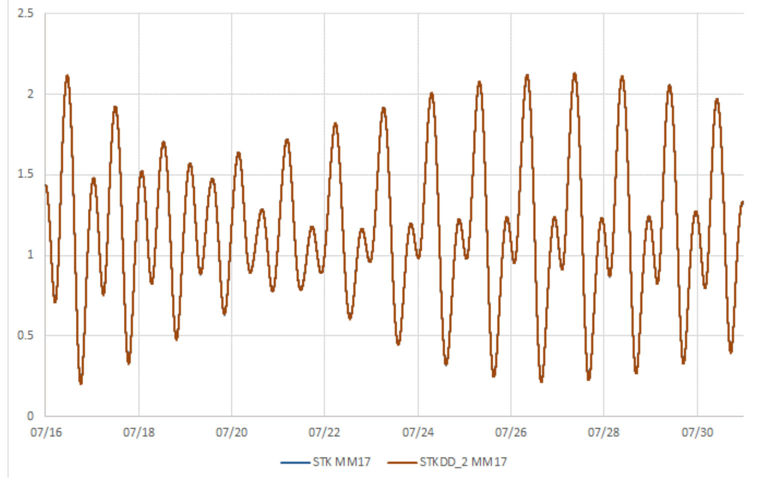
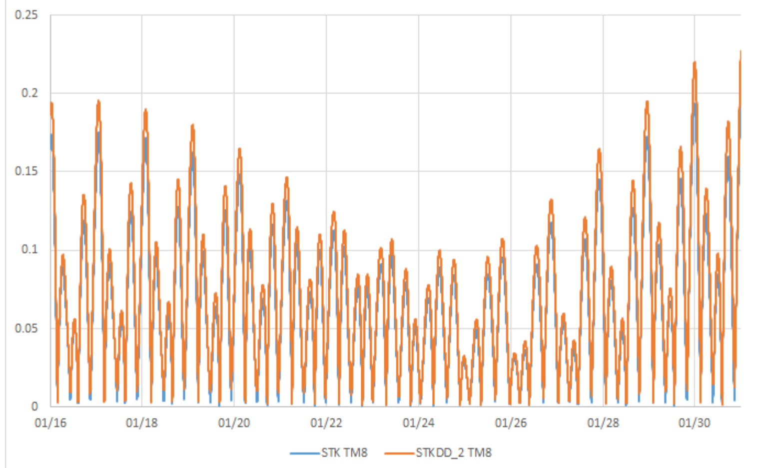
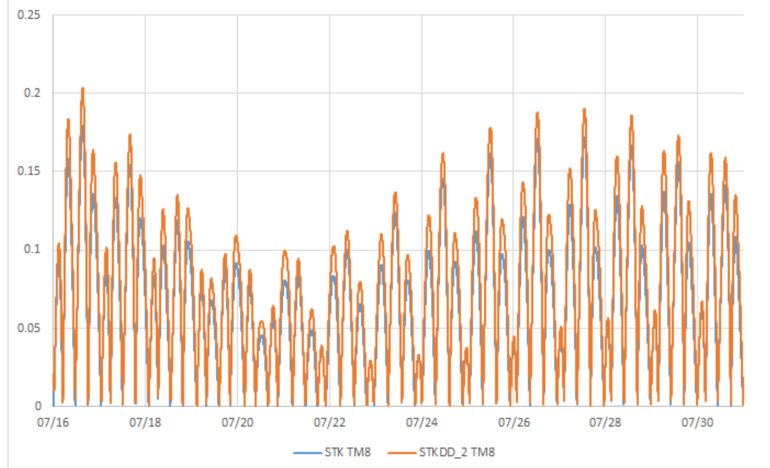
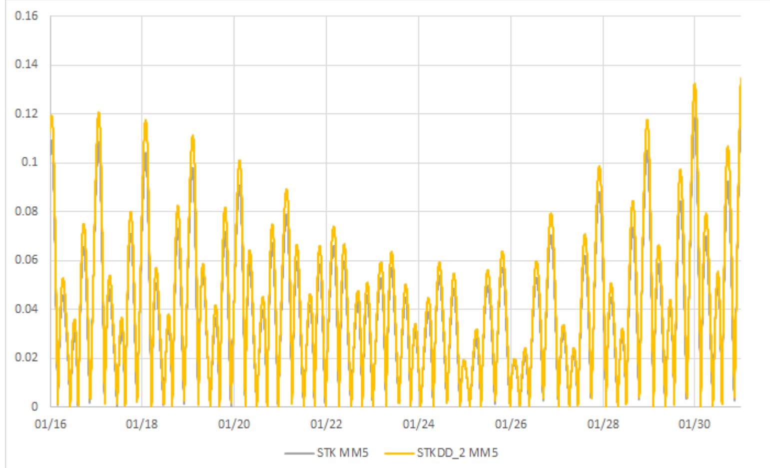
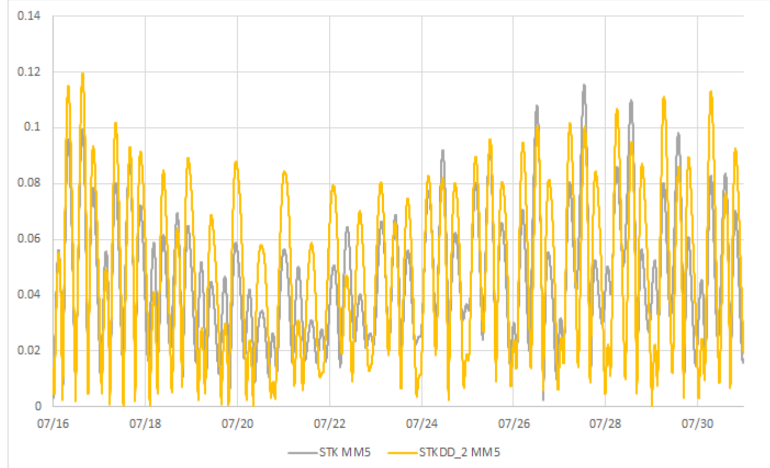


Table 1 Comparison of Select Hydrodynamic Parameters at Selected Locations for Model Validations (STK vs Modified STKDD)

Parameters	Locations	Dry Season (2014/01/16 – 2014/01/31)	Wet Season (2014/07/16 – 2014/07/31)
Water Level (m)	TM8 <u>RMSE%:</u> 0.13% (dry) 0.15% (wet) <u>Max. Phase Error:</u> 6 min (dry) 6 min (wet)		
	MM5 <u>RMSE%:</u> 0.06% (dry) 0.07% (wet) <u>Max. Phase Error:</u> 6 min (dry) 6 min (wet)		

	MM16 <u>RMSE%:</u> 0.03% (dry) 0.03% (wet) <u>Max. Phase Error:</u> 3 min (dry) 6 min (wet)		
	MM17 <u>RMSE%:</u> 0.08% (dry) 0.10% (wet) <u>Max. Phase Error:</u> 6 min (dry) 6 min (wet)		

Depth-Averaged Current Magnitude (m/s)	TM8 <u>Max. Cur. Speed Deviation</u> <u>:</u> 13% (dry) 15% (wet) <u>Max. Phase Error:</u> 12 min (dry) 15 min (wet)		
	MM5 <u>Max. Cur. Speed Deviation</u> <u>:</u> 12% (dry) 27% (wet) <u>Max. Phase Error:</u> 15 min (dry) 30 min (wet)*		

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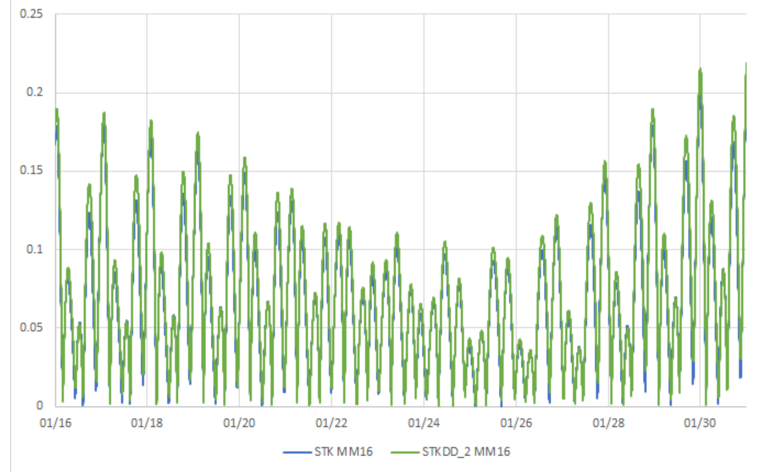
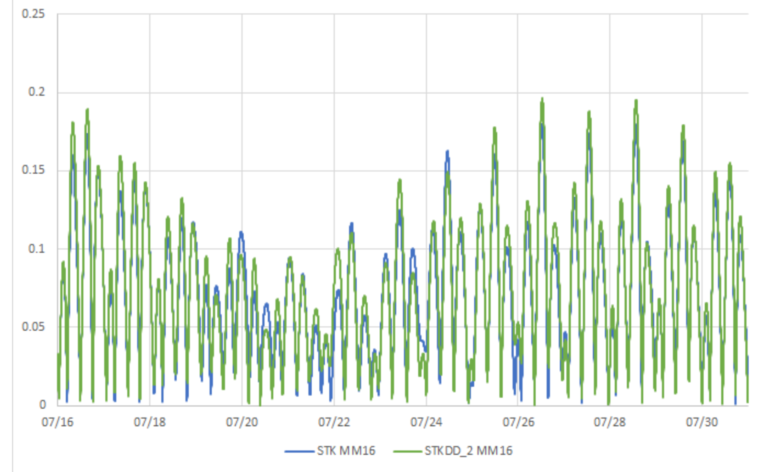
Max. Cur. Speed Deviation :
6% (dry)
13% (wet)

Max. Phase Error:
9 min (dry)
27 min (wet)*</td>
<td></td>
<td></td>
</tr>
<tr>
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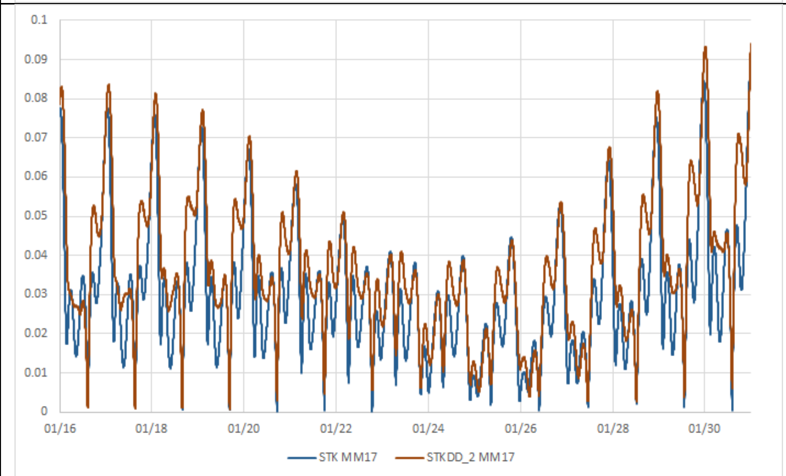
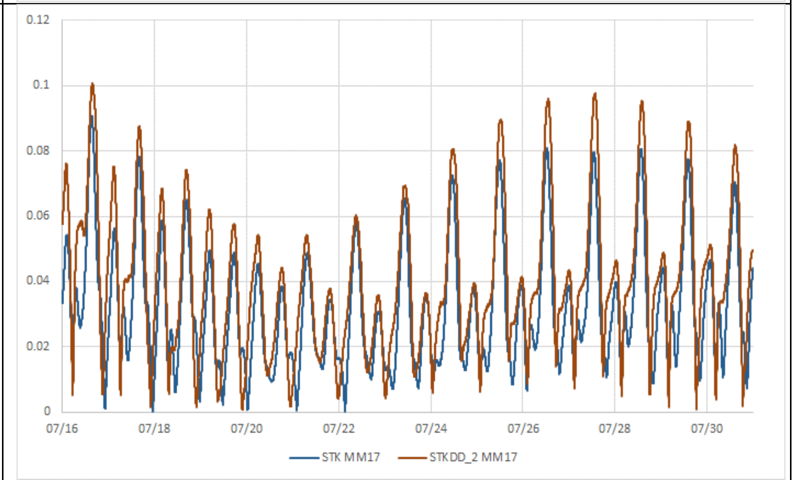
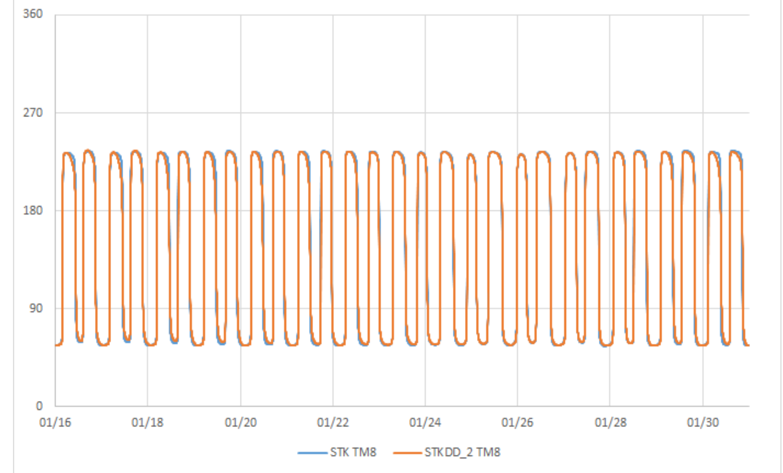
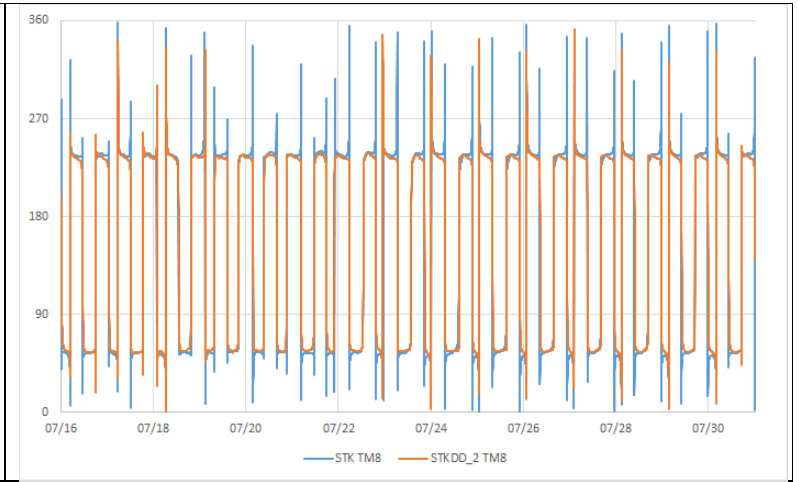
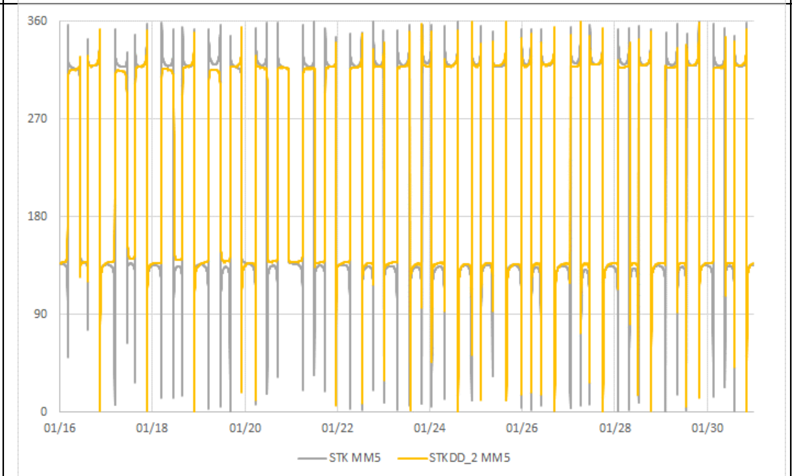
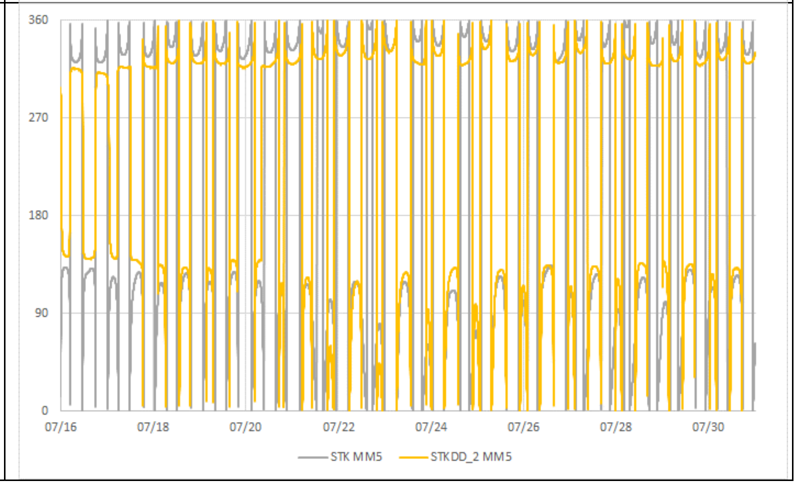
<td>MM17

Max. Cur. Speed Deviation :
17% (dry)
24% (wet)

Max. Phase Error:
42 min (dry)*
45 min (wet)*</td>
<td></td>
<td></td>
</tr>
</table>

Depth-Averaged Current Direction (Deg.N)	TM8 <u>Max. Dir. Error at Peak Speed:</u> 0° (dry) 5° (wet)		
	MM5 <u>Max. Dir. Error at Peak Speed:</u> 5° (dry) 10° (wet)		

<table>
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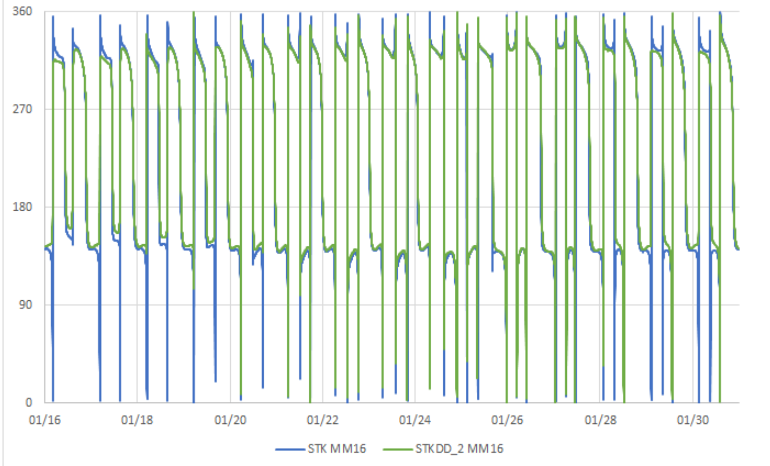
<td>MM16

<u>Max. Dir. Error at Peak Speed:</u>
5° (dry)
10° (wet)</td>
<td>
</td>
<td>
</td>
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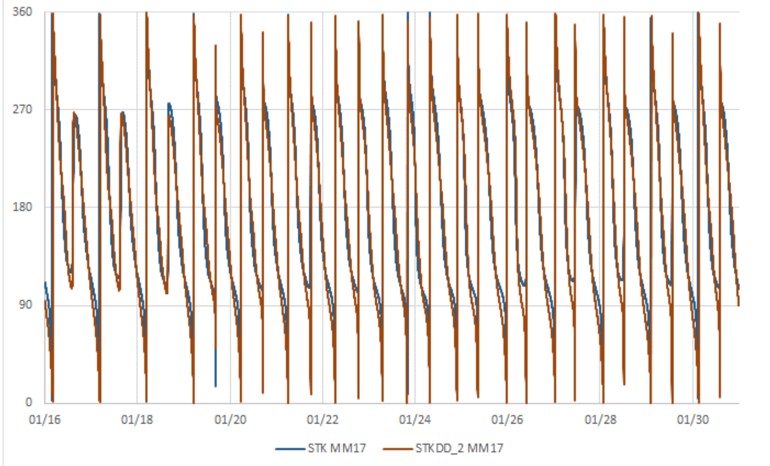
<tr>
<td></td>
<td>MM17

<u>Max. Dir. Error at Peak Speed:</u>
10° (dry)
5° (wet)</td>
<td>
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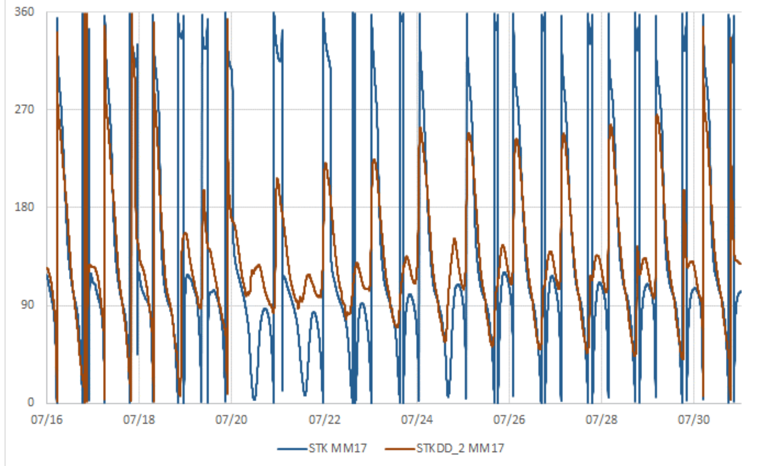
<td>
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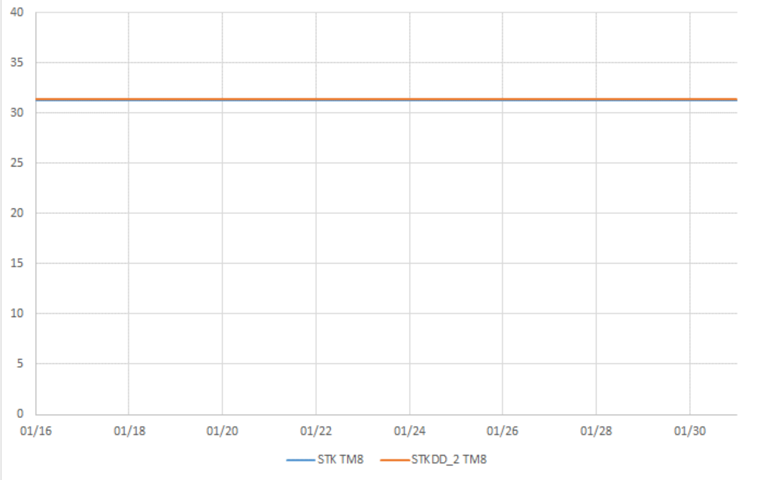
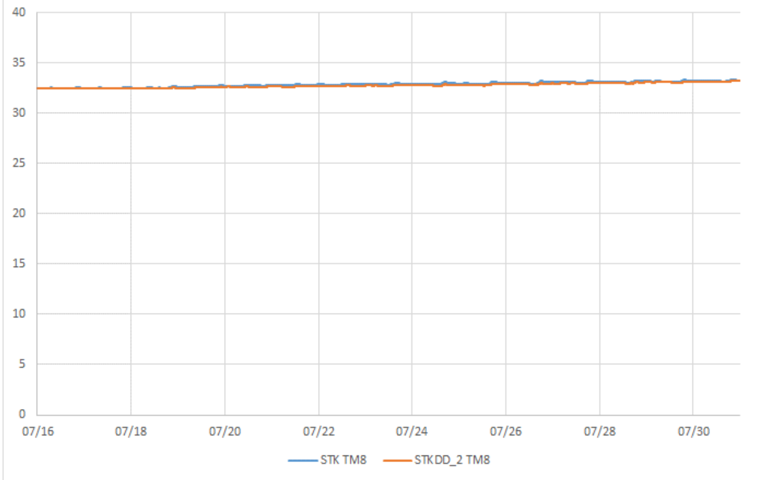
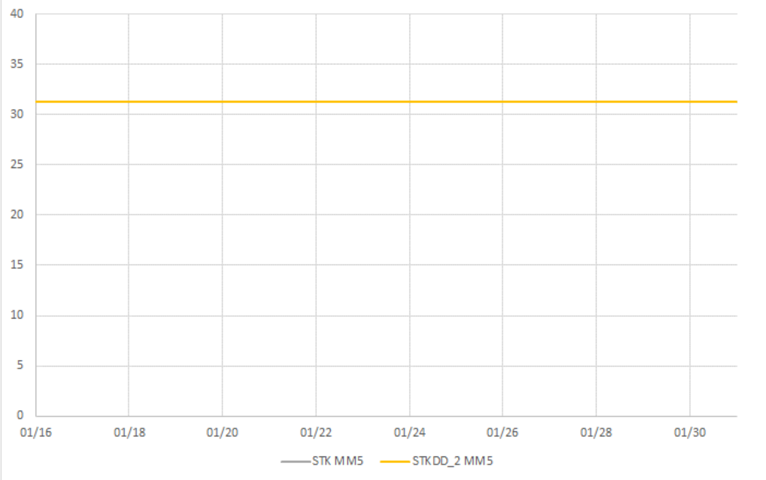
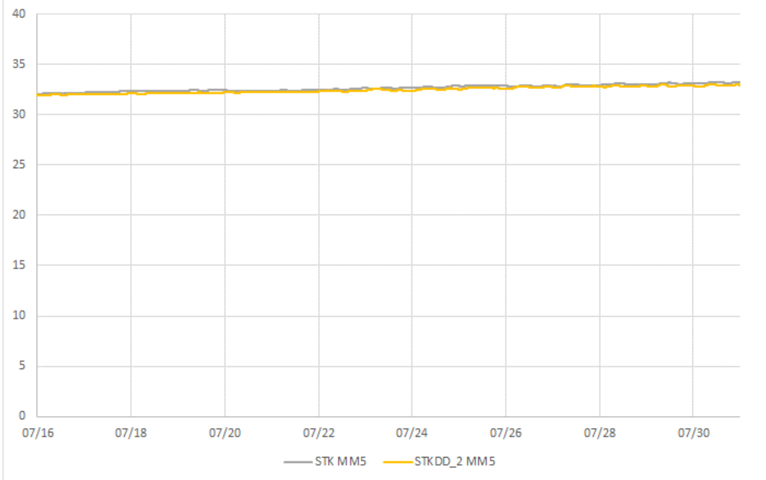
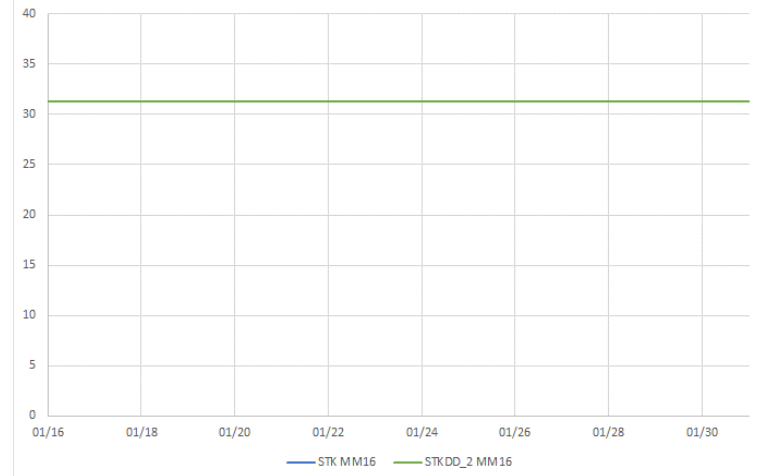
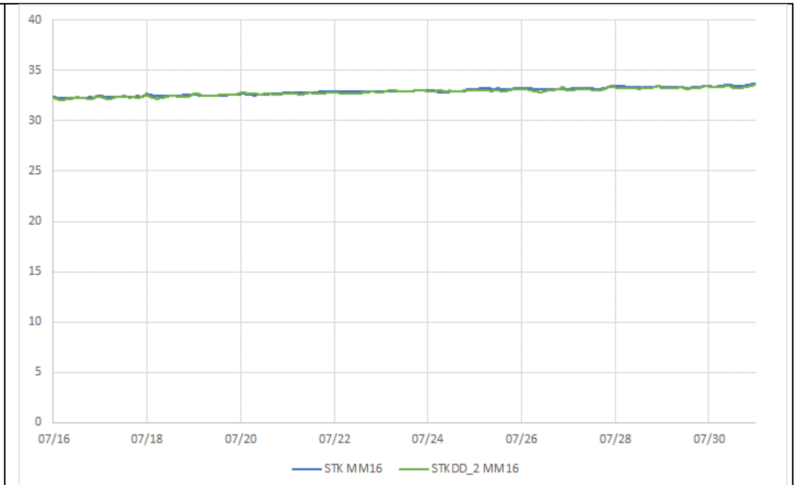
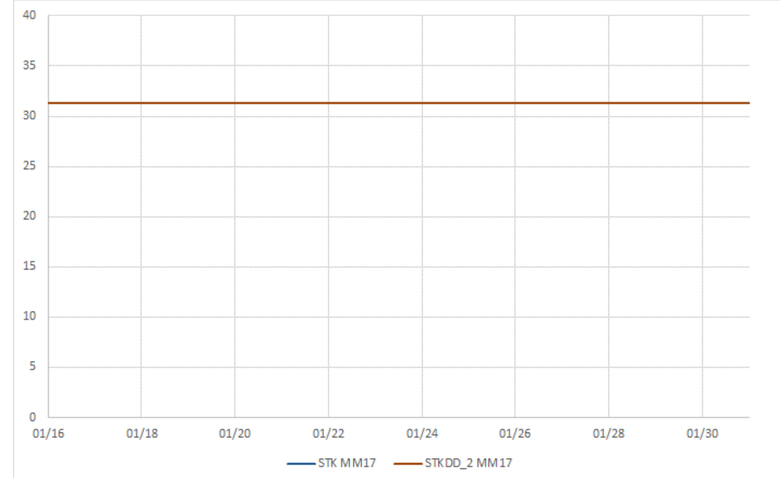
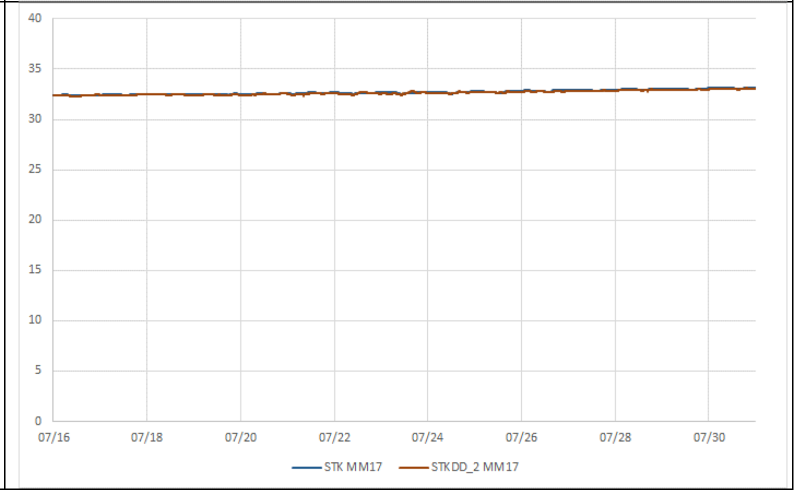
Mid-depth Salinity (PPT)	TM8 <u>Max. Salinity Deviation :</u> 0.07 ppt (dry) 0.23 ppt (wet)		
	MM5 <u>Max. Salinity Deviation :</u> 0.04 ppt (dry) 0.37 ppt (wet)		

	MM16 Max. Salinity Deviation: 0.02 ppt (dry) 0.30 ppt (wet)		
	MM17 Max. Salinity Deviation: 0.05 ppt (dry) 0.19 ppt (wet)		

* Note: The EIA Study Brief requires the model be calibrated and validated against applicable existing and/or newly collected field data. No new field data was collected for this Study, and thus model prediction from the validated STK model was adopted as surrogate for model validation. The predicted phase error at peak speed are higher than the 20 min criterion specified in the EIA Study Brief. Close inspection indicated given the low current velocity at these locations (max. around 0.2 m/s, typically below 0.1 m/s), a small change in predicted current speed (as a result of improved presentation of coastline and bathymetry due to grid refinement, reduced average due to increased resolution) can result in significant change in predicted time when velocity reaches maximum, even when the predicted speed does not change much. In view of the general compliance of all other technical criteria stipulated in the EIA Study Brief as well as compliance at other locations and other tide conditions, the limited deviation from the technical criteria in terms of maximum phase error at peak speed is deemed acceptable.

APPENDIX 3B ASSESSMENT OF CARRYING CAPACITY OF THE PROJECT SITE

3B.1 Assessment of Carrying Capacity of The Project site

This ***Appendix*** details the findings for carrying capacity assessment for the Project site, which has been conducted in accordance with the agreed *Water Quality Modelling Plan*.

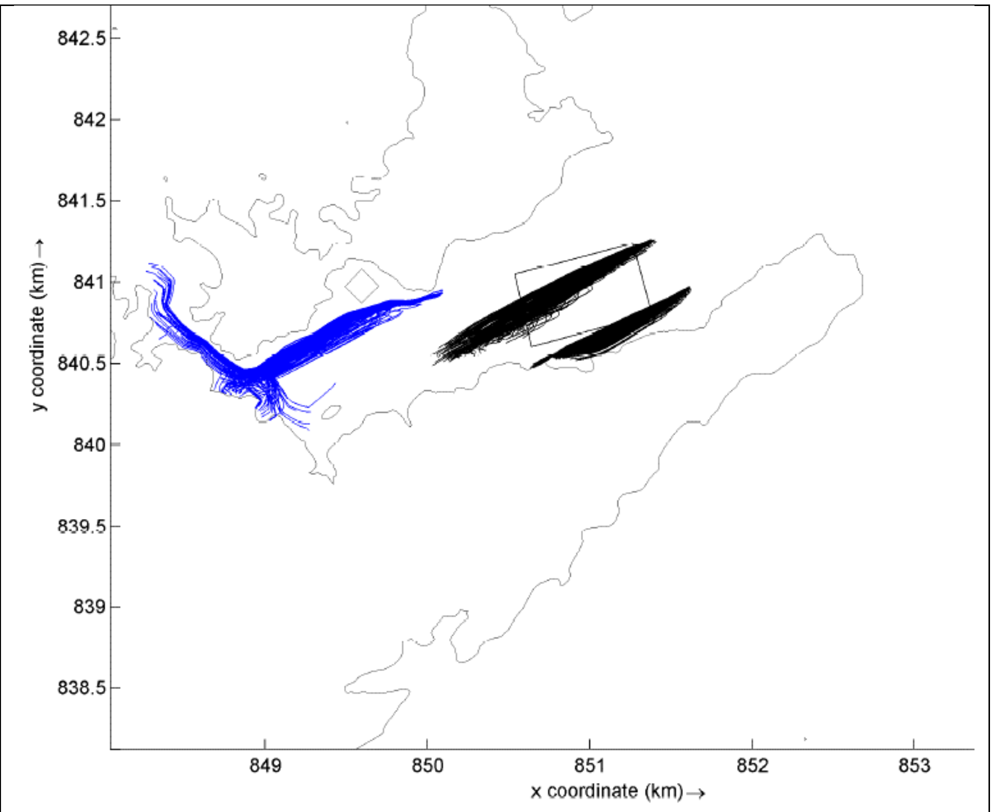
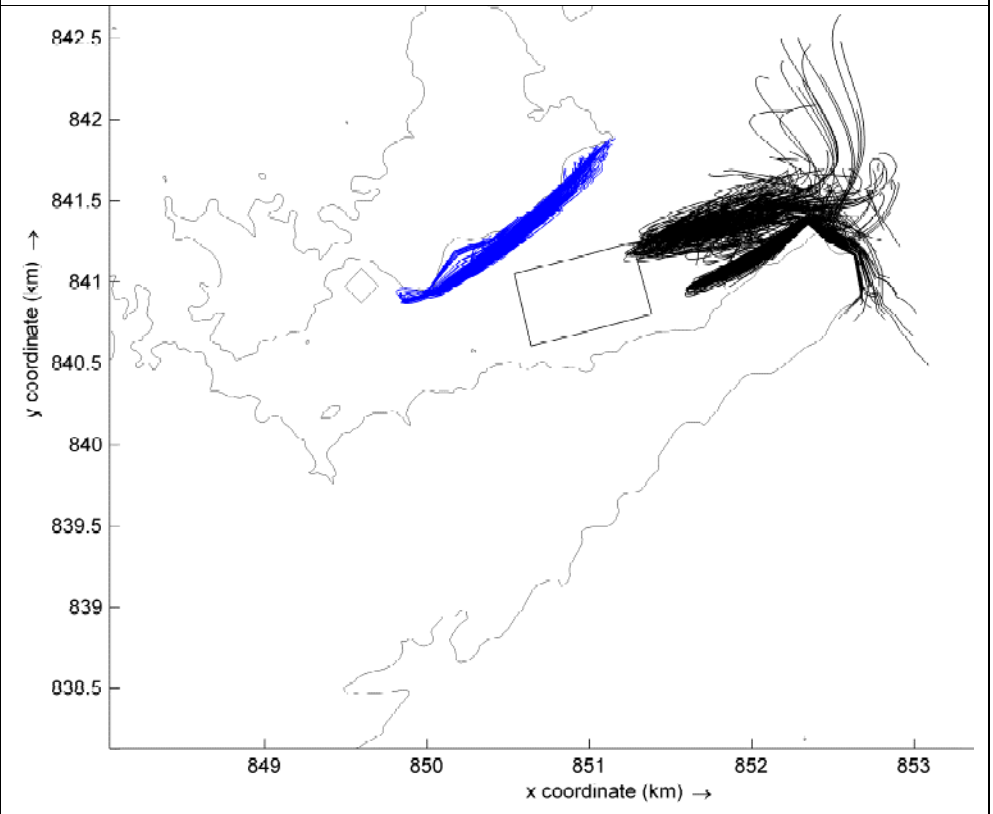
3B.1.1 Flushing Time Estimation

For flushing rate estimation, hydrodynamic modelling scenarios were conducted using Delft3D FLOW to achieve the following:

- Determination of initial dye area; and
- Estimation of flushing time of the Project site.

For the determination of initial dye area, one (1) modelling scenario would be conducted for each of the wet season and dry season. Drogues were released at 2-hour interval from near the boundary and corners of the Project site and the nearby surrogate site for a period of 15-day. The resulted drogue tracks were reviewed to determine the tidal excursion and the immediate proximity suitable for setting up initial tracer for tracer dispersion modelling to determine system-wide flushing time. Drogue tracks for the simulation of drogue release from the Project site and the nearby surrogate site of Wong Wan FCZ are shown in ***Figure 3B.1.1***. The drogue tracks indicate current velocity within the Wong Chuk Kok Hoi is rather low in both seasons. In the dry season, drogues tend to move into the embayment while in the wet season, they tend to move out of the embayment. Drogues typically move only for less than 2 km from the locations they are released within one flood-ebb cycle.

Figure 3B.1.1 Drogue Tracks from Wong Wan FCZ (Blue) and Project site (Black) in Dry (Top) and Wet (Bottom) Seasons

Dry Season	
Wet Season	

A number of sensitivity tests of tracer dispersion modelling exercise were conducted to evaluate the effect of different interpretation of the drogue simulation results. ***Figure 3B.1.2*** shows three initial tracer settings for sensitivity tests:

- Scenario 1 (green polygon) is a very restrictive read of the drogue track results. In this scenario, the initial tracer covers only an area within a short distance from all drogue tracks including the entire Wong Chuk Kok Hoi as well as its NE opening and its other end at Hung Shek Mun;
- Scenario 2 (red polygon) is a more expansive interpretation, with the entire Double Haven, a portion of the outer Tolo Channel, as well as the coverage under Scenario 1; and
- Scenario 3 (grey polygon) is even more expansive interpretation and considers all part of the inner Mirs Bay and Tolo Harbour embayment “behind” (in the sense relative to opening of the Mirs Bay in the SE) to be covered with tracer.

These three scenarios essentially differ by the interpretations on where “clean” water beyond the influence of Project site (as well as other pollution sources) starts. The average tracer decay curves (for seven cases), together with the corresponding best fit curves, for the three different scenarios in both seasons are shown in ***Figure 3B.1.3*** and ***Figure 3B.1.4***.

Figure 3B.1.2 Drogue Tracks and Initial Tracer Settings for Sensitivity Tests

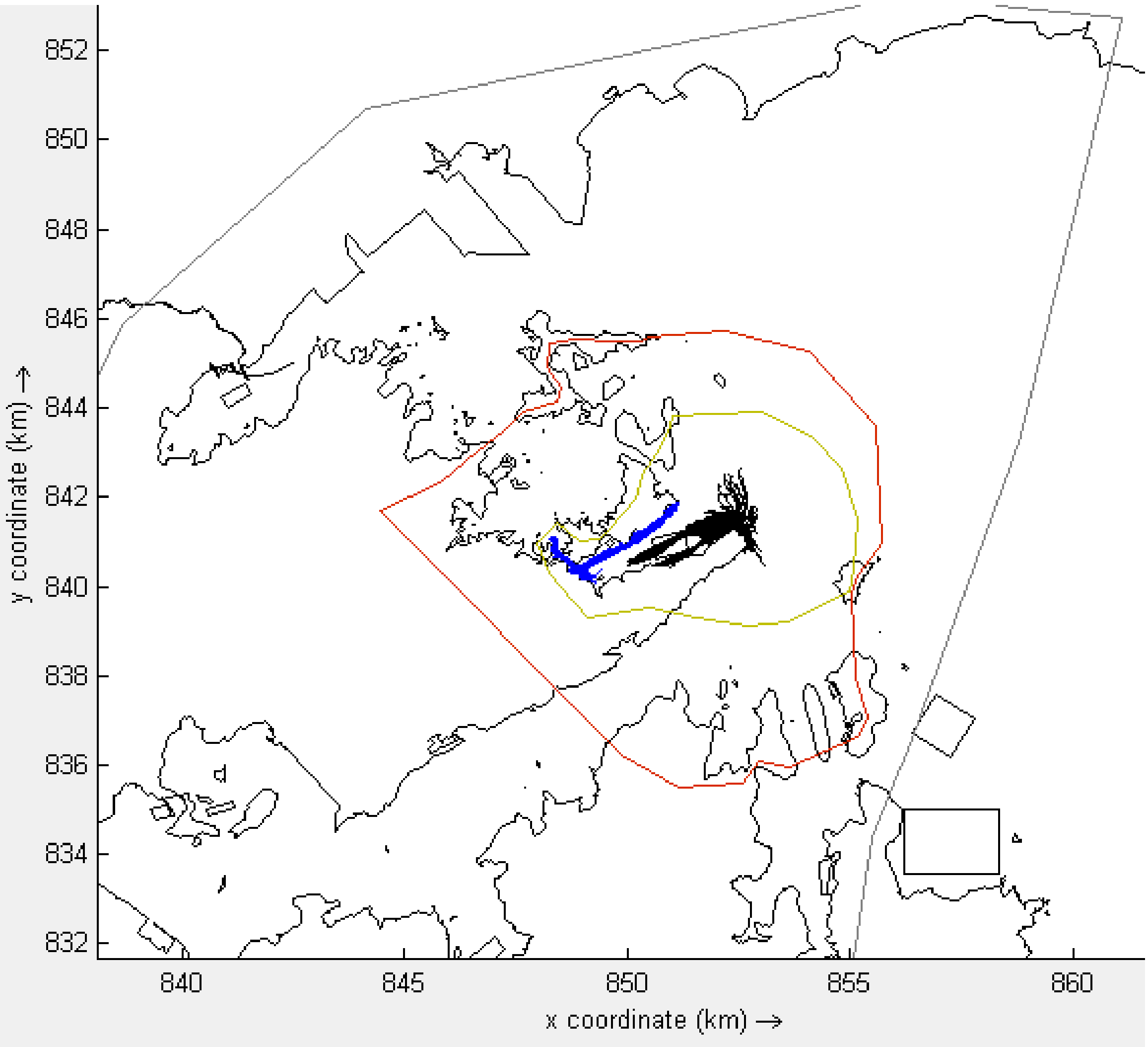
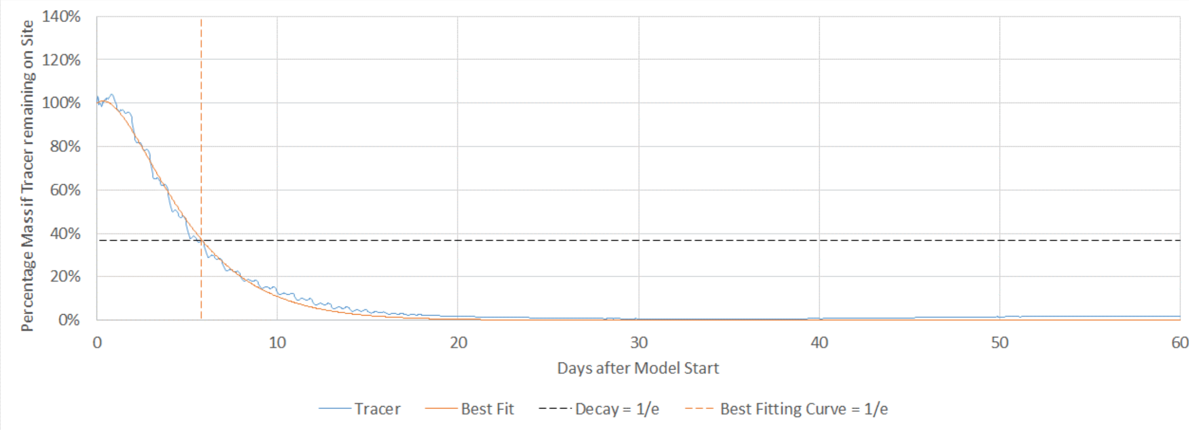
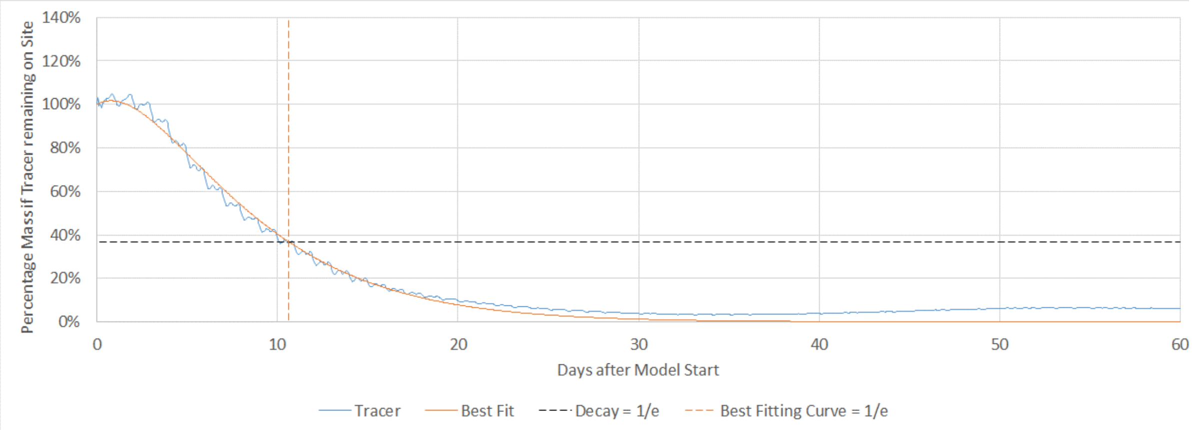


Figure 3B.1.3 Average Tracer Decay Curve at Project Site for Three Scenarios in Dry Season (Horizontal dashed line indicates tracer mass at a fraction of e [base of natural logarithm], vertical dashed line indicates estimated flushing time)

Dry Season – Scenario 1 Average of Project site (K_1: 0.42, K_2: 0.37)



Dry Season – Scenario 2 Average of Project site (K_1: 0.25, K_2: 0.20)



Dry Season – Scenario 3 Average of Project site (K_1: 0.04, K_2: 0.03)

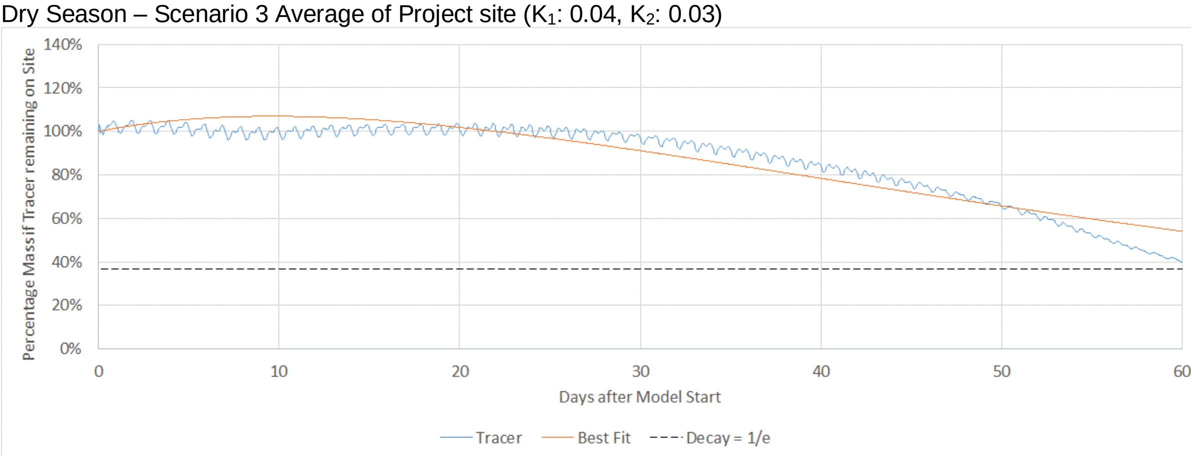
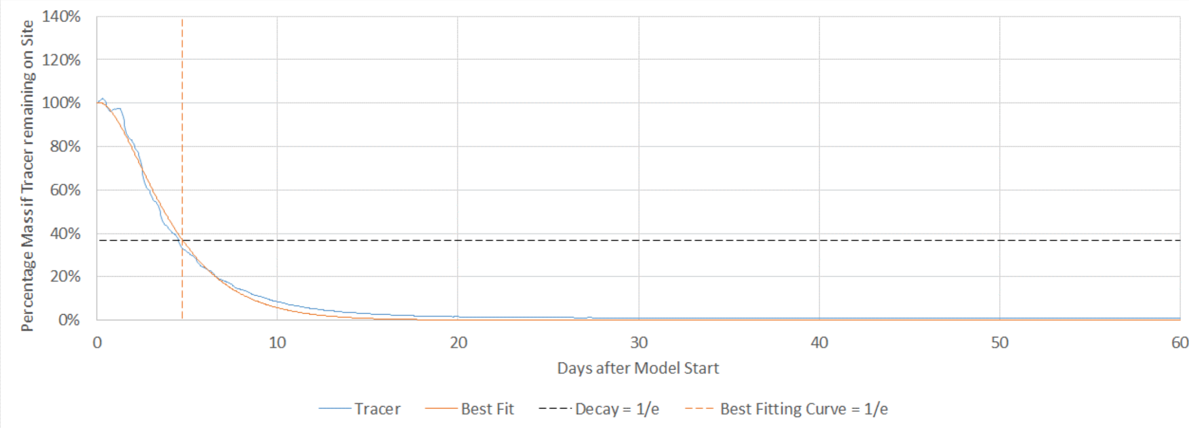
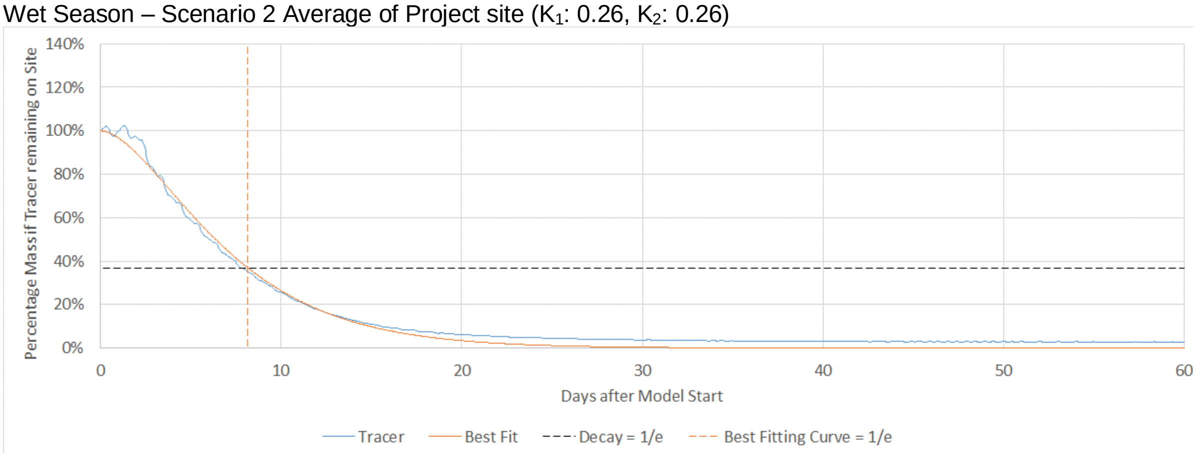


Figure 3B.1.4 Average Tracer Decay Curve at Project Site for Three Scenarios in Wet Season (Horizontal dashed line indicates tracer mass at a fraction of e [base of natural logarithm], vertical dashed line indicates estimated flushing time)

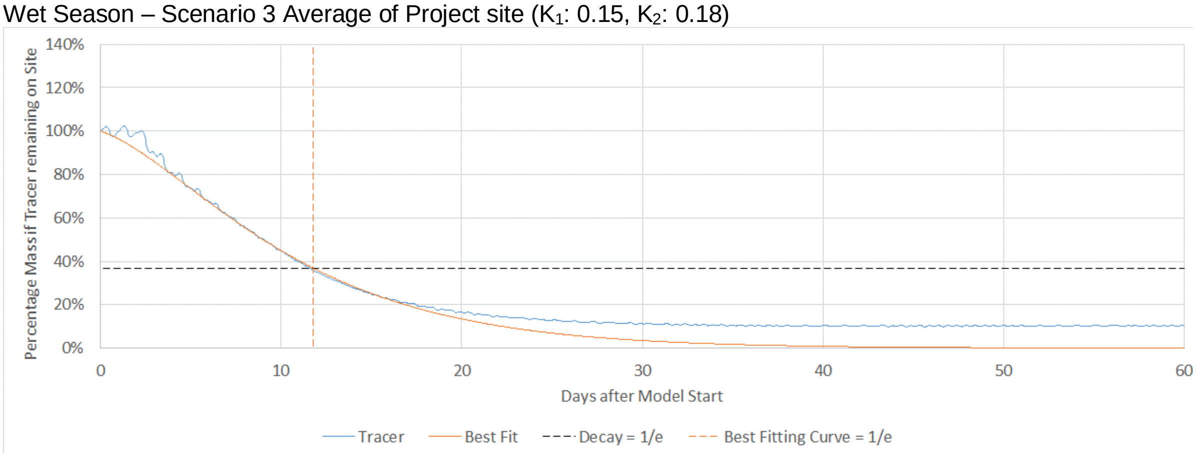
Wet Season – Scenario 1 Average of Project site (K_1: 0.48, K_2: 0.45)



Wet Season – Scenario 2 Average of Project site (K_1: 0.26, K_2: 0.26)



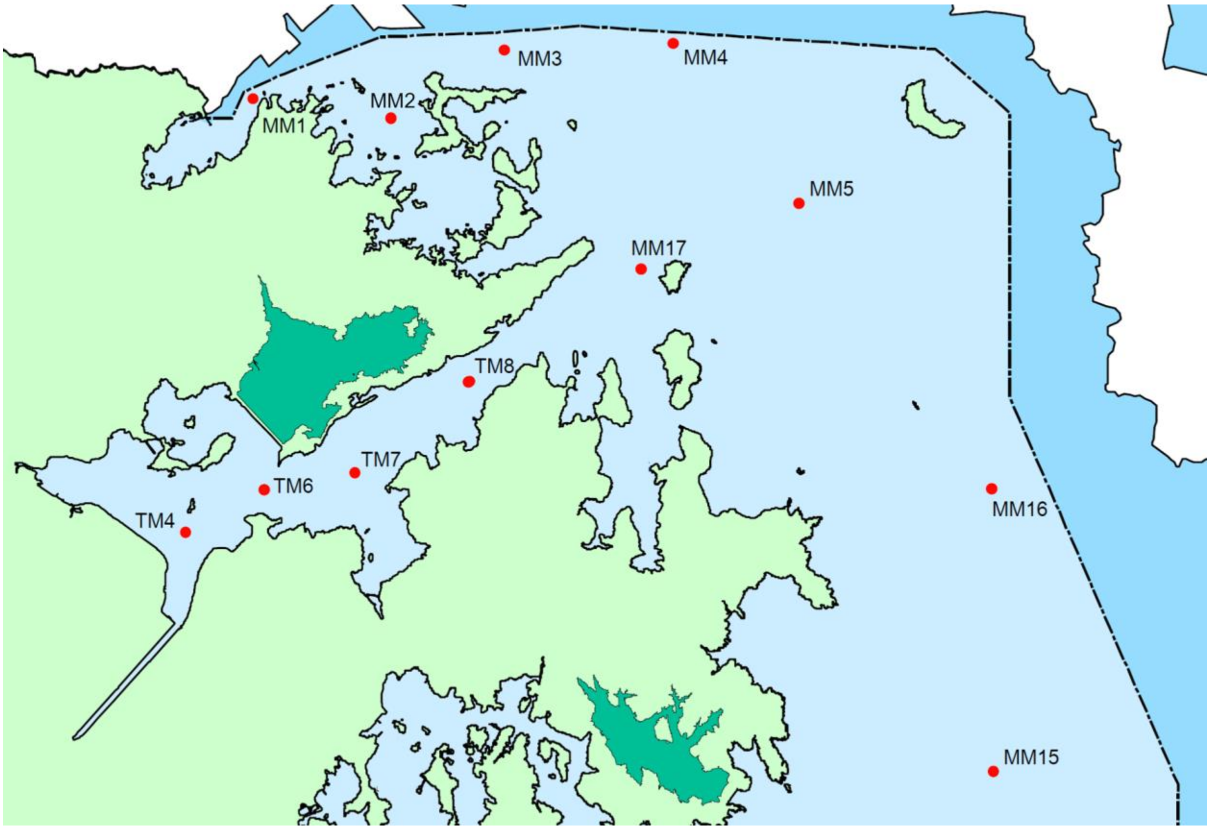
Wet Season – Scenario 3 Average of Project site (K_1: 0.15, K_2: 0.18)



As shown, the expansion of initial tracer area from Scenario 1 to Scenario 2 result only in a modest increase in flushing time. On the other hand, the decay of tracer in Scenario 3 is much slower than that in Scenarios 1 and 2, as a result of tracer from within the Tolo Harbour keeping the tracer level at the vicinity of the Project site high, thus reducing the flushing and dilution of Wong Chuk Kok Hoi significantly. This seems to indicate assuming the entire Tolo Harbour-Mirs Bay embayment be covered with tracer be an overestimation.

A review of long term marine water quality monitoring data by EPD along the lines from the inner embayment to opening of both embayments also provides similar findings. EPD Marine Water Quality Monitoring Stations reviewed are shown in ***Figure 3B.1.5***. Two lines of EPD marine water quality monitoring stations were considered. First line includes TM4, TM6, TM7, TM8, MM17 and MM5, which represents the contrast inside and outside of the Tolo Harbour. The second line include MM1, MM2, MM3, MM4, MM5, MM16 and MM15, which represents the contrast inside and outside of the Mirs Harbour. The long-term average water quality at these selected water quality parameters along these two lines are shown in ***Figure 3B.1.6***. As shown, water quality along the first line shows a clear gradient for all selected parameters. Such gradient typically flattens at around MM17 or TM8. For the second line, the gradient flattens at MM3. This means the effect of major pollution sources from the Tolo Harbour and the Starling Inlet is mostly dissipated at the end of Tolo Channel and the North of Crooked Island respectively. This supports the interpretation that the modelled Scenario 3 is an overestimation.

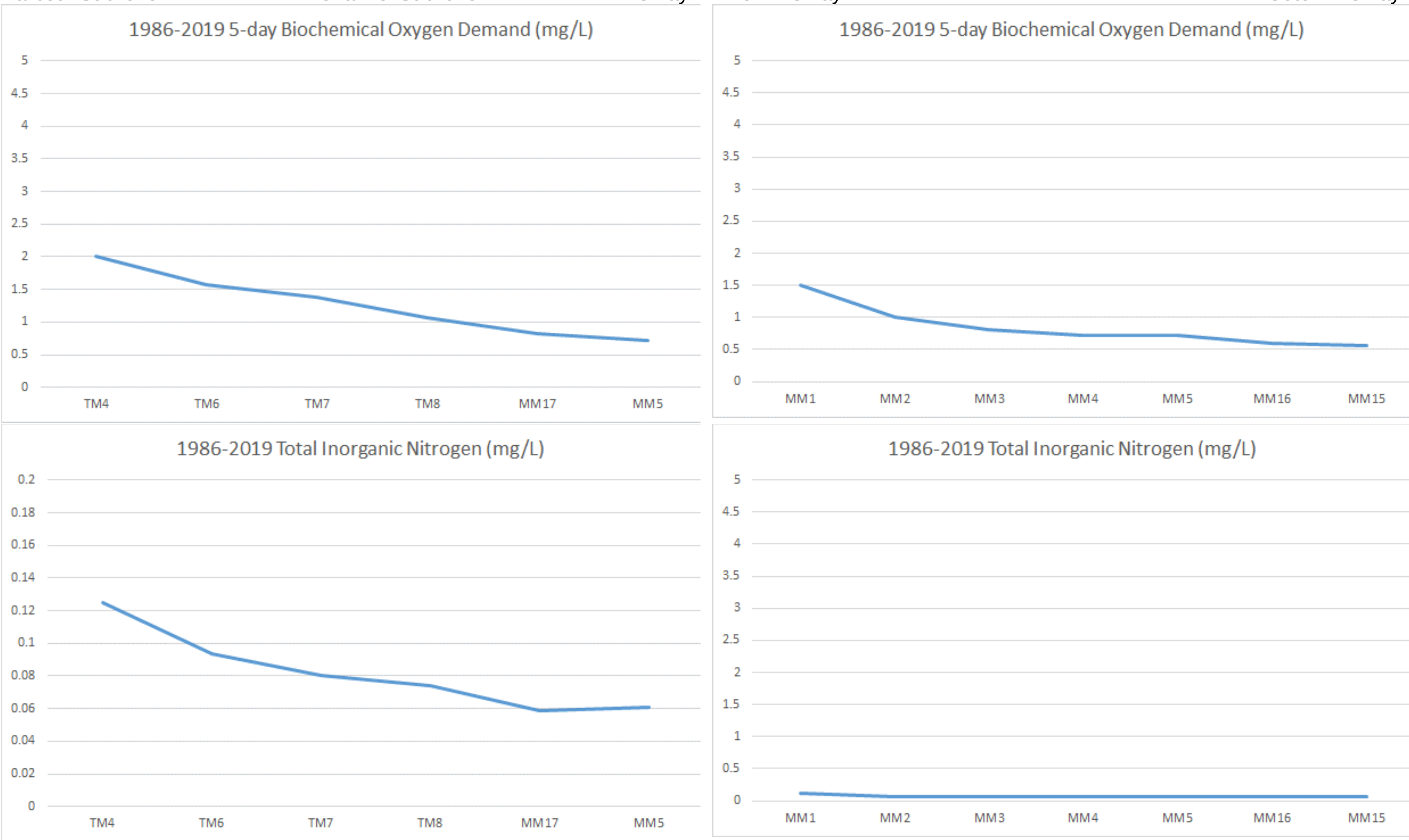
Figure 3B.1.5 Locations of EPD Marine Water Quality Stations Reviewed

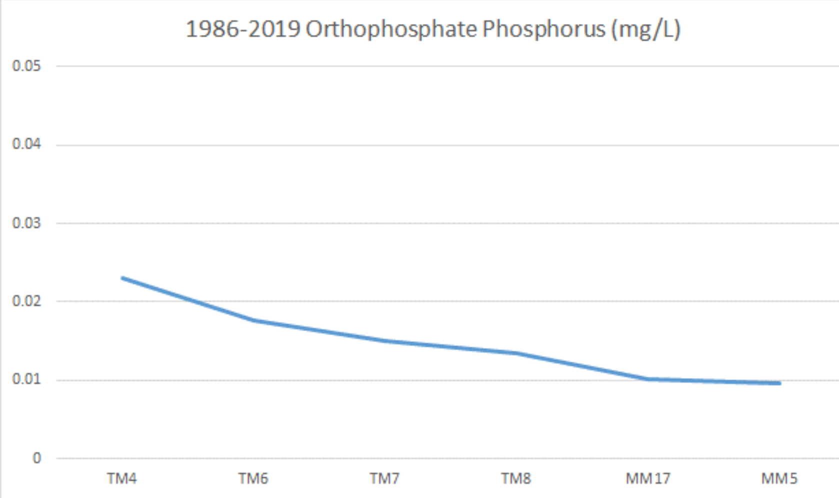
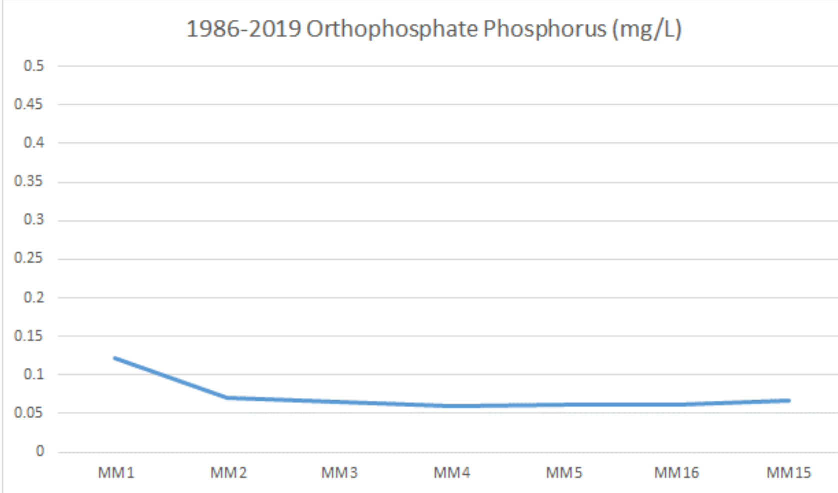
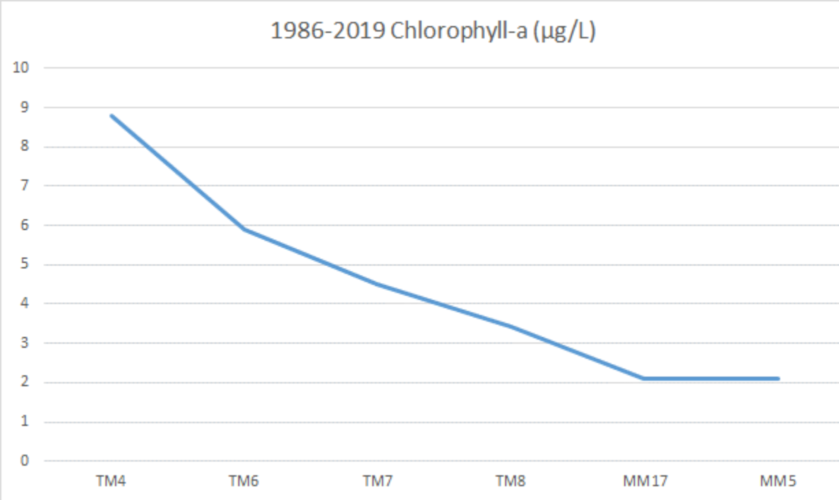
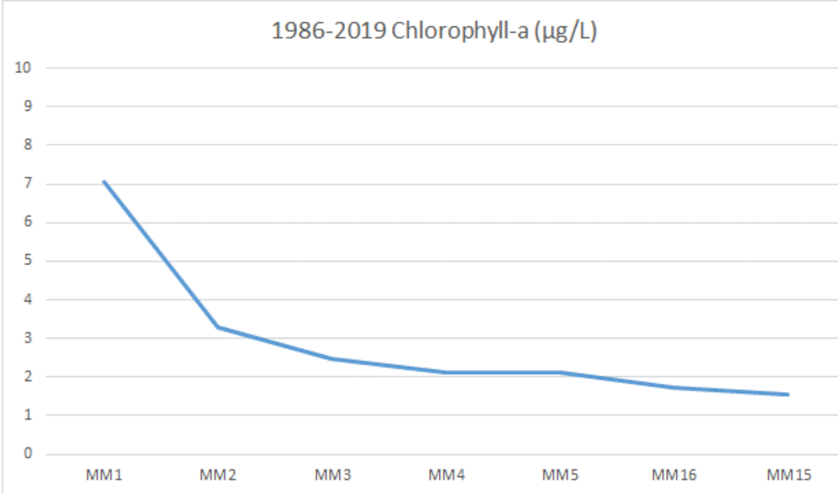


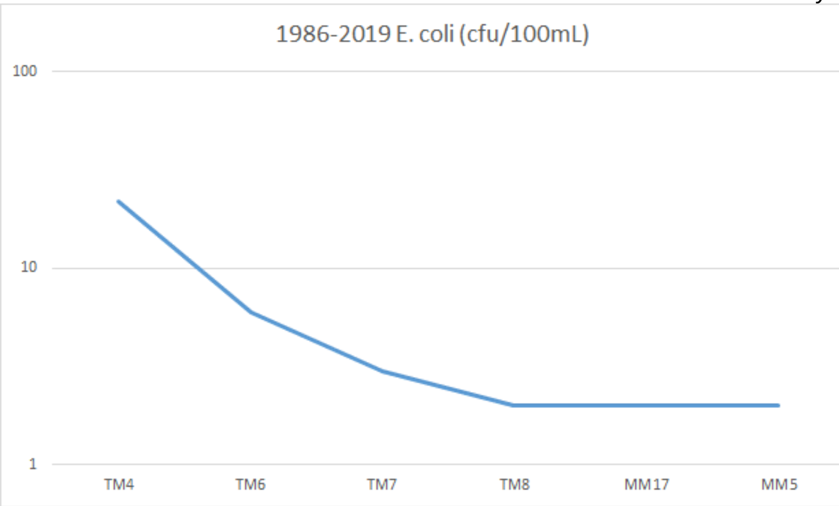
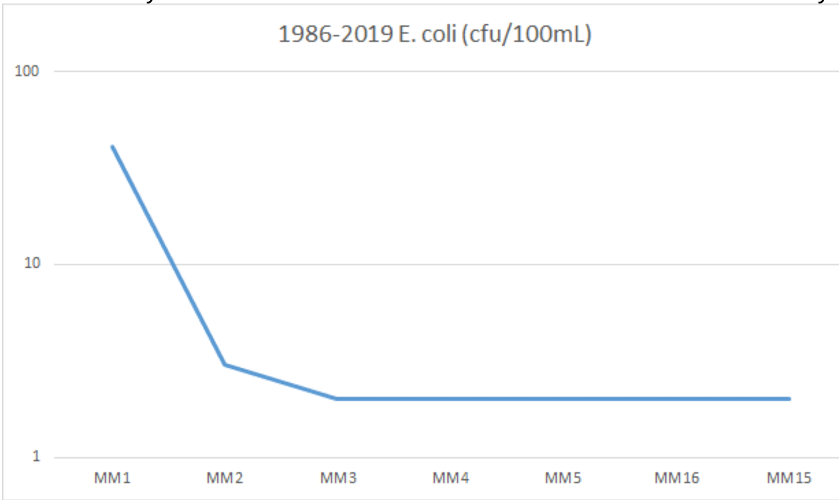
Source: EPD Marine Water Quality Report, 2019

Figure 3B.1.6 Long Term Average Water Quality along the Major Axes of Tolo Harbour and Mirs Bay.

Axis	Tolo Harbour – Tolo Channel – Mirs Bay Harbour Subzone / Channel Subzone / Mirs Bay	Mirs Bay – North to South Inner Mirs Bay / Outer Mirs Bay
BOD_5		
TIN		

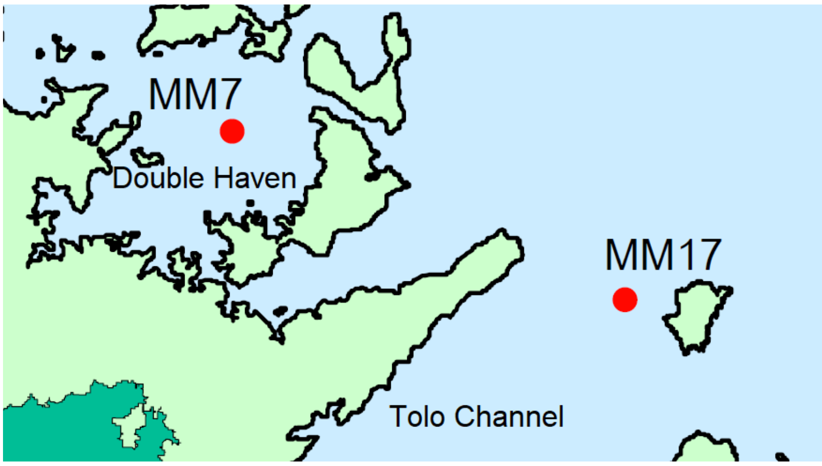


Axis	Tolo Harbour – Tolo Channel – Mirs Bay Harbour Subzone / Channel Subzone / Mirs Bay	Mirs Bay – North to South Inner Mirs Bay / Outer Mirs Bay
Ortho-P		
Chlorophyll -a		

Axis	Tolo Harbour – Tolo Channel – Mirs Bay Harbour Subzone / Channel Subzone / Mirs Bay	Mirs Bay – North to South Inner Mirs Bay / Outer Mirs Bay
E.coli (Note: log. scale y-axis)		

For Scenarios 1 & 2, the key difference is the inclusion of the land-locked water body of Double Haven. A review of EPD Marine Water Quality Data of MM7 (Double Haven) and MM17 (East to the Wong Chuk Kok Hoi) indicated water quality at MM7 is slightly worse than that of the less land-locked MM17 in terms of BOD_5, TIN and chlorophyll-a. This indicated waters in Double Haven should not be considered well-flushed. Given the drogue tracks from the existing Wong Wan FCZ as well as the Project site have the tendency to move into Double Haven, it is considered suitable to assume pollutants from the existing Wong Wan FCZ as well as the Project site would affect the water quality of Double Haven as well. In the perspective of carrying capacity, this means Scenario 2 is more representative of the situation for the existing Wong Wan FCZ as well as the Project site.

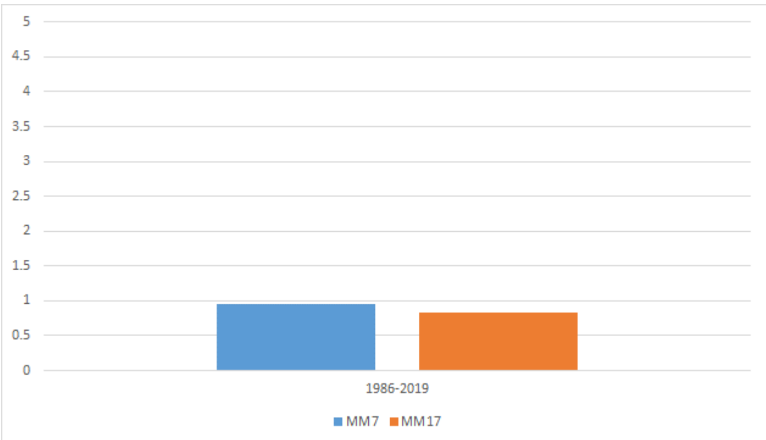
Figure 3B.1.7 Locations of Two Nearest EPD Marine Water Quality Monitoring Stations



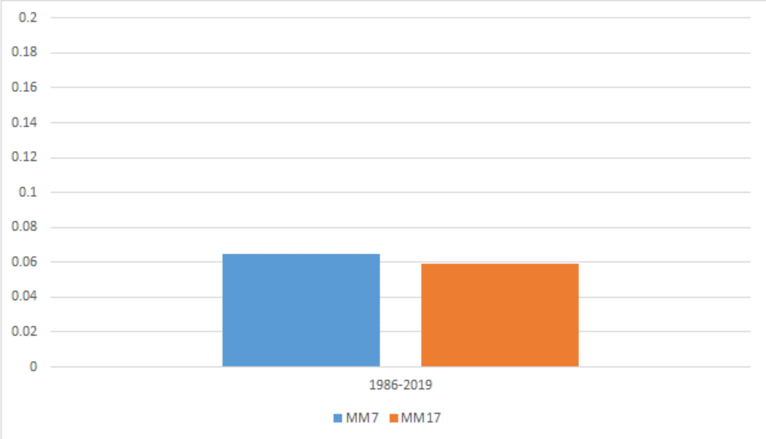
Source: EPD Marine Water Quality Report, 2020

Figure 3B.1.8 Comparison of Long Term Average for Selected WQ Parameters at MM7 and MM17

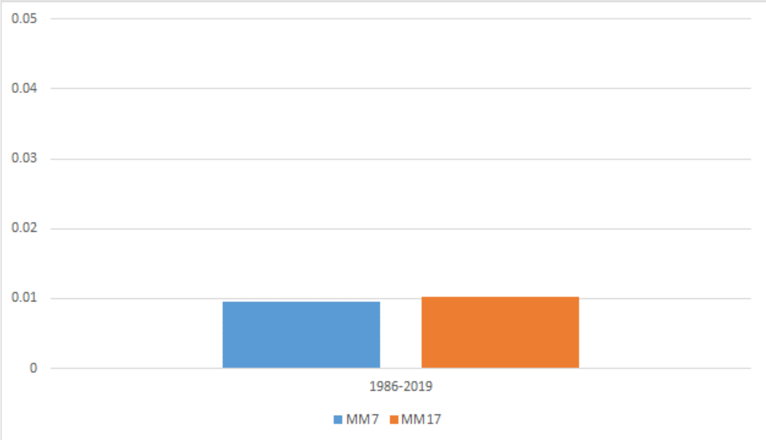
BOD_5



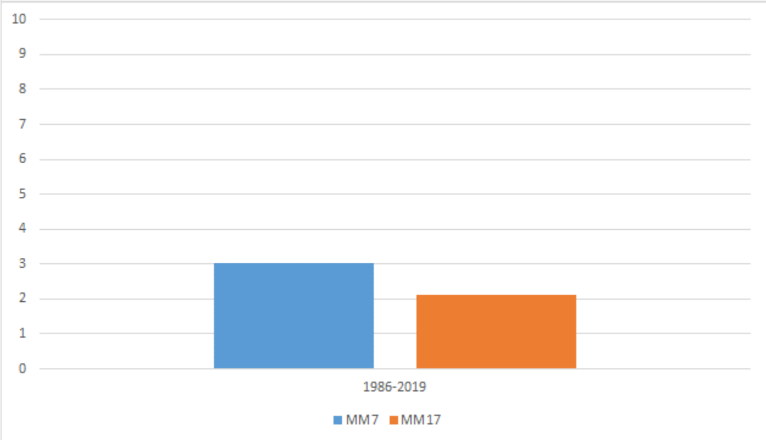
TIN



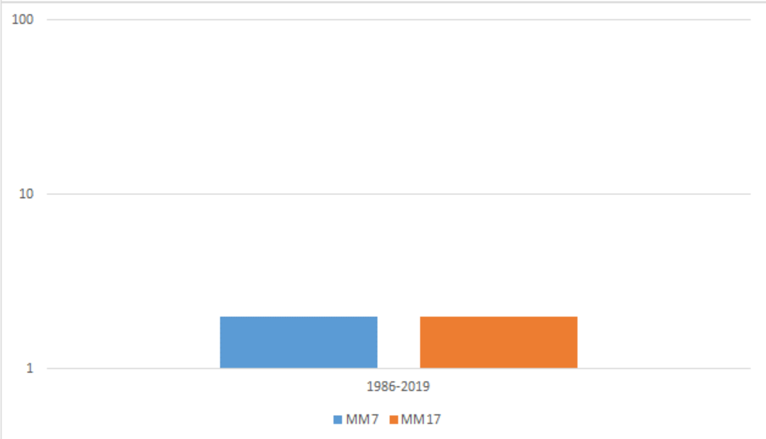
Ortho-P



Chlorophyll-a



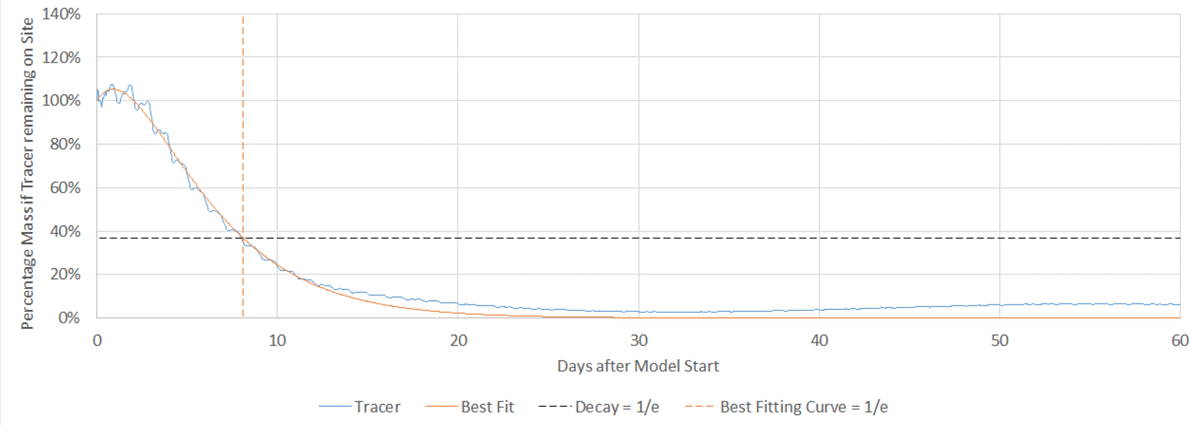
E.coli
(Note: log. scale y-axis)



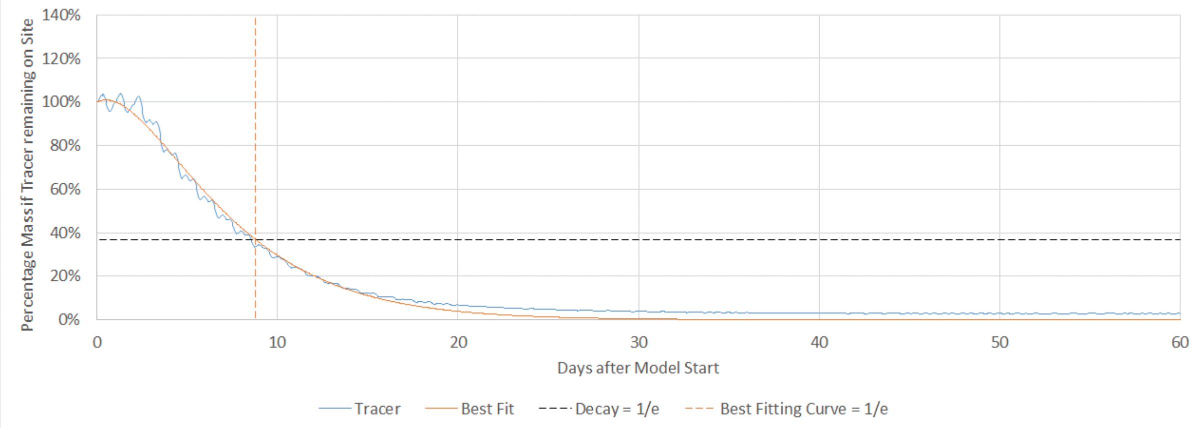
Tracer decay curves for the dry and wet seasons at the existing Wong Wan FCZ are shown in ***Figure 3B.1.9***.

Figure 3B.1.9 Tracer Decay Curves for the Existing Wong Wan FCZ under Scenario 2 (Horizontal dashed line indicates tracer mass at a fraction of e [base of natural logarithm], vertical dashed line indicates estimated flushing time)

Dry Season – Scenario 2 Average of Wong Wan FCZ (K_1: 0.38, K_2: 0.26)



Wet Season – Scenario 2 Average of Wong Wan FCZ (K_1: 0.28, K_2: 0.24)



The flushing time for the Project site, together with the surrogated site for calibration (existing Wong Wan FCZ), in both seasons under Scenario 2 are listed in ***Table 3B.1.1*** below. The estimated flushing time at the Wong Wan FCZ was adopted for calibration of the WATERMAN Carrying Capacity Model.

Table 3B.1.1 Estimated Flushing Time for the Project site and the Wong Wan FCZ

Flushing Time (Day)	Dry Season	Wet Season
Project site	10.0	7.6
Wong Wan FCZ	7.8	8.3

3B.1.2 Calibration of Water Quality Rate Kinetics and Equilibrium Parameters using WATERMAN Hindcast Modelling Tool

Annual production from 2015 to 2019 from the Wong Wan FCZ was obtained from AFCD to estimate the average daily pollution load from the fish farming operation at Wong Wan FCZ based on the estimated unit pollution load established in the *Water Quality Modelling Plan*. The annual fish production rate as well as the corresponding estimated pollution load are shown in ***Table 3B.1.2***.

Table 3B.1.2 Annual Fish Production from 2015 to 2019 and Estimated Pollution Load at the existing Wong Wan FCZ

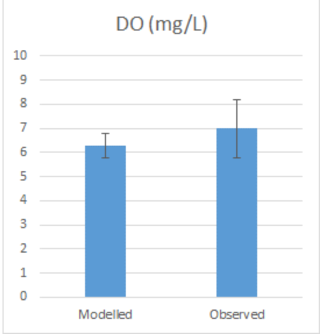
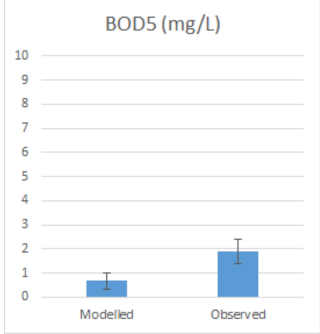
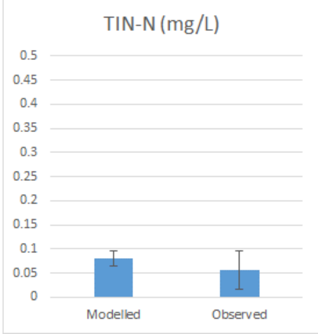
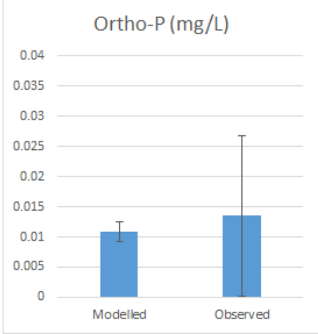
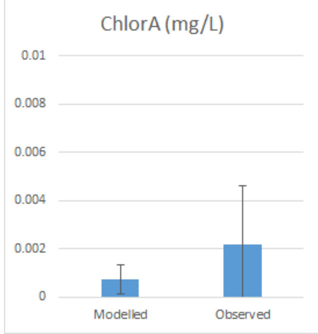
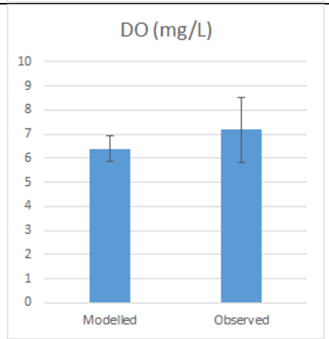
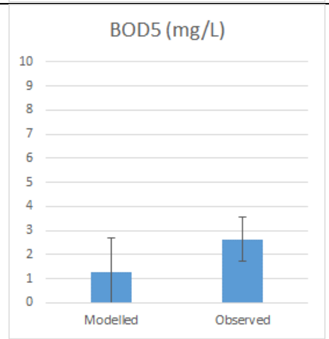
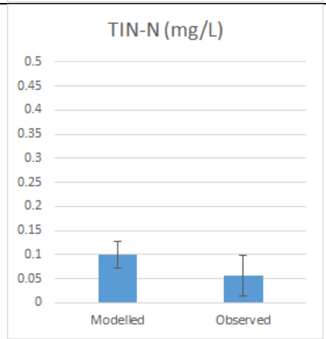
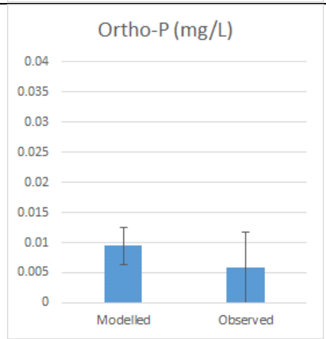
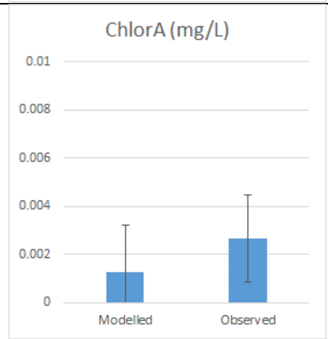
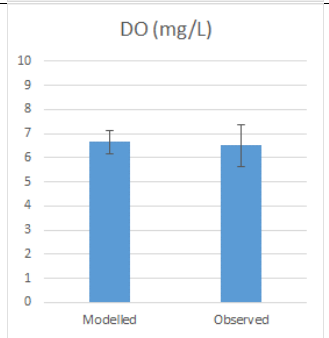
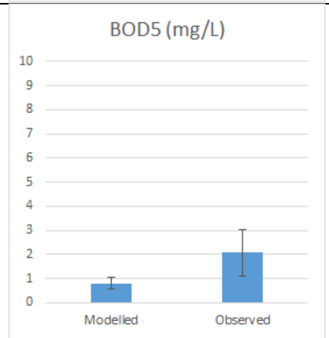
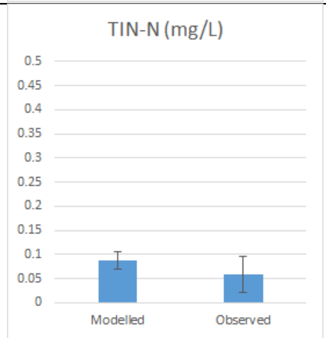
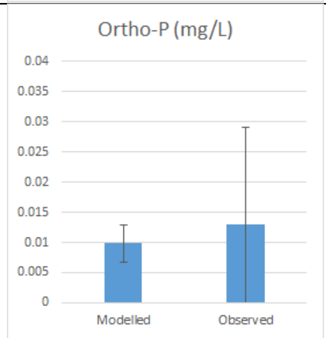
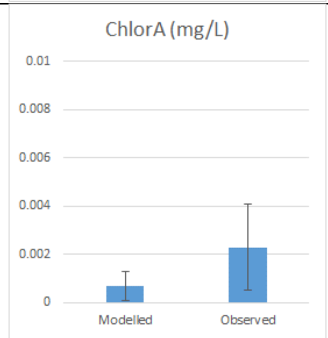
Item	Unit	Unit Load	2015	2016	2017	2018	2019
Annual Production	**Ton/year**	-	8.89	7.78	7.66	6.50	6.83
Estimated Pollution Load							
Oxidized- N	**g/day**	1.3597	12.21	10.69	10.52	8.93	9.38
Ammonia-N	**g/day**	236.0373	2175.20	1905.26	1875.43	1591.58	1672.12
TON	**g/day**	38.1865	1677.37	1469.21	1446.20	1227.31	1289.42
TIP	**g/day**	1.6969	150.27	131.62	129.56	109.95	115.51
TOP	**g/day**	3.5119	180.15	157.79	155.32	131.81	138.48
BOD	**g/day**	540.3082	10048.41	8801.39	8663.60	7352.32	7724.39
TSS	**g/day**	26.7298	6010.48	5264.57	5182.15	4397.81	4620.36

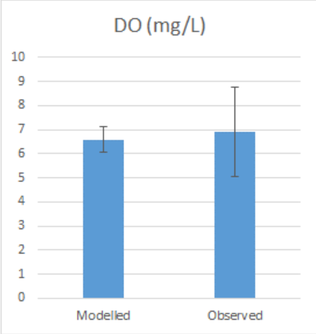
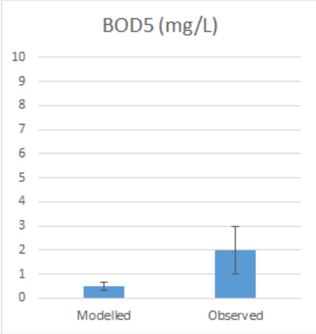
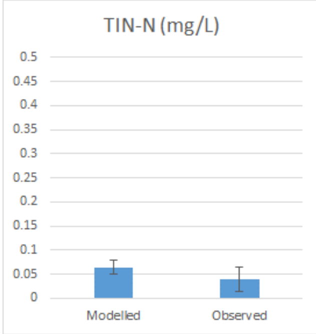
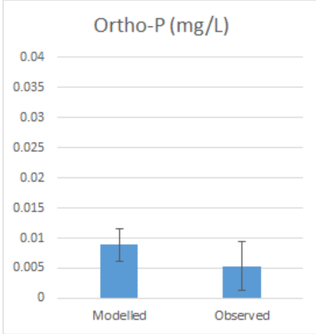
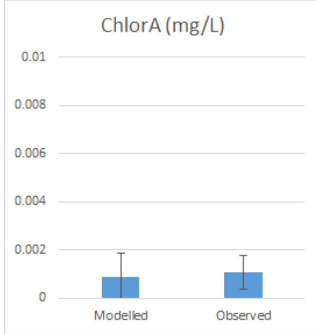
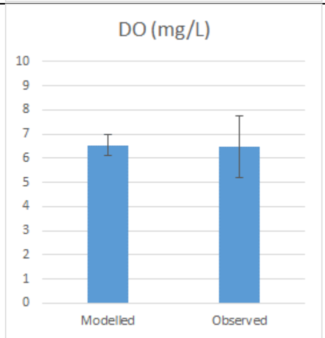
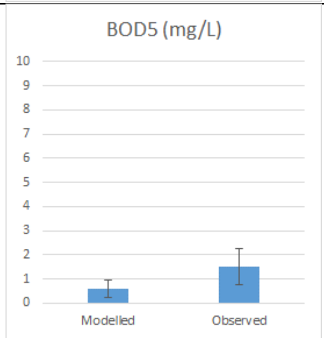
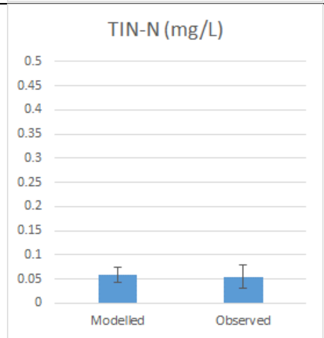
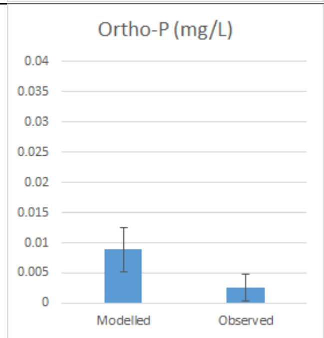
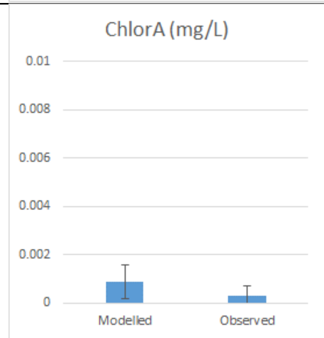
The predicted water quality at the Wong Wan FCZ is compared against the observed water quality to ensure the WATERMAN Hindcast Model is able to reproduce the water quality conditions at the FCZ. Given both the model input (background water quality from nearby EPD Marine Water Quality Monitoring Stations MM5, MM6 and MM16) as well as target for comparison (observed water quality at Wong Wan FCZ) have relatively low data frequency of once per month (and the sampling dates of both sources are not the same), the calibration and validation exercise targeted to reproduce the average water quality instead of the actual time series of specific water quality parameters.

To avoid over-calibrating the modelling parameters, the observed water quality data for year 2015-2017 would first be used to calibrate the modelling parameters and the data for year 2018 and 2019 would be used to compare the model prediction from the calibrated model. Comparison of the observed water quality as well as the predicted water quality using the WATERMAN Hindcast Model at the Wong Wan FCZ from 2018 and 2019 are provided in ***Table 3B.1.3***. The calibrated model generally produces predictions at similar levels of the observed water quality. The corresponding set of calibrated water quality parameters is provided in ***Table 3B.1.4***. For most of the water quality parameters, the calibrated values are the same as that in the previous WATERMAN study by Wong *et. al.*, 2012 [(1)].

(1) Wong *et. al.* 2012. Project WATERMAN - Carrying Capacity of Fish Culture Zones in Hong Kong.

Table 3B.1.3 Comparison of Results for Model Calibration using the WATERMAN Carrying Capacity – Unsteady State Hindcast Tool (Modelled: Left; Observed: Right [AFCD Monitoring Data at Wong Wan FCZ]))

	DO (mg/L)	BOD_5 (mg/L)	TIN (mg/L)	Ortho-P (mg/L)	Chlorophyll-a (mg/L)
2015					
2016					
2017					

	DO (mg/L)	BOD_5 (mg/L)	TIN (mg/L)	Ortho-P (mg/L)	Chlorophyll-a (mg/L)
2018					
2019					

Note: Values presented are mean depth-average of the specified years and error bars are the range for mean values ± one standard deviation.

Table 3B.1.4 Kinetic Parameters used in the WATERMAN Water Quality Model for this Study and in Wong *et. al.*, 2012

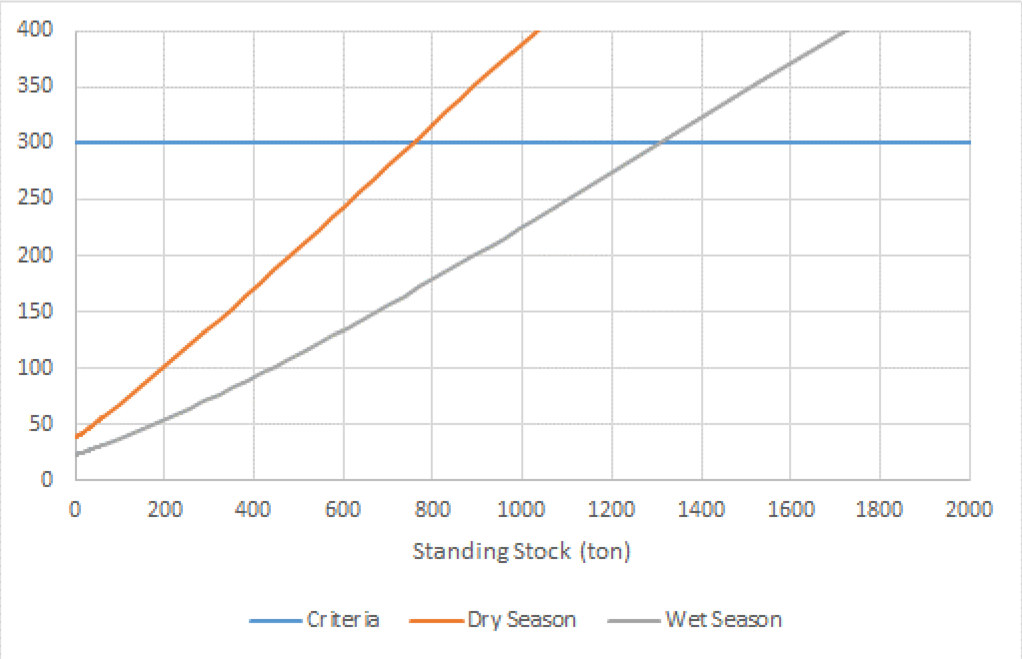
Parameters	Unit	Value for this Study	Value adopted by Wong *et. al.*, 2012
Maximum algal growth rate	d^{-1}	2	2.1
Temperature coefficient for growth at 20°C	-	1.066	1.066
Algal respiration rate	d^{-1}	0.11	0.11
Temperature coefficient for respiration at 20°C	-	1.080	1.080
Algal mortality	d^{-1}	0.02	0.02
Nitrification rate	d^{-1}	0.1	0.1
Temperature coefficient for nitrification at 20°C	-	1.080	1.080
Organic nitrogen mineralization rate	d^{-1}	0.025	0.025
Temperature coefficient for organic nitrogen mineralization at 20°C	-	1.080	1.080
Denitrification rate	d^{-1}	0.1	0.1
Temperature coefficient for denitrification at 20°C	-	1.045	1.045
Organic phosphorus mineralization rate	d^{-1}	0.060	0.060
Temperature coefficient for organic phosphorus mineralization at 20°C	-	1.080	1.080
Deoxygenation coefficient	d^{-1}	0.210	0.210
Temperature coefficient for deoxygenation at 20°C	-	1.047	1.047
Re-aeration coefficient	d^{-1}	0.543	0.543
Settling velocity of particulate	m/d	1.0	1.0
Half-saturation constant for N uptake	µg N/L	50.0	50.0
Half-saturation constant for P uptake	µP N/L	1.0	1.0
Half-saturation constant for oxygen limitation of nitrification	mg O_2/L	2.0	2.0
Half-saturation constant for oxygen limitation	mg O_2/L	0.5	0.5
Fraction of algal decay into organic nitrogen	-	0.5	0.5
Fraction of algal decay into organic phosphorus	-	1.0	1.0
Fraction of settleable organic matter	-	0.5	0.5
Fraction of dissolved phosphorus in water	-	0.8	0.8

3B.1.3 Estimation of Carrying Capacity

Based on the selected set of kinetic parameters, carrying capacity at the Project site was estimated using the steady state forecast tool WATERMAN Steady State Forecast Model. The estimation involves simulation of a number of scenarios with different scales of mariculture production. Results of water quality simulation were compared against the corresponding water quality criteria to determine the scenario which has the highest mariculture production without exceedance of water quality criteria (i.e. carrying capacity). Predicted water quality for relevant water quality criteria are presented in ***Figure 3B.1.10***.

As shown, among all the assessment criteria, TIN is found to be the critical water quality parameters at Project site. Carrying capacity at the Project site is estimated to be 755.2 ton of standing stock under typical average condition and is predicted to be limited by TIN in dry season. Other non-TIN water quality parameters were found to be less sensitive and less critical at or below the estimated carrying capacity. A summary of the predicted water quality condition at Project site when operating at its carrying capacity are provided in ***Table 3B1.7***

Figure 3B.1.10 Predicted TIN Level (µg/L) at the Project site under Various Mariculture Standing Stock in Both Seasons



Fluctuations in the weather, hydrodynamic and environmental conditions as well as the farming practices could result in different carrying capacity. Sensitivity tests were conducted to determine how the estimated carrying capacity responds to variations on three key selected parameters, namely flushing time, stock to production ratio and maximum algal growth rate. Three sensitivity test settings (by increasing or decreasing each of these parameters by 20%, i.e. 80%, 100% and 120% of the original values) for each of the above parameters were considered and a total of 3 × 3 × 3 was conducted for each season for the Project site. The carrying capacities with safety margin of 90th- and 95th-percentile were estimated accordingly based on these 27 tests for each season. This means while the estimated carrying capacity of 755.2 ton of standing stock would not result in significant deterioration of water quality under the typical average condition, the case with safety margin of 90th- and 95th-percentile would ensure no significant deterioration in water quality under 90% and 95% of likely condition. The estimated carrying capacities for sensitivity test scenarios with 90% and 95% safety margin are 591.5 ton and 551.9 ton of standing stock respectively. The estimated carrying capacity for the rest the sensitivity test scenarios are provided in ***Table 3B1.6***. As shown, estimated carrying capacity varies under different tested conditions while responded minimally to some other conditions, i.e. maximum algal growth rate under some conditions. This indicates under the specific conditions (for flushing time and stocking ratio) the algal growth rate is not limited by the specified maximum and thus the change in maximum algal growth rate would not result in material change in water quality and thus carrying capacity.

For subsequent Delft3D modelling, pollution load from mariculture activities was estimated based on 755.2 ton of standing stock under typical average condition as shown below in ***Table 3B.1.5***.

Table 3B.1.5 Estimated Pollution Loading from Mariculture Activities at the Project site at its Carrying Capacity under Typical Average Condition

Sources	Pollution Load Generated Per 1 ton of Standing Stock	Pollution Load Generated for Standing Stock at its Carrying Capacity at Project site
Oxidized-N (g/day)	1.4	1057
Ammonia-N (g/day)	236	178225
Org-N (g/day)	38.2	28848
TIP (g/day)	1.7	1284
TOP (g/day)	3.5	2643
BOD (g/day)	540.3	408029
TSS (g/day)	26.7	20164

Table 3B1.6 Estimated Carrying Capacity (ton) for All Sensitivity Test Scenarios

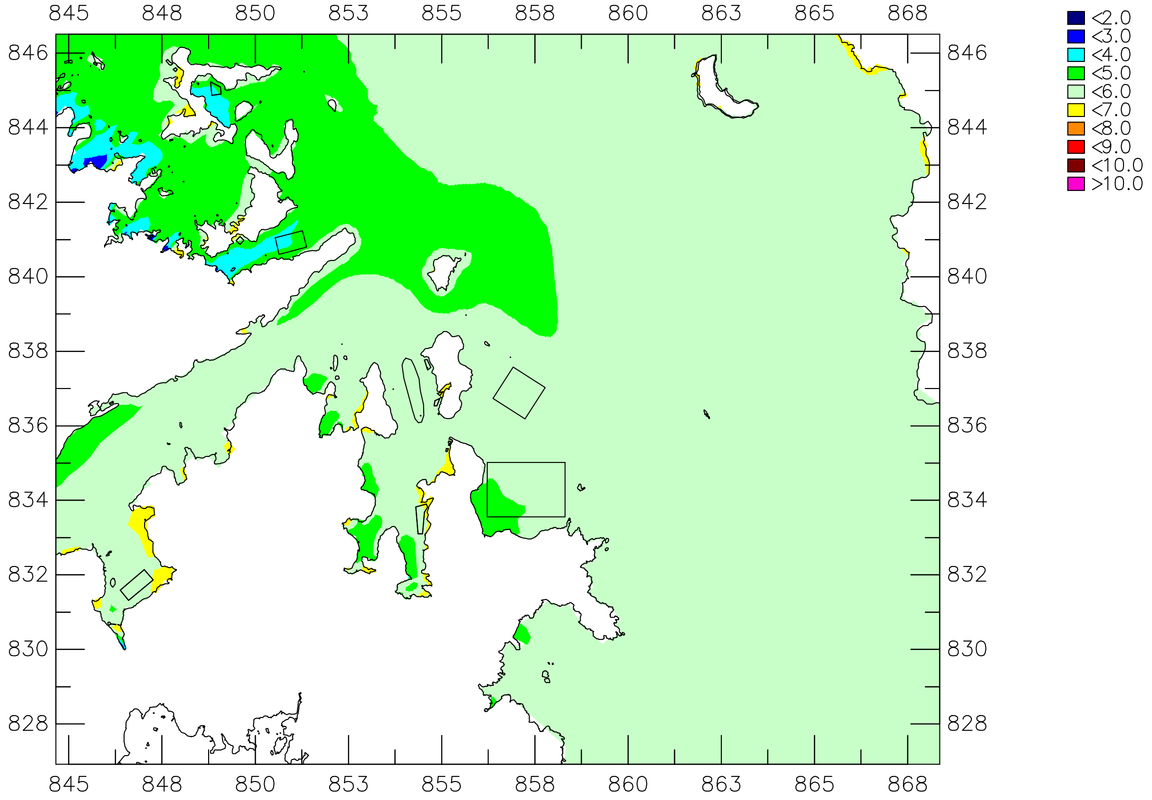
Flushing Capacity Scaling	Stock to Production Ratio Scaling	Maximum Algal Growth Rate Ratio		
		80%	100%	120%
80%	80%	708.1	708.1	708.1
	100%	635.6	655.8	677.5
	120%	529.7	546.5	564.6
100%	80%	811.0	811.0	811.0
	100%	731.3	755.2	780.6
	120%	609.4	629.3	650.5
120%	80%	916.1	916.1	916.1
	100%	828.0	855.2	884.0
	120%	690.0	712.7	736.7

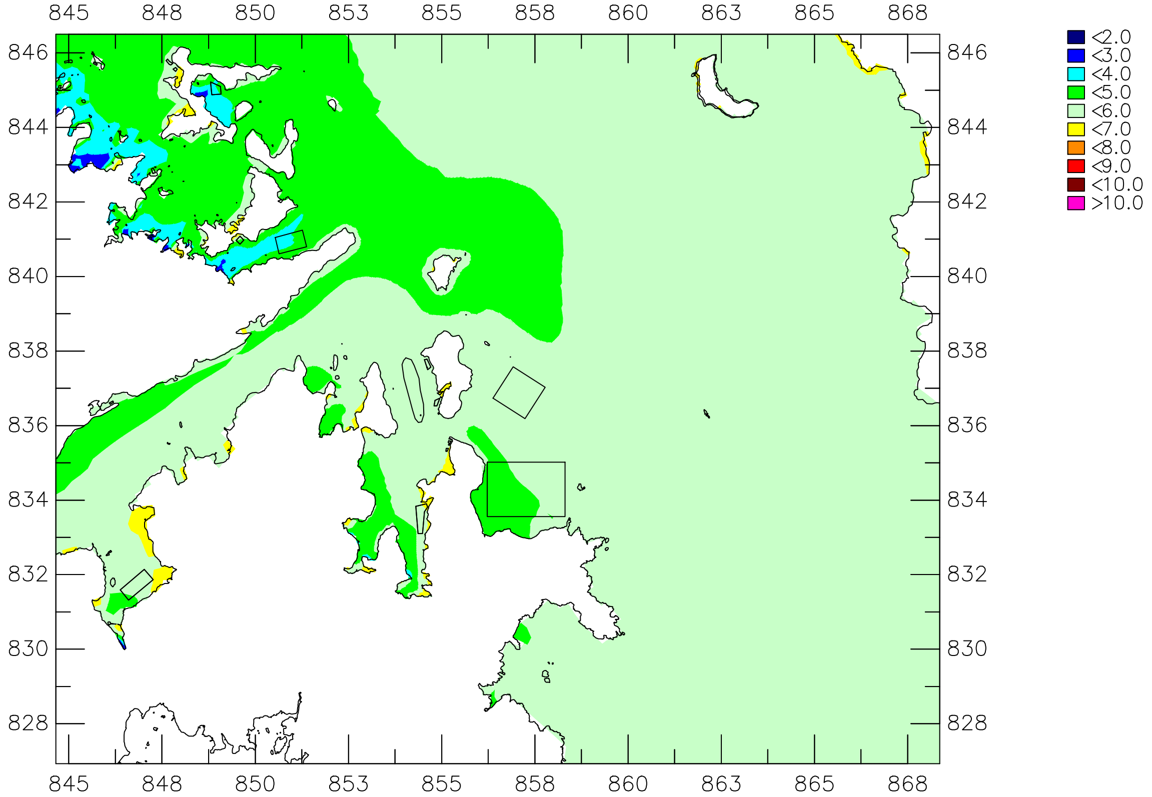
Table 3B1.7 Predicted Water Quality by WATERMAN Steady State Forecast Model under Typical Average Condition when the Project site Operates at its Predicted Carrying Capacity

	Dissolved Oxygen (mg/L)	Biochemical Oxygen Demand (mg/L)	Total Inorganic Nitrogen (mg/L)	Unionized Ammonia (mg/L)	Ortho-Phosphate Phosphorus (mg/L)	Chlorophyll-a (mg/L)
Criteria	**5**	**5**	**0.30**	**0.021**	**0.018**	**0.020**
Dry Season	7.2	0.5	0.30	0.011	0.008	0.001
Wet Season	6.4	0.5	0.17	0.011	0.006	0.002

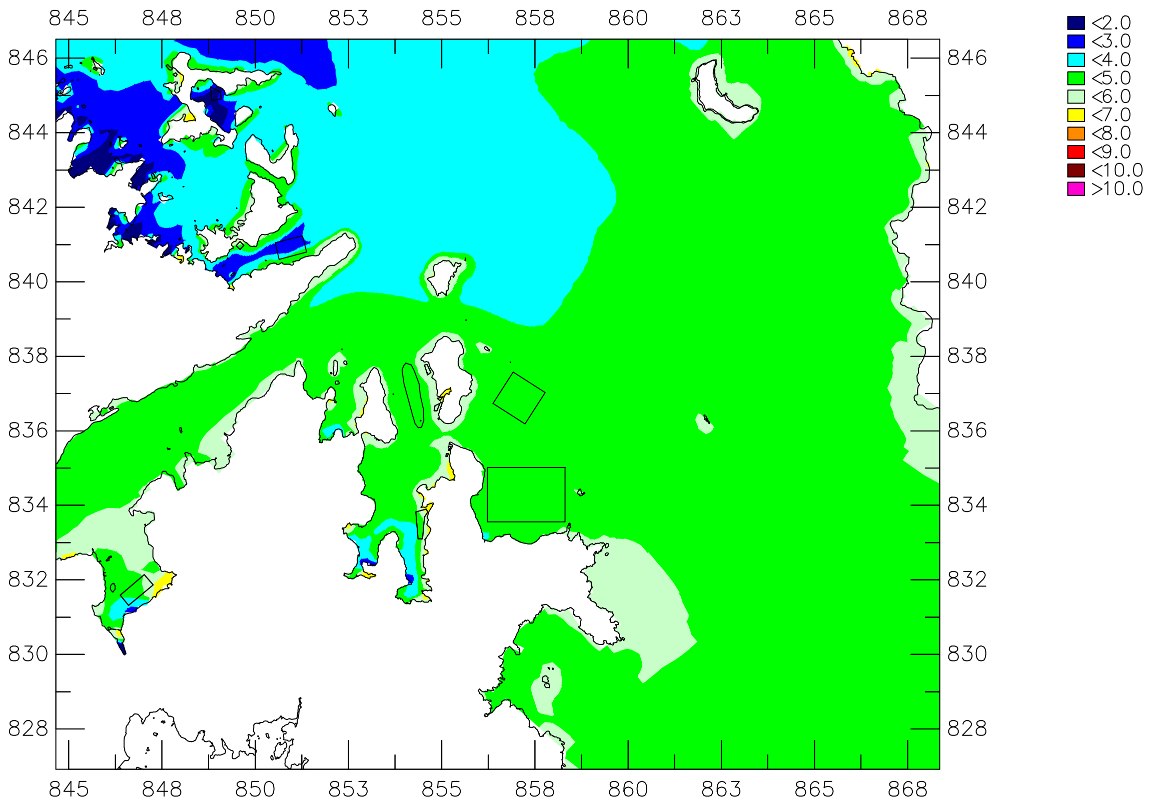
Note: Values presented are mean depth-average values.

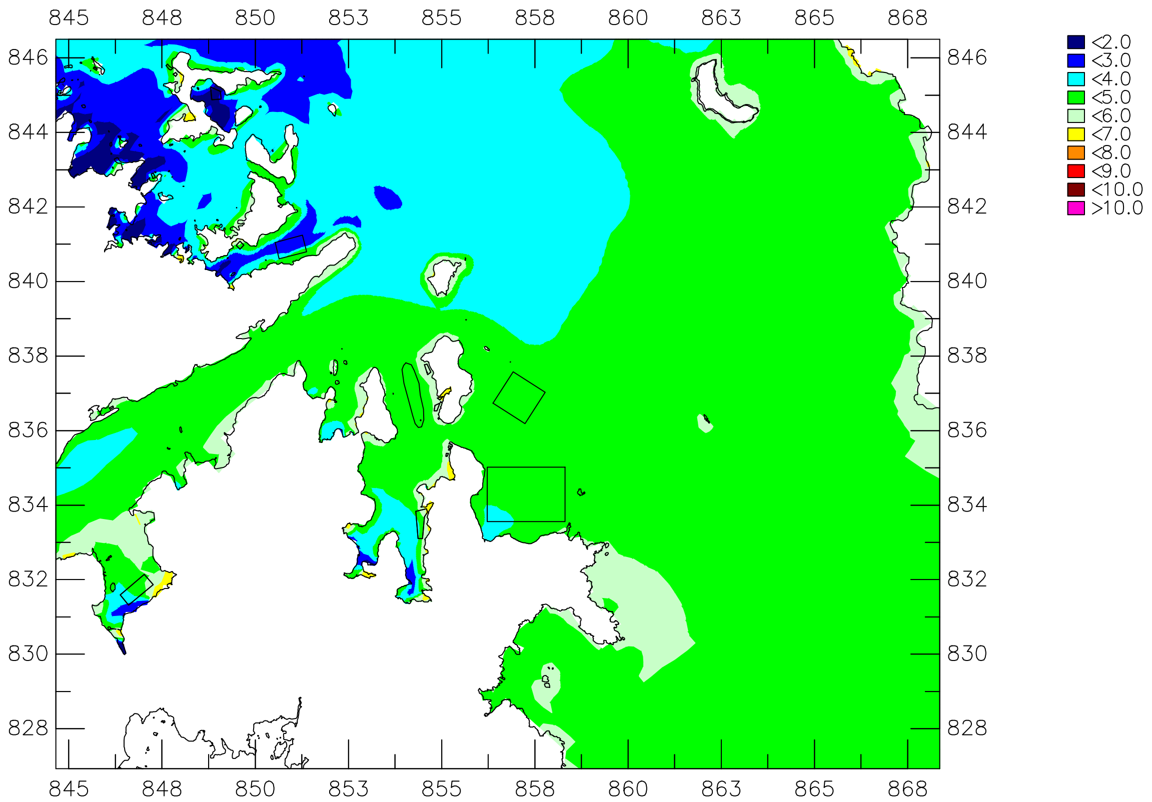
APPENDIX 3C CONTOUR PLOTS OF WATER QUALITY PARAMETER



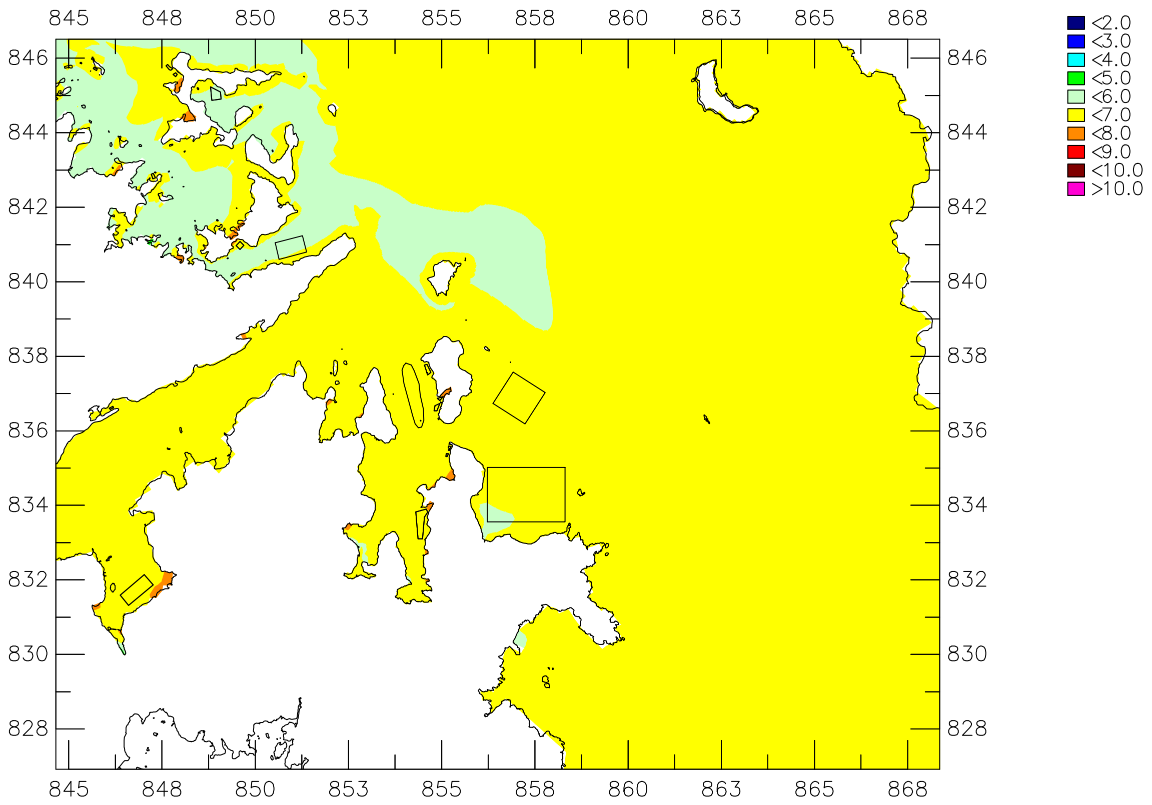


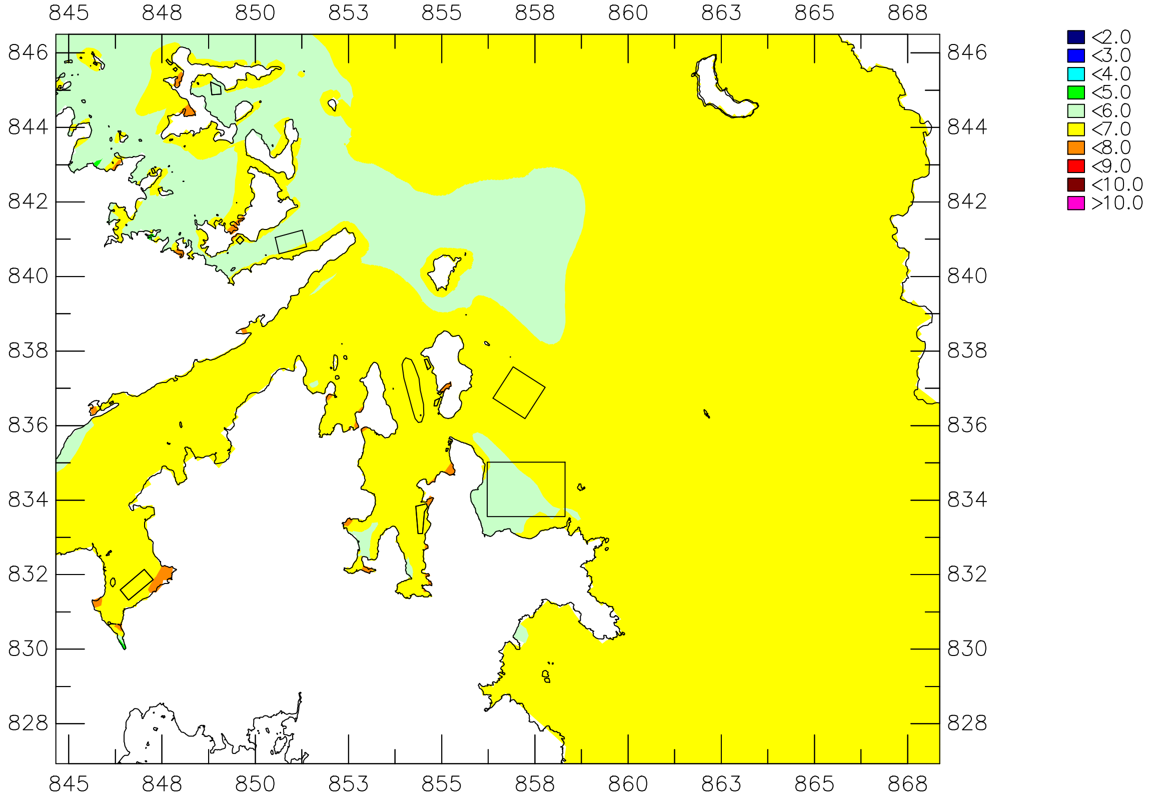
10th–percentile Depth–averaged Dissolved Oxygen (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



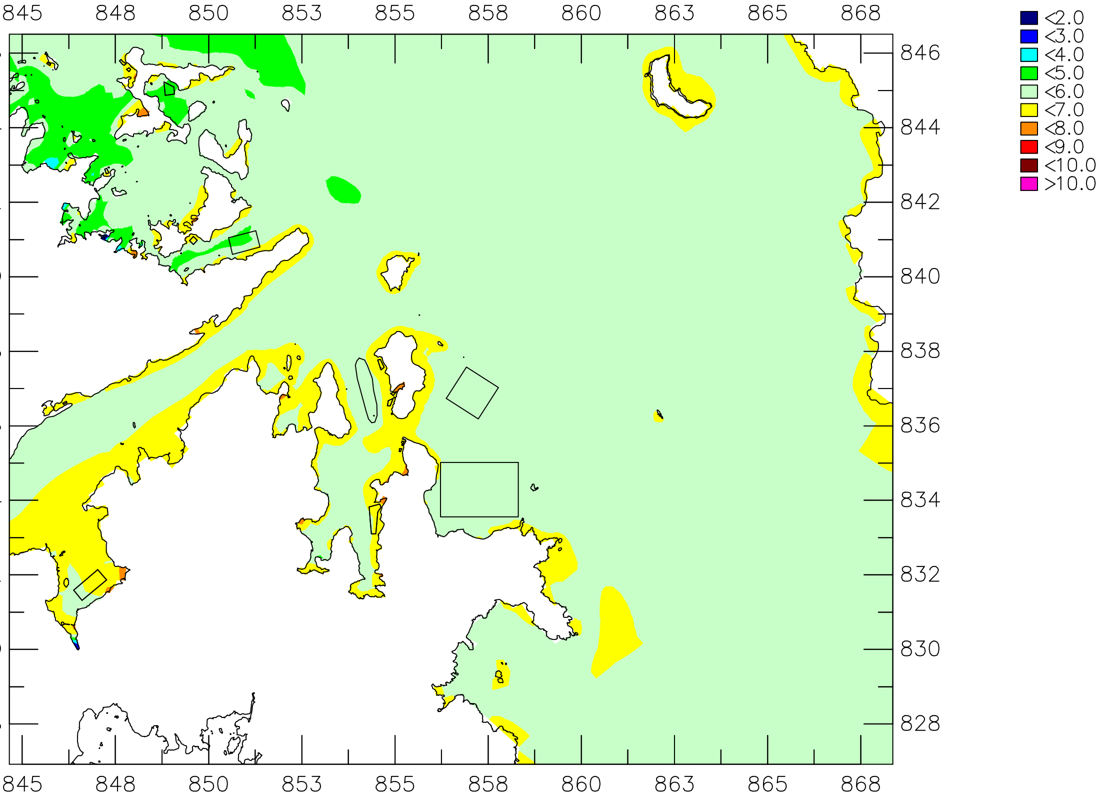


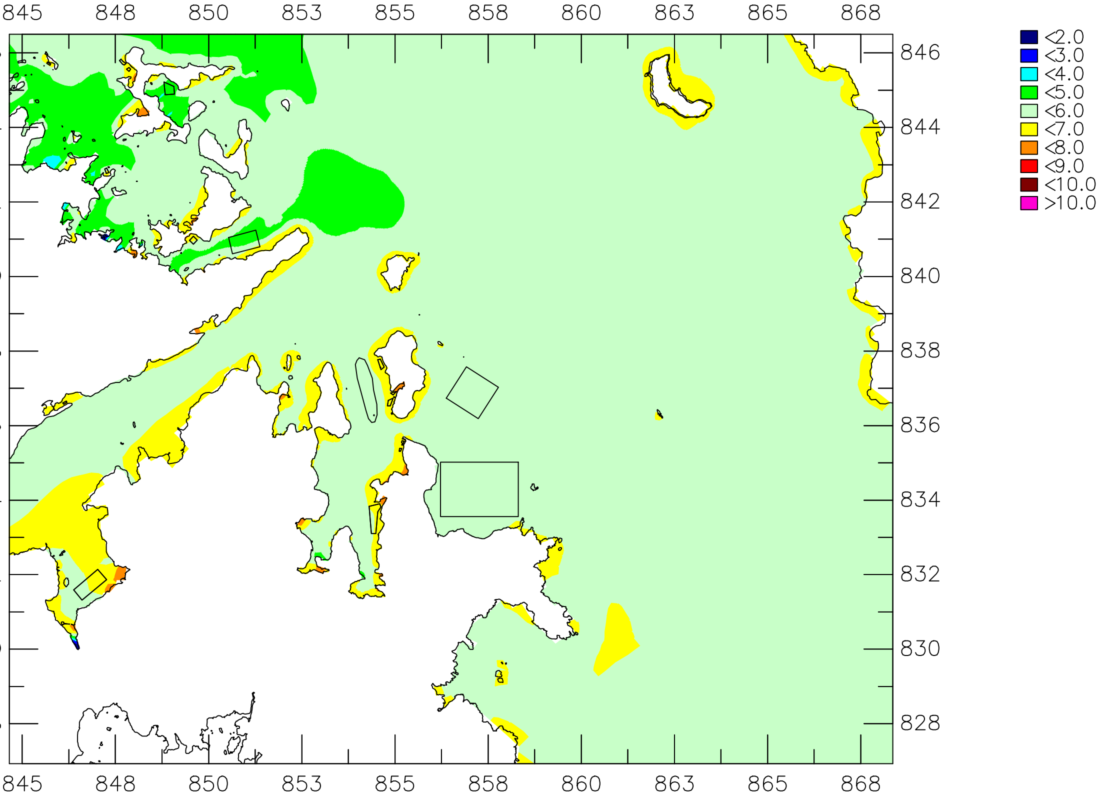
10th−percentile Bottom Dissolved Oxygen (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



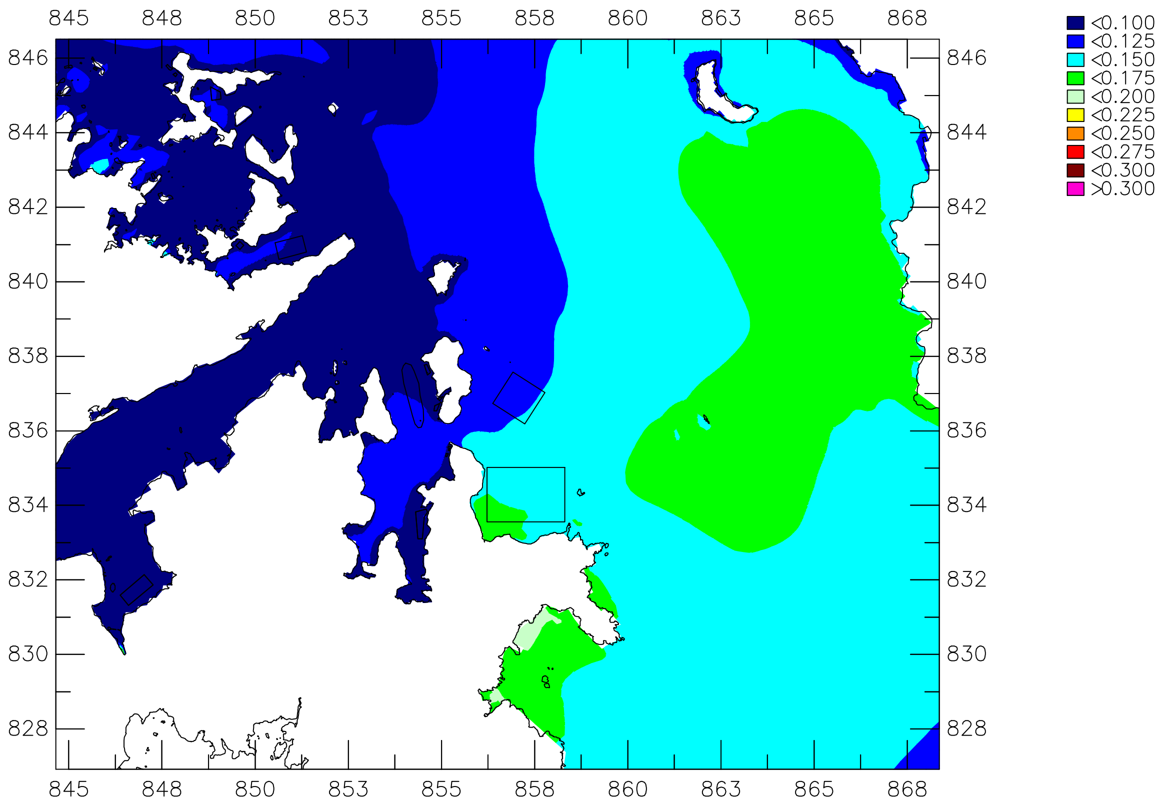


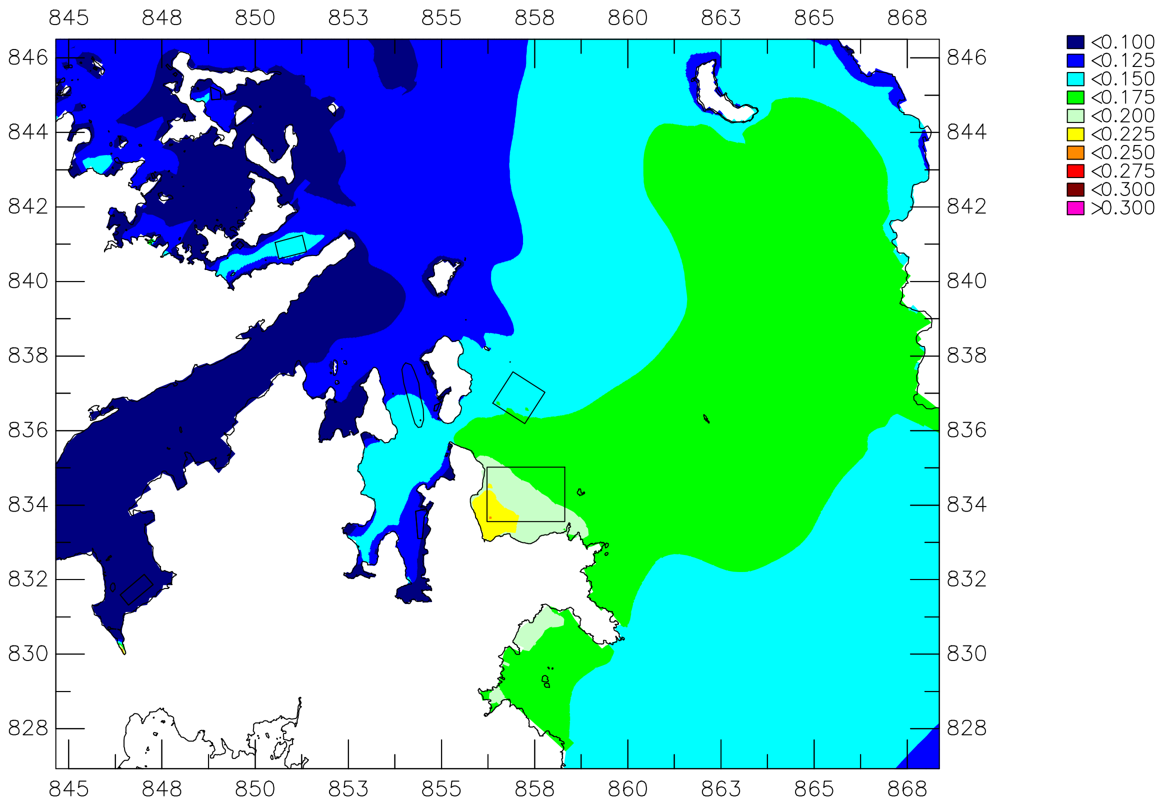
Mean Depth–averaged Dissolved Oxygen (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



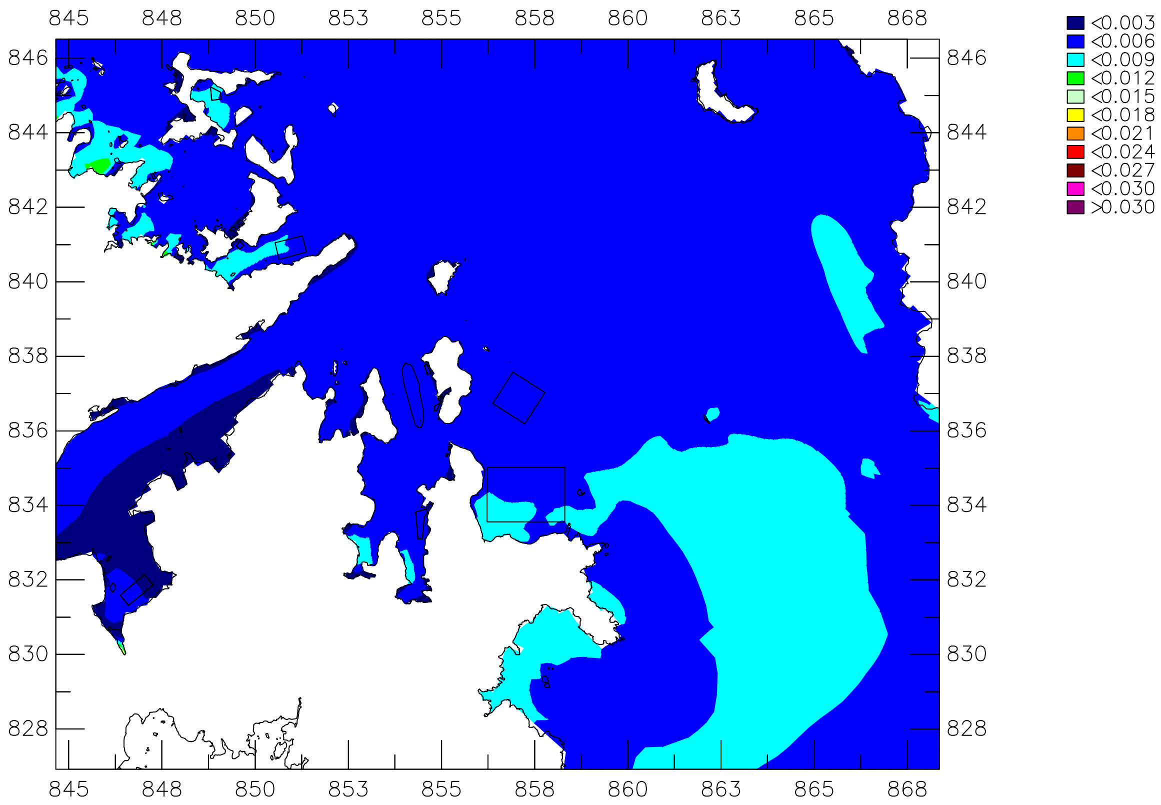


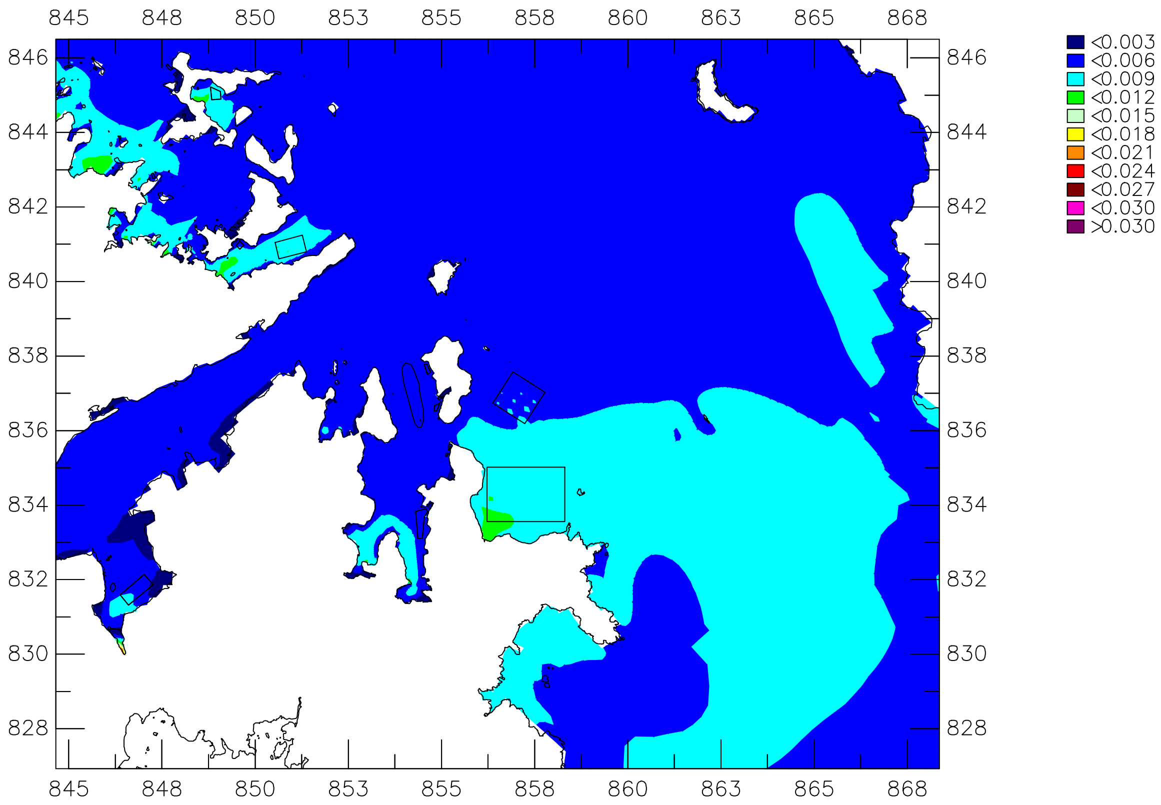
Mean Bottom Dissolved Oxygen (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



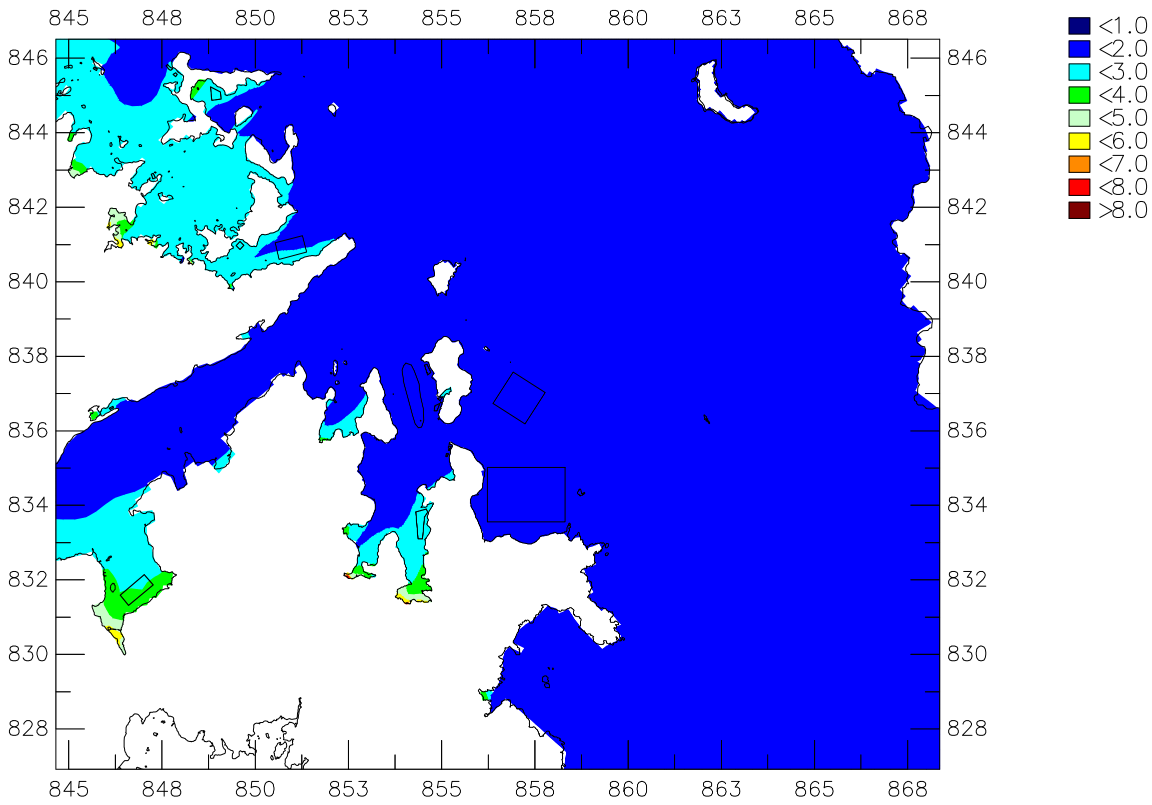


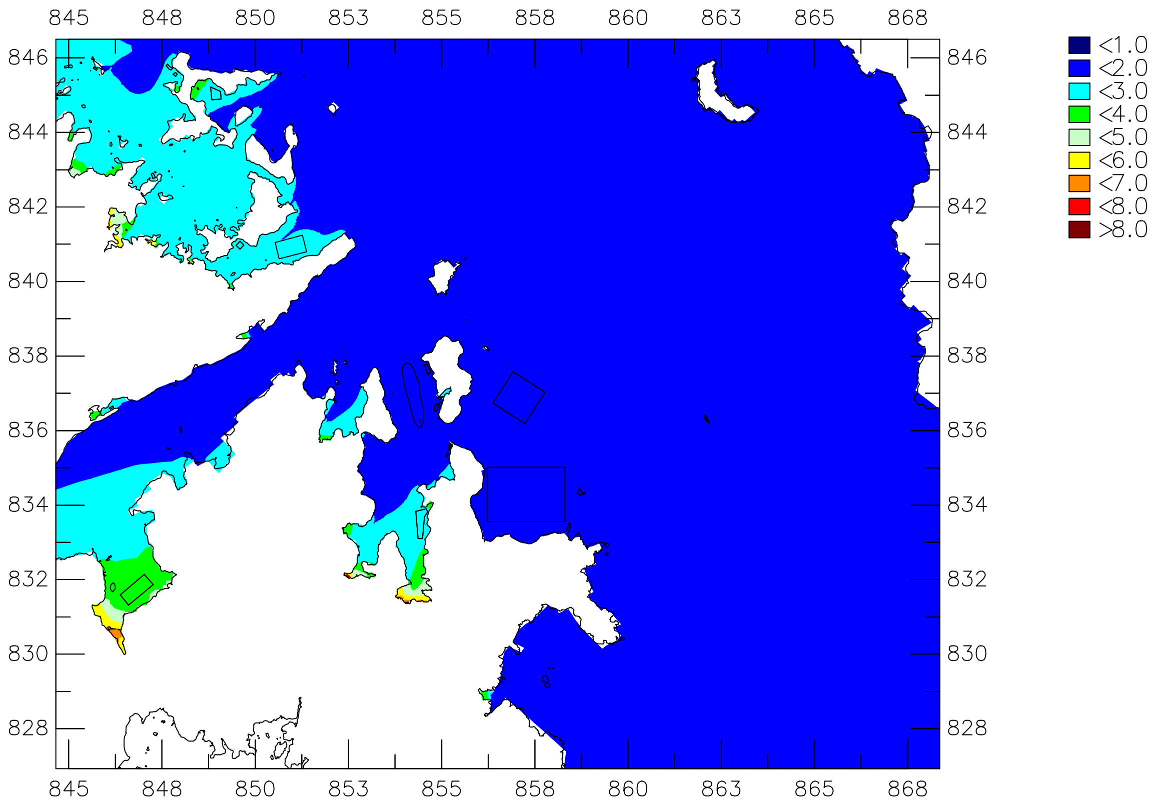
Mean Depth–averaged Total Inorganic Nitrogen (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



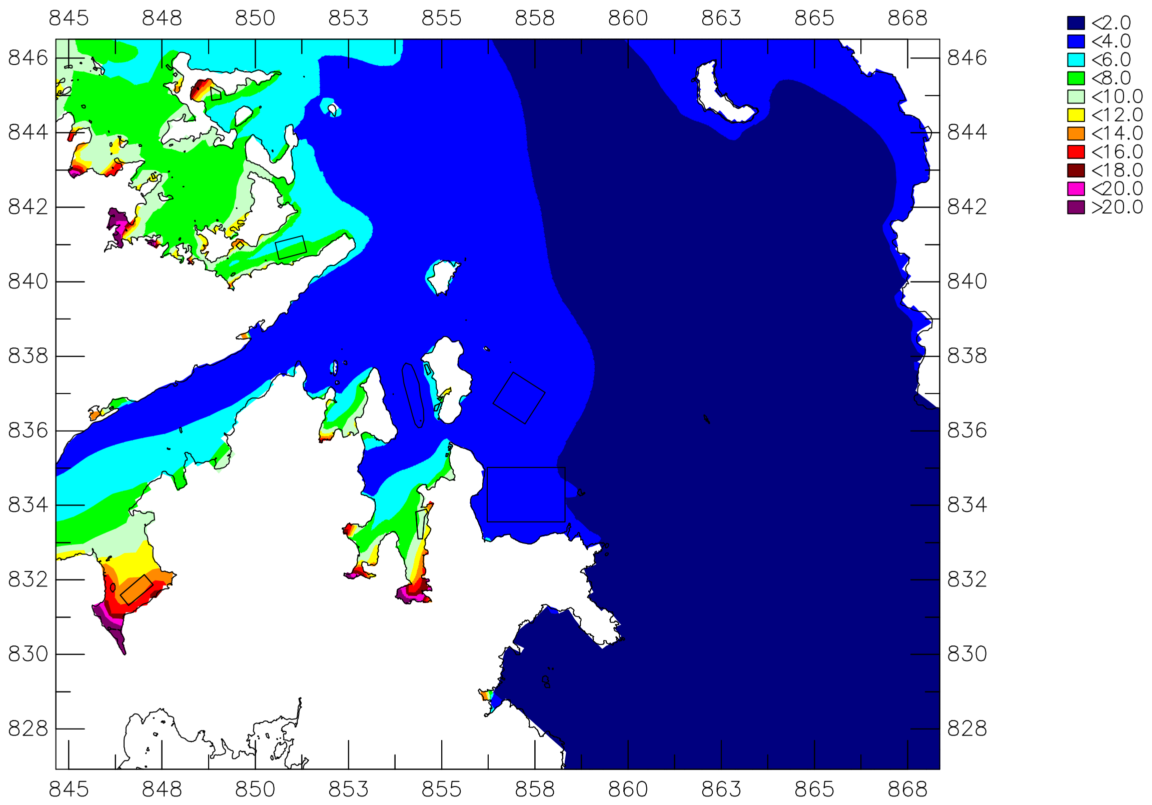


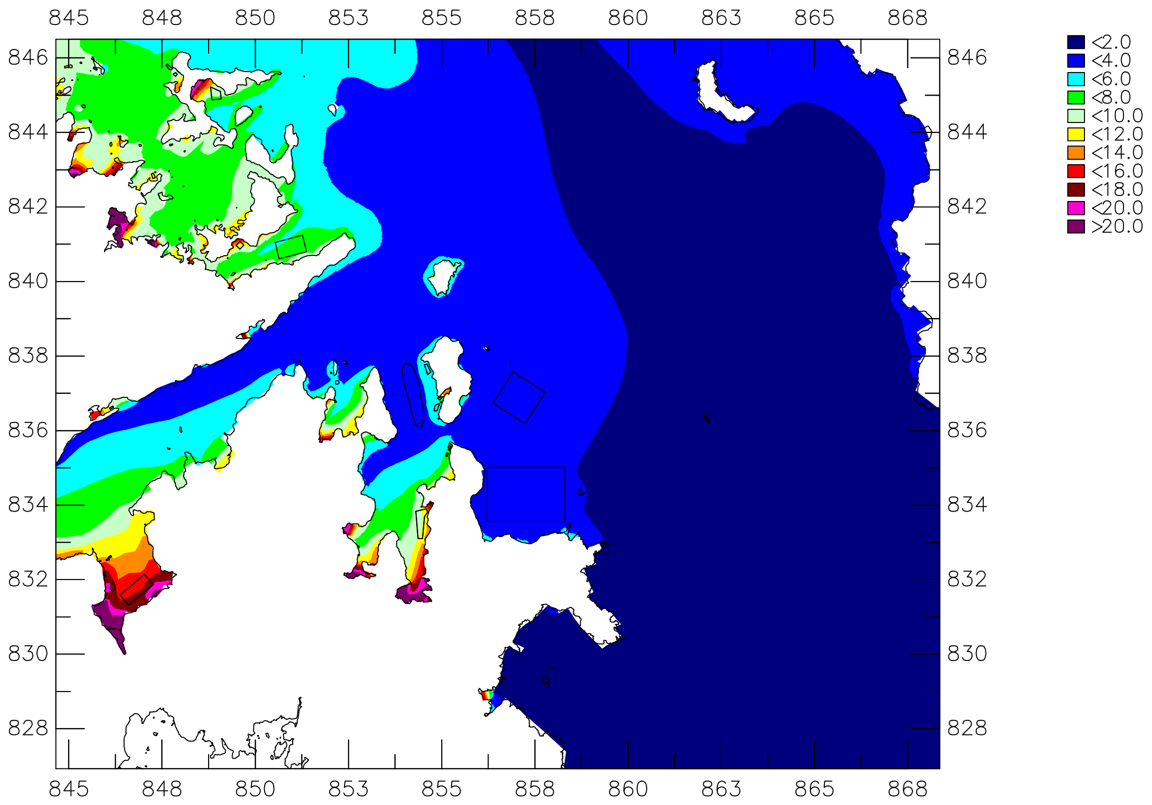
Mean Depth–averaged Unionized Ammonia (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



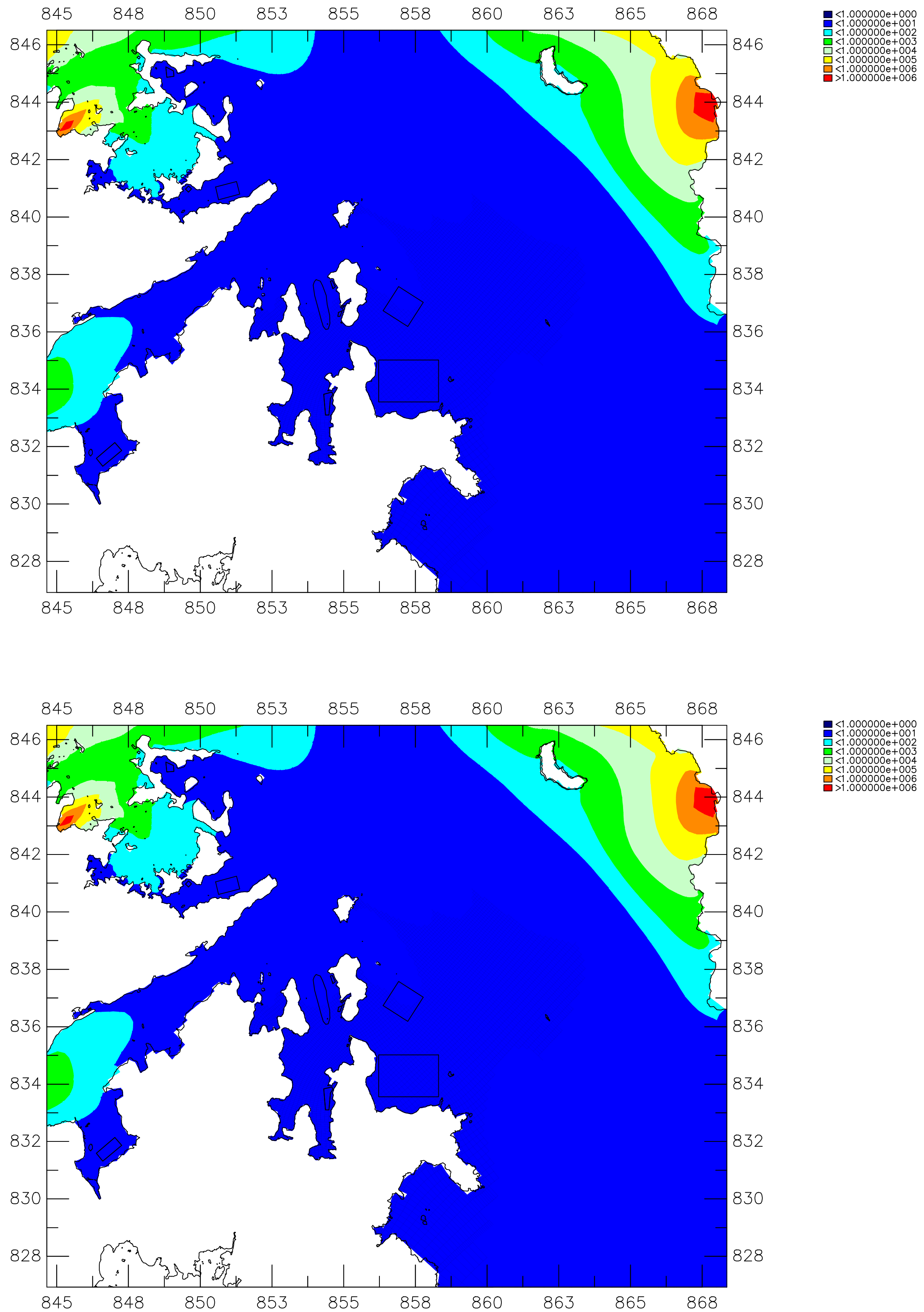


Mean Depth–averaged Suspended Solids (mg/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn

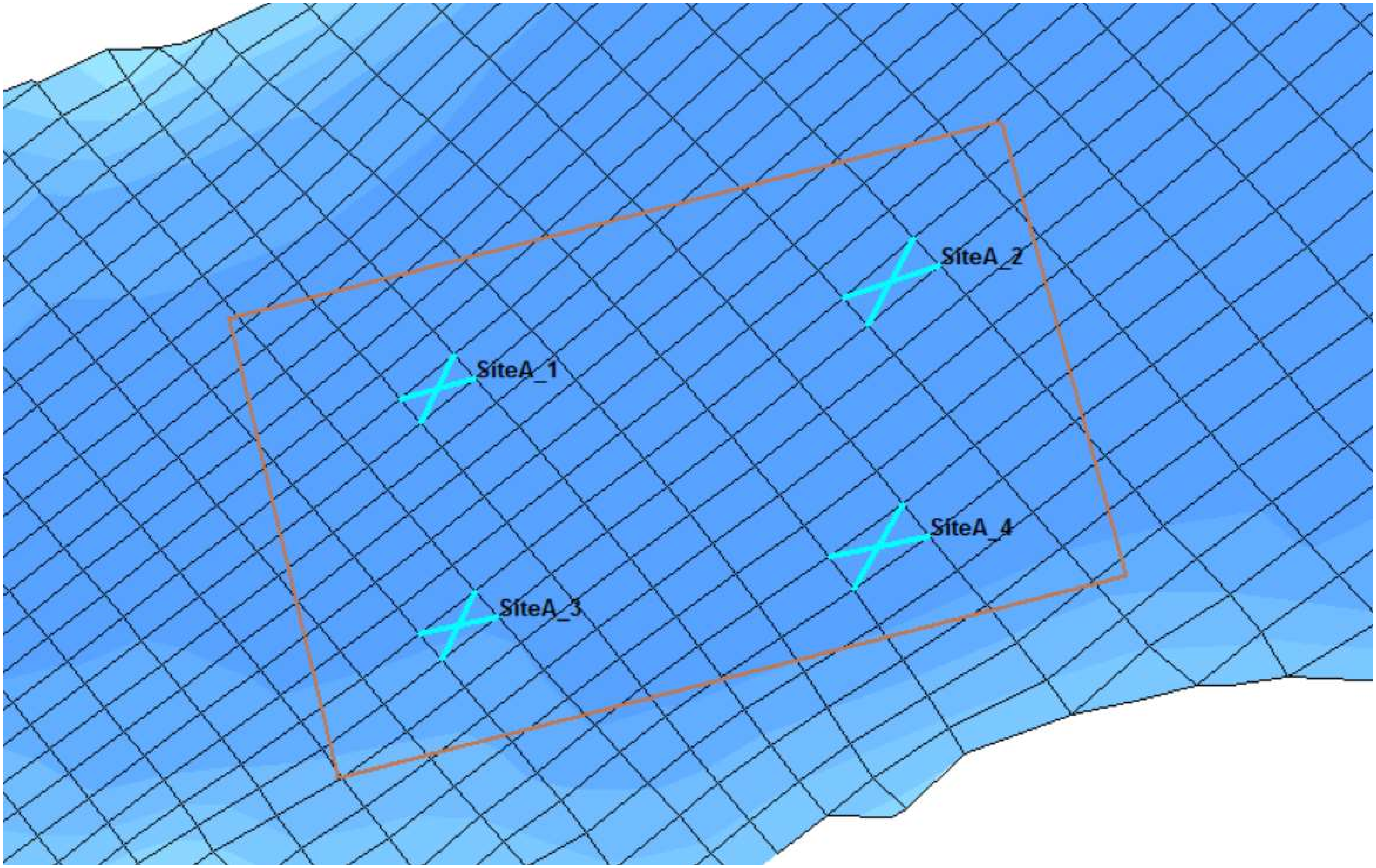




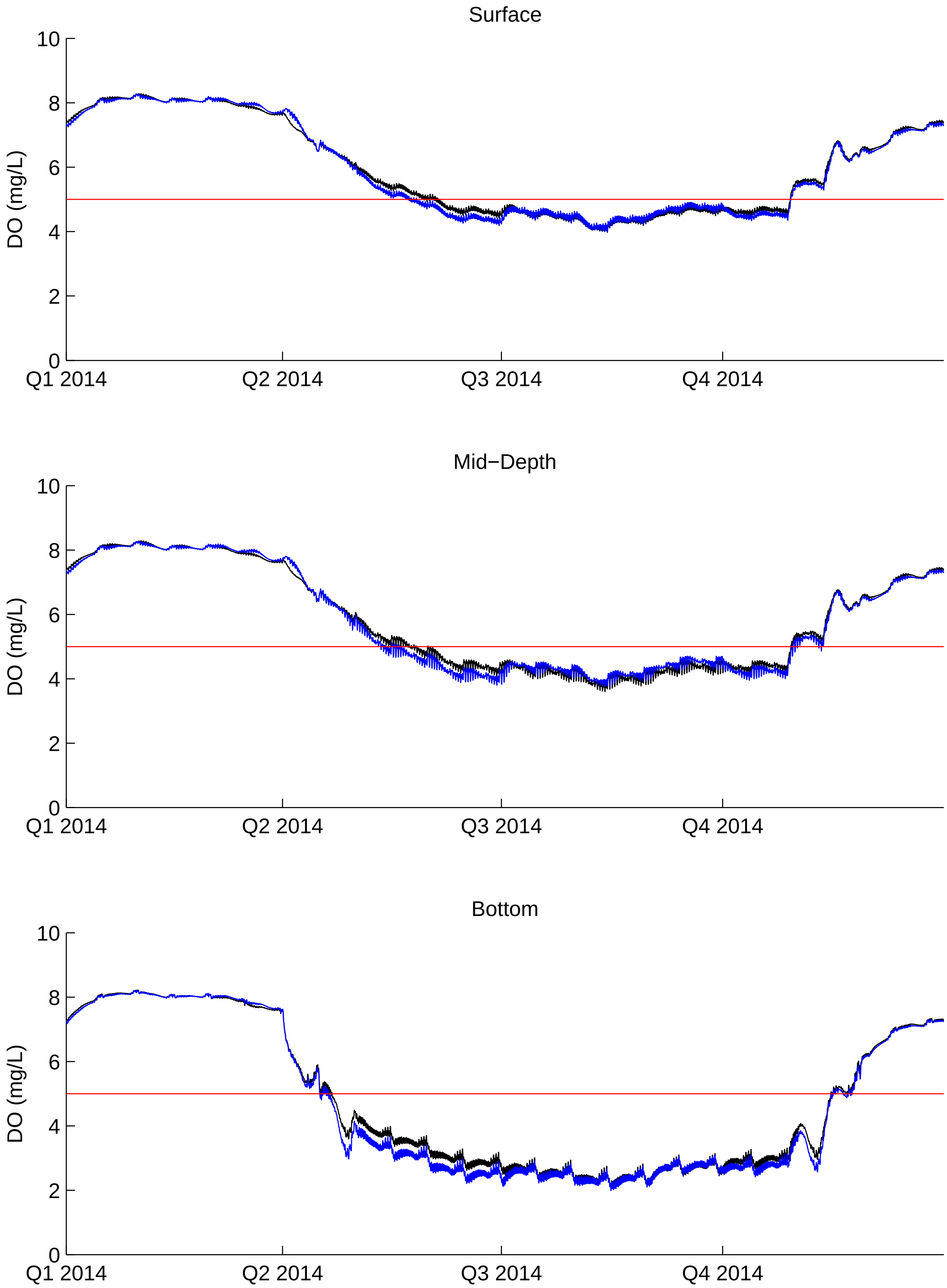
Mean Depth–averaged Chlorophyll–a (ug/L) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn



Geomean Depth–averaged E.coli (no./m3) Top: Baseline Scenario Bottom: Project Scenario	2023	Annual
	0549925	
ERM	GPP/WQ	Plot·STKDD·v2.ssn

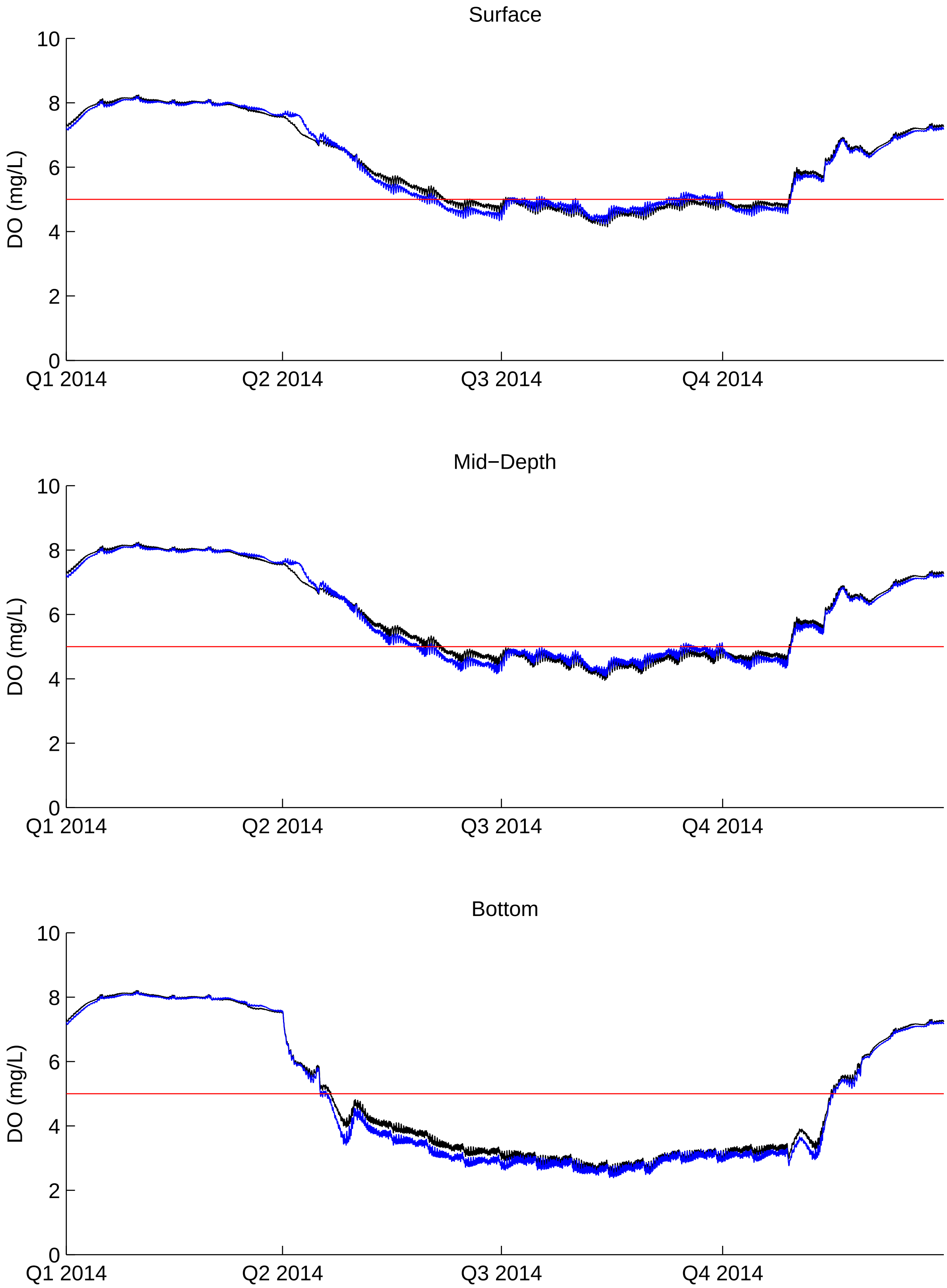


Output locations for time series output



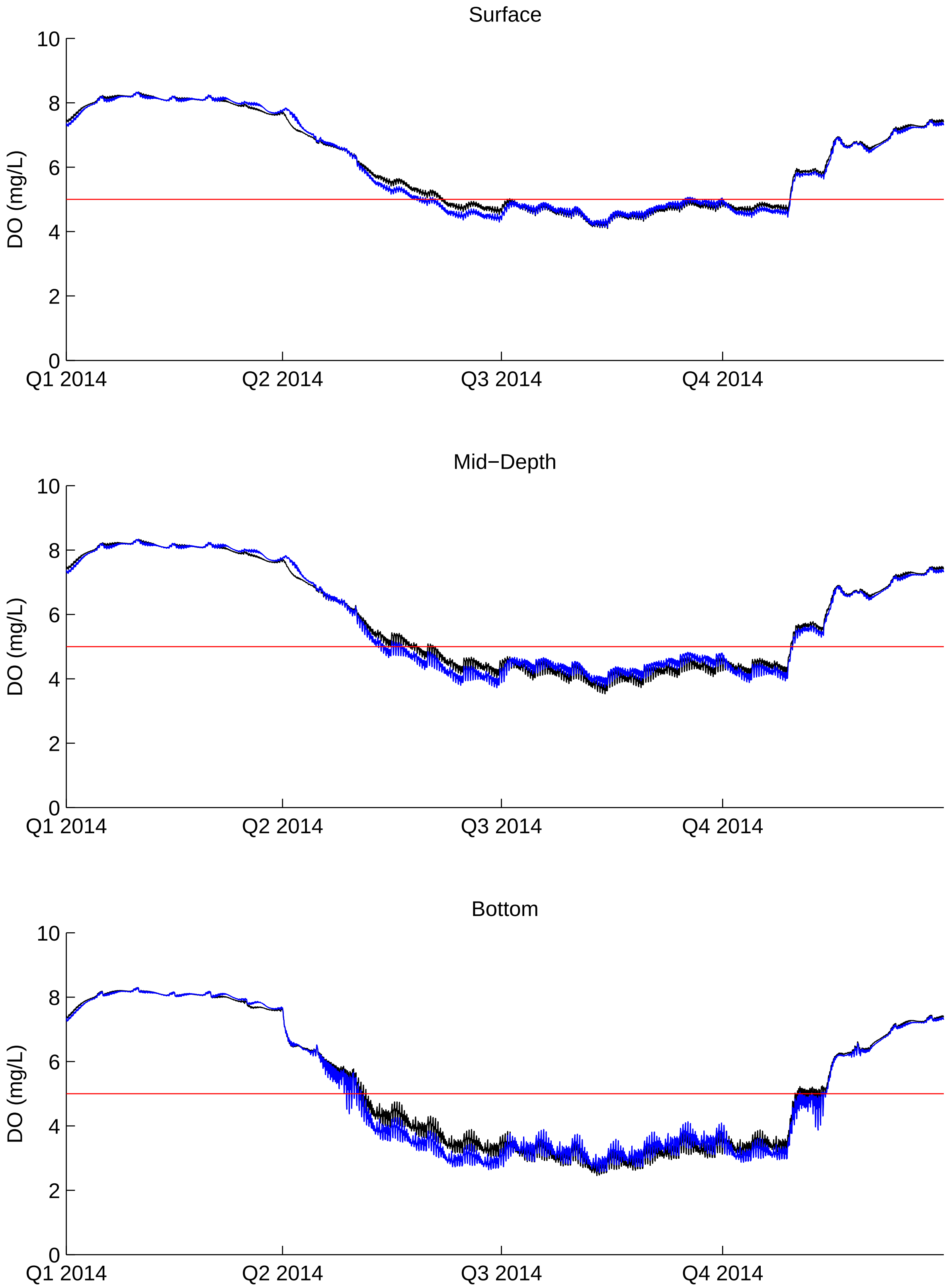
Dissolved Oxygen (mg/L) at Location 1 of Site A
Baseline: Black; Project: Blue; 16L/s: Criterion: Red

ERM



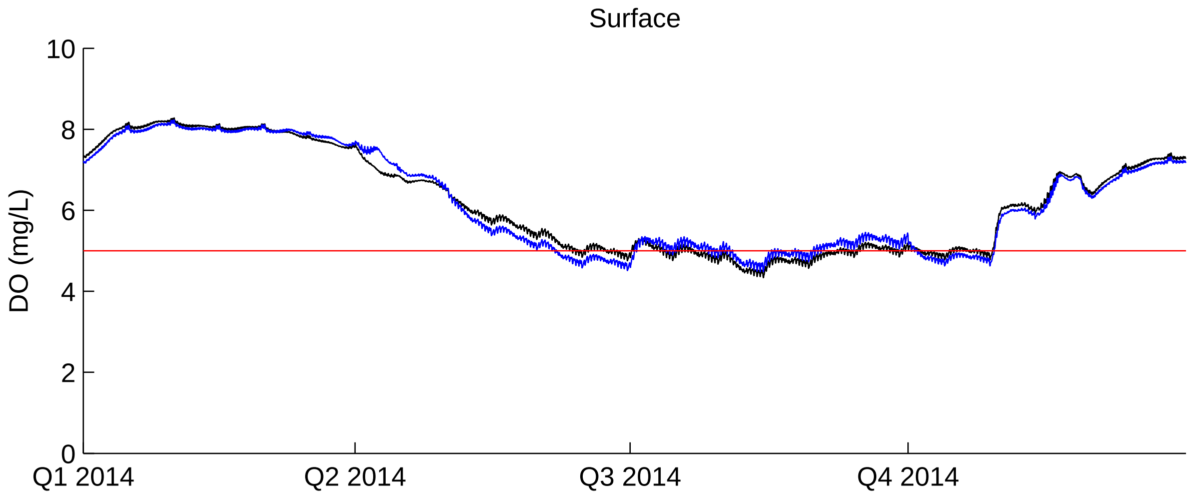
Dissolved Oxygen (mg/L) at Location 2 of Site A
Baseline: Black; Project: Blue; 16L/s: Criterion: Red

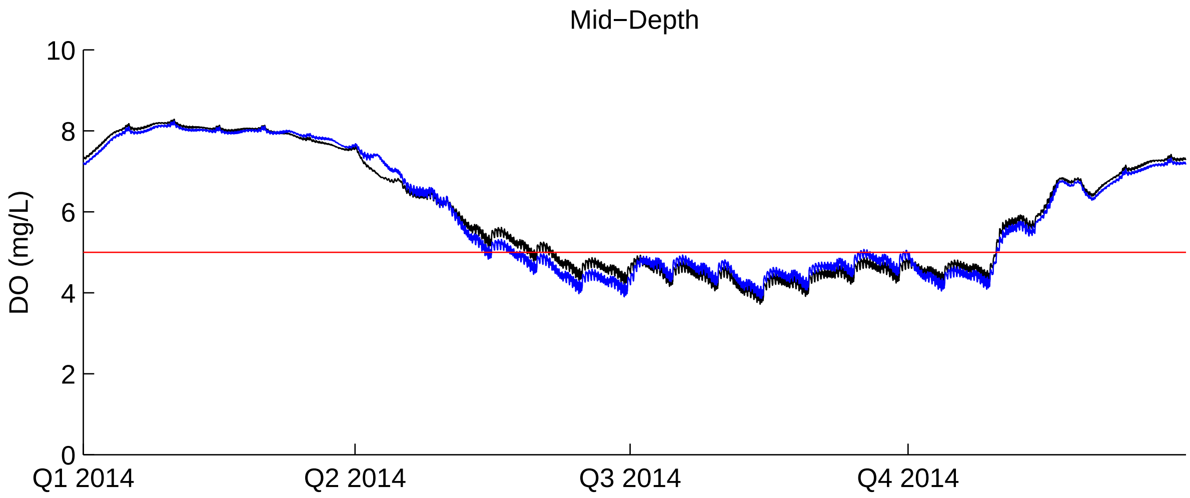
ERM

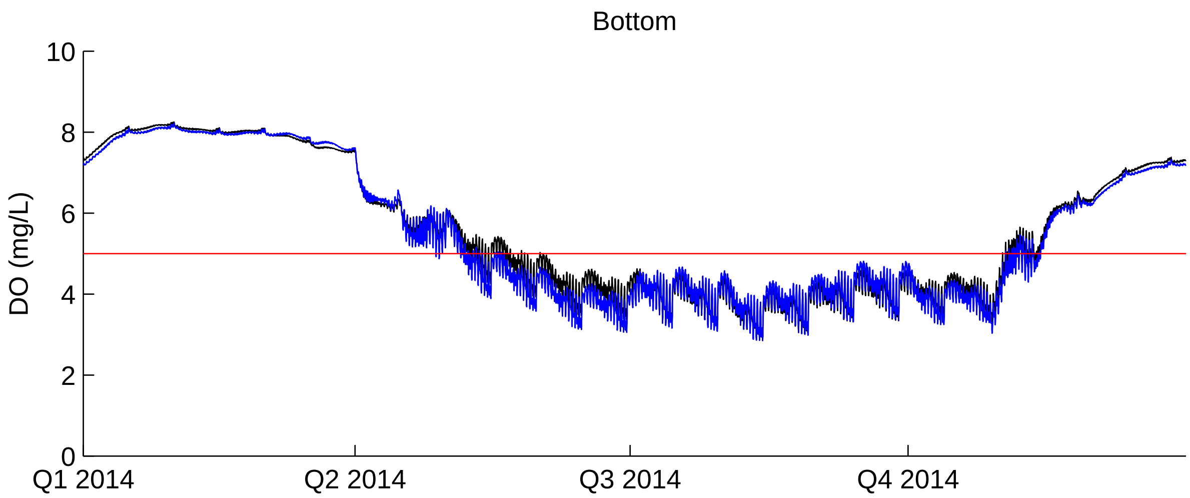


Dissolved Oxygen (mg/L) at Location 3 of Site A
Baseline: Black; Project: Blue; 16L/s: Criterion: Red

ERM







Dissolved Oxygen (mg/L) at Location 4 of Site A
Baseline: Black; Project: Blue; 16L/s: Criterion: Red

ERM

APPENDIX 3D COMPARISON OF OBSERVED WATER QUALITY AGAINST TIME SERIES PLOTS OF PREDICTED WATER QUALITY AT EPD WATER QUALITY MONITORING STATIONS NEAR PROJECT SITE

APPENDIX D COMPARISON OF OBSERVED WATER QUALITY AGAINST TIME SERIES PLOTS OF PREDICTED WATER QUALITY AT EPD WATER QUALITY MONITORING STATIONS NEAR PROJECT SITE

Source:

Observed Data

EPD Marine Water Quality Monitoring Stations MM5, MM6, MM7, 2011 to 2020.

Modelled Data

Time series prediction of Delft3D WAQ model (STKDD) at the same locations for 2016.

Approach

Average of observed data for each month of the 10 most recent years were used for comparison to smooth out inter-annual variation of meteorological and hydrological conditions which has not been taken into account in the Delft3D modelling scenario.

Discussion

Model prediction for key water quality parameters for this Project, namely, dissolved oxygen, 5-day biochemical oxygen demand, total inorganic nitrogen, orthophosphate phosphorus, suspended solids and chlorophyll-a, would be discussed in turn in the subsequent sections.

(a) Dissolved Oxygen

Predicted dissolved oxygen levels matched quite well with the observed data, with a small overall underestimation. Notable level of stratification observed in the region in wet season was reproduced in the model.

(b) Biochemical Oxygen Demand

Predicted biochemical oxygen demand were similar to the observed level at the nearby EPD monitoring stations with small underestimation. Such small underestimation is not considered to be of particular concern that could affect the conclusion of the modelling exercise given both the observed and predicted levels were significantly below that of the corresponding assessment criterion of 10 mg/L.

(c) Total Inorganic Nitrogen

The predicted level of total inorganic nitrogen were generally higher than that of the observed levels at the nearby EPD monitoring stations as a results of conservative assumptions adopted for estimation of pollution loading. The model was able to reproduce in the wet season the stratification as well as elevated levels of total inorganic nitrogen.

(d) Orthophosphate Phosphorus

Similar to the case of total inorganic nitrogen, the model prediction was generally slightly above the observed data (because of conservative pollution load estimation) and was able to reproduce stratification and slightly elevated levels in the wet season.

(e) Suspended Solids

The predicted levels of suspended solids matched quite well with the observed data, with a small overall underestimation.

(f) Chlorophyll-a

The predicted levels of chlorophyll-a were generally higher than the observed data as a result of conservative overestimation of nitrogenous and phosphorus nutrients discussed above. Nevertheless, the elevated levels during wet season as well as the stratification were both reproduced in the model.

<u>Conclusion</u>

The water quality model was able to reproduce key water quality characteristics including seasonal changes and stratification, as well as suitably accurate prediction of certain key water quality parameters. Note that the effect of conservative overestimation of pollution load, particularly for nitrogenous and phosphorus nutrients have been reflected in as the overestimated levels in the model, as well as an over-abundant of chlorophyll-a in the area. Such overestimation is deemed conservative in term of assessment and be suitable for the purpose of an environmental impact assessment study. It is therefore concluded this water quality model of STKDD suitable for this Study.

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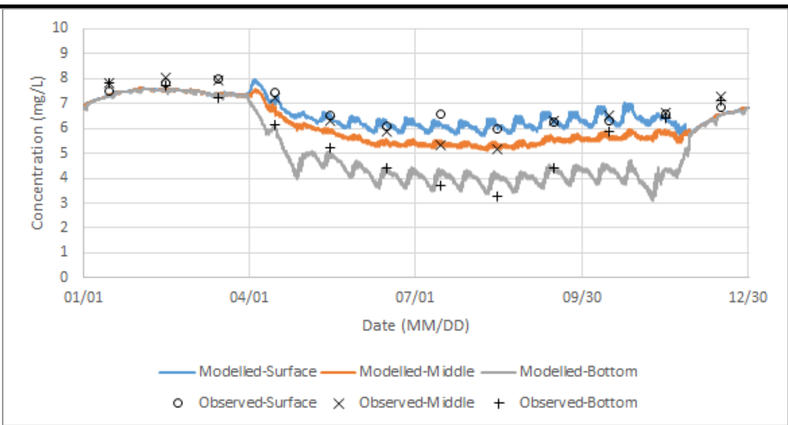
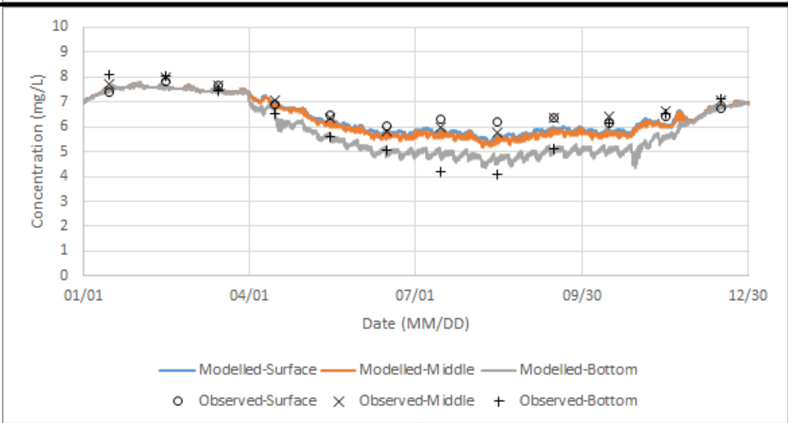
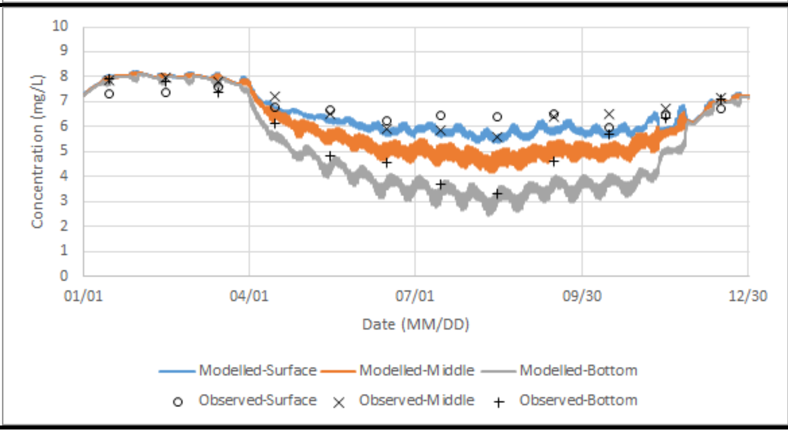
Dissolved Oxygen	MM5	
	MM6	
	MM7	

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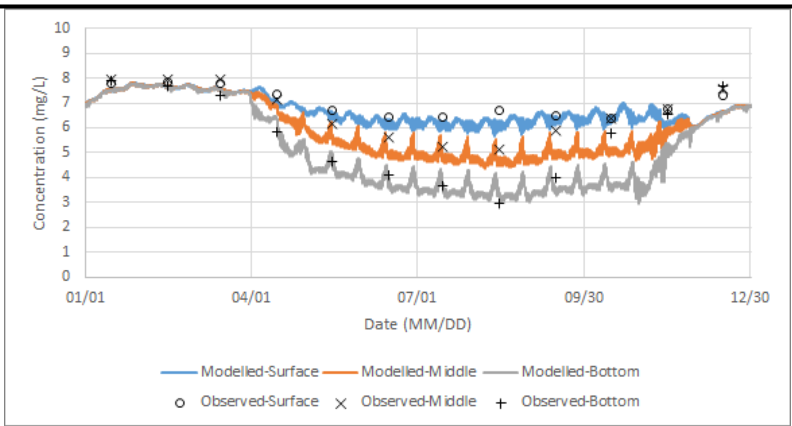
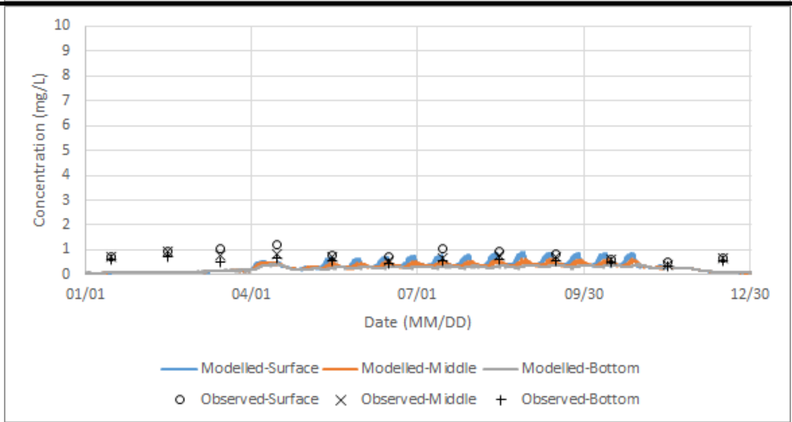
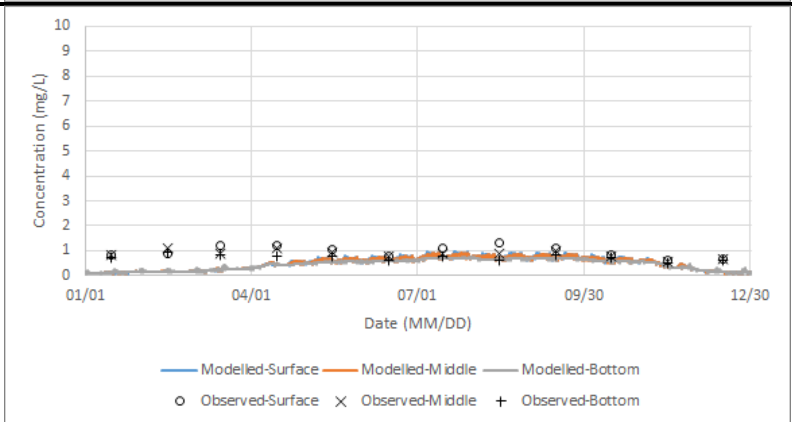
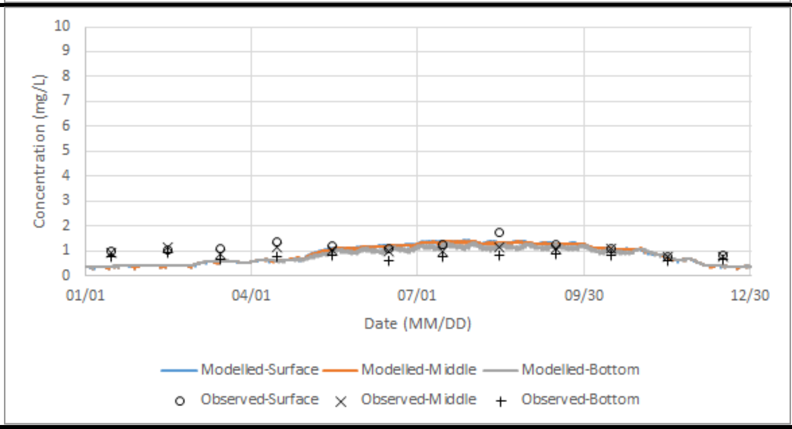
	MM17	
5-day Biochemical Oxygen Demand	MM5	
	MM6	
	MM7	

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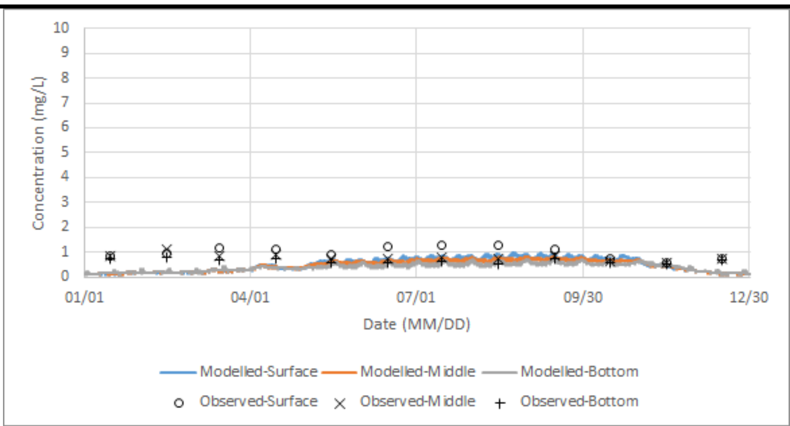

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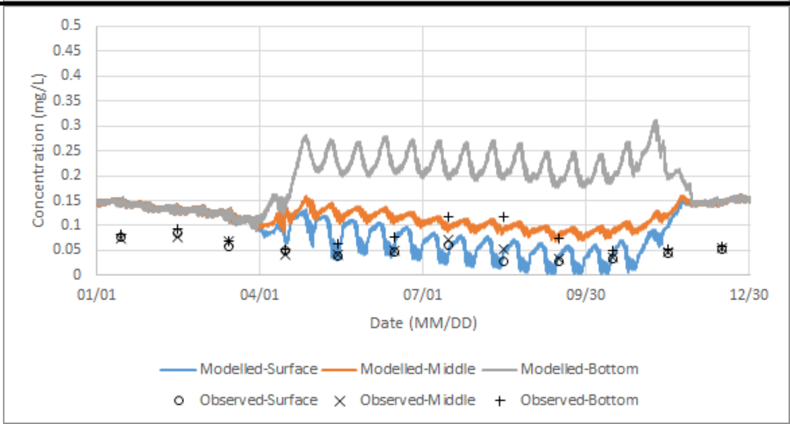

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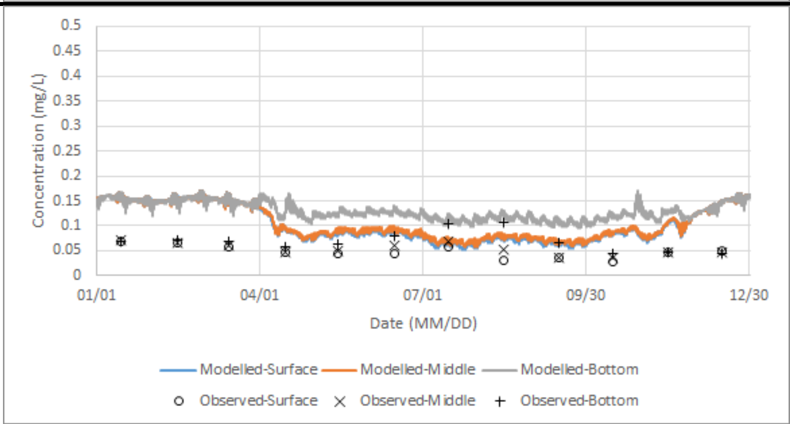

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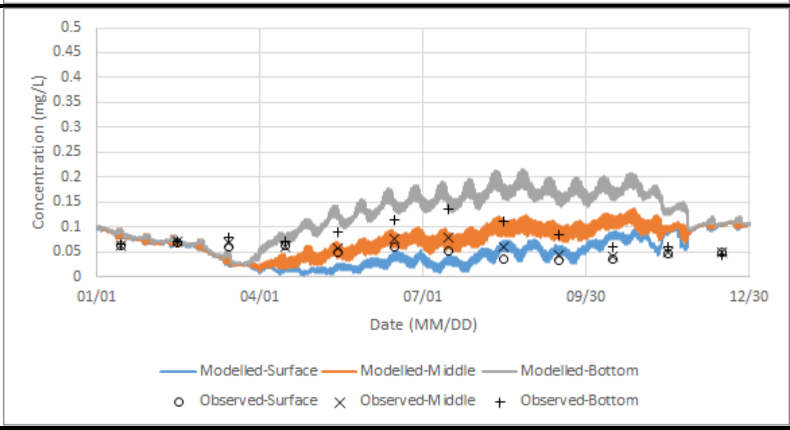

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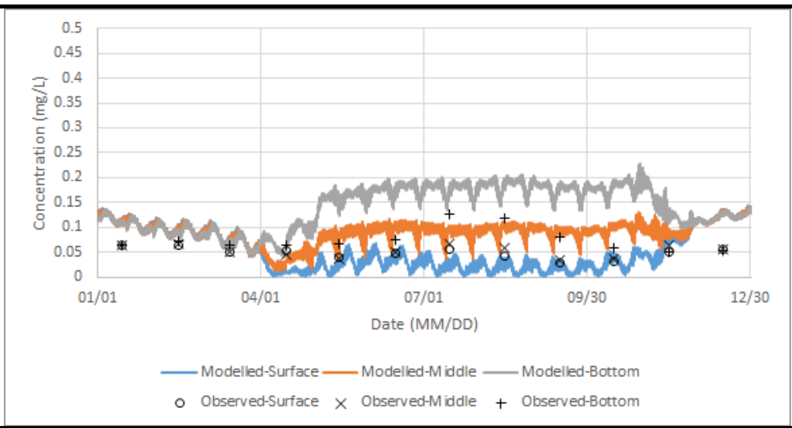
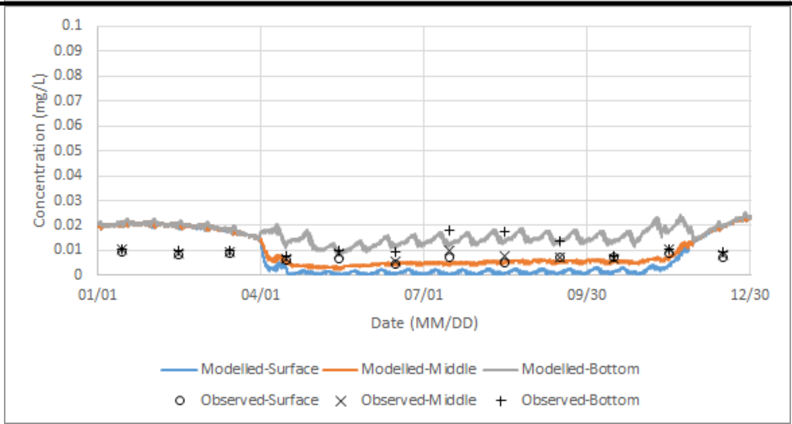
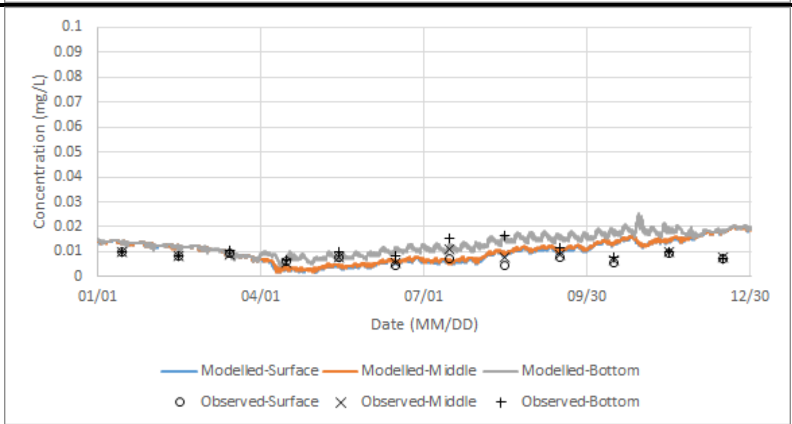
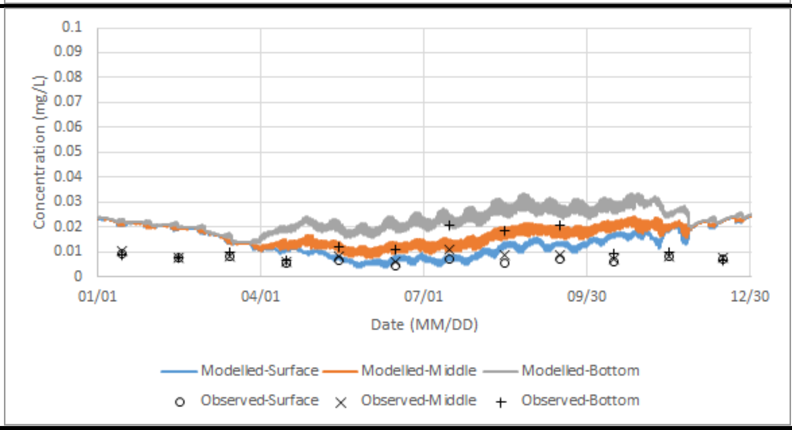
	MM17	
Orthophosphate Phosphorus	MM5	
	MM6	
	MM7	

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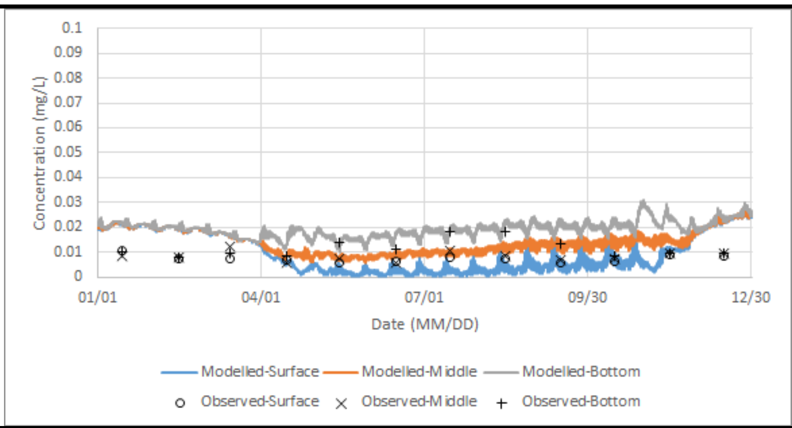
<tr><td></td><td>MM17</td><td>
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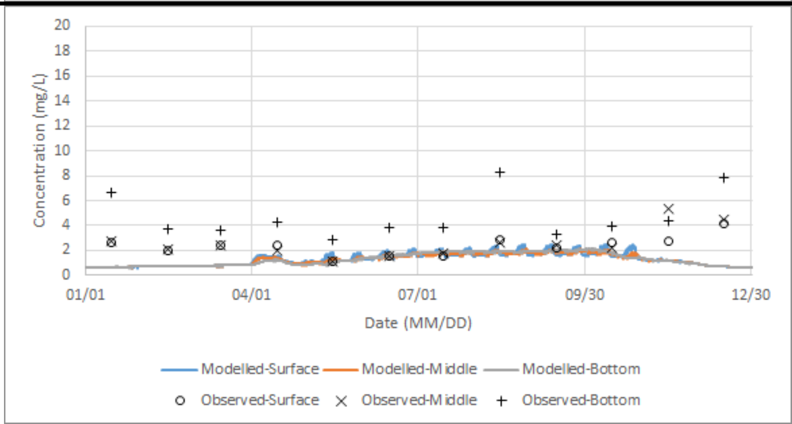
<tr><td>Suspended Solids</td><td>MM5</td><td>
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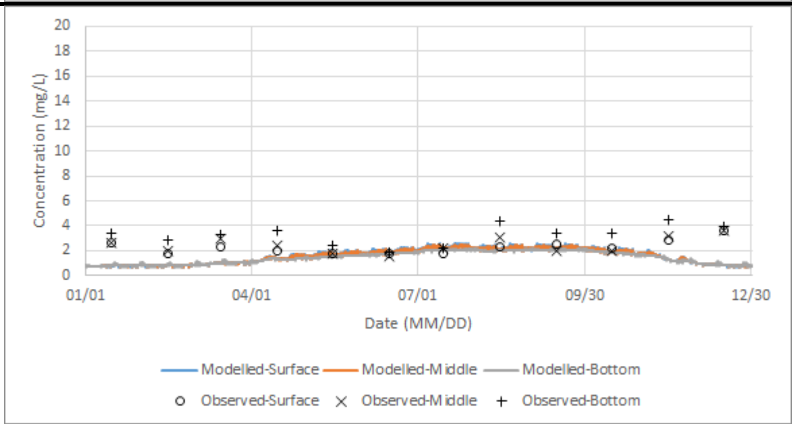
<tr><td></td><td>MM6</td><td>
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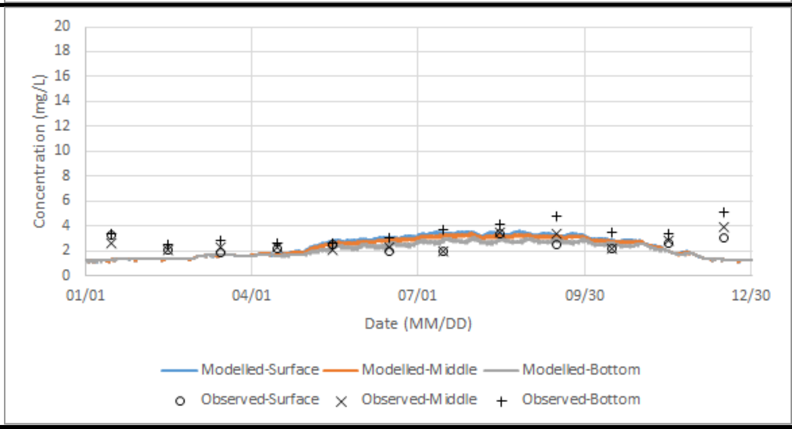
<tr><td></td><td>MM7</td><td>
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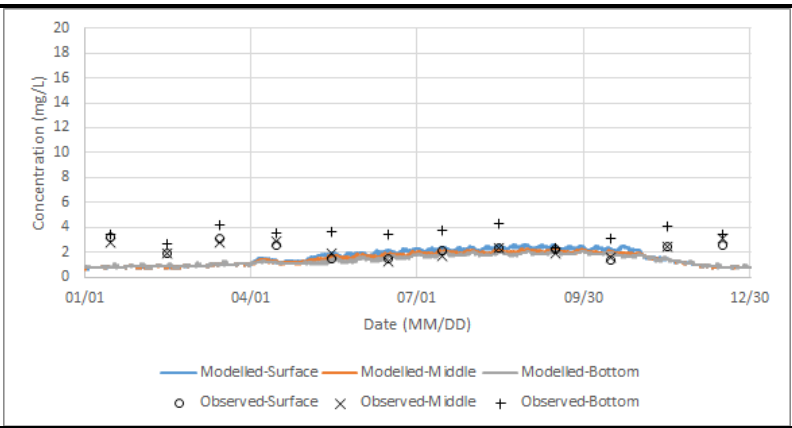
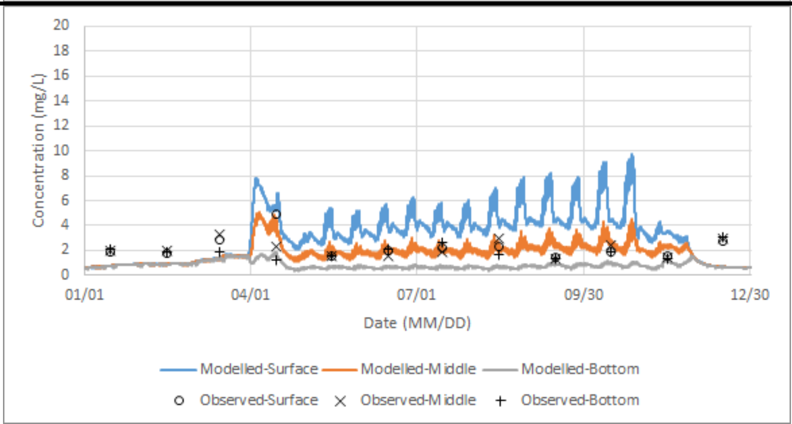
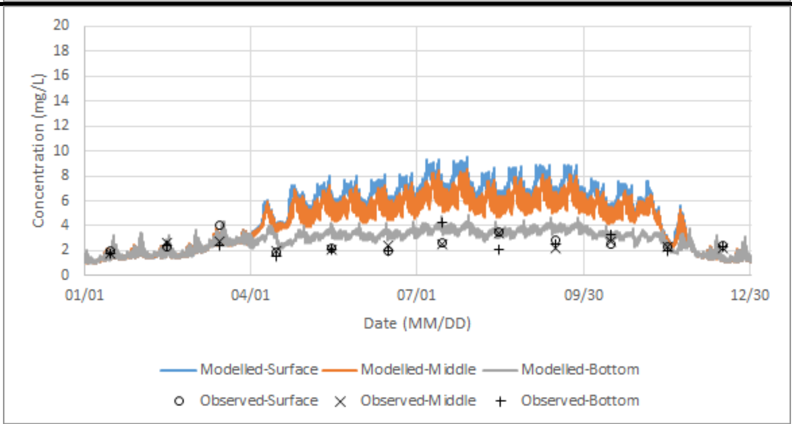
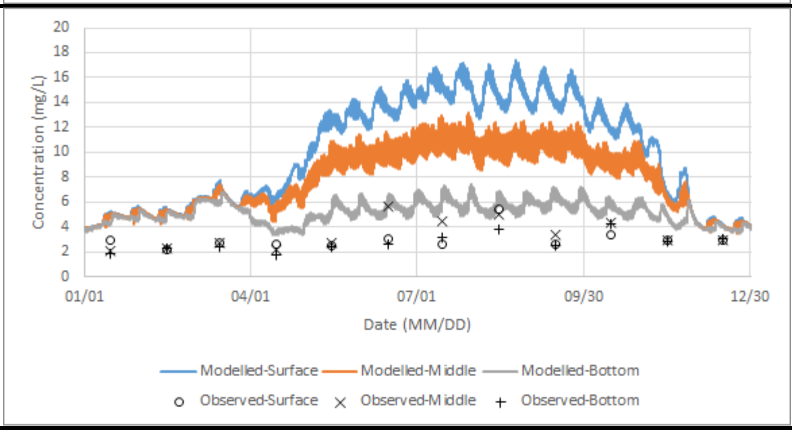
	MM17	
Chlorophyll-a	MM5	
	MM6	
	MM7	

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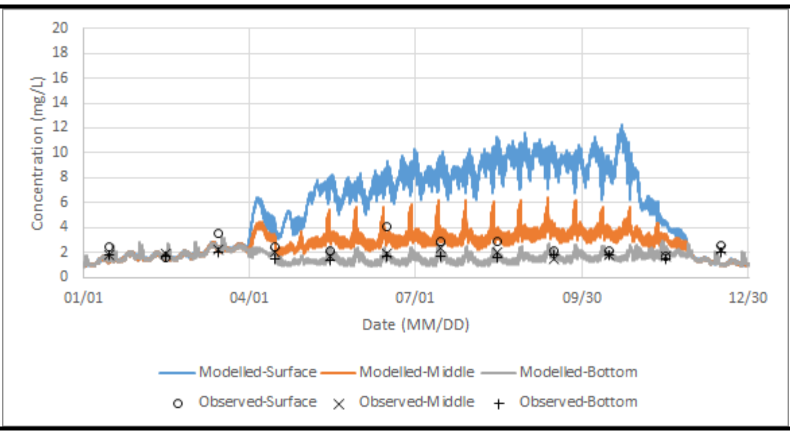
	MM17	

APPENDIX 3E DETAILED ANALYSIS ON EFFECT OF ARTIFICIAL AERATION AT MARICULTURE OPERATIONS

3E DETAILED ANALYSIS ON EFFECT OF ARTIFICIAL AERATION AT MARICULTURE OPERATIONS

This ***Appendix*** details the assumptions and findings for simulation of the effect of providing artificial aeration as a mean to improve the level of dissolved oxygen at the Project Site.

3E.1 Finding of Modelling Simulation and Implications

Under the modelled baseline scenario, the predicted 10th-percentile depth-averaged dissolved oxygen levels were predicted to be at 4.0 mg/L within the proposed FCZ of Wong Chuk Kok Hoi (also referred as Project Site), which are lower than the WQO criterion of 5 mg/L adopted for assessment. The other water quality parameters at Project Site were predicted to be in compliance to the corresponding WQO criteria.

Mariculturists typically are familiar with low dissolved oxygen conditions and would be aware of such conditions via observing behavioural change of the fish stock and / or by onsite water quality monitoring devices. Also, AFCD is expected to install real time water quality monitoring device at Project Site and inform mariculturists regarding notable water quality deterioration detected. As such, it is anticipated that mariculturists would apply suitable management / control for their own business interest.

One typical response for low dissolved oxygen for mariculture is aeration. Aeration allows oxygen to enter the water column and improve the anoxic conditions. For this Study, the project scenario took into account the change in dissolved oxygen level when aeration is applied at the fish farm of the Project Site by mariculturists.

It should also be highlighted that the observed 10th-percentile depth-averaged dissolved oxygen level at the existing Wong Wan FCZ (shown in ***Figure 3.2 of this EIA Report***) by AFCD was 5.4 mg/L from 2015-2021, which matches pretty well with the model prediction of 5.2 mg/L under the baseline scenario. Given the both the existing Wong Wan FCZ and Project Site are located within the Wong Chuk Kok Hoi embayment, the notable difference in dissolved oxygen levels under the baseline scenario is contributed to the notably higher water depth in Project Site (i.e. inclusion of larger portion of deeper water column resulting in lower depth-averaged dissolved oxygen). In fact, the predicted level of dissolved oxygen on the surface layer, where most of the maricultural activities take place, would be much better than the mid-depth and bottom layer (refer to time series provided in ***Appendix 3C***). This means the actual effect of low dissolved oxygen level on the fish stock at Project Site would likely be less significant than the corresponding figure presented based on the assessment criteria in WQO apparently indicates.

3E.2 Model Settings

For evaluation of the effectiveness for providing aeration at mariculture operation, the 10th-percentile depth-averaged dissolved oxygen would be adopted as the major criterion as that is the only criterion that does not comply to the assessment criteria at Project Site. Note that the assumed aeration method for this exercise was designed to evaluate against WQO compliance. Mariculturists may adopt different aeration regime based on their professional judgment to suit their need.

All the model settings adopted for the project scenario were identical to the baseline scenario, except for the pollution load from the proposed mariculture operation at the Project Site, the nearby proposed new FCZs at Site B and Site C, as well as provision of oxygen loading within Project Site. Please refer to ***Appendix 3A*** for model assumptions and other settings.

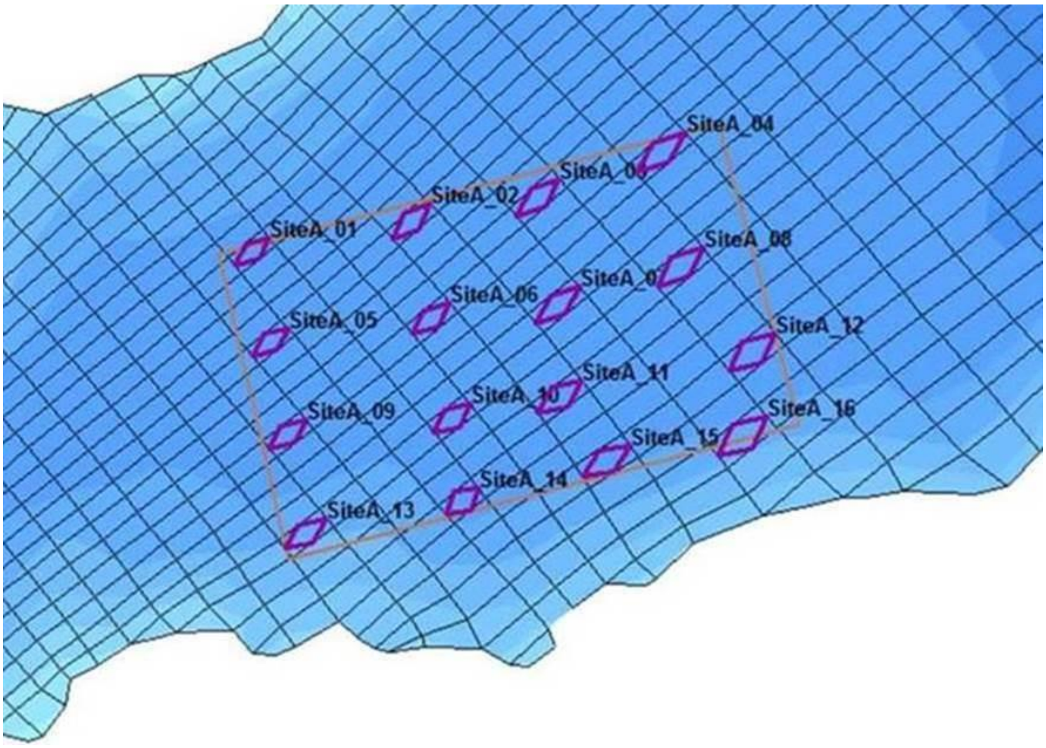
In terms of modelling of aeration, it is assumed air will be pumped and released at the lower end of the water column of mariculture operations in Site A at fixed rate for the three months with lowest dissolved oxygen levels predicted under the baseline scenario. It is assumed the released gas will be in form of fine bubbles to allow effective retention and gaseous exchange with the entire water column. The modelled scenarios were summarized below in ***Table 3E1.1***.

Table 3E1.1 Modelling Scenarios – Consideration for Aeration

ID	Aeration Rate and Duration	Description
Baseline	No aeration	Baseline Scenario – without Project.
Project-	16 L/s at each mariculture operation in July, August and September	Project operation with aeration for three months.

For the aeration scenario, aeration was assumed to occur at each fish farm (1) in the Project Site (indicatively shown in ***Figure 3E.1.1*** below). It is assumed diffused aeration method would be used to allow fine bubbles to be released from the lower end of the water column and passes through the entire water column to maximize gaseous exchanges. For 16 L/s aeration rate, about 4.3571 g/s of oxygen (2) would enter the water column. Assuming roughly 50% oxygen dissolved into the water column (3), about 2.1786 g/s of oxygen would become dissolved oxygen at each fish farm. The dissolved oxygen load was assumed to be evenly distributed in the entire water column.

Figure 3E.1.1 Locations of Loading Input for Project Site



3E.2 Model Findings

A summary of predicted results for dissolved oxygen under baseline and project scenarios are provided in ***Table 3E1.2***. Time series of dissolved oxygen level at surface, mid-depth and bottom levels at Site A under baseline and project scenarios were presented in ***Appendix 3C***. As shown, modelling results

(1) In the model, pollution load from mariculture operation was discharged into the water column at 16 discrete points in the Project Site. For this exercise, these 16 points are considered as individual fish farms. Accordingly, loading of dissolved oxygen were added to the model alongside with other pollution load during the specified period.

(2) Take density of air as 1.184 g/L and oxygen mass percentage of 23%, oxygen flow rate is calculated as:
16 L/s × 1.184 g/L × 23% = 4.3571 g/s

(3) Typical oxygen transfer efficiency for fine bubble diffuser could be up to 2% per foot of diffuser submergence (https://www.webpages.uidaho.edu/ce431/Handouts/Sanitaire%20Diffused%20Air%20Design%20Guide.pdf). For deployment near bed level at Project Site (>10 m or >32.8 ft), oxygen transfer efficiency would be over 50%. Therefore, assuming at 50% oxygen transfer is deemed conservative.

indicated aeration for 3 months at rate of 16 L/s will allow levels of 10th-percentile depth-averaged and bottom dissolved oxygen to remain at levels same as the baseline scenario.

Table 3E1.2 Modelling Results for Dissolved Oxygen for Aeration at Site A

ID	WSR	Scn.	Annual			
			10th-percentile		Mean	
			Depth-averaged	Bottom	Depth-averaged	Bottom
			Dissolved Oxygen (mg/L)			
Fish Culture Zone – Mirs Bay Assessment Criteria			≥5	≥2	N/A	N/A
Project site	Proposed Wong Chuk Kok Hoi FCZ	Baseline	**4.0**	2.9	5.8	5.2
		Project	**4.0**	2.8	5.8	5.1

3E.2 Summary and Conclusion

Water quality modelling simulation has taken into account aeration by mariculturists at Project Site in response to the predicted low dissolved oxygen levels under baseline scenario. Modelling results indicated aeration will result in localized increase of dissolved oxygen at Project Site and negate the effect of increase organic loading from Project operation. Within Project Site, the modelling results indicated aeration provided for the three months with the lowest dissolved oxygen levels at rate of 16 L/s at each mariculture operation will allow 10th-percentile depth-averaged dissolved oxygen levels be at level similar to the baseline condition (i.e. no aggravation of existing condition).

Overall, the modelling results indicated mariculturists will be able to exert control over the dissolved oxygen levels at their mariculture operation in response to low dissolved oxygen condition which typically occur in wet season. Therefore, the predicted reduction in dissolved oxygen at the Project Site could be controlled by adopting aeration as necessary and unacceptable water quality impact is not anticipated for mariculture operation at Project Site after adopting such control measure in case of low dissolved oxygen level.

APPENDIX 4A LITERATURE REVIEW – MARINE ECOLOGY

4A.1 LITERATURE REVIEW – MARINE ECOLOGY

4A.1.1 Introduction

A literature review was conducted to review the marine baseline ecological characters of the Assessment Area, identify habitat resources and species of potential conservation importance, and identify information gaps to determine whether field surveys are required to provide sufficient information for the marine ecological impact assessment. This Appendix presents the findings of this literature review.

4A.1.2 Legislative Requirements and Evaluation Criteria

4A.1.2.1 Marine Parks Ordinance (Cap. 476) and its Subsidiary Legislation

The *Marine Parks Ordinance (Cap. 476)* provides for the designation, control and management of marine parks and marine reserves. It also stipulates the Director of Agriculture, Fisheries and Conservation as the Country and Marine Parks Authority which is advised by the Country and Marine Parks Board. The *Marine Parks and Marine Reserves Regulation* was enacted in July 1996 to provide for the prohibition and control of certain activities in marine parks or marine reserves.

4A.1.2.2 Wild Animal Protection Ordinance (Cap. 170)

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

4A.1.2.3 Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)

The *Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)* was enacted to align Hong Kong's control regime with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). With effect from 1 July 2006, it replaces the *Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187)*. The purpose of the *Protection of Endangered Species of Animals and Plants Ordinance* is to restrict the import and export of species listed in CITES Appendices so as to protect wildlife from overexploitation or extinction. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them. Certain types of corals are CITES listed, including Blue coral (*Heliopora coerulea*), Organ pipe corals (family Tubiporidae), Black corals (order Antipatharia), Stony coral (order Scleractinia), Fire corals (family Milleporidae) and Lace corals (family Stylasteridae). The import, export and possession of listed species, no matter dead or living, is restricted.

4A.1.2.4 Country Parks Ordinance (Cap. 208) and its Subsidiary Legislation

The *Country Parks Ordinance (Cap. 208)* provides for the designation and management of Country Parks and Special Areas. Country Parks are designated for the purpose of nature conservation, countryside recreation and outdoor education. Special Areas are reserved generally for the purpose of nature conservation.

4A.1.2.5 Town Planning Ordinance (Cap. 131)

The *Town Planning Ordinance (Cap. 131)* provides for the designation of areas such as "Coastal Protection Areas", "Sites of Special Scientific Interest (SSSIs)", "Green Belt" and "Conservation Area" to promote conservation or protection or protect significant habitat.

4A.1.2.6 Environmental Impact Assessment Ordinance (Cap. 499) and the Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO-TM)

The *Environmental Impact Assessment Ordinance (Cap. 499)* specifies designated projects under Schedule 2 of the Ordinance, unless exempted, must follow the statutory environmental impact assessment (EIA) process and require environmental permits for their construction and operation. Annex 16 of the EIAO-TM sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. Annex 8 recommends the criteria that can be used for evaluating ecological impacts.

4A.1.2.7 Environmental Impact Assessment Ordinance (EIAO) Guidance Notes No. 6/2010, 7/2010 and 11/2010

The guidance notes provide respectively the observations on ecological assessment from the EIAO perspective, the general guidelines for conducting an ecological baseline survey for ecological assessment and methodologies for marine ecological baseline surveys in order to fulfil the requirements stipulated in the EIAO-TM in respect of marine ecological assessment for the proposed development.

4A.1.2.8 Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG)

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

4A.1.2.9 Other Relevant Legislation

The Peoples' Republic of China (PRC) is a Contracting Party to the *United Nations Convention on Biological Diversity (CBD) of 1992* and it was extended to Hong Kong on 9 May 2011. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The HKSAR Government has stated that it will be "committed to meeting the environmental objectives" of the Convention [(1)]. In the tenth meeting of the conference in 2010, the Parties adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for 2011-2020. This plan aims to "take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication". The Strategic Plan consisted with five strategic goals, which included 20 headline Aichi Biodiversity targets. The goals and targets comprised a flexible framework for the establishment of national and regional targets for biodiversity conservation.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora of Wild Fauna and Flora (CITES) was drafted and agreed at a meeting of members of International Union for Conservation of Nature (IUCN) with representative of 80 countries in 1972 and entered in force in 1975. This international agreement adheres voluntarily between government and aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

The IUCN is the world's oldest and largest authority on the conservation status of species. The IUCN Red List of Threatened Species™ is widely recognised as the most comprehensive, objective global

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

approach for evaluating the conservation status of plant and animal species. The goal of the IUCN Red List is to provide information and analyses on the status, trends and treats to species in order to inform and catalyse action for biodiversity conservation. In 1994, a scientifically rigorous approach was adopted to determine risks of extinction that is applicable to all species and it has become a world standard.

The Convention on *Wetlands of International Importance Especially as Waterfowl Habitat* (the Ramsar Convention) applies in the HKSAR. The Convention requires parties to conserve and make wise use of wetland areas, particularly those supporting waterfowl populations. Article 1 of the Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." The Mai Po/Inner Deep Bay wetland was been declared a Wetland of International Importance ("Ramsar Site") under the Convention in 1995.

The PRC in 1988 ratified the Wild Animal Protection Law of the PRC, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 96 animal species in Class I and over 230 species in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

4A.2 BASELINE CONDITIONS OF MARINE ECOLOGICAL RESOURCES OF THE ASSESSMENT AREA

4A.2.1 Information Reviewed

Baseline information on the marine ecological resources of the Assessment Area for marine ecology is available from the following key sources:

- Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study (AFCD/FIS/01/14);
- EIA Report for the Proposed Submarine Gas Pipeline From Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal (EIA-089/2003);
- Consultancy Study on Marine Benthic Communities in Hong Kong (Agreement No. CE 69/2000);
- A Study of Soft Shore Habitats in Hong Kong for Conservation and Education Purposes;
- AFCD Final Report on Monitoring of Marine Mammals in Hong Kong Waters;
- Hong Kong Reef Check;
- Field guides and published studies/literature for marine habitats and fauna of Hong Kong;

  and
- Available Published Scientific Literature.

Findings of the review of these key sources is summarised in the following sections.

4A.2.2 Recognised Sites of Conservation Importance

Recognised sites of conservation importance within the Assessment Area include Country Parks, Special Areas, Marine Parks, and Sites of Special Scientific Interest (SSSI) ***(Figure 4A.2.1)***. Some of these that are relevant to marine ecology and are located in the vicinity of the Project site are discussed below.

4A.2.2.1 Country Parks

The existing country parks which are in the vicinity of the Project site are the Plover Cove Country Park and Plover Cove (Extension) Country Park [(2)] ***(Figure 4A.2.1)***.

Plover Cove Country Park was designated in 1978 and has an area of 4,594 ha. The first record of butterfly Yellow Coster (*Acraea issoria*) in Hong Kong was found in the park. Other species of conservation importance includes Chinese Leopard Cat (*Prionailurus bengalensis*) and various forest birds. Plover Cove (Extension) Country Park was designated in 1979 and it mainly consists of islands in the northeastern Hong Kong including Tung Ping Chau, Port Island, Double Heaven, and Crooked Island. White-bellied Sea Eagles (*Haliaeetus leucogaster*) are known to nest in some of these islands [(3)].

As both country parks are of terrestrial conservation interest, impact of the Project on the two country parks are not anticipated and will not be discussed further.

4A.2.2.2 Special Areas

The existing special area in the Assessment Area is the Double Haven Special Area [(4)] located at >3 km from the Project site ***(Figure 4A.2.1)***.

(2) AFCD (2021) Country Parks.
(3) AFCD (2020) Plover Cove Country Park and Plover Cove (Extension) Country Park.
(4) AFCD (2021) HONG KONG : THE FACTS - Country Parks and Special Areas.

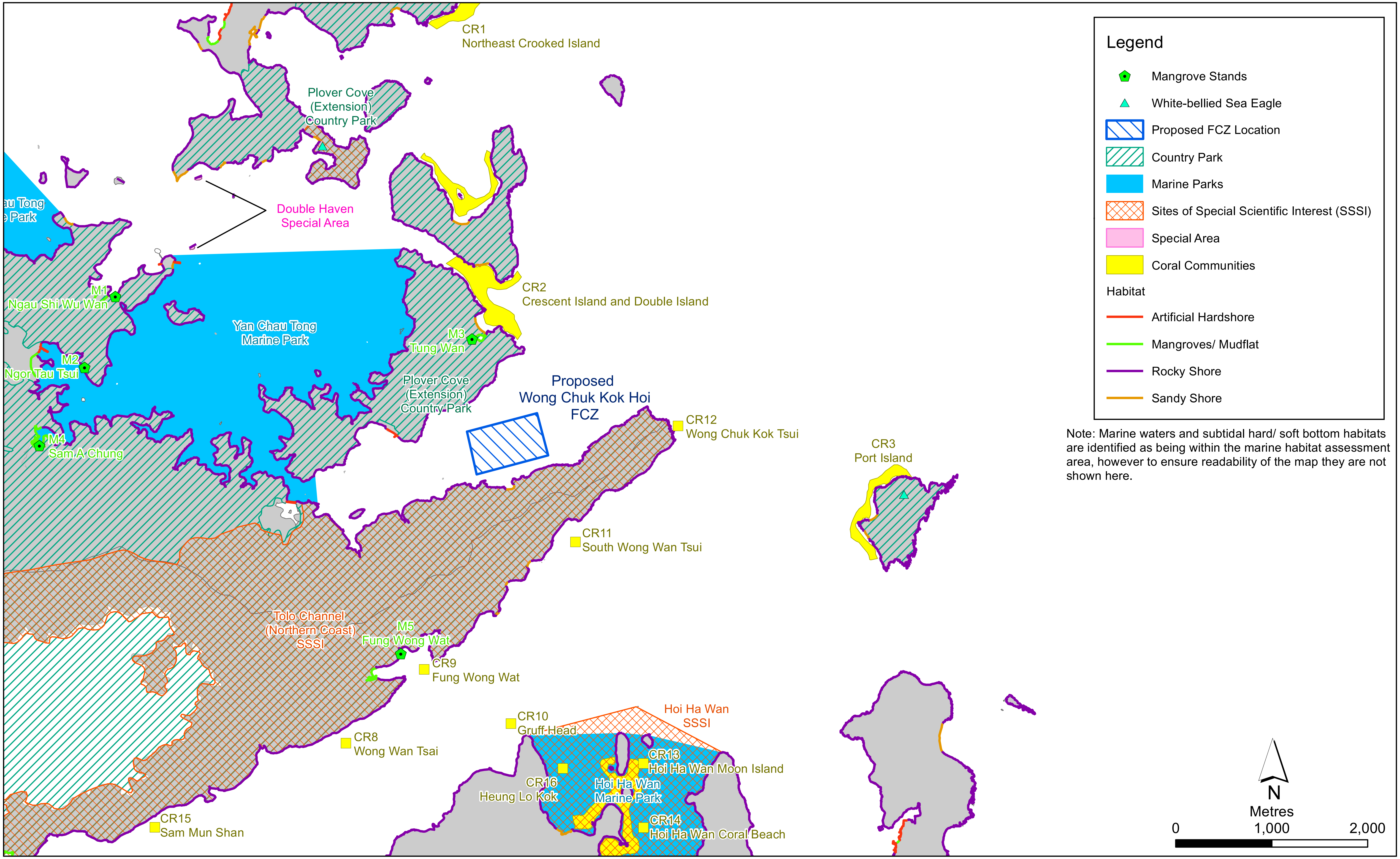


Figure 4A.2.1

Recognised Site of Conservation Importance and Marine Habitat Identified for the Proposed Wong Chuk Kok Hoi FCZ

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Double Haven Special Area was designated in 2011 with an area of 0.8 ha. The sedimentary rocks of Kat O formation can be found in the special area and it is a good location to study breccia in the field [(5)]. Six landforms within the special area including Yan Chau and Pak Ka Chau were named as 'six treasures' and they are of geological interest.

As the Special Area is located far away from the Project site and are mainly of non-marine ecological interest, impact of Project on the area is not anticipated and will not be discussed further.

4A.2.2.3 Marine Parks

The existing marine parks in the Assessment Area include Yan Chau Tong Marine Park (YCTMP) and Hoi Ha Wan Marine Park (HHWMP). YCTMP consists of two portions, including Yan Chau Tong (Double Haven) and Lai Chi Wo. There are no proposed or potential marine parks within and in the vicinity of the Assessment Area. Details of the marine parks are summarised in ***Table 4A.2.1*** and the locations of these marine parks are provided in ***Figure 4A.2.1*** [(6)].

4A.2.2.4 Sites of Special Scientific Interest

Sites of special scientific interest in the Assessment Area include Tolo Channel (Northern Coast) SSSI and Hoi Ha Wan SSSI. Tolo Channel (Northern Coast) SSSI is located nearest to the Project site, however, as the SSSI is established mainly due to its geographical value, it is considered not to be affected by the Project works which are all marine-based. Hoi Ha Wan SSSI consist of marine ecological interest but is located far away (i.e. ~2.8 km) to be affected by the Project. Details of the SSSIs are summarised in ***Table 4A.2.1*** and the location of the SSSIs are provided in ***Figure 4A.2.1***.

(5) The Legislative Council Commission (2021) LEGISLATIVE COUNCIL BRIEF Country Parks Ordinance (Chapter 208) DOUBLE HAVEN AND OTHERS (SPECIAL AREAS) ORDER 2010.

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

Table 4A.2.1 Existing Marine Parks & Sites of Special Scientific Interest in the Assessment Area

Marine Park/ Sites of Special Scientific Interest	Location	Distance to the Project site (km)	Date of Designation	Area (ha)	Conservation Purpose
Existing Marine Parks					
Yan Chau Tong Marine Park (1)	Northeastern coast of Plover Cove Country Park	1.0	July 1996	680	■ It was established as protected nursery grounds for larvae and juvenile of fishes, marine invertebrates and different marine lives. These rich fisheries resources are mainly supported by two important intertidal habitats, seagrass bed and mangroves. ■ It is inhabited by the main distribution of Marine Eel Grass (*Zostera japonica*) in Hong Kong (about 2 ha.). All 8 true mangrove species recorded in Hong Kong can be found in the YCTMP.
Hoi Ha Wan Marine Park (2)	North of the Sai Kung West Country Park	2.7	July 1996	260	■ It was established to protect the diverse marine and intertidal habitats and marine lives such as reef fishes and invertebrates. ■ There are 6 out of 8 true mangroves species recorded in HHWMP. 5 mangroves species can be found within a small area of 0.5 ha. ■ HHWMP has a high species diversity of stony corals with some sites of the marine park host more than 50 species of stony corals. The total number of stony coral species recorded is 64 out of 86 species recorded in Hong Kong. Common species include *Pavona decussata* and *Platygyra acuta*. ■ High diversity of other marine lives including black corals (*Antipatharian* sp.), ~120 species of coral associated fishes, and coral associated invertebrates are also recorded.
Sites of Special Scientific Interest					

Marine Park/ Sites of Special Scientific Interest	Location	Distance to the Project site (km)	Date of Designation	Area (ha)	Conservation Purpose
Tolo Channel (Northern Coast) [3]	Within the designated Plover Cove Country Park	>0.1	24 September 1982	1,287	■ The site is designated due to geological interest, with the oldest rock (formed about 400 million years ago during the Devonian Period) and fossil of ammonite, *Hongkongites hongkongensis* recorded at the site [7]. ■ Geological formation – folding, faulting, dip and strikes can be found.
Hoi Ha Wan [5]	At the northern coastline of Sai Kung Peninsula within Sai Kung West Country Park	2.7	5 January 1989	278	■ Geographical location of Hoi Ha Wan provides favourable environment for corals to thrive as it is a sheltered bay with pristine water quality. ■ Different hermatypic coral species can be found. ■ Corals species such as *Pavona decussata*, *Porites lobata*, and *Cyphastrea* spp. can be found at different depths of the subtidal area within the SSSI.

Note:
(1) AFCD (2021) Yan Chau Tong Marine Park.
(2) AFCD (2021) Hoi Ha Wan Marine Park.
(3) Planning Department (2005) Tolo Channel (Northern Coast).
(4) Planning Department (2005) Hoi Ha Wan.

(7) Hong Kong Geopark (2021) Permian rock garden of Hong Kong – Ma Shi Chau.

4A.2.3 Intertidal Hard Bottom Habitats

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

With reference to the site visits conducted between September 2020 to February 2021, the intertidal hard bottom habitat of the closest vicinity of the Project site and the Assessment Area consists primarily of natural rocky or boulder shore (***Figure 4A.2.1***). Artificial hard bottom shores within the Assessment Area such as piers and seawalls have also been identified. The literature reported that intertidal hard bottom assemblages within the Assessment Area consists of common and widespread organisms that can be found in other intertidal habitats of Hong Kong, including macroalgae (*Ulva lactuca* and *Colpomenia sinuosa)*, and short-spined sea urchin (*Heliocidaris crassispina)* were recorded in the natural rocky shore at the south coast of Wong Chuk Kok Hoi (8).

4A.2.4 Intertidal Soft Bottom Habitats

4A.2.4.1 Mangrove and Mudflat

Mangroves can be found in the northeastern area of Hong Kong especially in the sheltered parts of Mirs Bay and the Starling inlet (9). Within the Assessment Area, five mangrove stands have been identified, including four mangrove stands in the Mirs Bay WCZ extending from intertidal areas at Ngau Shi Wu Wan to Sam A Chung, and one mangrove stand in the Tolo Harbour and Channel WCZ at intertidal areas of Fung Wong Wat ***(Figure 4A.2.1)***. The nearest mangrove stand to the Project site is located at Tung Wan which is ~1 km away.

According to AFCD, all eight true mangrove species recorded in Hong Kong can be found in the YCTMP. Within the Assessment Area, Sam A have some substantial mangrove stands covering 3 ha with seven out of eight true mangrove species (10). Mangrove stands at Sam A Chung within the Assessment Area are located over 4.4 km from the Project site.

Overall, mangrove stands and associated mudflats of the Assessment Area are of high ecological value and conservation importance. The closest mangrove stand is 1 km from the Project site and most of them are located more than 4 km away.

4A.2.4.2 Horseshoe Crab

Two species of horseshoe crab, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*, have previously been recorded in AFCD surveys around Hong Kong waters (11). It was reported that the horseshoe crab populations have disappeared extensively in areas including the Tolo Harbour since 1980s (12). Juvenile horseshoe crabs were previously found at mudflats in Luk Keng, Sha Tau Kok and Lai Chi Wo in the northeastern New Territories (13). Based on the abundance of juveniles, Luk Keng and Sha Tau Kok were identified as the key nursery grounds for *C. rotundicauda* and *T.*

(8) Ng TPT, Cheng MCF, Ho KKY, Lui GCS, Leung KMY and Williams GA (2017) Hong Kong's rich marine biodiversity: the unseen wealth of South China's megalopolis. Biodiversity and Conservation, 26(1), 23-36.

(9) AFCD (2020) Distribution Map.

(10) AFCD (2021) Yan Chau Tong Marine Park.

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

(12) AFCD (2021) Horseshoe Crabs in Hong Kong.

(13) AFCD (2021) Appendix 10: Marine Living Fossils Report.

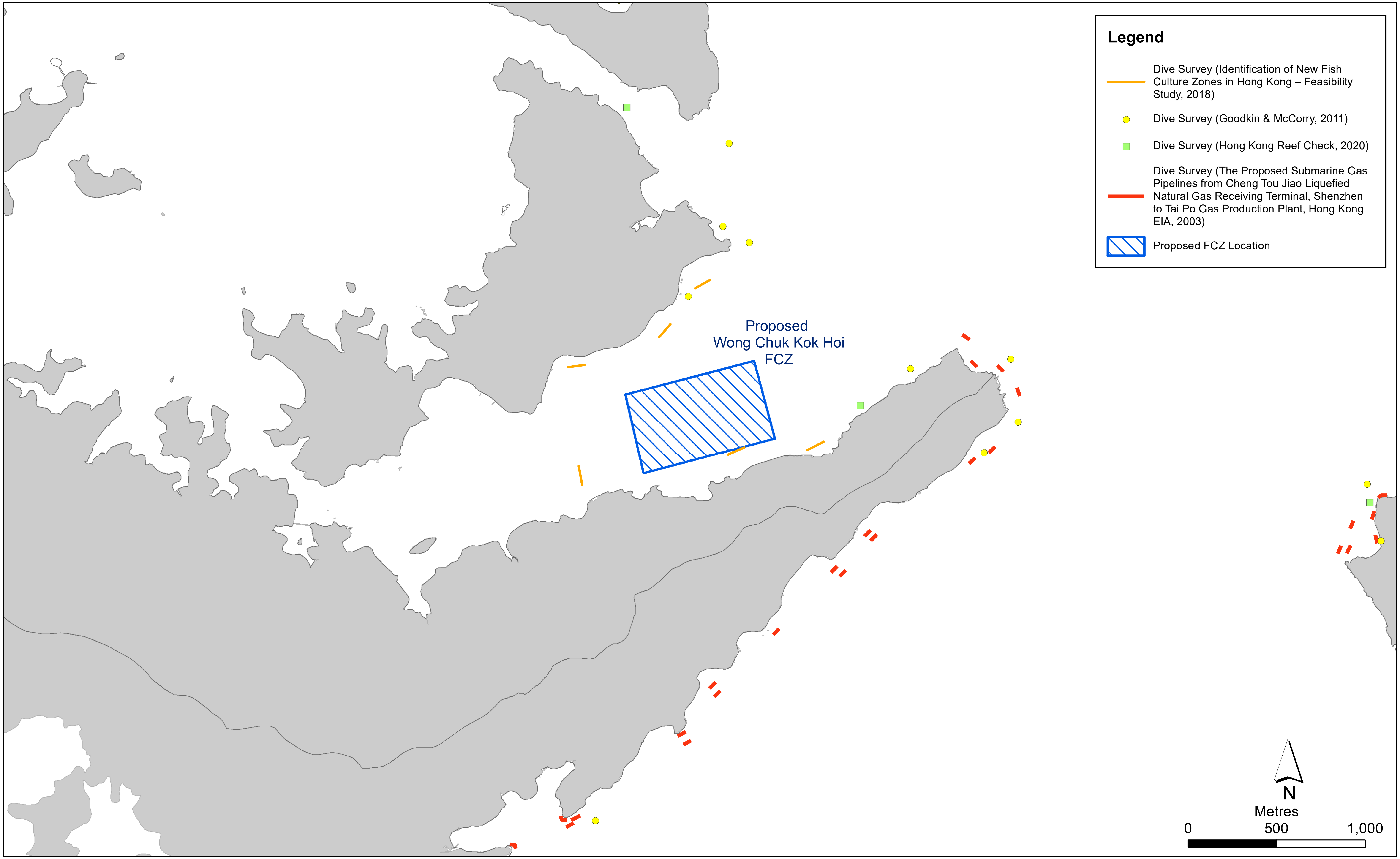

Figure 4A.2.2

Location of Survey Sites of Previous Subtidal Hard Bottom Assemblages Studies in the Vicinity of the Proposed Wong Chuk Kok Hoi FCZ

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tridentatus [14] [15] [16] [17]. There are no records of adult horseshoe crabs in the northeastern Hong Kong waters.

The closest records of occurrence in the vicinity of the Assessment Area were from the beach at Lai Chi Wo in YCTMP with the latest review and study on the distribution of horseshoe crab reported in 2016 [18]. It was reported that *C. rotundicauda* juveniles were recorded in the 2006 intertidal surveys conducted at Lai Chi Wo [19], however, data obtained during the surveys in 2012 and 2014 from this study showed that both horseshoe crab species were absent from the site. No occurrence of living horseshoe crab was recorded (post 1995) in the Project site. The nearest horseshoe crab population at Lai Chi Wo is located out of the Assessment Area.

4A.2.4.3 Seagrass

Seagrass beds are generally associated with mangroves, which are considered as important habitats that provides food, shelters and nursery grounds for marine lives, such as horseshoe crabs. Five seagrass species can be found in Hong Kong [20] with the second largest seagrass bed (~2 ha) mainly consisting of seagrass species, Marine Eel Grass (*Zostera japonica)* located in Lai Chi Wo [21] which is out of the Assessment Area ***(Figure 4A.2.1)***.

4A.2.5 Subtidal Hard Bottom Assemblages

Coral communities are commonly regarded as the most ecologically important and valuable subtidal hard bottom assemblages. AFCD reported that there are over 80 species of stony corals recorded in Hong Kong waters. The general trend for coral communities in Hong Kong is the increasing abundance and diversity from west to east with the greatest diversity and abundance generally found in the eastern waters of Hong Kong.

The northeastern waters of Hong Kong, including the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ, are less influenced by the Pearl River Estuary and have predominantly oceanic characteristics which allow higher salinity, decrease in turbidity and therefore more light penetration. These factors provide favourable conditions for coral growth [22]. It was reported that Tung Ping Chau, Hoi Ha Wan, Port Island and Kat O had more extensive stony coral communities and the colonies were larger compared with those more isolated colonies in other water regions in Hong Kong. The dominant species in the northeastern waters are brain corals *Platygyra* spp. and honey comb corals *Favia* and *Favites* spp.. These species grow in massive or submassive forms [23].

Recent information on the subtidal hard bottom assemblages of the Assessment Area is available in various reports, literature and approved EIA reports. The findings are summarised in ***Table 4A.2.2***. Previous survey locations of subtidal hard bottom assemblages in the vicinity of the Project site are shown in ***Figure 4A.2.2***.

(14) Chiu HMC, Morton B (1999) The distribution of horseshoe crabs *(Tachypleus tridentatus* and *Carcinoscorpius rotundicauda)* in Hong Kong. Asian Marine Biology 16: 185–196

(15) Huang Q, Chiu HMC, Morton B (1999) Nursery Beaches for Horseshoe Crabs in Hong Kong. Porcupine! 18: 9-10.

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

(17) Shin PKS, Li HY, Cheung SG (2009) Horseshoe Crabs in Hong Kong: Current Population Status and Human Exploitation. Biology and Conservation of Horseshoe Crabs. Springer US. 347-360.

(18) Kwan BK, Hsieh HL, Cheung SG, Shin PK (2016) Present population and habitat status of potentially threatened Asian horseshoe crabs *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* in Hong Kong: a proposal for marine protected areas. *Biodiversity and Conservation*, *25*(4), 673-692.

(19) Shin PKS, Li HY, Cheung SG (2009): *Op. cit.*

(20) AFCD (2020) Seagrasses in Hong Kong. *Op. cit.*

(21) Fong TCW (1999) Conservation and management of Hong Kong seagrasses. Asian Marine Biology, 16. 109–121.

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

(23) AFCD (2005) *Op. cit.*

Table 4A.2.2 Baseline Information on Subtidal Hard Bottom Assemblages in the vicinity of the Project site

Source	Location	Summary of Findings
Mirs Bay WCZ		
AFCD (2021) [24]	Surveys sites in the vicinity of the Project site include Wong Chuk Kok Hoi, Tung Wan and Port Island	These sites are within the Assessment Area with relatively low coral coverage from the results of Reef Check 2021, with 10.4% in Wong Chuk Kok Hoi, 21.9% in Tung Wan and 19.3% in Port Island.
ERM (2018) [25]	Wong Chuk Kok Hoi	In the Wong Chuk Kok Hoi site, a total of 34 hard coral species and 1 octocoral species were recorded in 6 surveyed transects. Hard coral coverage with 11 – 30% were present in the shallow water along the northern shoreline of Wong Chuk Kok Hoi (~200 m from the Project site) while coral covers were less than 5% at deep water of the northern shore and at both shallow and deep water of the southern shore. Most corals recorded are common and widespread, including *Dipsastraea* sp., *Favites* sp., *Lithophyllon undulatum*, *Platygyra* sp., *Plesiastrea versipora* and *Porites* sp., apart from some uncommon corals*; Acropora valida, Montipora mollis, Galaxea astreata, Acanthastrea echinata, Cyphastrea chalcidicum, Favites flexuosa, Goniopora djiboutiensis and Psammocora haimiana*.
Goodkin et al. (2011) [26]	Survey sites were scattered at Mirs Bay, including Wong Chuk Kok Hoi and Port Island	There was no sampling site within the Project site but only near the northern coastline of Wong Chuk Kok Hoi and Wong Chuk Kok Tsui. Hard coral coverage ranged from 10-50% to >50% and locations of 'old corals' were spotted. The community type of the northeastern waters was dominated by *Platygyra* sp *and Favia* spp..
ERM (2003) [27]	Port Island (Chek Chau)	In Chek Chau, a total of 44 hard coral species and 2 species of black coral were recorded at -2 to -10 mCD. All species of hard corals and soft corals were commonly recorded on rocky coasts in the East of Hong Kong except *Montipora mollis* and *Turbinaria mesenterina*. Large *Antipathes* sp. and *Cirripathes* sp. was identified at middle depth zone.

(24) AFCD (2021) Hong Kong Reef Check 2021 Results Summary.
(25) ERM (2018) Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study (AFCD/FIS/01/14).
(26) 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.
(27) 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.

Source	Location	Summary of Findings
Tolo Harbour and Channel WCZ		
Goodkin et al. (2011) (28)	Survey sites were scattered mainly in outer Tolo Channel including Fung Wong Wat	The coral coverage near Fung Wong Wat was less than 10% and the community type of the northeastern waters was dominated by *Platygyra* sp. *and Favia* spp..
ERM (2003) (29)	Wong Chuk Kok Tsui, South Wong Chuk Kok Tsui	In South Wong Chuk Kok Tsui, a total of 66 species of benthic organisms, including 45 hard coral species, 2 species of soft corals and 2 species of black coral, Antipatharia were recorded in 9 transects at -3 to -9 mCD. Hard coral cover was between 11-30 % with small patches of higher coverage (~50 %). All species of hard corals and soft corals were commonly recorded on rocky coasts in the East of Hong Kong except *Montipora mollis* and *Goniopora djiboutiensis*. The middle depth zone was dominated by large *Antipathes* sp., a lower abundance of *Cirripathes* sp. was recorded. In Wong Chuk Kok Tsui, a total of 57 species of benthic organisms, including 41 hard coral species, 1 species of soft corals and 2 species of black corals were recorded in 6 transects at -2 to -10 mCD. Hard coral cover was between 11-30 %. All species of hard corals and soft corals were commonly recorded on rocky coasts in the East of Hong Kong except *Montipora mollis*. *Antipathes* sp. communities increased in abundance along the headland towards the mouth of Tolo Channel.

Based on the literature review, hard coral coverage of 11 – 30% are present in the shallow waters along the northern shoreline of Wong Chuk Kok Hoi (~200 m from the Project site). Coral coverage was less than 5% at deep water of the northern shore and at both shallow and deep water of the southern shore. Most corals recorded within Wong Chuk Kok Hoi are common and widespread, such as *Platygyra* sp. and *Favites* sp., except for some uncommon coral species. Shallow hard coral communities of high cover and species richness were recorded from South Wong Chuk Kok Tsui, Wong Chuk Kok Tsui and Port Island (Chek Chau), while low coverage and abundance of soft corals, antipatharians and gorgonians were recorded within the Tolo Harbour.

It is reasonable to expect that coral communities only occur in small patches within the Assessment Area. Large or important communities of hard corals, octocorals or black corals are not anticipated within and in the vicinity of the Project site.

4A.2.6 Subtidal Soft Bottom Assemblages

4A.2.6.1 Epifaunal Assemblages

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

(28) Goodkin NF, Switzer AD, McCorry D, DeVantier L, True JD, Hughen KA, Angeline N, Yang TT (2011) *Op cit.*

(29) ERM (2003) *Op cit*.

the majority of available information on the epifaunal assemblages are based on data from the North Western WCZ and Southern WCZ, literatures on grab sampling surveys were also reviewed.

In 2003, an EIA study has conducted benthic grab sampling at the northeastern Hong Kong waters, covering waters from Tai Po to outer Mirs Bay near Tung Ping Chau during both wet and dry seasons, with the nearest sampling stations to the Project site located at east of Wong Chuk Kok Tsui and in Tolo Harbour. A total of 45 species and 324 individuals of benthic organisms were recorded with the majority of specimen belonging to the Phyla Mollusca, Annelida or Echinodermata with no rare species found (30). Similarly within Tolo Harbour, a study was conducted to examine the effects of trawling ban on demersal crustacean resources through demersal trawling surveys (31). The nearest sampling sites were located at the Outer Tolo Channel and the results showed that two commercially important and dominant crustacean species (in terms of biomass), namely *Portunus pelagicus/ trituberculatus* (swimming crab) were recorded. Other species with high relative abundance in the sampling sites were *Metapenaeopsis* sp. (shrimp), *Miyakea nepa* (mantis shrimp) and *Penaeus latisulcatus* (prawn). Overall, findings from these surveys suggested that the epifaunal assemblages of the Assessment Area are dominated by common and widespread species.

Previous survey locations of subtidal soft bottom epifaunal assemblages in the vicinity of the Project site are shown in ***Figure 4A.2.3***.

4A.2.6.2 Infaunal Assemblages

Subtidal infauna are organisms (>0.5 mm in size) living either on or within the surface sediments of the seabed. In order to provide an indication of the potential ecological value of the infaunal assemblages of the Assessment Area in the context of seabed of Hong Kong waters, it is considered useful to review studies that have investigated infaunal assemblages in Hong Kong on a wide scale.

An AFCD commissioned study was published in 2002 on marine benthic communities in Hong Kong (32). The study has examined the benthic community at 120 stations within Hong Kong waters, including areas in the vicinity of the Project site. The results were considered to provide representative information of the assemblages within the Assessment Area and showed that an impoverished benthic community was recorded in the northeastern waters due to prevailing hydrographic conditions. Lower species diversity and evenness were also recorded in inner Mirs Bay. No species of conservation importance were recorded in the sampling stations within the Assessment Area.

A study published in 2017 by Hong Kong Baptist University has compared sediment grab samples collected during 2001 and 2012 in Hong Kong (33). Six sampling stations located in Tolo channel and western Mirs Bay were grouped for statistical analysis and the study reported that the biodiversity and biomass of microbenthic communities in this group was the lowest compared to all other tested groups. *Sigambra hanaokai*, a species of polychaete worm was the representative species of this group and the microbenthic communities in Tolo Channel and Inner Mirs Bay was shown to be impoverished. This finding aligns with the results from the marine benthic communities study conducted by CityU Professional Services Limited (34). No species of conservation importance were recorded in the sampling stations within the Assessment Area.

(30) ERM (2003) *Op cit*.
(31) Tao, S (2018) Effects of the trawling ban on demersal crustacean resources (orders: decapoda and stomatopoda) in the marine environment of Hong Kong. (Thesis). University of Hong Kong, Pokfulam, Hong Kong SAR.
(32) CityU Professional Services Limited (2002) Consultancy Study on Marine Benthic Communities in Hong Kong (Agreement No. CE 69/2000). Final Report submitted to AFCD.
(33) Wang Z, Leung K, Li X, Zhang T, Qiu J (2017) Macrobenthic communities in Hong Kong waters: Comparison between 2001 and 2012 and potential link to pollution control. Marine Pollution Bulletin, 124 (2), 694-700.
(34) CityU Professional Services Ltd. (2002). *Op. cit.*

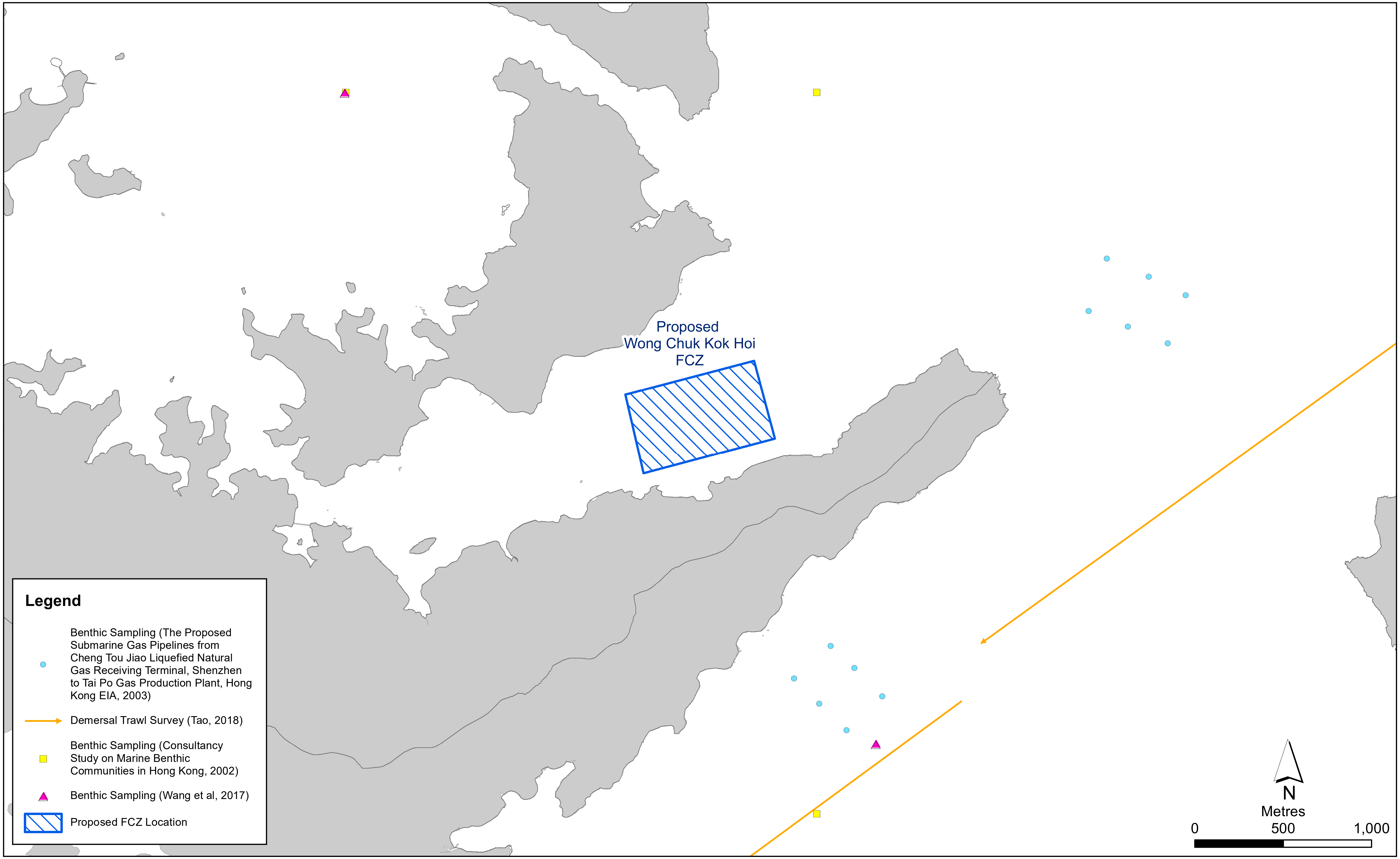

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Figure 4A.2.3

Location of Survey Sites of Previous Subtidal Soft Bottom Assemblages Studies in the Vicinity of the Proposed Wong Chuk Kok Hoi FCZ

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Among infaunal assemblages, amphioxus are considered to be of scientific interest as they are recognised as the closest living invertebrate to vertebrates. Suitable habitats for amphioxus are shallow, subtidal sand flats in tropical, subtropical and temperate waters, with coarse sand and shelly sediments [(35)]. Amphioxus have a wide geographic distribution but are considered rare animals as they present at scattered locations throughout their range and in high densities occassionally [(36)]. In Hong Kong waters, there are a total of five amphioxus species identified [(37)] and among them *B. belcheri* and *B. malayanum* are the two dominant species contributing to nearly 90% of the total number of specimens collected in the field.

Distribution studies revealed that amphioxus are present within Hong Kong's oceanic, eastern waters. Three *Branchiostoma* species have been recorded in Hong Kong in 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 [(38)]. This scientific study in 2007 specifically examined amphioxus in Hong Kong's eastern waters, however, the sampling sites were located out of the Assessment Area. Therefore, the abundance of amphioxus are further examined through baseline benthic grab surveys conducted for this Project.

Previous survey locations of subtidal soft bottom infaunal assemblages in the vicinity of the Project site are shown in ***Figure A2.3***.

4A.2.7 Marine Mammals

A total of 20 species of marine mammals (all cetaceans) have been recorded in Hong Kong waters (including one humpback whale sighted in 2009, one stranding of Omura's whale in 2014, one short-finned pilot whale stranded in 2015 and occasional sightings of passing false killer whale pods). Among these two of which are considered residents, including the Chinese White Dolphin (CWD) *Sousa chinensis* and the Finless Porpoise (FP) *Neophocaena phocaenoides* [(39)]. CWD are mainly distributed in western and southwestern waters of Hong Kong. As the Assessment Area is located in northeastern waters of Hong Kong within the habitats utilized by FP, the following context focusses on FP.

FP is a tropical/ sub-tropical cetacean widely distributed in coastal marine waters, as well as some river mouths and estuaries, from the Arabian/Persian Gulf eastwards around the rim of the Indian Ocean to the Taiwan Strait area in southern Japan. It is protected locally by the *Wild Animals Protection Ordinance (Cap. 170)*, and is listed as "Vulnerable" in the IUCN Red List of Threatened Species [(40)]. FP is also listed in CITES Appendix I (i.e. highest protection), and is listed as "Grade II National Key Protected Species" in China. As such FP is considered a species of conservation importance, both locally in Hong Kong and regionally in China and across the Asia Pacific.

Studies on the distribution, abundance, habitat use, life history and behaviour of FP in Hong Kong have been undertaken since 1998. It was estimated that there were at least 147 porpoises occurring in Chinese waters just south of Hong Kong, which makes the minimum population size estimate to be 217 animals [(41)].

(35) Chen Y, Cheung SG, Shin PKS (2013). A baseline study of benthic community associated with Amphioxus Sand in subtropical Hong Kong. Marine Pollution Bulletin. 72, 274–280.
(36) Chen Y et al. (2013) *Op. cit.*
(37) Chen Y (2007) The Ecology and Biology of Amphioxus in Hong Kong. PhD. Thesis. The City University of Hong Kong.
(38) Chen Y (2007) *Op. cit.*
(39) Jefferson TA, Hung SK (2007) An updated, annotated checklist of the marine mammals of Hong Kong. Mammalia 2007: 105–114
(40) Wang JY, Reeves R (2017) *Neophocaena phocaenoides*. The IUCN Red List of Threatened Species 2017: e.T198920A50386795.
(41) AFCD (2021) Finless Porpoise. Distribution and Abundance.

In Hong Kong, FPs occur year-round, and they can be found primarily in the southern (i.e. Po Toi, Lamma, Southeast and Southwest Lantau) and eastern (i.e. Sai Kung and Ninepins) waters of the territory [42] [43] [44] (***Figure 4A.2.4)***. The majority of porpoise sightings have been made to the south of Soko Islands and Cheung Chau, around Shek Kwu Chau, and between the waters of Soko Islands and Shek Kwu Chau. These areas are thus considered to be the main habitats for FP.

Seasonal variation in distribution is evident for FPs in Hong Kong. FPs move into the waters of south Lantau and Lamma in winter (from December to February), and peak abundance was recorded in spring (from March to May) when significant numbers occurred in southern waters. During summer (from June to August), FP generally vacated the waters of south Lantau and Lamma and moved to Po Toi, Ninepins and Sai Kung, and abundance appears to reach a low point in autumn (from September to November). Their abundance in Hong Kong waters ranges from approximately 152 individuals in spring to approximately 55 in autumn [45] and their abundance at northeastern waters near the Project site is considered to be minimal.

AFCD boat line-transect surveys do not cover the northeastern waters of Hong Kong due to its relatively lower accessibility by boat compared to other survey locations; therefore such data of FP is not available for waters near the Project site. Helicopter surveys were conducted to survey remote areas (e.g. Sai Kung, Mirs Bay). Several sightings were recorded in the eastern waters of Hong Kong, including the Sai Kung, Po Toi and Ninepins survey areas during 2018-2021 [46] (***Figure 4A.2.4)***. These areas of sightings are considered to be far away from the Project site and the Project site is not a key habitat for Finless Porpoises.

Overall, the encounter rate and seasonal distribution of FP 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.

4A.2.8 White-bellied Sea Eagles

White-bellied Sea Eagles (WBSE) *Haliaeetus leucogaster*, is one of the species of conservation importance in Hong Kong due to its protection status (PRC Class II protected and CITES Appendix II species). The species were restricted to nearshore coastal waters and belong to surface-feeding species [47]. Their foraging distance could reach as far as 2 km from nesting locations with the peak foraging period occurring between 5 pm and 7 pm [48].

Since 2002, AFCD has been conducting surveys on the species. There are 25 recorded nesting sites around Hong Kong covering Lung Kwu Chau in the west to Tsim Chau and Tsang Pang Kok in the east. WBSE was recorded nesting within the Assessment Area ***(Figure 4A.2.1)***. Nesting ground have been spotted on Crooked Island and Port Island. The nesting grounds are located more than 3 km from the Project site. Breeding behaviour of WBSE was recorded in 7-9 years in these 2 nesting grounds from 2002 to 2020. Compared with the rest of the nesting sites found in Hong Kong by the AFCD survey, the usage of these two nesting sites as breeding ground is moderate, the majority of

(42) Jefferson TA, Braulik G T (1999) Preliminary report on the ecology of the finless porpoise in Hong Kong waters. IBI Reports 9: 41-54
(43) Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. Raffles Bulletin of Zoology 10: 43-55.
(44) AFCD (2022) Monitoring of Marine Mammals in Hong Kong Waters (2021-2022).
(45) AFCD (2022) Finless Porpoise. Distribution and Abundance. *Op. cit.*
(46) AFCD (2022) Finless Porpoise. Distribution and Abundance. *Op. cit.*
(47) ERM (2010) EIA Report for the Development of a 100MW Offshore Wind Farm in Hong Kong (AEIAR-152/2010)
(48) Tsim ST, Lee WH, Cheung, CS, Chow K, Ma YN, Liu KY (2003) The Population and Breeding Ecology of white-bellied Sea-eagles in Hong Kong. Hong Kong Biodiversity, AFCD Newsletter: Issue 5.

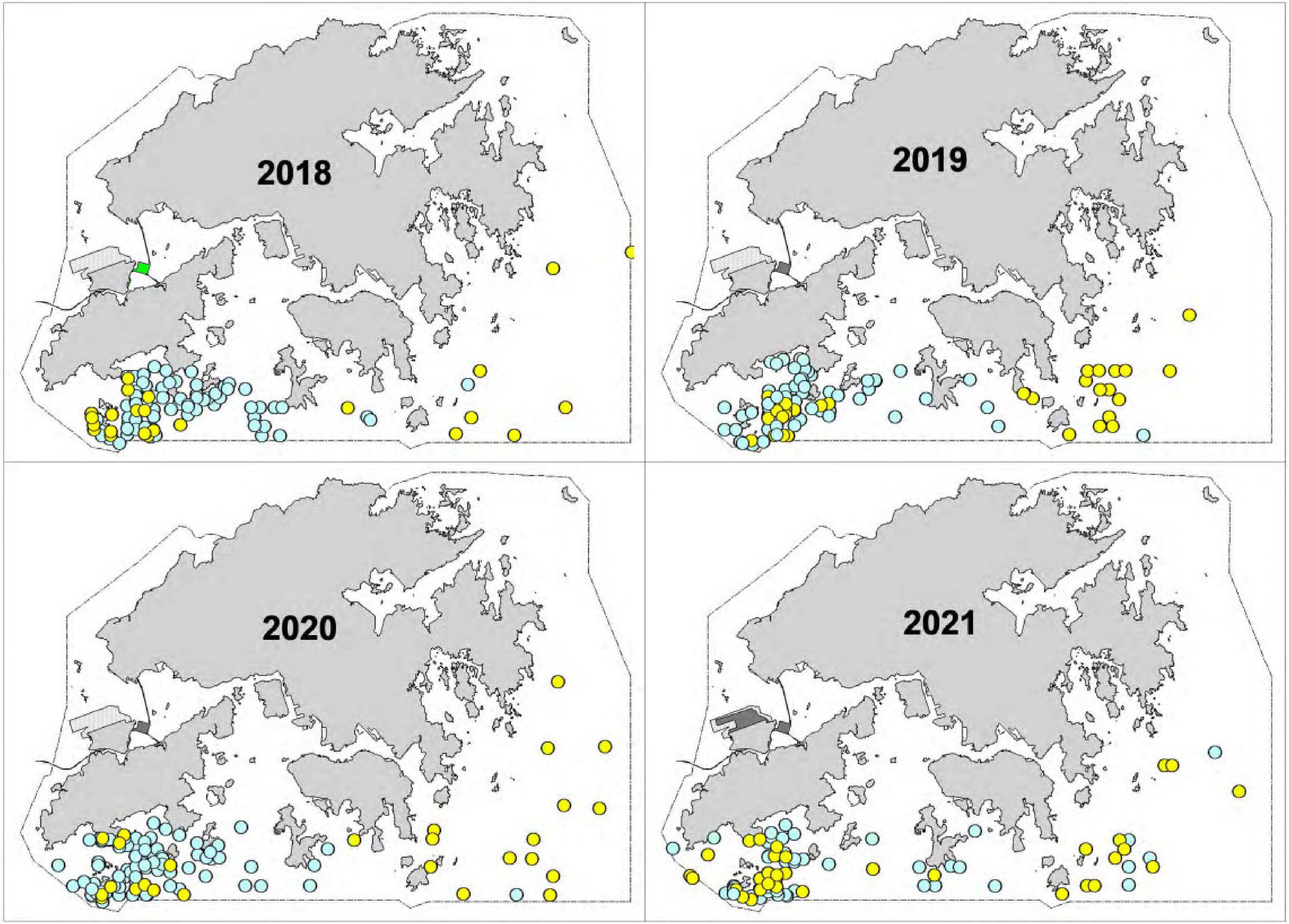

FIGURE 4A.2.4

Comparison of Annual Porpoise Distribution Patterns from 2018-2021 (Blue dots: sightings made during winter/spring months; yellow dots: sightings made during summer/autumn months) (Ref: AFCD (2022) Monitoring of Marine Mammals in Hong Kong Waters (2021-2022). Prepared by Hong Kong Cetacean Research Project.)

nesting sites with more than 10 years of recorded breeding behaviour are located at Sai Kung east like Tsim Chau and in Port Shelter [(49)].

Overall, it is considered that the data from the long-term survey conducted by AFCD are comprehensive and adequate for this Project. No further baseline survey for WBSE would be necessary. As both nesting sites are more than 3 km away from the Project site, the nesting sites of WBSE within the Assessment Area are considered to be too far to be affected by the Project.

(49) 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.

APPENDIX 4B APPROVED METHOD STATEMENT ON MARINE ECOLOGICAL IMPACT ASSESSMENT FOR WONG CHUK KOK HOI FCZ

Contract Ref.: AFCD/FIS/02/2019 Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

漁農自然護理署
Agriculture, Fisheries and Conservation Department

Method Statement on Marine Ecological Survey for Wong Chuk Kok Hoi Fish Culture Zone

8 October 2020

Project No.: 0549925

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8 October 2020

Contract Ref.: AFCD/FIS/02/2019 Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

Method Statement on Marine Ecological Survey for Wong Chuk Kok Hoi Fish Culture Zone

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Annex B-A

1. INTRODUCTION

1.1 Background

To pave the way for facilitating the sustainable development of the local mariculture sector, the Agriculture, Fisheries and Conservation Department (AFCD) proposed to lift the moratorium by designating new fish culture zones (FCZs) to create room for the mariculture sector to grow further, including allowing capture fishermen to switch to this sustainable mode of operation, and attracting new entrants. In 2014, the AFCD commissioned a consultancy study [1] to explore suitable sites as new FCZs and Wong Chuk Kok Hoi FCZ is one of the four Shortlisted Sites.

The designation of a FCZ of more than 5 hectares in size is classified as a designated project under Item M.1, Part I of Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499), and a statutory EIA is required before designation. In accordance with the EIAO, a Project Profile for application for an Environmental Impact Assessment (EIA) Study Brief has been prepared and submitted to Environmental Protection Department (EPD) on 15 October 2019. The EIA Study Brief (ESB-324/2019) (hereafter referred to as “the Study Brief”) was issued by EPD on 27 November 2019.

AFCD has commissioned ERM to undertake the “*Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones*” (“the Study”). In accordance with *Clause 3.4.4* of the EIA Study Brief, a marine ecological impact assessment shall be conducted to evaluate and assess potential impacts on marine ecology for the construction and operation of the Wong Chuk Kok Hoi FCZ (“the Project”).

1.2 Objectives and Scope of This Method Statement

Baseline information within the Assessment Area for the marine ecological impact assessment for the proposed FCZ at Wong Chuk Kok Hoi, i.e. the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ, in accordance with *Clause 3.4.4.2* of the EIA Study Brief (ESB-324/2019), is available from the following key sources:

- Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study (AFCD/FIS/01/14);
- Provision of Services on Desktop Review for Potential New Fish Culture Zones (AFCD/SQ/243/18/C);
- EIA Report for The Proposed Submarine Gas Pipeline From Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal (EIA-089/2003);
- EIA Report for the Development of a 100MW Offshore Wind Farm in Hong Kong (AEIAR-152/2010);
- EIA Report for Hong Kong Offshore Wind Farm in Southeastern Waters (EIA-167/2009);
- Hong Kong Reef Check 2019;
- AFCD Final Report on Monitoring of Marine Mammals in Hong Kong Waters (2018-2019); and
- Available Published Scientific Literature.

The *Feasibility Study* [2] included baseline coral survey at Wong Chuk Kok Hoi undertaken in 2016 and presents the up-to-date and representative information regarding coral communities in the vicinity of

(1) ERM (2018) Consultancy Ref. AFCD/FIS/01/14 Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study.

(2) ERM (2018) Consultancy Ref. AFCD/FIS/01/14 *Op. Cit.*

the proposed FCZ site. The survey results of the *Feasibility Study* are included as ***Annex B-A*** and this shall be reviewed for the EIA study. The above data sources also provide up-to-date baseline information on important ecological habitats or habitats with conservation interest such as existing marine parks and Sites of Special Scientific Interest, corals, mangroves, finless porpoise habitats etc. of the Assessment Area. Baseline survey of these habitats is not considered necessary.

There are identified data gaps with regards to the status of the subtidal habitat within the proposed FCZ site and along the coastline of the Plover Cove Country Park and the Tolo Channel (Northern Coast) Site of Special Scientific Interest (SSSI) in the vicinity of the Project, with no recent baseline information available. Therefore, baseline surveys at selected habitats within the Assessment Area where potential impact could occur and up-to-date baseline information is not present are proposed to be conducted, in order to update the latest ecological conditions in these areas.

In accordance with the requirements in *Appendix C* of the Study Brief, marine ecological surveys shall be conducted for a duration of at least 6 months to fill in the identified data gaps as well as verify and update the desktop information on existing conditions of the Assessment Area [(3)] [(4)] (***Figure B1.1***). The Assessment Area for Marine Ecological Impact Assessment 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. Considering the sensitive receivers in the vicinity of the Project as well as the potential impacts of the Project, the Assessment Area will cover a distance of about 7 km from the Project Site.

Subsequently, the information collected from desktop review and ecological surveys will be used to establish the general ecological profile and characterise the identified habitats within the Assessment Area. The proposed ecological surveys comprise:

- Coral survey; and
- Subtidal benthos survey.

This *Method Statement* presents the methodology of the aforementioned marine ecological surveys. Reference has been made to the guidelines of for evaluating and assessing marine ecological impact as outlined in Annexes 8 and 16 of the EIAO-TM, the relevant Guidance Notes (GN 7/2010, GN 10/2010 and GN 11/2010), and approved EIA reports on the EIA Register.

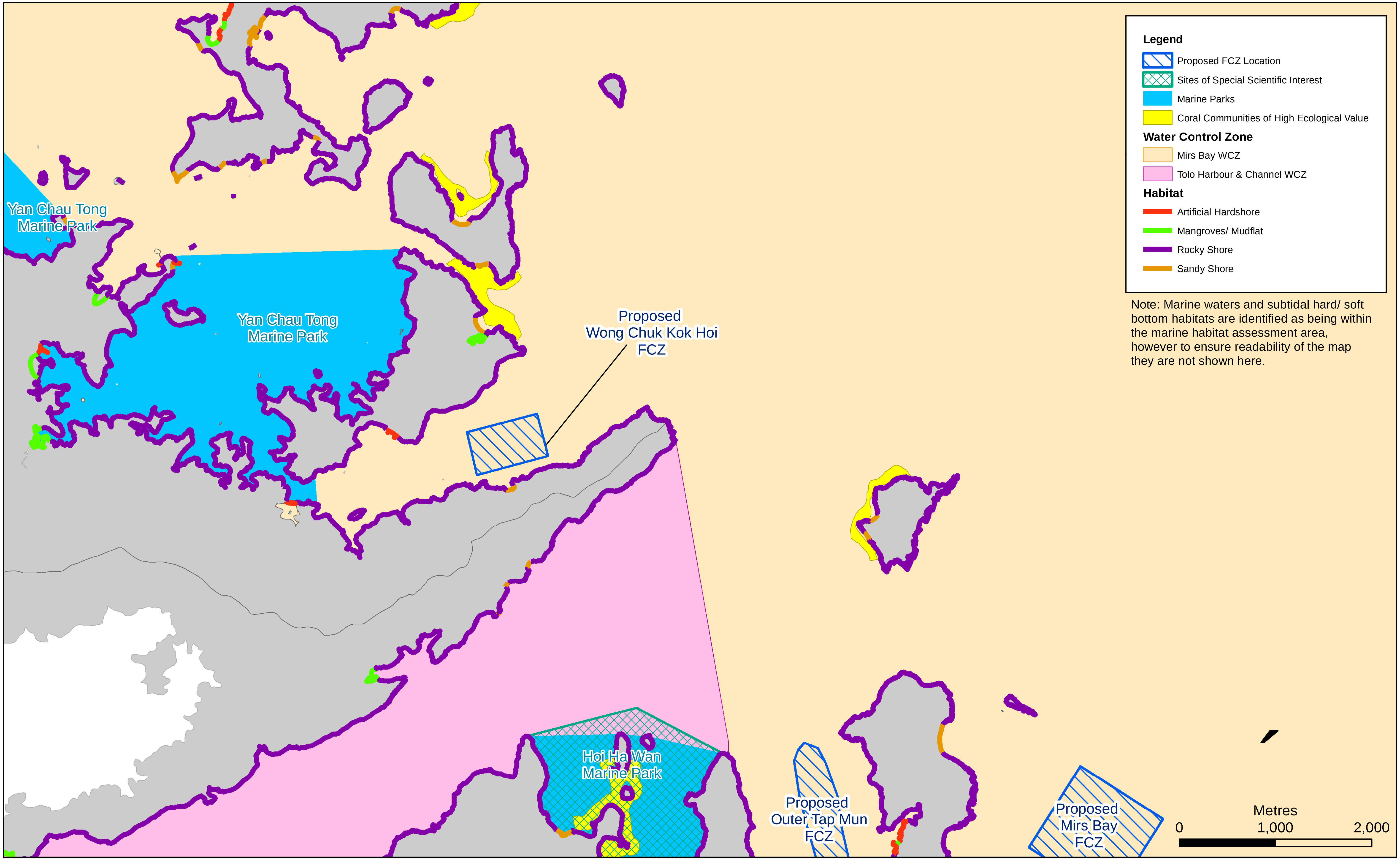
1.3 Structure of This Method Statement

Following this introductory section, the remainder of this *Method Statement* is presented as follows:

- Section 2 presents the methodologies for the marine ecological surveys, including coral survey and subtidal benthos survey.

(3) Chan, A.L.K, Choi, C.L.S., McCorry, D., Chan, K.K., Lee, M.W. and Ang, P. (2005) Field Guide to Hard Corals of Hong Kong. 1st edition (Eds. Chan, W.C. and Stokes, E.). Friends of the Country Parks and Cosmos Books Ltd, Hong Kong. 373 pp.

(4) Google Earth (2020). Available at: https://www.google.com/earth/ [accessed on 25-08-2020]



ERM

Figure B1.1

Assessment Area and Marine Habitat Identified for the Proposed Wong Chuk Kok Hoi FCZ

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Date: 29/7/2022

2. MARINE ECOLOGICAL SURVEY

2.1 Coral Survey

Coral and benthic surveys, as described below, will be conducted to identify and characterize the existing ecological conditions of the seabed and shoreline within and in the vicinity of the proposed FCZ site. Coral survey locations are proposed in areas which have not been surveyed previously during the *Feasibility Study*, in order to fill in information gaps. The subtidal coral surveys, which will be conducted once in the wet/ dry season, will comprise of the following three components:

- Qualitative spot dive reconnaissance check;
- Semi-quantitative Rapid Ecological Assessment (REA) survey; and
- Drop Camera Survey

2.1.1 Qualitative Spot-dive Reconnaissance Check

The qualitative spot dive reconnaissance check will investigate if coral communities (e.g. hard corals, soft corals, sea pen and black corals) are present at the areas along the natural shores in the vicinity of the proposed FCZ site (***Figure B2.1***).

At each survey location, a spot dive reconnaissance check will be conducted along a 100 m transect by coral specialists using SCUBA to identify the substrate type and associated sessile benthos, particularly the presence of hard and soft coral communities. The dive surveys will generally follow the bathymetry of the survey transect and will be separated into shallow water (< -5 mCD) and deep water (> -5 mCD) (to be adjusted based on the site condition and substrates). The characteristics of seabed and associated fauna along the survey transect will be recorded by photographs and videos to characterise the biological nature of the subtidal area along the survey transect. All organisms and coral colonies encountered will be identified to the lowest possible taxonomic level. This technique is regarded as standard practice for EIA marine baseline surveys in Hong Kong, with many previously approved EIA's utilising the same or similar methodology [(5) (6) (7) (8) (9) (10)].

2.1.2 Semi-quantitative Rapid Ecological Assessment (REA) Survey

When corals are recorded during the qualitative spot-dive reconnaissance check, semi-quantitative survey, Rapid Ecological Assessment (REA), will then be undertaken with reference to the EIAO Guidance Notes (*GN 11/2010*) to provide information on the relative coverage of coral and other benthic groups, in addition to creating an inventory of sessile benthic taxa used to define the community types. This technique is regarded as standard practice for EIA marine baseline surveys in

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(5) ERM (2016) Hong Kong Offshore LNG Terminal. EIA Study (AEIAR-218/2018). Prepared for CLP Power Hong Kong Limited.

(6) ERM (2015) Additional Gas-fired Generation Units Project. EIA Study (AEIAR-197/2016). Prepared for Castle Peak Power Company Limited (CAPCO).

(7) ERM (2010) Development of a 100MW Offshore Wind Farm in Hong Kong. EIA Study (AEIAR-152/2010). Prepared for Hong Kong Electric.

(8) 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.

(9) AECOM (2016) Sha Tin Cavern Sewerage Treatment Works. EIA Study (AEIAR-202/2016). Prepared for the Drainage Services Department.

(10) Black & Veatch Hong Kong Limited (2016) Outlying Islands Sewerage Stage 2 – South Lantau Sewerage Works. EIA Study (AEIAR-210/2017). Prepared for Drainage Services Department.

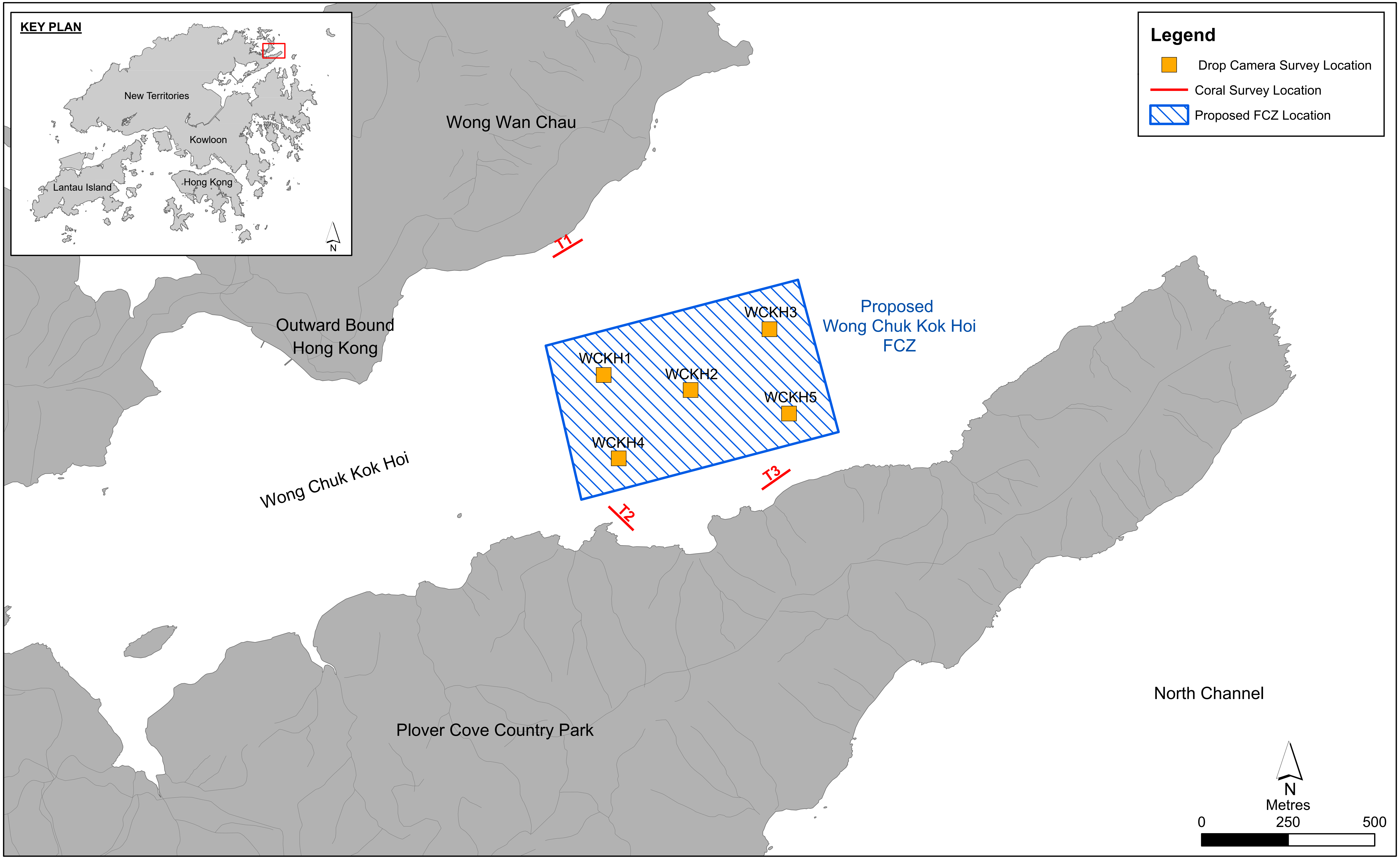


Figure B2.1

Proposed Coral Survey Locations at Wong Chuk Kok Hoi

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_Coral_Survey_Wong_Chuk_Kok_Hoi.mxd
Date: 16/9/2020

Hong Kong, with many previously approved EIA's utilising the same or similar methodology (11) (12) (13) (14) (15) (16). The methodology outlined has been modified from the standardised REA survey technique established for the assessment of coral communities on the Great Barrier Reef (17) for the marine environment of Hong Kong (18).

Based upon the information gathered in the qualitative spot-dive reconnaissance check, such areas where coral appear to be the most abundant, or in close proximity to the proposed FCZ, the REA survey will then be performed along a 100 m transect. REA surveys are proposed to be conducted at shallow and deep water (< -5 mCD and > -5 mCD zones dependant on the bathymetry of the site; to be adjusted based on the site condition and substrates) along the shoreline to search for hard coral, octocoral and black coral. After the transect line has been laid, video footage will be taken for the benthos along the transect and the assessment of the benthic cover (Tier I) and taxon abundance (Tier II) will be conducted in a swathe ~ 2 m wide, 1 m either side of each transect. The belt transect width is dependent on underwater visibility experienced, with regards to the marine environment in Hong Kong this generally consists of a swathe ~2 m wide, 1 m either side of the each transect. An explanation of the two assessment categories (Tiers) used in the survey is presented below.

Tier I - Categorisation of Benthic Cover

Upon the completion of each survey transect, ecological and substratum attributes (***Table B2.1***) will be assigned to standard ranked (ordinal) categories (***Table B2.2***).

Table B2.1 Tier I Benthic Attribute Categories

Ecological Attributes	Substratum Attributes
Hard coral	Bedrock
Dead coral	Continuous pavement
Octocoral (Soft corals and Gorgonians)	Rocks (<26 cm)
Black coral	Large boulders (>50 cm)
Dead standing coral	Small boulders (<50 cm)
Macroalgae	Rubble
Other Benthos (including sponges, zoanthids, ascidians and bryozoans)	Sand
	Mud/ Silt
	Other

(11) ERM (2016) (AEIAR-218/2018). *Op. Cit.*

(12) ERM (2015) (AEIAR-197/2016). *Op. Cit.*

(13) ERM (2010) (AEIAR-152/2010). *Op. Cit.*

(14) ERM (2003) (EIA-089/2003). *Op. Cit.*

(15) AECOM (2016) (AEIAR-202/2016). *Op. Cit.*

(16) Black & Veatch Hong Kong Limited (2016) (AEIAR-210/2017). *Op. Cit.*

(17) DeVantier LM, De'Ath G, Done TJ, Turak E (1998) Ecological assessment of a complex natural system: A case study from the Great Barrier Reef. *Ecological Applications* 8: 480-496.

(18) Fabricius KE, McCorry D (2006) Changes in octcoral communities and benthic cover along a water quality gradient in reefs of Hong Kong. *Marine Pollution Bulletin* 52: 22-33.

Table B2.2 Tier I Ordinal Ranks of Percentage Cover of Benthic Attributes

Rank	Percentage Cover (%)
0	None recorded
1	1-5
2	6-10
3	11-30
4	31-50
5	51-75
6	76-100

Tier II - Taxonomic Inventories to Define Types of Benthic Communities

An inventory of benthic taxa will be compiled for each transect. Taxa will be identified *in situ* to the following levels:

- Scleractinian (hard) corals to species, where possible;
- Soft corals, anemones and conspicuous macroalgae to genus level where possible;
- Other benthos (including sponges, zoanthids, ascidians and bryozoans) recorded to genus level, where possible, or phylum plus growth form.

Following the completion of the survey of each transect, each taxon in the inventory will be ranked in terms of abundance in the community (***Table B2.3***). These broad categories rank taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are visual assessments of abundance, rather than quantitative counts of each taxon. Representative photos of organisms will be taken.

Table B2.3 Ordinal Ranks of Taxon Abundance

Rank	Abundance
0	Absent
1	Sparse
2	Uncommon
3	Common
4	Abundant
5	Dominant

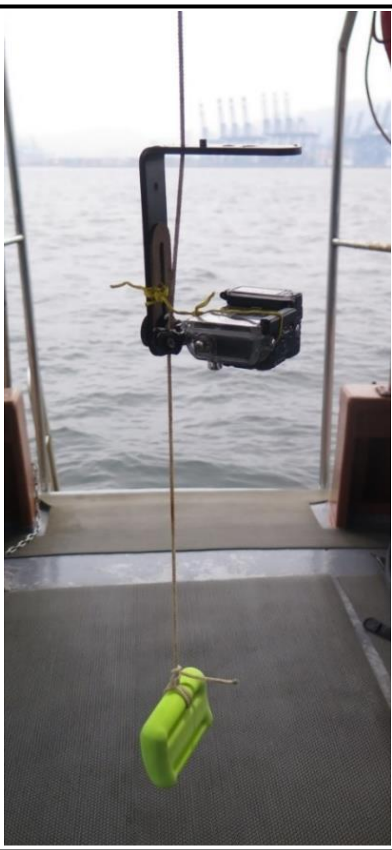
The photographs and videos recorded for each REA transect will be reviewed in order to compile the REA data. Species lists, species richness and the relative coverage for ecological and substratum attributes will be presented.

2.1.3 Drop Camera Survey

In order to characterise the substrate and benthic communities of the seabed within the proposed FCZ site, taking safety into consideration, the use of handheld drop cameras system will be utilised and deployed on vessel, mitigating the need of any person working underwater. This technique has been used for marine baseline surveys in Hong Kong and overseas, with previously approved EIA and projects utilising the same or similar methodology [19] [20] [21]. The drop camera system will consist of a high quality digital video camera (e.g. GoPro HERO3+ or equivalent) mounted on a tripod that could be lowered onto the seabed and towed above it to collect video footages and photographs (***Figure B2.2)***. These techniques allowed greater survey coverage in a relatively short period of time compared to the SCUBA surveys, especially for areas which are exposed and offshore.

The survey locations are presented in ***Figure B2.1***. During the survey, the drop camera system will be deployed from a support vessel at each survey location. Once the drop camera system reaches the bottom and maintain close to the seabed (~1m) or as far as practicable, the operator will allow the system to drift with the current, or alternatively move the system slowly and steadily over the substrate. Video footage and imagery of the seabed will be taken continuously throughout this deployment of at least two (2) minutes, with ~4m^2 of seabed recorded per second under wide angle camera setting (i.e. ~480m^2 for 2 minutes) if the camera is placed ~1m above seabed, to characterise the seabed substrate and benthic communities. Following retrieval, the footage and photographs will be examined ex-situ and verify the presence / absence of corals or other habitats / organism of interest (e.g. seagrass, soft mud with epifauna etc.).

Figure B2.2 Representative Photo of the Drop Camera System Set Up



(19) ERM (2010) (AEIAR-152/2010). *Op. Cit.*

(20) ERM-Hong Kong and ERM-Malaysia (2009) Marine Survey for Coral Habitats: Photo Quadrat Assessment (PQA) of Mampak, For Confidential Client.

(21) ERM-Hong Kong and ERM-Malaysia (2008) Coral Habitat Verification and Assessment Study for Block A-1 and Block A-3 Gas Development, Myanmar. For Confidential Client.

2.2 Subtidal Benthos Survey

Subtidal soft bottom surveys will be conducted as described below to characterize the existing ecological conditions of the seabed within the proposed FCZ site. Sampling locations, equipment involved, sampling procedure, laboratory analytical procedures, and QA/QC requirements for the proposed surveys are detailed below, with the methods similar to that of previously approved EIAs in Hong Kong (22) (23) (24) (25) (26) (27).

2.2.1 Benthic Grab Survey

Benthic sediment samples will be collected within the proposed FCZ site for biological analyses (i.e. taxonomic identification and abundance of subtidal benthos) with particular attention on the presence of amphioxus or any notable marine benthos. Seabed sediment samples will be collected from five (5) sampling locations representative of the subtidal soft-bottom habitats (***Figure B2.3***). Amphioxus habitat has not been identified at or in vicinity of the proposed FCZ site from the literature, and as reported in the literature, amphioxus are mostly found in shallow, subtidal sand flats (28). Consequently the muddy soft bottom of the proposed FCZ site may not be suitable habitats for amphioxus and the sampling locations are proposed within the FCZ site to confirm this. At each location, one grab sample will be collected from the seabed. The number of sampling locations is considered sufficient given the scale of the Project and the relatively homogenous nature of sediments at the proposed FCZ site. Sampling will be conducted twice, once in the wet season and once in the dry season.

The benthic grab surveys will be conducted utilizing a modified Van Veen grab sampler (960 cm^2 sampling area; 11,000 cm^3 capacity) with a supporting frame attached to a swiveling hydraulic winch cable. Sediments for biological analysis will be sieved on board the survey vessel. The sediments will be washed into a sieve stack (comprising 1 mm^2 and 500 μm^2 meshes) and gently rinsed with seawater to remove all fine material. Following rinsing, any material remaining on the two screens will be combined and carefully rinsed using a minimal volume of seawater into pre-labelled thick triple-bagged ziplock plastic bags. A 5% solution of borax-buffered formalin containing Rose Bengal in seawater will then be added to the bag to ensure tissue preservation. Samples will be sealed in plastic containers for transfer to the taxonomy laboratory for sorting and identification.

2.2.2 Parameters Measured

The parameters to be measured for subtidal benthos analysis are:

- Total number of species (diversity)
- Abundance of each species recorded (biomass)

In addition to the above parameters, other relevant data will also be measured and recorded, inclusive but not limited to; time, weather conditions, sea conditions, special phenomena (if any), and other activities undertaken around the sampling location that may influence the sampling results.

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(22) ERM (2016) (AEIAR-218/2018). *Op. Cit.*
(23) ERM (2015) (AEIAR-197/2016). *Op. Cit.*
(24) ERM (2010) (AEIAR-152/2010). *Op. Cit.*
(25) ERM (2003) (EIA-089/2003). *Op. Cit.*
(26) Cinotech Consultants LTD (2013). (AEIAR-206/2017). *Op. Cit.*
(27) Black & Veatch Hong Kong Limited (2016). (AEIAR-210/2017). *Op. Cit.*
(28) Chen Y, Cheung SG, Shin PKS (2013). A baseline study of benthic community associated with Amphioxus Sand in subtropical Hong Kong. Marine Pollution Bulletin. 72, 274–280.

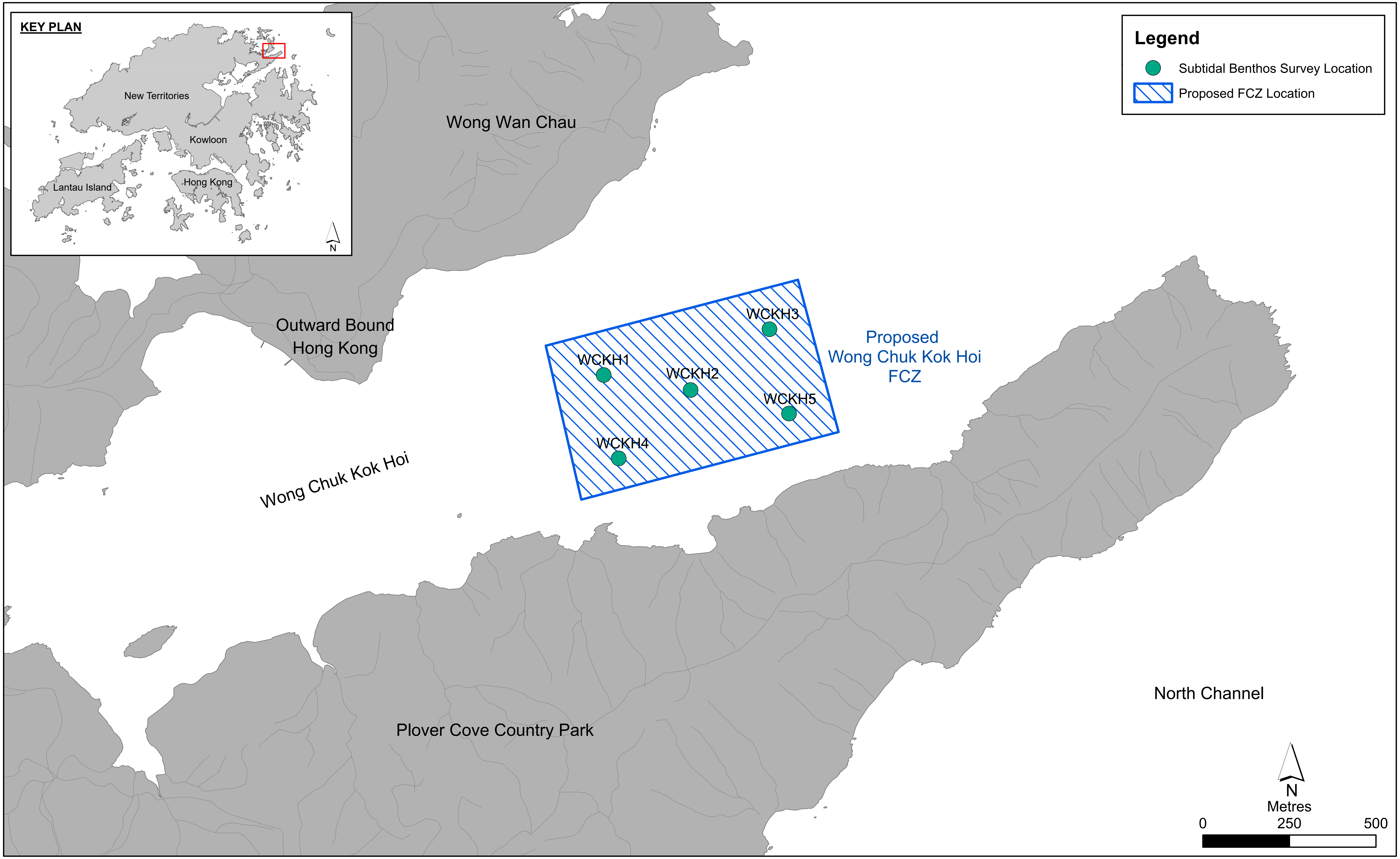

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Figure B2.3

Proposed Subtidal Benthos Survey Locations at Wong Chuk Kok Hoi

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Date: 21/7/2020

2.2.3 Laboratory Analyses

The benthic laboratory will perform sample re-screening after the samples have been held in formalin for a minimum 24 hours to ensure adequate fixation of the organisms. Individual samples from the 500 μm^2 and 1 mm^2 mesh sieves will be gently rinsed with fresh water into a 250 μm^2 sieve to remove the formalin from the sediments. Sieves will be partially filled while rinsing a specific sample to maximize washing efficiency and prevent loss of material. All material retained on the sieve will be placed in a labeled plastic jar, covered with 70% ethanol, and lightly agitated to ensure complete mixing of the alcohol with sediments. Original labels will be retained with the re-screened sample material.

Standard and accepted techniques will be used for sorting organisms from the sediments. Small fractions of a sample will be placed in a petri dish under a 10-power magnification dissecting microscope and scanned systematically with all animals and fragments removed using forceps. Each petri dish will be sorted at least twice to ensure removal of all animals. Organisms representing major taxonomic groups, such as Polychaeta, Arthropoda, Mollusca and miscellaneous taxa will be sorted into separate, labeled vials containing 70% ethanol.

Taxonomic identifications will be performed by qualified and experienced specialist using stereo dissecting and high-power compound microscopes. These are generally to the species level except for unidentified taxa, which will be identified to genera as far as practical. The careful sampling procedure employed minimizes fragmentation of organisms. If breakage of soft-bodied organisms occurred, only anterior portions of fragments will be counted, although all fragments will be retained and weighed for biomass determinations (wet weight).

2.2.4 Quality Assurance & Control (QA/QC) Procedures

The sediment samples will be evaluated for acceptance based upon the degree of disturbance, penetration depth, and amount of leakage from the grab. In the following cases, a sediment sample would be rejected and another sample collected:

- The sediment sampler doors open in recovery, causing possible surface washout.
- Half sample obtained where the sediment sampler had not struck a flat area of seabed, or improper deployment of benthic grab, or half sample of sediment.
- Disruption of the sample by heavy shaking or contamination (these can occur when a sample is badly handled or if the sediment sampler strikes the side of the vessel during operations).
- The sample represents less than 30% of the sediment sampler's total capacity (i.e. less than 15 cm penetration).
- Grab deployment location deviates from the designated position [(29)].

Before sieving each sample on site, the grab, frame and sample containers will be washed with seawater to avoid cross contamination of samples.

Sample integrity for subtidal benthos analyses should be maintained for the duration of the survey, demobilization through to delivery to the appropriate laboratory. All samples should be accompanied with a Chain of Custody form to document sample management and delivery.

2.3 Proposed Survey Schedule

The proposed survey schedule for marine ecological surveys to be conducted for the Project as outlined in *Sections 2.1* to *2.2*, is presented in ***Table B2.4***.

(29) Concerns about positional errors must be weighed against the aims of the survey. Horizontal accuracies to within a few metres are acceptable distance.

Table B2.4 Tentative Survey Schedule for Marine Ecological Surveys

		Wet Season		Dry Season			
Survey	**Method**	**Sep 20**	**Oct 20**	**Nov 20**	**Dec 20**	**Jan 21**	**Feb 21**
Coral Survey	Qualitative Spot-dive Reconnaissance Check			✓			
	REA			✓			
	Drop Camera Survey				✓		
Subtidal Benthos Survey	Benthic Grab Survey	✓	✓			✓	✓

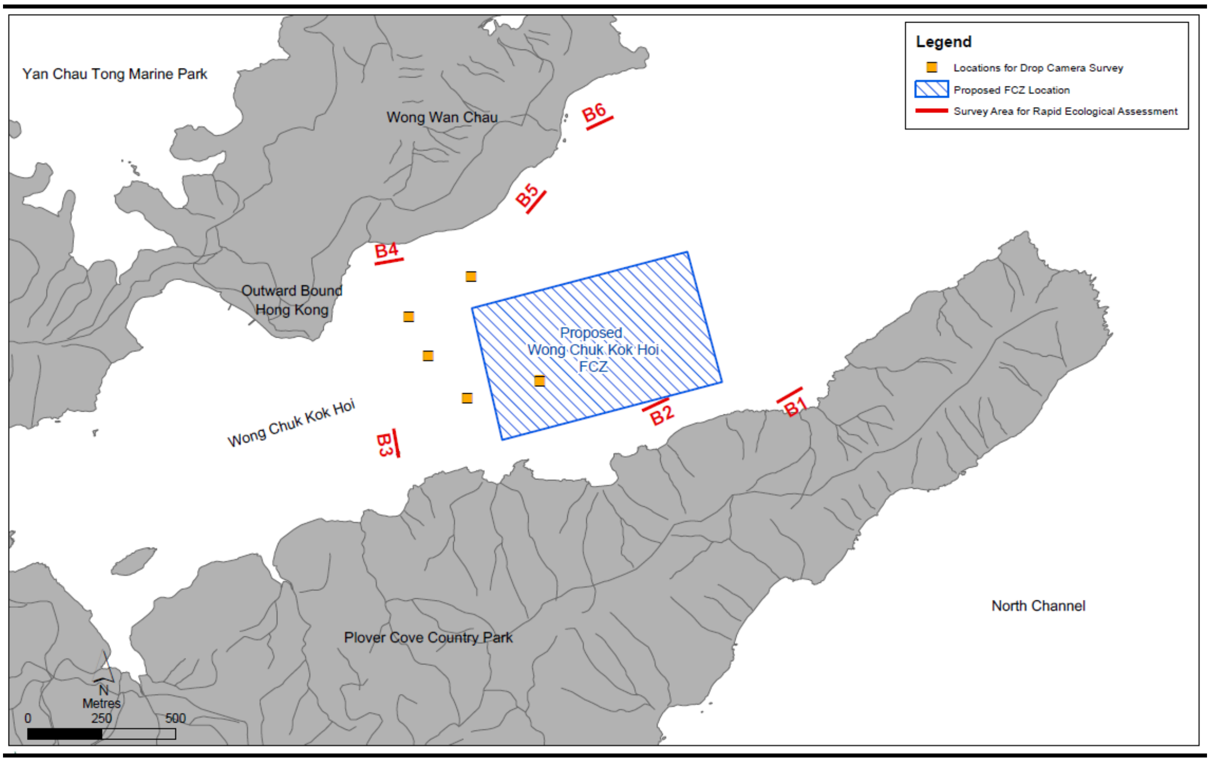
Annex B-A

Wong Chuk Kok Hoi Baseline Coral Survey Results from the *Feasibility Study*

1. MARINE ECOLOGICAL SURVEY

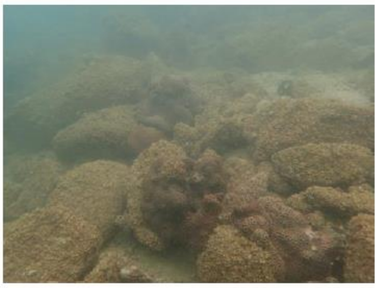
The *Feasibility Study* under *AFCD/FIS/01/14* conducted REA dive and drop camera surveys (***Figure B-A1.1***) which revealed that coral communities were sparse with low coverage (<5%), except from shallow areas in the northwest and northeast corners of proposed Wong Chuk Kok Hoi FCZ which the hard coral coverage was 11 – 30%. A total of 34 hard coral species and one octocoral species were identified in Wong Chuk Kok Hoi during these surveys. The species identified during the survey were generally regarded as common and widespread species in Hong Kong waters, apart from some uncommon corals; *Acropora valida, Montipora mollis, Galaxea astreata, Acanthastrea echinata, Cyphastrea chalcidicum, Favites flexuosa, Goniopora djiboutiensis* and *Psammocora haimiana* (1). Out of the six (6) transects conducted at Wong Chuk Kok Hoi, three (3) of the transects were dominated by large (i.e. diameter >50 cm) and small colonies (i.e. diameter <50 cm) of *Porites* sp. in both shallow and deep waters. One (1) transect recorded a few octocoral colonies of *Echinomuricea* sp. (<10 cm in height). Representative photos of the seabed and coral conditions during the surveys are presented in ***Figure B-A1.2***. Results of drop camera survey also showed that the seabed of this site (~15 mCD) was dominated by silty mud without any hard substrate or benthic organism (***Figure B-A1.3***).

Figure B-A1.1 Locations for Baseline Coral Survey at Wong Chuk Kok Hoi

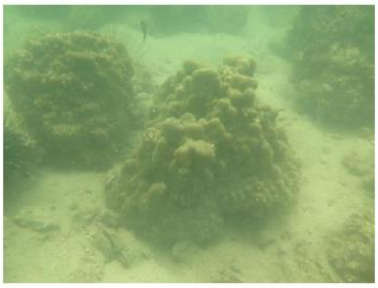


(1) AFCD (2005) Field Guide to Hard Corals of Hong Kong.

Figure B-A1.2 Representative Photos of the Seabed and Coral Conditions at the Survey Transects for Wong Chuk Kok Hoi



a) Hard coral, *Platygyra* sp., growing on the small boulders in shallow water of B1, B2 and B3.



b) Large colony of hard coral, *Porites* sp., in shallow water of B4.

c) Large colony of hard coral, *Porites* sp., in shallow water of B6.

d) Sandy substrata in deep water of B1, B2 and B3.

e) Sandy substrata in deep water of B4, B5 and B6.

f) Small colony of octocoral, *Echinomuricea* sp., in deep water of B2.

Figure B-A1.3 Representative Photos of the Seabed from the Drop Camera Survey for Wong Chuk Kok Hoi

APPENDIX 4C SURVEY DATA OF SUBTIDAL AND BENTHIC ASSEMBLAGES

Table 4C.1 Subtidal Soft Bottom Survey Raw Data - Wet Season Abundance

					Sample ID	WCKH1		WCKH2		WCKH3		WCKH4		WCKH5	
Kingdom	Phylum	Class	Order	Family	Species	Number	Biomass (g)	Number	Biomass (g)	Number	Biomass (g)	Number	Biomass (g)	Number	Biomass (g)
Animalia	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Micronephtys sphaerocirrata*	1	0.0019	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Phyllodocida	Pilargidae	*Sigambra hanaokai*	3	0.0012	0	0.0000	10	0.0055	4	0.0050	2	0.0011
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Malacoceros* sp.	0	0.0000	0	0.0000	7	0.0017	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Prionospio cirrifera*	0	0.0000	0	0.0000	4	0.0050	2	0.0005	0	0.0000
Animalia	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	*Idunella* sp.	1	0.0001	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Animalia	Chordata	Cephalochordata	Amphioxiformes	Branchiostomatidae	*Branchiostoma belcheri*	2	0.0168	1	0.0009	0	0.0000	0	0.0000	0	0.0000
Animalia	Mollusca	Scaphopoda	Dentaliida	Gadilinidae	*Episiphon kiaochowwanense*	0	0.0000	0	0.0000	0	0.0000	1	0.0251	0	0.0000

Table 4C.2 Subtidal Soft Bottom Survey Raw Data - Dry Season Abundance

					Sample ID	WCKH1		WCKH2		WCKH3		WCKH4		WCKH5	
Kingdom	Phylum	Class	Order	Family	Species	Number	Biomass (g)	Number	Biomass (g)	Number	Biomass (g)	Number	Biomass (g)	Number	Biomass (g)
Animalia	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera alba*	0	0.0000	1	0.0019	0	0.0000	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Phyllodocida	Goniadidae	*Glycinde bonhourei*	0	0.0000	0	0.0000	0	0.0000	1	0.0021	0	0.0000
Animalia	Annelida	Polychaeta	Phyllodocida	Hesionidae	*Oxydromus angustifrons*	0	0.0000	0	0.0000	1	0.0029	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus sinensis*	1	0.0073	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Micronephtys sphaerocirrata*	19	0.0226	15	0.0293	8	0.0084	18	0.0332	26	0.0293
Animalia	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys* sp.	1	0.0009	1	0.0010	0	0.0000	0	0.0000	3	0.0015
Animalia	Annelida	Polychaeta	Phyllodocida	Nereididae	*Perinereis cultrifera*	1	0.0113	1	0.0186	0	0.0000	0	0.0000	22	0.0022
Animalia	Annelida	Polychaeta	Phyllodocida	Pilargidae	*Sigambra hanaokai*	37	0.0270	27	0.0183	12	0.0103	35	0.0278	51	0.0298
Animalia	Annelida	Polychaeta	Phyllodocida	Polynoidae	*Harmothoe* sp.	0	0.0000	1	0.0085	1	0.0070	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Phyllodocida	Sigalionidae	*Ehlersileanira incisa*	1	0.0003	1	0.0010	1	0.0011	1	0.0010	6	0.0217
Animalia	Annelida	Polychaeta	Spionida	Poecilochaetidae	*Poecilochaetus tricirratus*	0	0.0000	1	0.4050	2	0.0760	0	0.0000	0	0.0000
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Malacoceros* sp.	0	0.0000	0	0.0000	0	0.0000	1	0.0013	0	0.0000
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Paraprionospio pinnata*	0	0.0000	0	0.0000	0	0.0000	0	0.0000	1	0.0064
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Prionospio cirrifera*	7	0.0004	6	0.0005	0	0.0000	13	0.0019	0	0.0000
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Prionospio ehlersi*	13	0.0054	8	0.0176	1	0.0053	13	0.0075	23	0.0039
Animalia	Annelida	Polychaeta	Spionida	Spionidae	*Prionospio malmgreni*	13	0.0036	13	0.0056	5	0.0009	10	0.0047	32	0.0064
Animalia	Arthropoda	Hexanauplia	--	--	--	1	0.0003	2	0.0003	3	0.0008	4	0.0009	1	0.0008
Animalia	Echinodermata	Echinoidea	Camarodonta	Temnopleuridae	*Temnopleurus toreumaticus*	0	0.0000	0	0.0000	0	0.0000	1	0.0069	0	0.0000
Animalia	Mollusca	Bivalvia	Cardiida	Tellinidae	*Jitlada culter*	1	0.0606	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Animalia	Mollusca	Bivalvia	Cardiida	Tellinidae	*Nitidotellina lischkei*	0	0.0000	5	0.4602	3	0.0066	20	0.6163	11	0.8321
Animalia	Mollusca	Bivalvia	Myida	Corbulidae	*Corbula sinensis*	1	0.0193	0	0.0000	0	0.0000	1	0.0013	1	0.0225
Animalia	Mollusca	Bivalvia	Venerida	Semelidae	*Theora lata*	5	0.3052	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Animalia	Mollusca	Gastropoda	Cephalaspidea	Philinidae	*Philine* sp.	4	0.0382	3	0.0272	1	0.0099	1	0.0028	2	0.0068
Animalia	Nemertea	--	--	--	--	5	0.0030	1	0.0001	2	0.0005	3	0.0011	4	0.0009

Table 4C.3 Seabed Attributes along the Survey Transects at Wong Chuk Kok Hoi

	Transect					
	T1		T2		T3	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Transect depth (mCD)	-3 to -4	-5 to -6	-3 to -4	-5 to -7	-3 to -4	-5 to -6
Substratum attributes						
Bedrock	0	0	0	0	0	0
Continuous pavement	0	0	0	0	0	0
Rocks (<26 cm)	3	2	2	2	2	2
Large boulders (>50 cm)	4	1	0	0	4	2
Small boulders (<50 cm)	3	2	2	2	0	2
Rubble	1	1	3	3	0	2
Sand	1	4	5	5	4	4
Mud/ Silt	3	3	0	0	0	0
Other	0	0	0	0	0	0
Ecological attributes						
Hard coral	2	1	2	2	2	1
Dead Coral	0	1	0	0	0	0
Octocoral (Soft corals and gorgonians)	0	0	0	0	0	0
Black coral	0	0	0	0	0	0
Dead standing coral	0	0	0	0	0	0
Macroalgae	1	0	0	0	0	0
Other Benthos (including sponges, zoanthids, ascidians and bryozoans)	1	1	0	1	1	1

Notes:

(1) 0 = 0%, 1 = <5%, 2= 5 -10%, 3 = 11 – 30%, 4 = 31- 50%, 5 = 51 – 75%, 6 = 76 – 100%

Table 4C.4 Benthic Communities Recorded Along the Survey Transects at Wong Chuk Kok Hoi

	Transect					
	T1		T2		T3	
	Shallow	**Deep**	**Shallow**	**Deep**	**Shallow**	**Deep**
Transect depth (mCD)	-3 to -4	-5 to -6	-3 to -4	-5 to -7	-3 to -4	-5 to -6
Hard corals						
Acanthastrea echinata	0	0	1	0	0	0
Acropora digitifera	0	0	1	0	0	0
Bernardpora stutchburyi	1	1	0	1	0	2
Coelastrea aspera	0	0	1	1	0	0
Cyphastrea chalcidicum	1	0	1	1	0	0
Cyphastrea serailia	1	1	0	0	0	0
Dipsastraea danae	0	0	0	0	0	1
Dipsastraea maritima	0	0	1	0	0	1
Dipsastraea rotumana	1	0	2	2	0	1
Duncanopsammia peltata	0	0	0	0	0	1
Echinophyllia aspera	0	0	1	0	0	0
Favites abdita	0	0	2	1	0	0
Favites chinensis	0	0	1	1	0	0
Favites flexuosa	0	0	0	1	1	1
Favites pentagona	0	0	2	0	0	0
Goniopora columna	0	0	0	0	0	1
Goniopora lobata	0	0	1	0	1	0
Hydnophora exesa	1	0	1	0	0	0
Leptastrea purpurea	0	0	0	0	0	1
Lithophyllon undulatum	1	0	1	0	0	0
Montipora mollis	0	0	0	0	0	1
Oulastrea crispata	3	1	0	1	2	1
Pavona decussata	0	0	1	0	1	0
Platygyra carnosa	0	0	3	0	0	0
Plesiastrea versipora	0	0	1	2	2	2
Porites sp.	4	3	1	0	3	2
Psammocora profundacella	0	0	0	1	0	0
Other benthos						
Dofleinia armata	0	2	0	0	0	0
Spheractis cheungae	0	0	0	0	2	1
Entacmaea quadricolor	0	1	0	0	0	0

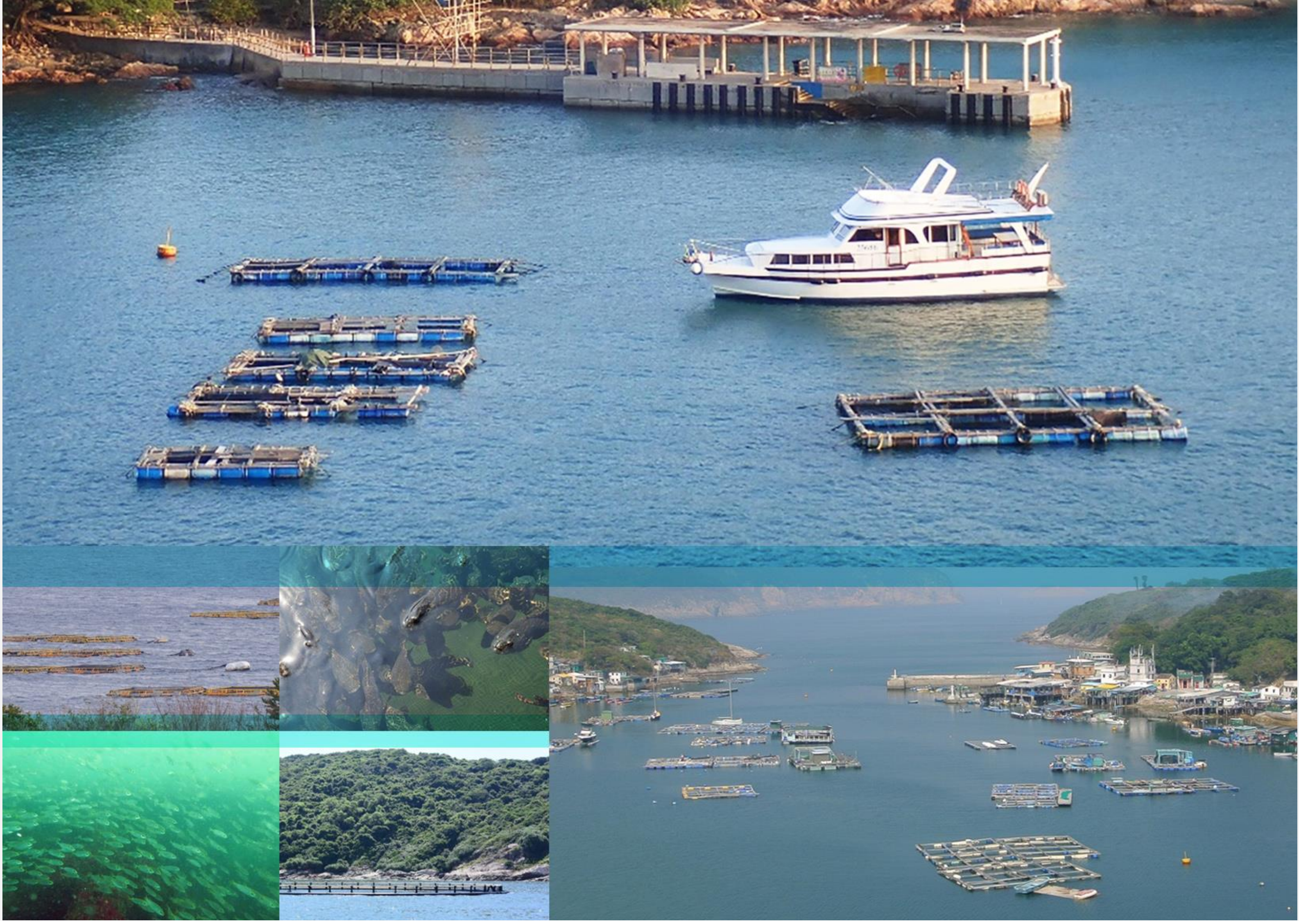
Encrusting Sponge	0	0	0	0	0	1

Notes:

(2) 0=absent, 1=rare, 2=uncommon, 3=common, 4=abundant, 5=dominant

(3) The ranks shown in the Table above indicate the relative abundance of each coral in relation to other corals in the community. In other words, these broad categories rank taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are subjective assessments of abundance, rather than quantitative counts of each taxon. For instance, if a coral is ranked as ‘common’, it means it was more frequent than other coral species along the transect. It should be borne in mind that coral cover along all of the transects where corals occurred was low (<10% cover).

APPENDIX 5A APPROVED METHOD STATEMENT ON FISHERIES IMPACT ASSESSMENT OF WONG CHUK KOK HOI FCZ



漁農自然護理署
Agriculture, Fisheries and Conservation Department

Contract Ref.: AFCD/FIS/02/2019 Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

Method Statement on Fisheries Impact Assessment for Wong Chuk Kok Hoi Fish Culture Zone

24 July 2020

Project No.: 0549925

The business of sustainability

ERM

Signature Page

24 July 2020

Contract Ref.: AFCD/FIS/02/2019 Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones

Method Statement on Fisheries Impact Assessment for Wong Chuk Kok Hoi Fish Culture Zone

Dr Jasmine Ng
Partner

ERM-Hong Kong, Limited

2507, 25/F One Harbourfront

18 Tak Fung Street

Hunghom

Kowloon

Hong Kong

CONTENTS

List of Figures

1. INTRODUCTION

1.1 Background

To pave the way for facilitating the sustainable development of the local mariculture sector, the Agriculture, Fisheries and Conservation Department (AFCD) proposed to lift the moratorium by designating new fish culture zones (FCZs) to create room for the mariculture sector to grow further, including allowing capture fishermen to switch to this sustainable mode of operation, and attracting new entrants. In 2014, the AFCD commissioned a consultancy study (1) to explore suitable sites as new FCZs and Wong Chuk Kok Hoi FCZ is one of the four Shortlisted Sites.

The designation of a FCZ of more than 5 hectares in size is classified as a designated project under Item M.1, Part I of Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499), and a statutory EIA is required before designation. In accordance with the EIAO, a Project Profile for application for an Environmental Impact Assessment (EIA) Study Brief has been prepared and submitted to Environmental Protection Department (EPD) on 15 October 2019. The EIA Study Brief (ESB-324/2019) (hereafter referred to as “the Study Brief”) was issued by EPD on 27 November 2019.

AFCD has commissioned ERM to undertake the “*Consultancy Services for Environmental Impact Assessment Study for Designation of New Fish Culture Zones*” (“the Study”). In accordance with *Clause 3.4.5* of the Study Brief, a fisheries impact assessment shall be conducted to evaluate and assess potential impacts on fisheries for the construction and operation of the Wong Chuk Kok Hoi FCZ (“the Project”).

1.2 Objectives and Scope of This Method Statement

Baseline information within the Assessment Area for the fisheries impact assessment for the proposed FCZ at Wong Chuk Kok Hoi, i.e. the Mirs Bay Water Control Zone (WCZ) and the Tolo Harbour and Channel WCZ (***Figure A1.1***), in accordance with *Clause 3.4.5.2* of the EIA Study Brief (ESB-324/2019), is available from the following key sources:

- AFCD Port Survey 2016/17;
- Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study (AFCD/FIS/01/14);
- Provision of Services on Desktop Review for Potential New Fish Culture Zones (AFCD/SQ/243/18/C);
- EIA Report for The Proposed Submarine Gas Pipeline From Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal (EIA-089/2003);
- EIA Report for the Development of a 100MW Offshore Wind Farm in Hong Kong (AEIAR-152/2010);
- EIA Report for Hong Kong Offshore Wind Farm in Southeastern Waters (EIA-167/2009);
- EIA Report for Sha Tin Cavern Sewage Treatment Works (AEIAR-202/2016);
- EIA Report for Port Shelter Sewerage, Stage 3 – Sewerage Works at Po Toi O (Agreement No. CE 41/2013);
- EIA Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters – Investigation (Agreement No. CE 26/2008);

(1) ERM (2018) Consultancy Ref. AFCD/FIS/01/14 Consultancy Services for Identification of New Fish Culture Zones in Hong Kong – Feasibility Study

- ERM-Hong Kong, Ltd (1998). Fisheries Resources and Fishing Operations in Hong Kong Waters. Final Report. Prepared for the Agriculture, Fisheries and Conservation Department.
- Hong Kong Artificial Reef Project. Access via <https://www.artificial-reef.net/English/main.htm>; and
- Available Published Scientific Literature.

The desktop information from the above relevant previous studies has been reviewed and it is considered sufficient to evaluate the importance of potentially impacted fisheries resources and fishing operations within the Assessment Area. In addition, the fisheries interview surveys conducted by the AFCD and reported in the AFCD Port Survey 2016/17 are sufficiently comprehensive to provide an up-to-date and representative baseline for fisheries impact assessment. The approach to use AFCD Port Survey data as baseline data, supplemented by other desktop information, in EIA studies is an acceptable practice [(2) (3) (4) (5) (6) (7)]. Therefore, no information gap is identified and fisheries field survey is considered not required for the EIA study of this Project.

The potential impacts due to the construction and operation of the Project will be assessed (with reference to the EIAO-TM Annex 17 guidelines) and the impacts evaluated (with reference to the criteria in EIAO-TM Annex 9). Reference will also be made to the approved EIA reports on the EIA Register. The fisheries impact assessment shall pay particular attention to the loss or disturbance of fishing ground, water quality deterioration at sensitive receivers such as existing and planned FCZs in the vicinity, artificial reefs deployed in Yan Chau Tong Marine Park, spawning and nursery ground of commercial fisheries resources.

(2) 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.

(3) Mott Connell Ltd. (2005). Drainage Improvement in Tsuen Wan and Kwai Chung – Tsuen Wan Drainage Tunnel. EIA Study (EIA-108/2005). Prepared for The Drainage Services Department.

(4) Black & Veatch Hong Kong Ltd. (2008). Hang Hau Tsuen Channel at Lau Fau Shan. EIA Study (EIA-163/2008). Prepared for the Civil Engineering and Development Department.

(5) ARUP (2009). Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation. EIA Study (EIA-173/2009). Prepared for The Highways Department.

(6) ERM (2010). Development of a 100MW Offshore Wind Farm in Hong Kong. EIA Study (AEIAR-152/2010). Prepared for Hong Kong Electric.

(7) Black & Veatch Hong Kong Ltd. (2016) Outlying Islands Sewerage Stage 2 – South Lantau Sewerage Works. EIA Study (AEIAR-210/2017). Prepared for Drainage Services Department.

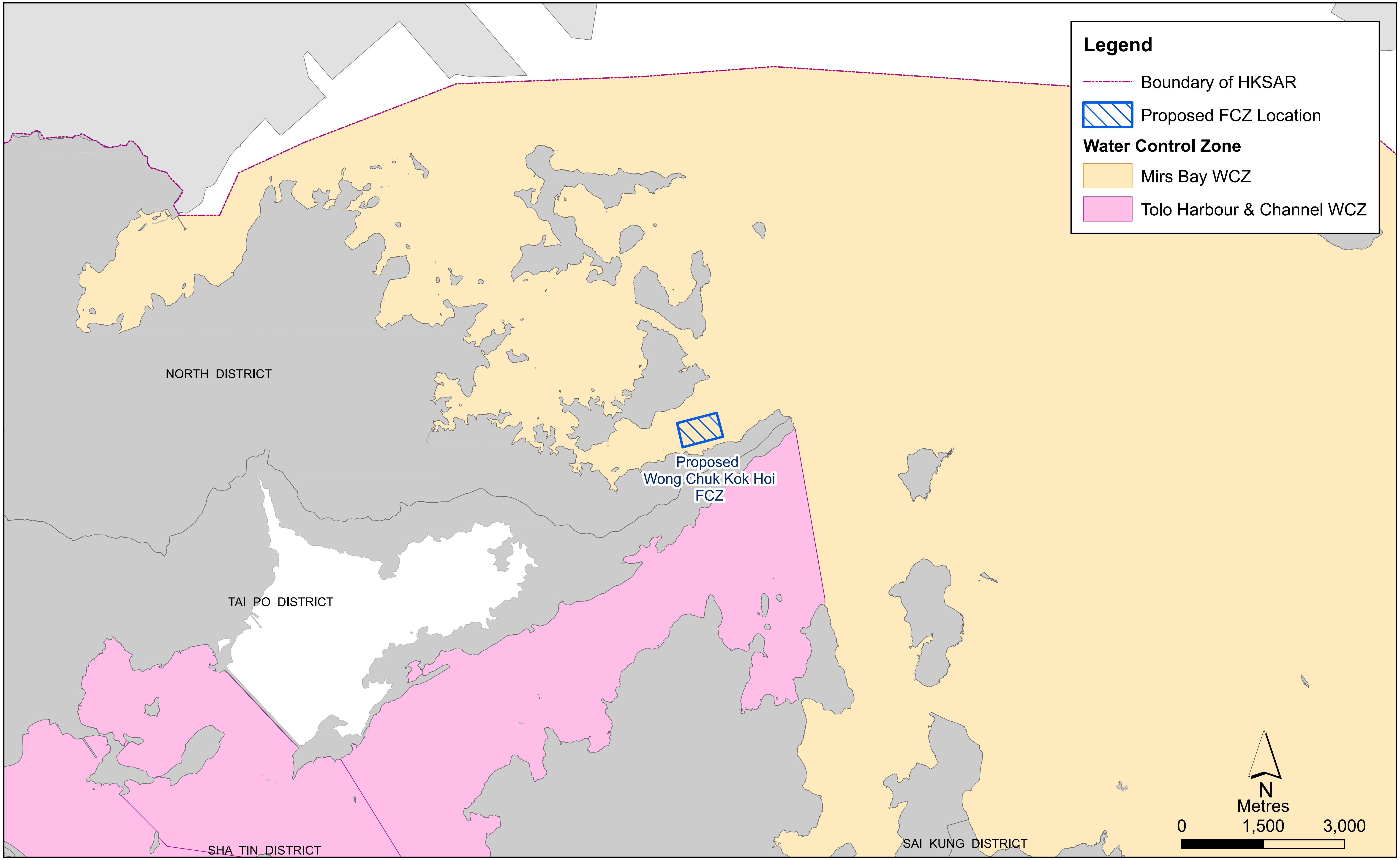


Figure A1.1

Assessment Area for the Proposed Wong Chuk Kok Hoi FCZ

File: T:\GIS\CONTRACT\0549925\mxd\EIA\0549925_Assessment_Area_of_Wong_Chuk_Kok_Hoi.mxd
Date: 21/7/2020

APPENDIX 8A PHOTOGTRAPHS OF REPRESENTATIVE NOISE SENSITIVE RECEIVERS (NSRS)

N1 - Outward Bound Hong Kong – Wong Wan Chau Base

N2 - Plover Cove Country Park

Appendix 8A

Photographs of Representative Noise Sensitive Receivers (NSRs)

DATE: 17/05/2022

Environmental Resources Management

ERM

N3 - Plover Cove (Extension) Country Park

Appendix 8A

Photographs of Representative Noise Sensitive Receivers (NSRs)

DATE: 17/05/2022

Environmental Resources Management

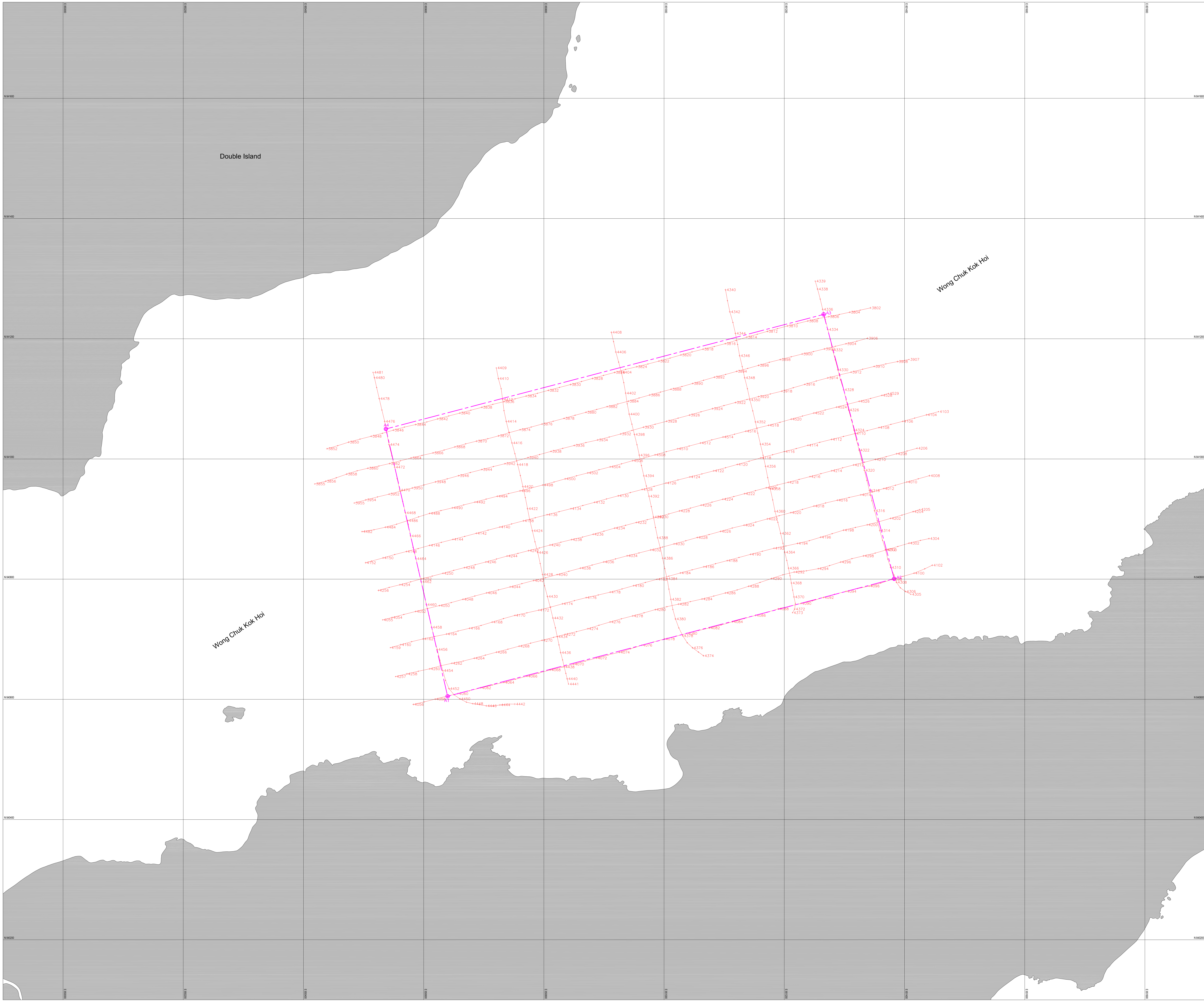
ERM

APPENDIX 8B INDICATIVE CONSTRUCTION PLANT INVENTORY

Appendix 8B: Indicative Construction Plant Inventory

No.	Activities	Plant	TM Ref.	No. of PME
1	**Towing of existing fish rafts to the new FCZ**	Tug boat	CNP 221	1
2	**Assembly and anchoring of fish rafts**	Winch (electric)	CNP 262	1

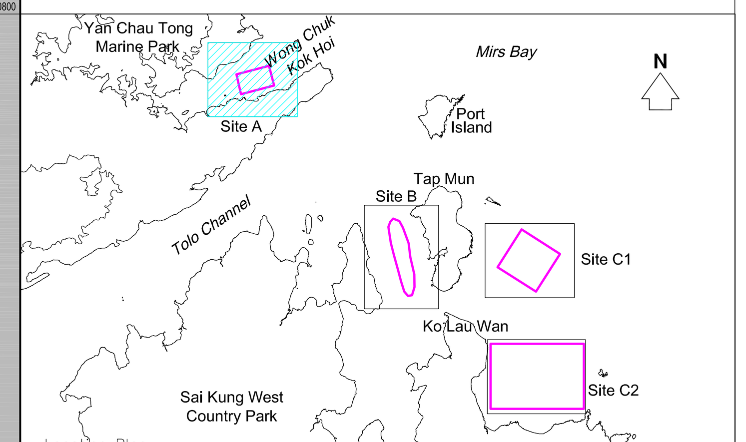
APPENDIX 9A SURVEY TRACK PLOTS



Legend :

260 Multi–beam echo sounding track with fix positions

Survey boundary



Location Plan

Project :

MARINE GEOPHYSICAL SURVEYS FOR FISH CULTURE ZONE EIA STUDY

AREA : Site A (Wong Chuk Kok Hoi) | FIGURE NUMBER : A01

Drawing Title :

ECHO SOUNDING TRACK PLOT

Notes :

1. Survey Date : 03 March 2021
2. Survey Grid : Hong Kong 1980 Grid System
3. Vertical Datum : Hong Kong Principal Datum
4. Positioning : C–Nav GcGPS (Globally corrected GPS)
5. Equipment : Knudsen 320M Echo Sounder
   R2Sonic Sonic 2024 Multibeam Echo Sounding System
   EdgeTech 4200 Side Scan Sonar System
   EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	31/03/2021	Clarence Siu	Milton Chang	Margie Chen	Preliminary

METRIC SCALE 1:2,000

100 80 60 40 20 0 100 200

Client : ERM Environmental Resources Management

Surveyor : EGS EARTH SCIENCES & SURVEYING

EGS (ASIA) LIMITED
15th FLOOR, NORTH POINT INDUSTRIAL BUILDING,
499 KING'S ROAD,
NORTH POINT, HONG KONG
Tel: (852) 28948622
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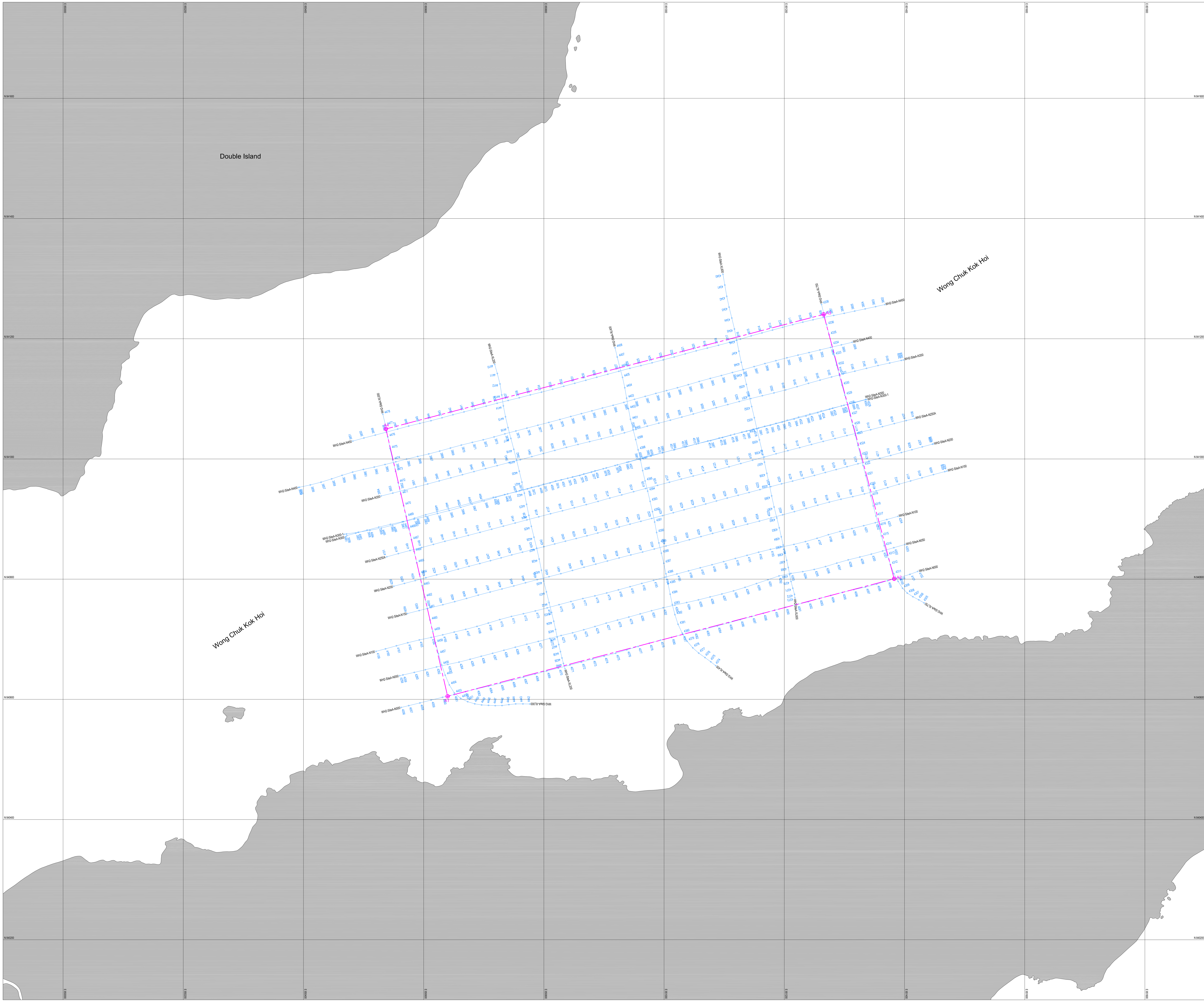
Web: www.egssurvey.com

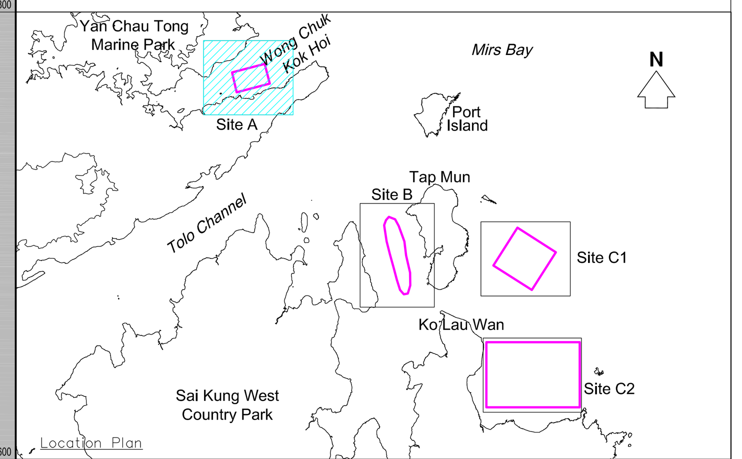
JOB NO. : HK260021



Legend :

WH2-SiteA-600 — Hydrophone track with fix positions and line name

Survey boundary



Project :

MARINE GEOPHYSICAL SURVEYS FOR FISH CULTURE ZONE EIA STUDY

AREA : Site A (Wong Chuk Kok Hoi) | FIGURE NUMBER : A02

Drawing Title :

HYDROPHONE TRACK PLOT

Notes :

1. Survey Date : 03 March 2021
2. Survey Grid : Hong Kong 1980 Grid System
3. Vertical Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : Knudsen 320M Echo Sounder
   R2Sonic Sonic 2024 Multibeam Echo Sounding System
   EdgeTech 4200 Side Scan Sonar System
   EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	31/03/2021	Clarence Siu	Milton Chang	Margie Chen	Preliminary

METRIC SCALE 1:2,000

100 80 60 40 20 0 100 200

Client : Environmental Resources Management

ERM

Surveyor :

EGS (ASIA) LIMITED
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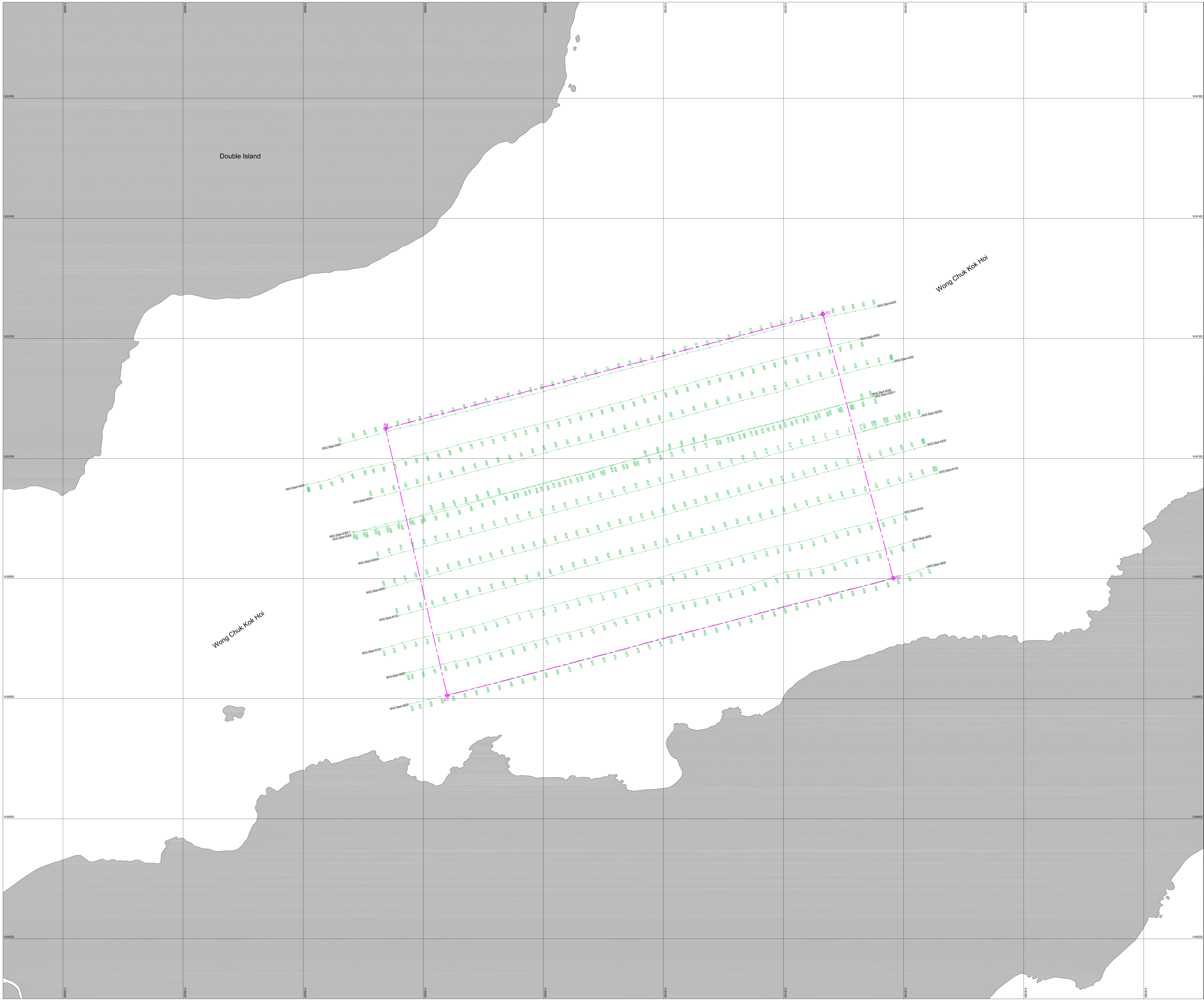
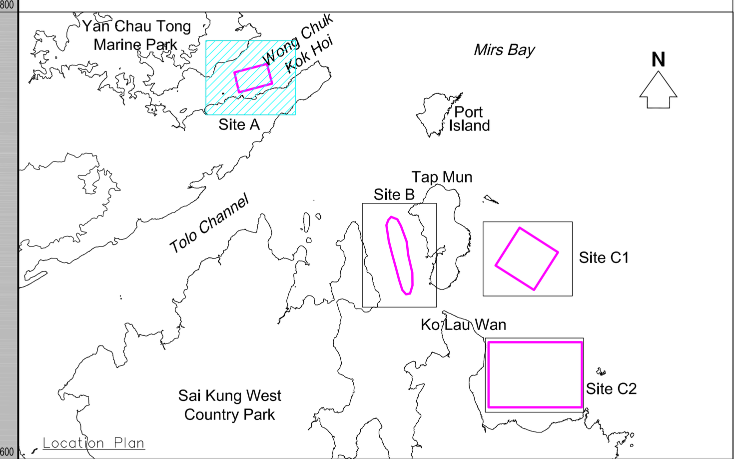
JOB NO. : HK260021



Legend :

WH2-SiteA-600 — Side scan sonar track with fix positions and line name

Survey boundary



Location Plan

Project :

MARINE GEOPHYSICAL SURVEYS FOR FISH CULTURE ZONE EIA STUDY

AREA : Site A (Wong Chuk Kok Hoi) | FIGURE NUMBER : A03

Drawing Title :

SIDE SCAN SONAR TRACK PLOT

Notes :

1. Survey Date : 03 March 2021
2. Survey Grid : Hong Kong 1980 Grid System
3. Vertical Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : Knudsen 320M Echo Sounder
   R2Sonic Sonic 2024 Multibeam Echo Sounding System
   EdgeTech 4200 Side Scan Sonar System
   EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	31/03/2021	Clarence Siu	Milton Chang	Margie Chen	Preliminary

METRIC SCALE 1:2,000

100 80 60 40 20 0 100 200

Client : ERM Environmental Resources Management

Surveyor : EGS EARTH SCIENCES & SURVEYING

EGS (ASIA) LIMITED
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499 KING'S ROAD,
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Fax: (852) 25763590
Web: www.egssurvey.com

JOB NO. : HK260021

APPENDIX 10A IMPLEMENTATION SCHEDULE OF RECOMMENDED ENVIRONMENTAL PROTECTION MEASURES / MITIGATION MEASURES

Appendix 10A - Implementation Schedule of Recommended Environmental Protection Measures / Mitigation Measures

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [a]	Implementation Stage [b]			Relevant Legislation & Guidelines
					D	C	O	
Water Quality								
S3.9.1	S2	Any sewage / wastewater generated should be collected at the transportation / work vessel(s) for disposal at appropriate facilities on land.	All area / During construction	Contractor(s)		✓		*Cap. 358 Water Pollution Control Ordinance*
S3.9.2	S2	The licensees will adopt the operational measures and best practice for mariculture activities.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S3.9.2	S2	Standing stock should not exceed 755.2 ton at any given time. AFCD will ensure the production scale of the Project site will not exceed the maximum standing stock level by controlling the mariculture production scale permitted under individual license.	All area / During operation	AFCD			✓	*Cap. 353 Marine Fish Culture Ordinance*
S3.9.2	S2	AFCD and mariculturists should be aware of potential occurrence of low dissolved oxygen at the Project Site by self-monitoring and the mariculturists will apply suitable control measures (e.g. aeration) as necessary.	All area / During operation	Contractor(s) / AFCD			✓	*Cap. 353 Marine Fish Culture Ordinance*
S3.9.2	S2	In case of 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.	All area / During operation	Contractor(s) / AFCD			✓	*Cap. 353 Marine Fish Culture Ordinance*
S3.9.2	S2	Only pellet feed or alternative feed with better feed conversion ratio will be permitted within the proposed FCZ.	All area / During operation	AFCD			✓	*Cap. 353 Marine Fish Culture Ordinance*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [a]	Implementation Stage [b]			Relevant Legislation & Guidelines
					D	C	O	
S3.9.2	S2	No chemically-laden solution from culture gears disinfection should be discharged into the sea.	All area / During operation	Contractor(s)			✓	*Cap. 358 Water Pollution Control Ordinance*
S3.9.2	S2	Onsite storage of chemicals should be controlled and minimized as practicable. Excess chemicals as well chemical waste generated should be removed from the site at appropriate facilities or by licensed contractor as soon as possible.	All area / During operation	Contractor(s)			✓	*Cap. 354C Waste Disposal (Chemical Waste) (General) Regulation*
S3.9.2	S2	Fuel storage onsite should be minimized, and if needed, be located at sheltered and secure location.	All area / During operation	Contractor(s)			✓	*Cap. 354C Waste Disposal (Chemical Waste) (General) Regulation*
S3.9.2	S2	Littering of the sea should be prohibited.	All area / During operation	Contractor(s)			✓	*Cap. 228 Summary Offences Ordinance*
S3.12	S2	Water quality monitoring for operation is recommended when the standing stock is expected to achieve 75% of the carrying capacity (i.e. 755.2 ton x 75% = 566.4 ton) or when the standing stock is expected to achieve 95% of the carrying capacity (i.e. 755.2 ton x 75% = 717.4 ton) for at least a month in a fish farming cycle.	All area / During operation	ET / IEC			✓	-
Marine Ecology								
S4.8	S3	The mitigation measures designed to mitigate water quality impacts through proper fish farm management shall be adopted.	All area / During operation	AFCD / Contractor(s)			✓	-

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
Fisheries								
S5.8	S4	The mitigation measures designed to mitigate water quality impacts and proper fish farm management designed to mitigate marine ecological impacts shall be adopted.	All area / During operation	AFCD / Contractor(s)			✓	-
Waste Management								
S6.5.1	S5	The contractor(s) / fish farmers shall implement the following control measures: ▪ Submit an Environmental Management Plan under the Fish Farm Operational Plan on the control of environmental impacts from the mariculture activities for agreement with AFCD; ▪ Disposal or destruction of any fish within any site found or suspected to be suffering from any infectious disease; ▪ Disposal of any noxious or waste matter resulting from the fish collection or fish harvest.	All area / during construction / during operation	Contractor(s)		✓	✓	*Marine Fish Culture Ordinance (Cap. 353)*
S6.5.1	S5	The contractor(s) / fish farmers shall implement the following control measures: ▪ Liquid oil waste or any other mixtures which contain oil and noxious liquid substances or any such residues shall not be discharged into the sea;	All area / during construction / during operation	Contractor(s)		✓	✓	*Merchant Shipping (Prevention and Control of Pollution) Ordinance (Cap. 413)*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
		▪ Oily waste from vessels should be discharged to CWTC.						
S6.5.1	S5	The Contractor(s) will consult AFCD for the final disposal of wastes and, as appropriate, implement the good site practices and mitigation measures given below. ▪ Nomination of approved personnel (e.g. environmental officer of the contractor(s), representative of the project proponent) to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility of all wastes generated at the site; ▪ Training of site personnel in proper waste management and handling procedures by AFCD; ▪ Provision of sufficient waste disposal points and regular collection for disposal; ▪ Appropriate measures to reduce windblown / floating litter and dust during transportation of waste by transporting wastes in enclosed containers; and ▪ A recording system (e.g. log book for mariculture operation) for the amount of wastes generated, recycled and disposed of and the disposal sites for checking by AFCD.	All area during contract mobilisation / during construction / during operation	Contractor(s)		✓	✓	*Marine Fish Culture Ordinance (Cap. 353)*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [a]	Implementation Stage [b]			Relevant Legislation & Guidelines
					D	C	O	
S6.5.2	S5	The Contractor(s) must ensure that all the necessary waste disposal permits or licences (e.g. registration as a chemical waste producer) are obtained prior to the commencement of the construction works.	All area during contract mobilisation / during construction	Contractor(s)		✓		*Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)*
S6.5.2.1	S5	General refuse and floating refuse will be stored in enclosed bins. The general refuse and floating refuse will be delivered to nearest accessible FEHD refuse collection points with public pier on a regular basis to reduce odour, pest and litter impacts following the existing practice under Cap. 353.	All area / During construction	Contractor(s)		✓		*Cap. 132BK Public Cleansing and Prevention of Nuisances Regulation Marine Fish Culture Ordinance (Cap. 353)*
S6.5.2.1 S6.5.3.1 S6.5.3.3	S5	General refuse, floating refuse and organic waste requiring disposal will be collected in designated garbage bags after the official implementation of MSW charging scheme.	All area / During construction / During operation	Contractor(s)		✓	✓	*Waste Disposal (Charging for Municipal Solid Waste) (Amendment) Ordinance 2021*
S6.5.2.1 S6.5.3.1 S6.5.3.3	S5	Public transport will not be used for handling (including stockpiling, labelling, packaging & storage), collection, transportation and re-use / disposal of wastes generated under the Project. Thus, impacts to public transport is not expected and specific mitigation measure for public transport is considered not necessary.	All area / During construction / During operation	Contractor(s)		✓	✓	-
S6.5.2.1 S6.5.3.3	S5	Recycling bins will be provided at appropriate locations to facilitate collection of recyclable materials (including aluminium can, waste paper, glass bottles and plastic bottles) from the Project site.	All area / During construction / During operation	Contractor(s)		✓	✓	-

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
S6.5.2.1 S6.5.3.3	S5	To avoid entrapment of floating refuse within the Project site, the fish cages / rafts and vessels should be properly designed such that there are no sharp turns or abrupt indentation in order to avoid or minimise any trapped or accumulated refuse.	All area / During construction / During operation	Contractor(s)		✓	✓	-
S6.5.2.2	S5	Prior to the commencement of the construction works, AFCD will provide training to the construction workers on the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling. In particular, the training will emphasize no dumping of waste into the sea is allowed, particularly within the licensed area and on marine vessels.	All area / During construction	AFCD		✓		-
S6.5.3.1	S5	Good quality feed, such as pellet feed, should be used for feeding instead of trash fish as it effectively reduces the feed conversion ratio, and thus the quantity of uneaten feed wastage.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S6.5.3.1	S5	Optimal feed input should be implemented while the fish feed should be even distributed within the licensed area. The feed will also be sieved to remove broken pieces and dust before feeding.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S6.5.3.1	S5	The fish farmers will keep detailed operational records for each licensed area including the type and quantity of feed used, estimated number of fish stock and biomass, water temperature and growth rates of cultured organisms to allow more accurate estimation of fish feed input and to minimise unnecessary wastage of feeds.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
S6.5.3.1	S5	The fish farmers and other personnel are required to take all precautions to prevent spillage during the delivery of feed to the Project site.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S6.5.3.1	S5	The uneaten feeds should be cleaned up immediately, especially during summer times when the decomposition of organic waste is more rapid, so as to minimise leaching to the adjacent water.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S6.5.3.1	S5	The quantity of feed delivered to the licensed area will also be recorded in order to ensure an appropriate quantity of feed stock is procured.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S6.5.3.1	S5	It is recommended that the fish pellets should be stored in covered areas to prevent unnecessary spoilage and spillage to adjacent waters.	All area / During operation	Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*
S6.5.3.1 S6.5.3.3	S5	General refuse, floating refuse and organic waste will be stored in enclosed bins. The general refuse, floating refuse and organic waste will be delivered to the landside refuse collection points on a regular basis to reduce odour, pest and litter impacts.	All area / During operation	Contractor(s)			✓	*Cap. 132BK Public Cleansing and Prevention of Nuisances Regulation* *Marine Fish Culture Ordinance (Cap. 353)*
S6.5.3.1	S5	In case of large quantity of organic waste generated as a result of extensive fish deaths, for example, due to algal bloom or fish diseases, the fish farmers will report to AFCD in due course, and AFCD, Food and Environmental Hygiene Department (FEHD), Marine Department (MD) and other relevant departments will provide assistance to the fish	All area / During operation	AFCD / Contractor(s)			✓	*Cap. 353 Marine Fish Culture Ordinance*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
		farmers to transport the organic waste directly to NENT landfill for disposal.						
S6.5.3.2	S5	The fish farmers will register as a chemical waste producer with the EPD. Chemical waste will be handled in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*.	All area / During operation	Contractor(s)			✓	*Waste Disposal (Chemical Waste) (General) Regulation; Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S6.5.3.2	S5	Containers used for storage of chemical wastes will: ■ Be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed; ■ Have a capacity of less than 450 L unless the specifications have been approved by the EPD; and ■ Display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the Regulations.	All area / During operation	Contractor(s)			✓	*Waste Disposal (Chemical Waste) (General) Regulation; Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S6.5.3.2	S5	The storage area for chemical wastes will: ■ Be clearly labelled and used solely for the storage of chemical waste; ■ Be enclosed on at least 3 sides; ■ Have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest; ■ Have adequate ventilation;	All area / During operation	Contractor(s)			✓	*Waste Disposal (Chemical Waste) (General) Regulation; Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
		■ Be covered to prevent rainfall entering (water collected within the bund must be tested and disposed of as chemical waste, if necessary); and ■ Be arranged so that incompatible materials are appropriately separated.						
S6.5.3.2	S5	Chemical waste will be disposed of: ■ Via a licensed waste collector; and ■ To a facility licensed to receive chemical waste, such as the Chemical Waste Treatment Facility which also offers a chemical waste collection service and can supply the necessary storage containers.	All area / During operation	Contractor(s)			✓	*Waste Disposal (Chemical Waste) (General) Regulation; Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S6.5.3.4	S5	Prior to the commencement of the operation phase, AFCD will provide on-farm training to all staff working at the Project site on the concepts of sustainable mariculture practice, site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling.	All areas / During operation	AFCD			✓	-
S6.7	S5	Site inspections at the Project site (on marine vessels) are recommended on a regular basis at biweekly interval during the time of construction activities by the ET to check if wastes are being managed in accordance with good site practices and the recommended mitigation measures. The inspections will investigate all aspects of waste management including waste generation, storage, handling, recycling, transportation and disposal.	All area / During construction	ET / IEC		✓		-

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
S6.7	S5	AFCD will conduct regular inspections at monthly interval and review on FCZ operation to check if wastes are being managed in accordance with good site practices and the recommended mitigation measures. The inspections will investigate all aspects of waste management including waste generation, storage, handling, recycling, transportation and disposal.	All area / During operation	AFCD			✓	*Cap. 353 Marine Fish Culture Ordinance*
Visual								
S7.9	S6	Pre-construction and construction period for the Project site should be reduced as far as practical to lower visual impact	All area / Detailed design / During construction	Contractor(s)	✓	✓		-
S7.9	S6	The new structures will be designed in accordance with relevant marine safety standards and regulations. Sensitive architectural design will be considered where practicable. This should take into account material texture, colour, finishes to structures to ensure the fish rafts / cages blend into the existing context, cause least disturbance to the existing seascape, and are the most visually appealing.	All area / Detailed design/ During construction	AFCD / Contractor(s)	✓	✓		-
S7.9	S6	After operation, the open water occupied by the Project site will be reinstated to their former state	All area / After operation	Contractor(s)			✓	-
S7.9	S6	Light intensity and beam directional angle should be controlled at the Project site at the design stage to reduce light pollution and glare (e.g. hooded lights, specific directional focus, etc.). In	All area / Detailed design / During operation	AFCD / Contractor(s)	✓		✓	-

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
		addition, lighting will be limited to auxiliary structures to reduce night-time impacts.						
Noise								
S8.6	S7	Good construction site practice and noise management could be considered to reduce the noise nuisance from the construction activities as follows: ▪ Only well-maintained plant will be operated on-site and plant will be serviced regularly during the construction phase; ▪ Silencers or mufflers on construction equipment will be utilised and will be properly maintained during the construction phase; ▪ Mobile plant, if any, will be sited as far away from NSRs as possible; ▪ Machines and plant that may be in intermittent use will be shut down between work periods or will be throttled down to a minimum; ▪ Plants known to emit noise strongly in one direction will, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and	All area / During construction	Contractor(s)		✓		*Cap. 400 Noise Control Ordinance*

EIA Reference	EM&A Reference	Recommended Environmental Protection Measures / Mitigation Measures	Location / duration of recommended measures & timing of completion of recommended measures	Implementation Agent [(a)]	Implementation Stage [(b)]			Relevant Legislation & Guidelines
					D	C	O	
		▪ Other structures will be effectively utilised, wherever practicable, in screening noise from on-site construction activities.						
Cultural Heritage								
S9.7	S8.1	A buffer area of 20 m radius as shown in ***Figure 9.1*** of the EIA Report from A-SC001 to avoid any tug boat anchoring and anchoring of the fish rafts/cages in the area.	A buffer area of 20 m radius from A-SC001 / during the construction and operation stage of the Project	Contractors / AFCD		✓	✓	-
S9.7	S8.1	Site inspections on a regular basis by the Environmental Team are recommended to check if any seabed disturbance work is conducted in the buffer area during construction phase of the Project.	Buffer area / during construction stage of the Project.	ET / IEC		✓		-
S9.7	S8.1	AFCD will conduct regular inspections to check if any seabed disturbance work is conducted in the buffer area.	Buffer area / during operation stages of the Project	AFCD			✓	-

(a) AFCD: Project Proponent; Contractor(s): Licensee(s) / the contractor(s) supporting the construction of fish raft structures; ET: Environmental Team; IEC: Independent Environmental Checker

(b) D: Design, C: Construction, O: Operation

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