

10 FISHERIES ASSESSMENT

10.1 Introduction

This section presents the findings of an impact assessment on existing capture and culture fisheries, including fisheries resources, fishing operations and fish culture activities, from the construction and operation of the proposed Project. It summarizes baseline information on fisheries production around Eastern buffer Water Control Zone (WCZ) and its vicinity gathered from literature review. The assessment of fisheries impacts is based on the Project Description (*Section 3*) and the findings of the Water Quality Assessment (*Section 6*).

10.2 Relevant Legislation & Assessment Criteria

10.2.1 Technical Memorandum

The criteria for evaluating fisheries impacts are stated in the EIAO-TM. Annex 17 of the EIAO-TM prescribes the general approach and methodology from assessing fisheries impacts caused by 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 evaluation of fisheries impacts.

10.2.2 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 license in designated Fish Culture Zones.
- *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.
- *Environmental Impact Assessment Ordinance (Cap. 499)*, Section 5(7) – Environmental Impact Assessment Study Brief no. ESB-266/2013 Section 3.4.8 and Appendix H which outline the key fisheries impacts to be reviewed and assessed in the EIA Report.

10.3 Baseline Conditions & Fisheries Sensitive Receivers

The Study Area for fisheries is the same as that for the Water Quality Impact Assessment (see *Section 6*) and includes other areas likely to be impacted by the Project, particularly area with significant fisheries resources and fishing activities, spawning and nursery grounds, and the Fish Culture Zones.

A desktop review of existing information on commercial fisheries resources and fishing operations in waters of the Study Area has been undertaken, and the most up-to-date information was obtained primarily from the Agriculture, Fisheries and Conservation Department (AFCD). For a detailed description of the physical and biological characteristics of the marine environment of the Study Area please refer to *Sections 6 and 9* respectively.

10.3.1 Overview of Hong Kong Fisheries

Marine-based commercial fishing operations in Hong Kong are broadly classified into culture and capture fisheries.

Mariculture fishery operations occur at 26 Fish Culture Zones (FCZs) which altogether occupy about 209 ha of Hong Kong waters. They involve rearing of marine fish from fry or fingerlings to marketable size in cages suspended by floating rafts usually in sheltered coastal areas/ embayments. Fish farms are typically small scale, family-run operations comprising only one or two rafts with an average size of about 290 m².

With effect from June 2002, the marine fish culture licence is transferable. The existing moratorium for FCZs has been reviewed and three new measures are proposed to promote the sustainable development of the local fisheries industry ⁽¹⁾, including:

1. Issue new marine fish culture licences in three FCZs (i.e. O Pui Tong, Wong Wan and Sham Wan FCZs) with approximately 30 new marine fish culture license to be issued at the initial stage;
2. Expand the existing FCZ at Yim Tin Tsai; and,
3. Identify any potential area for designation of new FCZs.

In 2013, the marine fish culture industry produced about 1,005 tonnes of fish valued at HK\$94 million which accounts for about 6 % of local demand for live marine fish. Some recent figures on the local marine culture fisheries are presented in **Table 10.1**.

(1) Legislative Council Panel on Food Safety and Environmental Hygiene – Marine Fish Culture in Hong Kong on 11 June 2013. Available from: <http://www.legco.gov.hk/yr12-13/english/panels/fseh/papers/fe0611cb2-1284-5-e.pdf>

Table 10.1 Marine Culture Fisheries Summary Statistics 2002 - 2013 (source: AFCD)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Licensed Mariculturists	1,237	1,157	1,125	1,104	1,081	1,072	1,060	1,050	1,035	1,010	1,008	987
Production (tonnes)*	1,210	1,490	1,540	1,540	1,490	1,530	1,370	1,437	1,512	1,185	1,299	1,005
Value (HK\$ million)*	57	76	79	76	89	99	82	92	118	94	117	94

* AFCD estimates

Capture fisheries is primarily concentrated in the waters of Hong Kong, the Pearl River Estuary and the adjacent continental shelf of the South and East China Seas ⁽¹⁾. The AFCD reported that in 2013 an estimated 170,129 tonnes of fish was produced, which was equivalent to an economic value of about HK\$2,338 million ⁽²⁾. In addition, 8,800 local fishermen with approximately 4,000 vessels were servicing in the fishing industry ⁽³⁾. The major fishing methods include trawling, long-lining, gill-netting and purse-seining with the majority of the total catch obtained through trawling.

Based on the latest data from AFCD Port Survey 2006, the highest fisheries production (600 to 1,000 kg ha⁻¹) in Hong Kong was recorded in the vicinity of the Ninepin Island Group, Po Toi and Tap Mun ⁽⁴⁾. These areas also recorded the highest number of fishing vessels. Scad (Carangidae), shrimp, rabbitfish (Siganidae), squid, croaker (Sciaenidae), crab, mullet (Mugilidae), sardine (Clupeidae), seabream (Sparidae) and anchovy (Engraulidae) 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, an outright trawling ban was put into effect in an attempt to restore the seabed and the depleted fisheries resources ⁽⁵⁾. To complement the trawl ban and bring local fisheries industry back to a sustainable path, the government seeks to implement other fisheries management measures through legislative amendments to the *Fisheries Protection Ordinance (Cap. 171)*. These measures include: (1) setting up a registration system for local fishing vessels; (2) limiting new entrants to control the fishing number of fishing vessel and fishing effort; (3) restricting fishing activities of non-fishing vessels and prohibiting fishing activities of non-local fishing vessels; (4) designating fisheries protection areas; (5) habitat enhancement and restoration (i.e. artificial reefs); and (6) fish restocking trials.

Since 1999, Mainland Authorities have implemented a fishing moratorium for South China Sea fishing grounds for about 2.5 months during mid-summer (between mid-May to August). The moratorium prohibits fishing activity by the Hong Kong fleet outside of Hong Kong waters except by gill-netting, long-lining, hand-lining and cage trapping.

(1) Sumaila, U. R., Cheung, W. and I. Teh (2007) Rebuilding Hong Kong's Marine Fisheries: An Evaluation of Management Options. Fisheries Centre Research Reports 15 (3). pp.112.

(2) AFCD (2014), available on: http://www.afcd.gov.hk/english/fisheries/fish_abt/fish_abt.html

(3) *Ibdi.*

(4) *Ibdi.*

(5) *Ibdi.*

10.3.2 Culture Fisheries in the Study Area

There are no Fish Culture Zones (FCZs) located within the proposed submarine intake and outfall of the desalination plant (*Figure 10.1*). The closest AFCD designated FCZs are located at Tung Lung Chau (1 km from the proposed submarine intake and outfall) and Po Toi O (1.5 km from the proposed submarine intake and outfall, distance in the sea).

10.3.3 Capture Fisheries in the Study Area

a) Fishing Operations

The area and number of vessels operating in the Study Area during 2005 are presented in *Figure 10.2*. It should be noted that trawling was still allowed at time when the Port Survey was conducted in 2005. Moderate numbers of fishing vessels (100 – 400 vessels), mostly sampans, gill netters, and to a lesser extent long liner and shrimp trawlers, operated in waters around the proposed submarine intake and outfall in 2005. Elsewhere within the Study Area, moderate to high number of vessels (400 – 700 vessels) were recorded near Ninepin Island Group, Po Toi Island Group, Tap Mun and Port Shelter Island. Vessels operating in the Project Area are largely sampan (100 – 400 vessels), and to a lesser extent gill-netter (10 – 50 vessels), long-liner (1 – 50 vessels), stern trawler (1 – 10 vessels), shrimp trawler (1 – 10 vessels) hand liner (1 – 10 vessels) and purse seiner (0 – 50 vessels) in year 2005.

b) Fishing Production

The level of fisheries production in the waters around Tseung Kwan O Area 137 in 2005 is presented in *Figure 10.3*.

More recent data from the AFCD Port Survey 2006 indicated that fisheries production in waters around the submarine intake and outfall of the proposed desalination plant ranged 100 – 400 kg ha⁻¹ for adult fish accounting for HK\$ 2,000 – 10,000 ha⁻¹ in value (*Figure 10.4*). Key fish families recorded by Port Survey 2006 include Siganidae (Rabbitfish), Engraulidae (Anchovy), Sciaenidae (Croaker) and Sparidae (Seabream).

In comparison to other areas of the Hong Kong fishing ground, fisheries production in the waters around Tseung Kwan O Area 137 is moderate. Other areas of high fisheries production include areas around Cheung Chau, Lamma Island, the Ninepin Island Group, the Soko Islands, the Po Toi Island Group and Tap Mun.

c) Fish Fry Production

As presented in *Figure 10.5*, there is no record of fish fry catches within the direct footprint of the submarine intake and outfall pipelines. Other areas of fish fry production outside of the direct footprint of submarine intake and pipeline area include the Po Toi Island Group, Port Shelter and Tap Mun.

10.3.4 Spawning Areas

The Port Shelter and Southeastern waters were identified in 1998 as fisheries spawning grounds for high value commercial species (**Figure 10.1**)⁽¹⁾. The key species recorded spawning in the Port Shelter waters include *Apogon quadrifasciatus* (Twostripe cardinal), *Parapristipoma trilineatum* (Chicken grunt), *Sebastes marmoratus* (Common rockfish), *Trichiurus lepturus* (Hairtail), *Upeneus sulphureus* (Sulphur goatfish) and *Upeneus tragula* (Freckled goatfish). *Cynoglossus macrolepidotus* (Largescale tonguesole) and *Larimichthys crocea* (Yellow croaker) were recorded spawning in the Southeastern waters. The recognized spawning grounds at the Port Shelter and Southeastern waters are located > 2 km east and > 6 km south of the Tseung Kwan O Area 137, respectively.

10.3.5 Nursery Area

Nursery areas in Hong Kong waters that are important habitat area for a number of commercial juvenile fish and crustacean species have been previously identified to extent across southern waters from Lantau Island to Lamma Island and within Port Shelter waters⁽²⁾, whilst no nursery ground was identified within the direct foot print of the submarine intake and outfall of the proposed desalination plant (**Figure 10.1**). The identified nursery grounds are located distant from the waters off the Tseung Kwan O Area 137.

10.3.6 Artificial Reef Deployment

The AFCD has been undertaking a programme to enhance existing marine habitats and fisheries resources through the siting, construction and deployment of artificial reefs (ARs). Generally ARs provide hard bottom, high profile habitat in areas without natural cover and may potentially act as fish enhancement devices. Between 2001 and 2009, AFCD deployed a total volume of 103,260 m³ of ARs on seabed of Outer Port Shelter area as to prevent trawling and enhance habitat quality and marine resources. These ARs are located at least 5 km from the submarine intake and outfall of the proposed desalination plant.

10.3.7 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 fisheries sensitive receivers that may be affected by the Project activities are identified as follows:

- Recognized spawning and nursery ground of commercial fisheries resources at Port Shelter (located at least 2 km east from the proposed Project);
- Artificial reefs at Outer Port Shelter area (located at least 5 km east from the proposed Project)
- Fish Culture Zone at Tung Lung Chau (south to the proposed Project at a distance of about 1 km)

The locations of the sensitive receivers are shown in **Figure 10.1**.

(1) ERM (1998) Fisheries Resources and Fishing Operations in Hong Kong waters.

(2) Ildi

10.3.8 Fisheries Importance

Based on the baseline information provided above, the importance of the fisheries within the Study Area is evaluated. The fishing areas within and in the vicinity of the Project's footprint are considered to be of moderate commercial value. Whilst these waters are of moderate commercial value, considering the small size of these areas, the Project Area is considered as of low importance to the Hong Kong fishing industry.

According to *Annex 9* of the *EIAO-TM*, spawning and nursery grounds can be regarded as an important habitat type as they are critical to the regeneration and long-term survival of many organisms and their populations. No spawning and nursery area has been identified within the footprint of the proposed submarine intake and outfall of the Project and in the vicinity. The closest recognized spawning area is located at least 2 km east of the Project site.

The waters within the project's footprint and its vicinity also do not support mariculture activities. The closest FCZ is about 1 km away. Also there is a large separation between the project and the AR site in Outer Port Shelter. Overall, considering the separation distances between the project and various fisheries sensitive receivers, it is considered that the Project Area is of low importance to fisheries.

10.4 Assessment Methodology

A desktop literature review of baseline fisheries conditions was conducted for the purpose of establishing the fisheries importance of the waters in the vicinity of the proposed facilities at Tseung Kwan O Area 137. Information from the water quality impact assessment (*Section 6*) was examined to refine the size of the Study Area as that is potentially affected by perturbations to water quality parameters. This area, refined to within 7 km from the Project facilities, became the main focus for this fisheries impact assessment. The importance of potentially impacted fisheries resources and fishing operations within this area was studied. The potential impacts due to the construction and operation of the Project were then assessed (with reference to the *EIAO-TM Annex 17* guidelines) and the impacts evaluated (with reference to the criteria in *EIAO-TM Annex 9*).

10.5 Potential Impacts & Impact Assessment on Fisheries Resources

10.5.1 Construction Phase

- Direct disturbances of fisheries habitat and fishing ground; and,
- Perturbations to key water quality parameters.

a) Habitat Disturbance

Direct impacts to fisheries resources, habitats and fishing operations include disturbance caused by marine construction works, i.e. dredging and intake/outfall installation. The seabed area to be disturbed by dredging activities for the installation of submarine intake and outfall is very small (0.11 ha), and the area is of low fisheries importance, hence unacceptable impacts on the fishery resources and activities are not expected. In addition, marine construction works are expected to cause temporary disturbance (about 18 months for the

marine construction period) to a marginally larger marine construction works area. Owing to the very small area of the fishing ground temporarily lost to the marine construction works and due to its low fisheries importance, unacceptable impacts to local fisheries resources, habitats and fishing operations are not expected. Fisheries resources are expected to return to the area following the cessation of marine construction activities. Issuance of Marine Department Notice or other notification is expected to reduce the risk of collision of increased marine traffic and fishing vessels to within acceptable levels.

b) Perturbations to key water quality parameters

Indirect impacts to fisheries resources, habitats and fishing operations during the construction phase are primarily associated with the suspension of sediments due to the marine works. Potential impacts to water quality from sediment release due to marine dredging at submarine outfall and seawater intake, vessel discharges and land-based site runoff from construction workforce as described in the water quality impact assessment in Section 6.

During construction period, discharges and runoff from the site, particularly during civil works, excavation and backfilling works, will contain SS which could be a source of water pollution. Uncontrolled disposal of debris and rubbish such as packaging, construction materials and refuse and spillages of chemicals stored on-site, such as oil, diesel and solvents would also result in contamination of construction site runoff. However, it is anticipated that no unacceptable water quality impacts would arise from the land-based works if standard site practices and mitigation measures, described in *Section 6.9.1*, are in place and properly implemented.

Sediment or SS could be lethal or sublethal to fish and other fisheries resources through reduction in survivorship, growth rate and reproductive potential due to stress incurred by the need to constantly flush out deposited material. High SS level may clog gill structure of fish and cause physical damage and hinder transfer of oxygen. Fish egg and larval fish (fry) are more susceptible to deleterious impacts from sedimentation through burial and clogging of their respiratory systems. Adult fish are more likely to move away when they detect certain SS level and therefore less sensitive to effects from SS.

Increase in SS in water column combining with a number of other physical or biotic factors would reduce DO in water column. Elevated SS reduces light penetration, lowers the photosynthetic rate of phytoplankton and eventually would lower the rate of oxygen production in water column. Also, the release of inorganic substances from the sediments may cause eutrophication and algal bloom. Oxidation of dead algae may use up some of the oxygen in the water. If oxygen levels are depleted to low levels, fish, especially those in early life stages may be unable to tolerate such conditions and suffer hypoxia-induced mortality and / or stress including reduced feeding and growth rate.

According to the water quality impact assessment, surface runoff from land-based construction activities near the coastal waters would not cause any significant change in sediment, SS, organic and inorganic water pollutants. It is unlikely to cause unacceptable impact on the aquatic environment from an ecotoxicological point of view. Moreover, important fisheries resources, such as

fish spawning and nursery grounds, fish culture zones, and artificial reefs are at large distances (> 1km) away from the proposed works area. With the implementation of mitigation measures proposed in water quality impact assessment in *Section 6*, such as the use of silt curtain around grab dredger, and effective site drainage would minimize any impacts to the marine environment resulting from land-based construction activities. No adverse impact associated with water quality change is expected on fisheries resources during the construction phase.

10.5.2 Operation Phase

- Permanent loss of fisheries habitat;
- Impingement and entrainment of fisheries resources
- Change in water quality

a) Permanent loss of fisheries habitats

As mentioned in *Section 10.5.1 (a)*, the Project would result in a permanent loss of about 0.11 ha of seabed habitats due to the installation of submarine intake and outfall. There will be no loss of habitat in the water column. From the evaluation of the productivity and value of the local fisheries in *Section 10.3*, the affected area is considered as of low fisheries importance. Overall, the very small size and low fisheries importance of the affected area suggest that unacceptable impacts to fisheries caused by permanent habitat loss are not expected to occur.

b) Impingement and entrainment of fisheries resources

From a fisheries perspective, the high volume and velocity of inflowing seawater may have negative effects on fish, fish eggs and crustacean due to the physical damage caused by collisions with the screen (impingement) and due to their uptake to the process system (entrainment). The swimming speeds of juvenile and larval fishes vary greatly but are generally slower than the water velocity of the intake pipe. Owing to their larger size juvenile fish are generally more susceptible to impingement, whilst fish and crustacean larvae and eggs, zooplankton and phytoplankton are more exposed to entrainment, as their small size enables them to pass through the screen ⁽¹⁾ ⁽²⁾. Whilst it is acknowledged that the intake of seawater may minimally increase the natural mortality rate of fish larvae, crustaceans and fish eggs due to impingement and entrainment, it has been noted that the significance of such impacts is strongly dependent on the ecological sensitivity and the productivity of the impacted area as well as the rate of water intake. The rate of water intake is slow, and the design of the intake structure to minimize the potential of impingement and entrainment of eggs and larvae would be explored. Also no spawning and nursery area has been identified in the direct footprint and proximity of the submarine intake (*Section 10.3*), thus unacceptable impacts due to impingement and entrainment of fisheries resources is not anticipated. The recognized spawning and nursery

(1) Fernando Martinez-Andrade and Donald M. Baltz (2003). Coastal Marine Institute: Marine and Coastal Fishes subject to Impingement by Cooling-Water Intake Systems in the Northern Gulf of Mexico - An Annotated Bibliography. U.S. Department of the Interior.

(2) Turnpenny, A. W. H (1988) Fish impingement at estuarine power stations and its significance to commercial fishing. *Journal of Fish Biology*, Vol. 33, pp. 103-110.

grounds over 2km away are considered unlikely to be affected by the operation of this Project.

c) Change in water quality

According to the results of water quality impact assessment in Section 6, the discharge of RO concentrate (brine) is the primary concern in the operation of the desalination plant. The hypersaline brine sinks to seabed due to its greater density and potentially stratifies the receiving water body ⁽¹⁾ ⁽²⁾. Furthermore, antiscaling agents and a variety of chemical agents are added for pre- and post-treatment process to enhance flocculation or to avoid membrane deterioration. Antiscaling agents like polyphosphates, polymers of maleic acid, sulphuric acid and antifoaming agents like fatty acids, alkylated polyglycoles are used as chemical components which are discharged in the RO concentrate via the submarine outfall ⁽³⁾.

The effect of brine on salinity change in seawater and the secondary impact on marine environment has been documented in the literature ⁽⁴⁾. Changes in salinity and prolonged exposure to the chemical components used in desalination process would impede the growth and development of marine species. Although marine species are tolerant to the fluctuation in salinity by osmoregulation, the sudden augmentation of salinity from brine discharge could present an unfavorable condition for marine species. Studies showed that the abrupt increase in salinity and prolonged exposure to brine discharge may potentially impair osmoregulation and hinder the growth as well as reduce the survival rate of marine species ⁽⁵⁾ ⁽⁶⁾ ⁽⁷⁾. Also it has been reported that juvenile fish tends to be more sensitive to the brine discharge than adult fish ⁽⁸⁾ ⁽⁹⁾.

During operation phase, changes in the hydrodynamic regime and water quality due to the discharge of RO concentrate from the Project are anticipated, whilst there would be no temperature elevation from the discharge. A maximum of 464,000 m³/day of saline water would be discharged from the proposed desalination plant to the coastal water. According to the water quality impact assessment in *Section 6*, the salinity would be approximately 2 times higher than the ambient condition. As per the modelling results in *Section 6*, the

(1) Roberts DA, Johnston EL & Knott NA (2010) Impacts of desalination plant discharges on the marine environment: a critical review of published studies. *Water Research* 44: 5117 - 5128.

(2) Medeazza GLM (2005) Direct and socially-induced environmental impacts of desalination. *Desalination* 185: 57 - 70.

(3) Ibd

(4) Ahmed M and Anwar R (2012) An Assessment of the Environmental Impact of Brine Disposal in Marine Environment. *International Journal of Modern Engineering Research* 2: 2756 - 2761

(5) Yoon SJ and Park GS (2012) Ecotoxicological effects of brine discharge on marine community by seawater desalination. *Desalination and Water Treatment* 33: 240 - 247.

(6) Perez-Talavera J and Quesada-Ruiz J (2001) Identification of the mixing processes in brine discharges carried out in Barranco del Toro Beach, south of Gran Canaria (Canary Islands). *Desalination* 139: 277 - 286.

(7) Parry G (1960) The development of salinity tolerance in the salmon, *Salmo Salar* (L.) and some related species. *Freshwater fisheries laboratory, London*.

(8) Walsh SJ, Haney DC, Timmerman CM and Dorazio RM (1998) Physiological tolerances of juvenile robust redhorse, *Moxostoma robustum*: conservation implications for an imperiled species. *Environmental Biology of Fishes* 51: 429 - 444.

(9) Vega-Cendejas ME & Hernandez-Santillana M (2004) Fish community structure and dynamics in a coastal hypersaline lagoon: Rio Lagartos, Yucatan, Mexico. *Estuarine, Coastal and Shelf Science* 60: 285 - 299.

concentrated saline water would be localized within close proximity to the submarine outfall area and subsequently diluted by marine waters to the level as the feedwater. Thus, the impact would be localized and confined to close proximity of the submarine outfall. Fisheries importance at the waters in the vicinity of the desalination plant is low and the impact zone is at large distances away from the fisheries sensitive receivers (i.e. fish culture zones, fish spawning and nursery ground and artificial reefs). Literature on operating desalination plant indicates that potential adverse impact on fisheries due to the discharge of brine would be minimal, as marine fishes usually have a higher salt tolerance than their freshwater counterparts and they are fairly mobile ⁽¹⁾.

In addition, most antiscalants are classified as “inherently biodegradable” with relatively long half-life (e.g. one-month or longer), thus no adverse impact on invertebrate and fish species is anticipated as the exposure levels are considerably lower than the concentrations at which acute and chronic toxic effects can be observed (see *Section 6* for assessment criteria for antiscalants and related results). Given that non-metal and corrosion resistance materials, such as super-duplex stainless steel, would be adopted in the proposed desalination plant, corrosion products, namely copper and nickel, is not anticipated in the RO concentrate. Also chemicals in the RO concentrate are predicted to disperse quickly and be diluted to very low levels, if at all notable, upon discharge, hence the residual concentrations is unlikely to impact on fisheries resources. Besides, the discharged saline water would comply with the standards for effluents discharged into the coastal waters of Eastern WCZ, and the levels of other chemical constituents are predicted to comply with the relevant assessment criteria such as the WQO at the fisheries sensitive receivers. Therefore, the impact due to discharge of RO concentrate on fisheries resources is insignificant and considered acceptable.

10.6 Impact Evaluation

From the information presented above, the fisheries impact associated with the Project is not considered to be significant. An evaluation of the impacts accordingly to *Annex 9* of the *EIAO-TM* is presented below:

- **Nature of Impact:**
Permanent impacts are predicted to occur as a result of the loss of seabed fisheries habitats in the 0.11 ha area to be used for installation of submarine intake and outfall. Temporary disturbance to fishing grounds in the Project’s marine works area is expected as a result of the marine construction works. Temporary and localized impacts to pelagic and demersal fisheries resources as a result of perturbations to water quality are predicted to occur only in the immediate vicinity of the works area. No significant adverse impacts to fisheries resources are expected from the impingement and entrainment of fish and crustacean larvae or eggs in the intake system for the reverse osmosis process.
- **Size of Affected Area:**
The construction and operation of the Project is predicted to result in the permanent loss of approximately 0.11 ha of fishing ground on the seabed only. This loss is considered to be insignificant for local fishery resources and fishing

⁽¹⁾ Graham JB (2005) Marine biological considerations related to the reverse osmosis desalination project at the Encina Power Plant, Carlsbad, CA. pp. 108.

operations given the very small size of habitat lost and low fisheries importance in these waters.

- **Size of Fisheries Resources/Production:**
The value of the fisheries resources/ production of the marine waters around the submarine utilities is low in comparison to other waters in Hong Kong. The area affected is very small.
- **Destruction and Disturbance of Nursery and Spawning Grounds:**
No important spawning or nursery grounds have been identified within the Project Area. The recognized spawning and nursery area at Port Shelter lies at least 2 km from the proposed Project, and the recognized spawning ground at Southeastern waters is located at least 6 km from the proposed Project. As the water quality modelling results have indicated that impacts to water quality are predicted to be localised and short-term, impacts to the identified nursery and spawning grounds are not expected to occur.
- **Impact on Fishing Activity:**
Due to the small size of the affected area and the low fisheries importance, impacts on fishing activity are expected to be minimal.
- **Impact on Aquaculture Activity:**
No impact has been identified on the Fish Culture Zones, as temporary SS elevations and impact of RO concentrate discharge are compliant with the assessment criteria, and the closest fish culture zones are located at Tung Lung Chau and Po Toi O and they are located at least 1 km from the proposed Project, and thus are distant to be affected by the works .

10.7 Mitigation Measures

In accordance with the guidelines in the EIAO-TM Annex 17 on fisheries impact assessment, the policy adopted in this EIA for mitigating impacts to fisheries, 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, restoration (and possibly enhancement) of disturbed fisheries resources and habitats.
- **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.

Construction impacts to fisheries resources, habitats and fishing operations have largely been avoided (i.e. important spawning and nursery area of commercial fisheries resources, fish culture zones, artificial reefs) and reduced through proper planning and design of the works, in particular those associated with the dredging activities (e.g. adoption of trenchless method to reduce dredging volume and extent, and optimisation of project construction schedule). The main works have been

designed to confirm compliance with the assessment criteria at sensitive receivers and control water quality impacts to within acceptable levels and water quality mitigation measures will be implemented to further avoid/ reduce potential impacts (see *Section 6*). These measures are expected to control and reduce potential impacts to fisheries resources as well, and no fisheries-specific mitigation measures or compensation are thus required during construction.

No significant impacts to fisheries resources and fishing operations is expected to occur during the operation phase of the Project. Compliance with the relevant discharge standards to control water quality impacts to within acceptable levels is also expected to control impacts to fisheries resources. Furthermore, impingement and entrainment of fisheries resources will be reduced through appropriate design of the intake screens on the seawater intake. No additional fisheries-specific mitigation measures or compensation are required during operation.

10.8 Residual Impacts

Impacts to fisheries resources, habitats and fishing operations during construction and operation phase are considered to be within acceptable level. The permanent loss of 0.11 ha of seabed fisheries habitat for the installation of submarine utilities is considered to be of negligible significance and within acceptable level.

10.9 Cumulative Impacts

Information from publicly available sources suggested that the construction/ implementation programmes of the major projects listed in *Section 3.8* would coincide with the construction of the Project. These projects either do not have a marine element or are at large separation distances (> 3 km) from this Project. It is noted from the approved EIA reports of these projects that their impacts are not expected to be significant for fisheries resources in this part of Hong Kong, consequent no unacceptable cumulative impacts is anticipated. In addition, a discussion of potential cumulative water quality impacts arising from concurrent projects is provided in *Section 6*. Since it is unlikely for water quality mixing zone of this Project to overlap with those of other concurrent projects in this part of Hong Kong, it is thus concluded that cumulative impacts on water quality impacts and consequently on fisheries are not predicted to occur.

Given that the no operational impacts on fisheries resources are anticipated from the concurrent projects, operational cumulative impacts with other development in and around Tseung Kwan O Area 137 are not predicted to occur.

10.10 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.

Monitoring activities designed to detect and mitigate any unacceptable impacts to water quality during construction phase are also expected to serve to protect against unacceptable impacts to fisheries. The details of the water quality monitoring programme are presented in the EM&A Manual attached to this EIA.

10.11 Conclusions

A literature review of baseline information on commercial fisheries resources and fishing operations surrounding the waters of the proposed Project has been undertaken. Results from the review indicate that fisheries importance of the Project Area and its vicinity is low when compared to other waters of Hong Kong. Sensitive receivers including spawning ground, nursery ground, artificial reefs and Fish Culture Zone area have been identified; however, the assessment of water quality impacts demonstrated that these areas will not be affected.

During construction of the Project, direct impacts arising from the proposed marine works include loss of approximately 0.11 ha of seabed fisheries habitat due to seabed dredging. Given the small size of the fishing ground and temporal nature of the marine works, no significant direct impacts on fishing operations are expected to occur. Indirect impacts to fisheries resources related to perturbations to key water quality parameters are also expected to be insignificant as the predicted changes in water quality are short term and localised to immediate vicinity of the works area. Marine construction works have been designed to reduce potential impacts on the water quality which will, in turn, reduce impacts on fisheries resources. No fisheries-specific mitigation measures are required during construction.

No significant operational phase impacts to fisheries resources, habitat and fishing operations are expected to occur. Impingement and entrainment of fisheries resources will be mitigated through the appropriate design of the intake screens. Unacceptable impacts from discharges of RO concentrate are not anticipated to occur as the effects from these discharges will be localised to the lower layers of the water column in direct vicinity of the outfall. Compliance with the relevant discharge standards to control water quality impacts to within acceptable levels is also expected to control impacts to fisheries resources. No additional fisheries-specific mitigation measures are required during operation.

All of the potential construction and operational fisheries impacts identified are deemed acceptable.