10. FISHERIES

10.1 INTRODUCTION

10.1.1 This chapter assesses the impacts of the Project upon commercial fisheries.

10.1.2 The Project consists of the construction of an extension of the golf course on Kau Sai Chau, Sai Kung by 18 holes, from 36 to 54 holes. The golf course is basically constructed on hill slopes, thus it is a terrestrial rather than a marine project. No component of the Project would cause a permanent loss of marine habitat. The Project does, however, include three components that could affect the marine environment. These are a desalination plant to provide irrigation water and a temporary barging point for transport of building and excavated materials during construction. The potential impacts of these project components and the potential for degradation of marine water quality by surface runoff are the key concerns of this assessment.

10.1.3 The objective of this assessment is to identify existing fisheries resources in the Fisheries Assessment Area so as to evaluate any impacts of the Project at both construction and operational phases and, where required, to propose mitigation measures to minimize adverse impacts. The assessment follows the criteria and guidelines in Annexes 9 and 17 of the EIAO TM and the EIA Study Brief No. ESB-064-2000.

10.1.4 The assessment is mainly focused on the two marine structures for the proposed golf course and the receiving water bodies. These are the temporary barging point and the permanent desalination plant. The impacts from site formation are covered in the chapter for terrestrial ecological assessment in this report and in this chapter with respect to fisheries.

10.1.5 The nature and scope of the Project is described in **Section 2** of this Report. In accordance with the EIA Study Brief No. ESB-064-2000, this section identifies and assesses the fisheries impact associated with the Designated Project (DP) described in Section 2.

10.1.6 There are no scheduled concurrent designated projects in the vicinity of the proposed golf course extension, temporary barging point or desalination plant during the construction or operation phase.

10.2 Environmental Legislation, Standards and Guidelines

10.2.1 The following Hong Kong SAR Government legislation, standards and guidelines are relevant to the assessment of impacts to fisheries associated with the construction and operation of the project:

- Environmental Impact Assessment Ordinance (Cap.499) and the Technical Memorandum on Environmental Impact Assessment Process (EIAO TM);
- Fisheries Protection Ordinance (Cap. 171) and its subsidiary legislation, the Fisheries Protection Regulations;
- Marine Fish Culture Ordinance (Cap. 353) and associated subsidiary legislation; and
- Water Pollution Control Ordinance (WPCO) and its supporting regulations and statements.

10.3 Environmental Baseline Methodology

10.3.1 The proposed new golf course is located on eastern Kau Sai Chau, Sai Kung (**Figure 10.1a**). The assessment area for fisheries includes all areas within 500 m from the project areas (**Figure 10.1b**), which is in Port Shelter Water Control Zone (WCZ) in HKSAR.

10.3.2 Literature was reviewed to provide information on existing conditions in the assessment area, and to identify fisheries resources that may be affected by the Project. Literature review included Government and private sector reports, independent and Government published literature and academic studies. Literature review included the following:

- Port Survey 96/97 (AFCD 1998);
- Port Survey 2001-2002 (AFCD 2003);
- AFCD annual reports

10.4 Assessment Methodology

10.4.1 Impacts to fisheries were assessed based on the guidelines in Annexes 9 and 17 of the TM, the consultants' local knowledge and international standards.

10.4.2 The significance of fisheries impacts is evaluated based primarily on the criteria set forth in Annex 9 of the TM:

- Nature of impact;
- Size of affected area;
- Loss of fisheries resources/production;
- Destruction and disturbance of nursery and spawning grounds;
- Impact on fishing activity; and
- Impact on aquaculture activity.

10.4.3 Impacts are generally ranked as "minor", "moderate" or "severe", although in a few cases a ranking of "minimal" (less than "minor") may be given. The ranking of a given impact would vary based on the criteria listed above. For example, an impact might be ranked as "minor" if it affected only common species and habitats, or if it affected only small numbers of individuals or small areas, whereas it might be ranked as "severe" if it affected rare species or habitats, large numbers of individuals or large areas. The major factors giving rise to a ranking are explained in the text. As noted in Annex 16 of the TM, a degree of professional judgment is involved in the evaluation of impacts.

10.5 BASELINE CONDITIONS

10.5.1 The proposed golf course lies within the Port Shelter WCZ. There are some sites of fisheries importance within the Fisheries Assessment Area for the present Project and within the Port Shelter WCZ (**Fig. 10.2a**).

Sites of Fisheries Importance

10.5.2 The following sites of fisheries importance are located within or on the boundary of the Fisheries Assessment Area and are shown in **Figure 10.2a**:

- Tiu Cham Wan Fish Culture Zone.
- Tai Tau Chau Fish Culture Zone.
- Kai Lung Wan Fish Culture Zone.

10.5.3 Three additional sites of fisheries importance are located in the Port Shelter WCZ and are shown in **Figure 10.2a**:

- Kau Sai Fish Culture Zone.
- Ma Lam Wat Fish Culture Zone.
- Leung Shuen Wan Fish Culture Zone.

10.5.4 A fisheries protection area has been proposed for establishment in Port Shelter (**Figure 10.2b**). Within the fisheries protection area fishing would be regulated and artificial reefs would be deployed. A "No-take Zone" within the fisheries protection area is also proposed at outer Port Shelter. Although designated to provide specific controls on fishing activities, the area can be regarded as a sensitive water body and any impacts should be minimised as far as possible to achieve compliance with the Water Quality Objectives.

10.5.5 No other designated or recognized sites of fisheries importance lie within the assessment area or the Port Shelter WCZ

Capture Fisheries

10.5.6 Detailed data on HKSAR capture fisheries in the fisheries study area were taken from the results of Port Survey. Port survey is the most comprehensive fisheries study conduced by AFCD every few years.

10.5.7 Within HKSAR waters, the highest yields for local fisheries were mainly derived from the eastern and northeastern coasts as indicated in the AFD Port Survey 96/97, while the western waters were comparatively less productive.

10.5.8 The Port Shelter WCZ is within the "Port Shelter" (SE10) sector (**Figure 10.3**). In the 96/97 Port Survey "Port Shelter" sector ranked 11th of the 12 sectors in terms of average adult fish production, and 10th in terms of average production value (**Table 10.1**). However, the fry production from this sector ranked 2nd in Hong Kong. Fishing in Port Shelter is mainly done from small-sized vessels (vessels not exceeding 15 m).

10.5.9 More recent data were extracted from the latest Port Survey in 2001-2002. In this report a uniform grid of 720 ha cell size was overlaid on Hong Kong waters and the fisheries related information (e.g. production, vessel number, catch value) was presented in the form of several categories (**Figure 10.4**). For easy reference, in the present FIA study the rows and columns of the grid are named by number and alphabetic order respectively, and a reference number is assigned to each cell.

10.5.10 The results of the 2000/2001 Port Survey show that the fisheries production in Port Shelter is generally distributed in a gradient of increasing production from the inner bay to the outer bay. The waters at the innermost part of Port Shelter (Grid cells Q9, R9 & S9) produced 50 to 100 kg/ha, the waters around Kau Sai Chau and Sharp Island (Grid cells P10, Q10, R10, S10, R13, S13) produced 100-200 kg/ha, the waters between Kau Sai Chau and Small Palm Beach as well as between Kau Sai Chau and High Island (Grid cells Q10 to T10; Q12, S12, T12, R14) produced 200 – 400 kg/ha, and the waters around Shelter Island (Grid cells R12) produced between 400 – 600 kg/ha.

10.5.11 Of the fishing areas in SE10 (Port Shelter), those around Kau Sai Chau are the focus of this assessment (i.e. areas 193, 194 & 199). The proposed desalination plant would be located in Fishing Area 193, while the temporary barging point would be located in Fishing Area No. 194 (**Figure 10.3**).

Table 10.1 Fishing Areas within SE10 "Port Shelter" sector

Fishing Area	Area	Total Production	Total fish fry	Total value	Production /ha	Fish fry/ha	Value/ha	Rank of Production / ha	Rank of Fish fry/ha	Rank of Value/ha

121B	Mirs Bay	17,495.75	7,363.44	\	179,000.00	0.42	\	10.23	117	\	178
147	Bate & Fung Head	2,502.55	5,885.31	45,938.65	373,642.94	2.35	18.36	149.3	172	67	170
148	Tung & Sai Wan	392.87	44,334.48	1,596.49	259,836.70	112.85	4.06	661.38	86	85	156
182	Clear Water Bay	150.94	25,390.89	246,851.56	1,511,295.39	168.22	1,635.40	10,012.40	58	2	20
183	Lung Ha Wan	1,160.51	29,767.67	5,000.00	771,847.22	25.65	4.31	665.09	144	83	155
184	Sheung Sze Wan	123.06	20,041.39	21,897.51	464,836.06	162.85	177.95	3,777.18	61	27	66
185	Shelter Island	400.99	114,592.35	68,301.51	3,332,517.36	285.78	170.33	8,310.79	27	28	24
186	Silver Strand	246.25	93,140.53	36,440.32	2,583,979.73	378.24	147.98	10,493.39	20	30	17
187	Pak Shui Woon	268.34	30,490.23	10,432.45	1,405,936.64	113.63	38.88	5,239.43	84	51	51
188	Hebe Haven	167.61	17,952.76	4,561.40	615,498.53	107.11	27.21	3,672.15	88	64	71
189	Ma Nam Wat	449.84	44,771.57	115,355.45	1,647,162.48	99.53	256.44	3,661.67	94	21	73
190	Sai Kung	127.03	38,697.06	137,901.31	1,389,551.79	304.62	1,085.56	10,938.58	25	7	14
191	Yeung Chau	134.01	42,957.33	119,194.41	1,481,652.77	320.55	889.44	11,056.25	22	9	11
192	Sharp Island	389.31	39,870.00	445,936.92	2,592,496.36	102.41	1,145.46	6,659.22	90	6	32
193	Kau Sai Chau W	380.98	22,241.11	11,777.77	860,669.41	58.38	30.91	2,259.10	121	60	101
194	Kau Sai Chau E	189.45	17,418.48	101,364.95	658,251.27	91.94	535.04	3,474.46	99	13	76
195	Tiu Chung Chau	632.48	29,751.83	11,777.77	734,421.40	47.04	18.62	1,161.18	128	66	134
196	Wong Chuk Wan	149.92	\	\	\	\	\	\	\	\	\
197	Tai Mong Tsai	64.69	2,508.31	104,179.69	328,083.33	38.78	1,610.48	5,071.72	136	3	54
198	Tsam Chuk Wan	129.71	2,508.31	104,179.69	328,083.33	19.34	803.16	2,529.30	152	10	95
199	Urn Island	109.79	24,696.50	627,340.31	2,153,770.35	224.94	5,713.88	19,616.77	40	1	2
200	Sham Tuk Mun	84.62	1,420.18	104,179.69	277,812.50	16.78	1,231.15	3,283.05	154	5	81
201	Tai She Wan	264.3	45,864.27	22,677.15	458,176.97	173.53	85.8	1,733.55	56	35	115
202	Leung Shuen Wan	128.58	63,203.72	62,245.59	1,331,404.47	491.56	484.11	10,354.80	15	15	19
203	Nam Fung Wan	117.37	60,502.97	50,989.86	1,220,092.28	515.51	434.45	10,395.68	14	18	18

204	Futaupun & Wang Chau	1,097.46	40,229.07	40,033.19	1,091,257.24	36.66	36.48	994.35	138	55	138
205	Basalt & Bluff Islands	2,122.77	52,841.48	112,661.31	1,720,289.50	24.89	53.07	810.4	145	44	149
206	Pak Lap	104.78	3,390.59	7,441.41	130,764.72	32.36	71.02	1,247.96	141	41	132
207	Po Pin Chau	858.63	3,100.48	7,441.41	116,369.37	3.61	8.67	135.53	171	80	171
208	Long Ke Wan	139.64	\	\	\	\	\	\	\	\	\
209	Fan Tsang Chau	632.19	387.07	\	7,000.00	0.61	\	11.07	174	\	177
210	Tai Yue Ngam	903.4	360.04	\	19,843.75	0.4	\	21.97	178	\	175
SE10	**Port Shelter**	**32,119.84**	**925,679.42**	**2,627,697.77**	**30,045,543.86**	**28.82**	**81.81**	**935.42**	**11**	**2**	**10**

10.5.12 Five locations within Port Shelter were reported as home ports in the 2001/2002 Port Survey, including Pak Sha Wan/Ma Nam Wat, Tai Tau Chau/Kai Lung Wan, Leung Shuen Wan, Sai Kung, and Kau Sai. Only one of them (Tai Tau Chau/Kai Lung Wan) lies on the boundary of the Fisheries Assessment Area, while others lie outside.

10.5.13 Among these, Sai Kung is the biggest home port. 160 out of the 4,857 fishing vessels in Hong Kong claimed Sai Kung as homeport in 96/97 Port Survey. During the 2001/2002 Port Survey, 89 vessels were interviewed at this port. But Sai Kung is still a small home port when compared with the largest homeport in Hong Kong, Aberdeen where there were 701 vessels were interviewed for the 96/97 Port Survey.

10.5.14 Tai Tau Chau/Kai Lung Wan is the closest homeport to the golf course location. In the 96/97 Port Survey 129 of the 4857 fishing vessels in Hong Kong claimed it as homeport, and all were less than 15 m in length. The fish catches from this homeport ranked 18 among the 38 ports in Hong Kong (128,128 kg). However, the fish fry production was the highest in Hong Kong (2,586,831 tails). High levels of fry production account for the higher ranking of this port (ranked the eighth) in terms of the total value of the catches (HK$ 10,219,531.27). 27 fishing vessels from Tai Tau Chau/Kai Lung Wan were also interviewed for the 2001/2002 Port Survey.

10.5.15 The focal areas for capture fisheries issues are the marine water around Kau Sai Chau, covering the 500 m Fisheries Assessment Area, in which the desalination plant and temporary barging point would be located. These areas are covered by Fishing Areas 193 (Kau Sai Chau W), 194 (Kau Sai Chau E) and 199 (Urn Island). These three fishing areas cover 680.22 ha. The production was 64,356 kg (= 94.6 kg/ha) at a value of HK$ 3,672,691 (= 5,399.27 HKD/ha) (**Table 10.1**). Of all fishing areas in Hong Kong, Fishing Area 193, 194 & 199 ranked 121st, 99th and 40th in terms of production/ha, respectively and 101st, 76th and 2nd in terms of value/ha respectively.

10.5.16 It is noteworthy that Fishing Area 199 Urn Island ranked first in Hong Kong in terms of fish fry production per hectare (5,714 tails/ha). This contributed to its high ranking (2nd in Hong Kong) for total value/ha among Fishing Areas in all of Hong Kong.

10.5.17 The 1996-97 data revealed that the dominant taxa reported from the areas as landed catches are typically of low economic value. In rank order (by weight), the majority of the top 10 fish types caught were mixed fish, *Siganus oramin* (rabbitfish), Sardinella jussieu (Sardine), *Argyrosomus* spp. (Croaker), *Sebasticus marmoratus* (Rockfish), and *Platycephalus indicus* (Flathead) (**Table 10.2**).

Table 10.2 Top ten adult fish caught in the three Fishing Areas

Fishing Area	Rank order of catch by Adult Fish Weight									
	1	2	3	4	5	6	7	8	9	10
193	MIXSPP (Mixed fish)	ARGSPP (Croaker)	CARANX (Scad)	SPARID (Sea breams)	SARJUS (Sardine)	MCRAB (Mud crab)	NEMJAP (Melon coat)	SIGORA (rabbit fish)	LOLEDU (Squid)	PLAIND (Flathead)
194	MIXSPP (Mixed fish)	SARJUS (Sardine)	SIGORA (rabbit fish)	SPARID (Sea breams)	LOLEDU (Squid)	SEBMAR (Rockfish)	MCRAB (Mud crab)	ARGSPP (Croaker)	NEMJAP (Melon coat)	CARANX (Scad)
199	SIGORA (rabbit fish)	MIXSPP (Mixed fish)	SEBMAR (Rockfish)	SPARID (Sea breams)	PLOANG (Marine catfish)	SEPPHA (Cuttle fish)	MCRAB (Mud crab)	LOLEDU (Squid)	LOLIGO (Squid)	MONCHI (File fish)

10.5.18 As reported in the Port Survey 2001/2002, the catches from the grid cells in which the desalination plant (Grid Cell R10) and temporary barging point (Grid Cell S10) would be located (direct impact grid cells) (**Figure 10.4**) were not high, having 100-200 kg/ha adult fish production. Fishing vessels operated in these two grid cells include single trawler, shrimp trawler, gill netter, long liner, purse seiner, miscellaneous craft and Sampan. Sampan was the dominant fishing vessel in both grid cells, as all other fishing vessels were less than 10 in number. About 50-100 fishing vessels operated in S10, while 100-400 fished in R10. Among these, however, only less than 10 were over 15 m in length in each grid cell.

10.5.19 The top species (by weight of fish) in these two grid cells in the 2000-2001 Port Survey was rabbitfish, with production of 40-60 kg/ha in R10 and 20-40 kg/ha in S10.

10.5.20 Fishing Area 199 Urn Island ranked the highest in Hong Kong for fish fry production per hectare during the 96/97 Port Survey. Grid cell S10, in which Urn Island is located, also ranked high in terms of fry production in the 2001/2002 Port Survey. It is one of the two grid cells in Hong Kong having fish fry production of 500-1000 tails/ha. The other is T5 at Grass Island. Fish fry production from these two grid cells ranked second behind the highest fish fry production in Hong Kong, which was recorded at Starling Inlet and Double Haven areas. Fish fry production of less than 50 tails/ha at R10 was much lower than that at S10.

10.5.21 For the economic value of the production, both cells ranked medium in Hong Kong waters, i.e. 2000-5000 HK$/ha.

10.5.22 These figures demonstrate that among the two direct impact grid cells, S10 (in which the proposed temporary barging point is located) is of medium to high importance to capture fishing operations in Hong Kong, while R10 (proposed desalination plant) is of medium importance.

Mariculture

10.5.23 The predominant type of mariculture in Hong Kong is marine fish culture which involves rearing of marine fish from fry or fingerlings to marketable size in cages suspended from floating rafts usually located in sheltered coastal areas. Common species under culture include green grouper, brown-spotted grouper, Russell's snapper, mangrove snapper, red snapper, cobia and pampano.

10.5.24 Marine fish culture is protected and regulated by the Marine Fish Culture Ordinance (Cap. 353) which requires all marine fish culture activity to operate under licence in designated fish culture zones. Currently, there are 26 fish culture zones in which 1,125 licensed operators occupy a total sea area of 209 ha. In 2004, the production from local marine fish culture was 1,540 tonnes (of value 79 million HK dollars), constituting 9.1% of the local live marine fish consumption.

10.5.25 Water quality in Marine FCZs is regulated under the WPCO and its supporting regulations and statements. Within Fish Culture Subzones, the dissolved oxygen level should not be less than 5 mg l^{-1} 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 mg l^{-1} within 2 metres of the seabed for 90% of the sampling occasions during the year, and the annual geometric mean of *E. coli* should not exceed 610/100 ml.

10.5.26 Of the 26 Fish Culture Zones (FCZs) in Hong Kong, there are three gazetted FCZs within the Fisheries Assessment Area for the Project. FCZs in the fisheries assessment area include Tiu Cham Wan FCZ, Tai Tau Chau FCZ, and Kai Lung Wan FCZ. Three additional fish culture zones lie within the Port Shelter Water Control Zone, i.e. Kau Sai FCZ, Ma Lam Wat FCZ and Leng Shuen Wan FCZ.

10.5.27 Tiu Cham Wan FCZ is the nearest to the Project area. It is located in a sheltered bay just below the hill slopes adjacent to the proposed golf course. However, it has not been utilized for mariculture for many years there are no fish culture rafts at the site. The other two FCZs, i.e. Tai Tau Chau east of Kau Sai

Chau and Kai Lung Wan west of Kau Sai Chau, were located distant from the proposed golf course near the boundary of the fisheries assessment area.

10.6 FISHERIES SENSITIVE RECEIVERS

10.6.1 Fisheries sensitive receivers identified within the Study Area include the followings:

- Grid cell R10 and S10; and
- Six fish culture zones, particularly Tai Tau Chau and Kai Lung Wan FCZs.

10.7 IMPACT ASSESSMENT

Identification of Environmental Impacts

10.7.1 Construction of the golf course, the desalination plant and the temporary barging point would include site preparation and clearance, excavation, dredging, backfilling, and structure construction.

10.7.2 Potential sources of impact during the construction phase include:

- Temporary loss of fishing grounds; and
- Marine water quality impact caused by coastal construction.

10.7.3 Potential sources of impact during the operation phase include:

- Marine water quality impact caused by the discharge from the desalination plant; and
- Marine water quality impact caused by runoff from the future golf course.

Construction phase

10.7.4 This section of the report considers the potential impacts of project construction on capture fisheries and mariculture. The marine construction activities include the desalination plant works which involve dredging and backfilling, and the temporary barging point. Other activities at the construction site include site preparation and clearance and excavation.

Fishing ground loss

10.7.5 In order to reduce the traffic burden on the only road on the existing golf course, a temporary barging point will be constructed on the east side of Kau Sai Chau. It will be used for delivery of supporting materials or equipment for construction to the construction site. The dimension of this temporary pier would be 20m in width x 40m in length. The temporary barging point will be a floating-pontoon (see **Figure 9.8**), to replace the pile-supported design from the early stage of this study (see **Figure 9.7**). The entire pier is designed to float thereby avoiding any and all direct impacts due to loss of seabed. No filling works would be required for the barging point. Although there would be no direct loss of seabed area, the entire shallow sea area occupied by this barging point (800 m^2) would be unavailable for fishing operations. Construction of the proposed golf course would require 1 year. After the construction works are finished, the temporary barging point would be removed. The area occupied by the barging point would again be available for capture fisheries after the 1-year golf course construction period.

10.7.6 Besides the temporary barging point, a desalination plant would be constructed on the west side of Kau Sai Chau, beside the existing ferry pier. The desalination plant itself would affect terrestrial habitats only but two pipelines would extend into the sea. These would collect seawater and discharge effluent form

the desalination plant, respectively. The two pipelines would be installed beneath the seabed surface by first dredging and then backfilling to cover the two pipelines. There would be a short-term and temporary seabed loss during the construction of these two pipelines.

10.7.7 The dimension of the intake pipelines would be 110 m in length by 60 cm in diameter. The discharge pipeline would be 40 m in length and 30 cm in diameter. A dredging area of about 1,500 m^2 would be required for installation of the pipelines. Construction works on the pipelines would be completed within 3 months (for dredging, installation and backfilling). The area disturbed by the dredging works would not be available for fisheries during this period.

10.7.8 The fisheries production and catch value in grid cells R10 and S10 were ranked as medium and medium to high. However, the small area of fishing ground affected (about 1,500 m^2 (0.15 ha) & 800 m^2 (0.08 ha) or 0.02% of R10 and 0.01 % of S10 grid cells), the temporary nature of the loss, and the short period of impact duration (about 1 year at the barging point and about 3 months for the pipelines) must all be considered when evaluating fisheries impact. Based on these considerations, the impact of fishing ground loss is ranked as minimal. This temporary loss would not be significant to the proposed fisheries protection area which covers all of Port Shelter.

Marine water quality

Desalination plant

10.7.9 Installation of the two pipelines for the desalination plant will involve dredging of approximately 1,500 m^3 seabed materials and backfilling, and might lead to re-suspension of sediments. Without controls or mitigation measures, suspended solids would increase the turbidity of the waters thus reducing the amount of light reaching the sea bed. As the suspended particles settle they could bury sessile organisms, or settle on the surface of other benthos. Re-suspension of sediments would also reduce oxygen levels and potentially release pollutants into the water column. All these consequences could affect the health and survival of marine organisms, including commercial species, as well as mariculture species if the sediments are carried to Fish Culture Zones by currents. These impacts would be short-term (less than 3 months), small-scale and localised in nature, and are therefore mitigable. As discussed in Section 6 of this report (**Section 6.9**), 50mg/L is adopted as the criteria for suspended solid for fish culture zone. This standard has been applied in many other studies in which impacts on fish culture zone in Hong Kong waters were assessed (Hyder 2002). A WQO criteria of 1.485 mg/L is adopted in this EIA for elevation of suspended solids (= ambient SS 4.95 mg/L x 30%). This makes the criterion much more stringent than that previously adopted for assessing SS impacts on FCZ in Hong Kong waters (i.e. SS level of 50 mg/L, see Hyder 2002). The nearest location of water quality receivers would be the bedrock about 80 m south of the pier with some scattered coral colonies on top. As shown in **Table 6.10** in **Section 6.9**, the dredging period would be around 50 days (20 days for closed grab dredging and 30 days for backhoe excavation). With the application of silt curtains in both closed grab dredging and backhoe excavation, the elevation of SS at the bedrock would be lower than 1.094 mg/L, which is below the proposed SS criteria for the present study of 1.485 mg/L, and well below the allowed elevation based upon the criteria of 50mg/L adopted in FCZ (i.e. 45.05 mg/L = criteria of 50mg/L – ambient 4.95 mg/L). As the SS level would decrease with distance from the source, the elevation of SS at the nearest FCZ (Kai Lung Wan, 450m away) would be much lower than 1.094mg/L. Furthermore, the DO depletion due to dredging would be smaller than 0.00421 mg/L which is undetectable. Since the sediment testing results showed that marine sediments to be dredged were classified as Category L and no exceedance of the respective LCELs were recorded (please refer to **Chapter 7** of this report for details), the potential impact of contaminants released from the sediments would be minimal. In other words, the potential release of metals and organics from sediment into the water column would not result in adverse impacts during the dredging works. If proper mitigation measures are implemented, the residual impacts would not be expected to be detectable on the marine communities of western Kai Sai Chau or on any FCZs, in particular Kai Lung Wan FCZ 450 m from the works area. Impacts would be largely self-correcting after project completion without active restoration efforts. There would also be potential impacts from the dumping, leakage or spillage of chemicals from the working vessels, but these potential impacts could be controlled by good site practice. The potential impact is ranked as minor. Mitigation for these impacts would be required as precautionary protective measures for Kai Lung Wan FCZ (see **Section 10.8** below for details).

Golf course site

10.7.10 Siltation is could affect marine water quality. Sediment would be generated by construction works on the proposed golf course site, foremost among these being earthworks for formation of the fairways, tees and greens. Cut and fill earth works, if not properly controlled could cause sediment runoff.

10.7.11 Construction site runoff can contain sediments, organic substances, oil, grease and solvents that can affect marine ecology and therefore fisheries. These substances can increase turbidity, decrease oxygen levels and introduce contaminants, potentially injuring or killing benthic organisms (such as shellfish) and driving motile organisms (such as fishes) away from the vicinity and thereby causing a short-term degradation of fisheries resources. If the pollutants are carried by currents

to Fish Culture Zones, mariculture species might also be affected.

10.7.12 Impacts would be short-term and self-correcting after project completion even in the absence of active restoration efforts. This was the case following construction of the existing 36-hole golf course, which required a larger earthmoving operation than would the proposed 18-hole extension. Construction site runoff could enter the sea either through existing watercourses on Kau Sai Chau or through the temporary drainage system of the construction site. It was stated clearly in both the water quality assessment section and the terrestrial ecology section of this report that only minimal disturbance would affect the water courses. There would also be a temporary drainage system which would receive flows from all areas subject to earth works. As stated in **Section 6** Water Quality Assessment of this report, the majority of the heavy construction works, in particular, the cut and fill earth works, would be conducted within the 2005-2006 dry season. This means that the exposed cut and fill slopes would be covered with new turfgrass prior to the onset of the wet season in 2006. This would minimise runoff because the slopes would be stabilised by vegetation. Any runoff would be retained for turf grass irrigation. In addition, there would be measures to control sedimentation such as silt fencing. Unacceptable marine water quality impacts are not be predicted. The impacts of such runoff would be ranked as minor but mitigation measures are required.

Temporary barging point

10.7.13 To avoid marine water quality impacts, a floating barging point (see **Figure 9.8** of this report) is proposed as an alternative to the originally proposed barging point on piles (see **Figure 9.7** of this report). The alternative floating barging point would require no underwater construction works and no piling. Construction works would take place on land above the high-tide line. This would avoid any construction works in the shallow waters of the coastal zone or on the seabed. It would also avoid production of sediment-bearing waste water during piling works. Impacts on marine water and fisheries resources would thus be avoided.

Operation phase

10.7.14 This section of the report considers the potential impacts of Project operation on capture fisheries and mariculture.

Water quality change by the desalination plant

10.7.15 The water quality assessment showed that the operation phase effluent from the desalination plant would have only limited and localized impacts on marine water quality.

10.7.16 During the dry season (November to March each year, about 5-6 months) the desalination plant would operate and produce freshwater for turfgrass irrigation. During the wet season, for around 6-7 months, the plant would be shut down except for maintenance or infrequent contingencies. Thus the plant would be operated for less than half of each year. Seawater would be taken in (about 3,816 m^3/d) and the water within would be extracted through a Reverse Osmosis process (maximum 1,450 m^3/d). The remaining seawater would have higher salinity and would be discharged as return flow. The discharge flow rate would be 0.0168 m^3/s.

10.7.17 The main difference between the discharge and the normal seawater would be elevated salinity in the discharge. It was reported in the water quality assessment section of this report that about 40% of freshwater will be extracted out of the seawater, and the salinity of the discharge would be 56.8 ppt. This represents an increase of 22.7 ppt when compared with the ambient salinity of 34.1 ppt. This increase would dilute very quickly, dropping to 2.643 ppt above normal at the edge of the near field region (about 5.06 m from the discharge point), and to 1.103 ppt above normal about 200 m away and south of the pier. This scenario complies with the water quality criterion of no more than a 10% change. The increase itself is also negligible because the ambient salinity also fluctuates greatly with varying amounts of rainfall. The nearest site of fisheries importance would be Kai Lung Wan FCZ which is located about 500 m north of the pier. The change in salinity there would be undetectable. Besides salinity, other related WQO parameters (which will be affected by the desalination plant) including SS elevation (0.695 mg/L vs the tolerance criteria of 1.485 mg/L), sediment deposition rate (0.030 kg/m2/day vs the criteria of 0.1kg/m^2/day), and oxygen depletion (0.0027 mg/L, undetectable) at the nearest water quality receivers (80m, the bedrock with corals) are also well within the WQO requirements. The changes in these water quality parameters at Kai Lung Wan FCZ would also be much lower or undetectable.

10.7.18 The active ingredient in the anti-scalant proposed for use in the desalination plant would contain no heavy metals or hazardous substances. None of the substances in this product are considered carcinogenic and the potential toxicity is low. The concentration of anti-scalant prior to discharge was expected to be 3 mg/

L. According to the dilution factor (**Table 6.9** in Water Quality Assessment), this concentration would drop to 0.168 mg/L at 50 m distance, and further dilute to 0.146 mg/l at 200 m. The anti-scalant it is not predicted to have adverse impacts on aquatic biota given the low toxicity and low initial concentration (**Appendix 6.3** in Water Quality Assessment Section). Minimal impact is predicted and mitigation measures are not required.

Water quality impacts

10.7.19 Runoff from golf course turfgrass has been shown over 9 years of water quality monitoring to be free of fertilizers and pesticides (see **Section 6.4**). Based on this performance history, it is unlikely that detectable concentrations of such chemicals would to enter the sea or affect marine ecological or fisheries resources.

10.7.20 Fertilizes are mostly inorganic nutrients (nitrogen, phosphorous, potassium). Should large volumes of such nutrients be introduced to the sea, there would be a risk of exacerbating the problem of red tide by increasing concentrations of nutrients in seawater. Due to proper handling and applications of fertilizers at Kau Sai Chau this has not happened during 10 years of operation. Although all pesticides used at Kau Sai Chau are selected from a list of pesticides approved for use in Hong Kong by AFCD, any pesticide is potentially harmful to non-target organisms. Thus presence of pesticides in marine water could be a threat to marine ecology and/or commercial fisheries. Due to proper training of personnel and handling and application of pesticides at Kau Sai Chau, this threat has not materialised.

10.7.21 The use fertilizers and pesticides will be controlled and minimized by following a Turfgrass Management Plan which has been proven at the existing golf course over the last 10 years. During that time there was never an incident where marine or freshwaters around/or Kau Sai Chau showed levels of nutrients or pesticides that were not in compliance with the WQO. Although it is not possible to improve a flawless record, the amount per unit area of fertilizers and pesticides applied on the new golf course can be reduced by 20-30 % due to the higher pest resistance of the proposed Paspalum turfgrass.

10.7.22 With proper management practices, losses of nitrogenous fertilizer would be minimal, as they have been for the past decade. The nitrogen source used in the existing golf course is a slow-release formulation, and is rapidly absorbed by the soil. Based on the marine water quality monitoring results of the existing course during the last decade, the absorption by turfgrass of nitrogen and phosphorus is as high as 97% and 99%, respectively. Before reaching marine waters, any remaining nutrients carried by runoff must pass over lands of varying widths that are densely vegetated with natural grass, shrub and/or woody vegetation. Because these areas have been protected from fire since construction of the golf course, they support increasingly dense stands of vegetation that produce increasing volumes of leaf litter. This contributes to development of soil and increases infiltration of surface water. These areas act as effective natural buffers to absorb nutrients, thereby preventing their entry to the surrounding marine waters. This buffering effect probably explains the absence of any impact of golf operations on nutrient levels in marine waters.

10.7.23 Under the current drainage plan, most runoff from the fairways would not be discharged to the sea, but would be collected by a closed drainage system and transferred to the existing reservoir at the north end of Kau Sai Chau for recycling as irrigation water. This is to supplement the freshwater supply from the desalination plant. The only exception is the runoff from Hole 5 and part of Hole 6, which will be discharged to an existing marsh. The marsh is currently receiving runoff from Holes N15, and S1 to S9 of the existing golf course, and the marsh overflows to the sea. After the new golf course is completed, the proposed closed drainage system of the new golf course would also collect the runoff from some of the holes on the existing golf course, including S1, S7 and S9. Even with the extra runoff from Hole 5 and Hole 6 of the new golf course, it is estimated that there would still be a net reduction 7.3% of runoff flow volume to the marsh. There would also be a reduction of the concentration of the chemicals in the runoff collected by the marsh because, as mentioned in the above paragraphs, the amount of chemical applied per unit area on the new golf course (including Hole 5 and Hole 6) would be reduced due to greater disease resistance of the Paspalum turfgrass. In addition, the monitoring results at **Marine Station B** (immediately offshore from the marsh, see **Figure 6.2** of this report) from the last decade show that all parameters complied with the WQOs for Port Shelter WCZ. With the reduction in both volume of runoff and applications of chemicals, no impact on the water quality from the discharge of the marsh is predicted.

10.7.24 The future monitoring programme of the proposed golf course will be tailored to the practices on the golf course, e.g. monitoring will focus on those chemicals to be used. All turfgrass chemicals to be used on the golf course will be selected from the list of chemicals approved by AFCD for use in Hong Kong.

10.7.25 Based upon the experience from the existing golf course, during the 1995 to 2004 monitoring period, the concentrations of all pesticides were below detection limits (0.5 ug/L). By reducing the amount of chemical applied and recycling a high percentage of runoff, it is expected that the new golf course would meet water quality standards as high as those of the existing golf course.

10.7.26 In the case of heavy rainfall, the proposed closed drainage system might overflow. The frequency of overflowing would be low, based upon the

estimation from past 10-year rainfall records. The predicted water quality from the proposed drainage system would be better than that in the existing reservoir, which also overflows when it reaches its capacity. No water quality impact is anticipated from overflowing.

10.7.27 The existing golf course has been operated for a decade. The operation of the FCZs within Port Shelter was not affected and the production of fish fry at Urn Island remained very high during both 96/97 (Fishing Area 199) and 2001/2002 (Grid Cell S10) Port Surveys. This demonstrates that the results of the marine water quality monitoring program were accurate and that any runoff from the existing golf course did not affect marine organisms, even the more sensitive juveniles. That the existing 36-hole golf course operated for a decade without affecting fisheries suggests that the proposed 18-hole golf course, with reduced applications of chemicals and greater recycling of runoff, would also have no effect on mariculture or fish fry production.

10.7.28 The magnitude of the changes in water quality and the extent of the area affected by the operational discharge are very limited. Fisheries resources within Grid cells R10 and S10 are not going to be impacted significantly. None of the Fish Culture Zones would be affected significantly either. Even Kai Lung Wan west of Kau Sai Chau, the nearest FCZ to the discharge point of the desalination plant, lies beyond the affected range. Tai Tau Chau, east of Kau Sai Chau, is far away from the influence of the desalination plant and would be unlikely to be impacted by the runoff from the golf course. All other FCZs within Port Shelter WCZ are further away from the golf course and the affected area. No insurmountable impact on the FCZs is expected. The impacts from the operation of the golf course are thus ranked as minimal. **Table 10.3** below summaries the construction and operation phase impacts for easy reference.

Table 10.3 Summary of fisheries impacts

Impacts	Due to	Duration	Receiver	Severity	Need for mitigation
Construction phase					
Temporary fishing ground loss (1,500 +800 = 2,300m^2)	Dredging at desalination plant	Temporary	Capture fisheries	Minimal	No
Marine water quality	Construction of desalination pipelines Dumping, spilling, and leakage of chemicals from vessels or equipment	Temporary	Capture fisheries and mariculture	Minor	Yes
Operational Phase					
Marine water quality by desalination plant	Increase in salinity during operation	Permanent	Capture fisheries and mariculture	Minimal	No
Marine water quality by golf course	Pesticides and fertilizers	Permanent	Capture fisheries and mariculture	Minimal	No (but precautionary measures would be adopted)

Cumulative impacts

10.7.29 This section of the report considers the potential cumulative impacts from other concurrent projects in the assessment area.

10.7.30 There are no scheduled concurrent designated projects (DPs) in the vicinity of the proposed golf course during the construction or operation phase.

10.7.31 As stated in the results of water quality assessment, no cumulative impacts from other projects is expected on marine water quality . There is also no other concurrent marine works project in the vicinity of the desalination plant or the barging point. Therefore, no cumulative construction and operational fisheries impacts are likely to arise from this DP.

10.8 MITIGATION MEASURES

Construction phase

10.8.1 Potential sources of marine water quality impact during construction phase include:

- Site runoff;
- Suspended solid during the dredging and backfilling for the pipelines of the desalination plant; and

10.8.2 In addition to the temporary drainage system which would collect site runoff for re-use for irrigation, site runoff would also be controlled by general site practices during the construction period.

10.8.3 Silt curtains will be deployed during dredging and backfilling for the desalination plant. With the deployment of silt curtains around the desalination plant construction area, adverse water quality impacts associated with the dredging and back-filling would be controlled.

Operation phase

10.8.4 Runoff from Hole 5 and part of Hole 6 would discharge into a marsh and thence to the sea.

10.8.5 Although the water quality assessment has demonstrated that the fisheries resources in the vicinity, including capture fisheries resources and Tai Tau Chau FCZ, are unlikely to be affected by the runoff, some precautionary measures would be adopted to further protect the nearby fisheries resources.

10.8.6 A filter system is proposed to further improve the quality of the runoff from Hole 5 and part of the Hole 6. Nutrients and pesticides would be absorbed by the filter system with the effectiveness ranging from 67-96%.

10.8.7 Biological methods will also be applied at Holes 5 and 6. The proposed biological insecticide and fungicide products are all registered by AFCD. All are microbial or plant extracts, which are non-toxic to non-target organisms according to USEPA information (see Water Quality Assessment section). Chemical methods will only be used when necessary. This could significantly reduce the already low concentrations of chemicals in the runoff from Holes 5 and 6. **Table 10.4** below summaries the construction and operation phase mitigation measures for easy reference.

Table 10.4 Mitigation measures recommended for construction and operation phases impacts of the Project

Impacts	Mitigation measures and effects
Construction phase	
Site Runoff	Temporary drainage system for works areas Buffer zones for stream courses to prevent sedimentation Good Site practices

Water quality impact from dredging at desalination plant	Deployment of silt curtains
Operational phase	
Runoff from the third golf course (precautionary measure)	Filter system and biological methods to further reduce the chemical concentrations in runoff from Holes 5 and 6

10.9 RESIDUAL IMPACT

10.9.1 No residual impacts on capture fisheries are predicted. This is due to the small scale and short duration of the construction phase impacts, the small magnitude of water quality change during operation, and the mitigation measures proposed.

10.9.2 No residual impacts on the FCZs within the fisheries assessment area are predicted. This is due to the small scale and short duration of the construction phase impacts, the small magnitude of water quality change during operation, and the mitigation measures proposed. For the other FCZs within Port Shelter, there is no overlap between the area of waters affected during the operational phase and these FCZs.

10.10 ENVIRONMENTAL AUDIT AND MONITORING

10.10.1 During the construction phase, water quality monitoring will be undertaken three days a week for the dredging works at the desalination plant. Stream water would also be monitored to ensure no sedimentation would go into the sea through the stream courses. During operation phase, the outfall of the desalination plant would be monitored at lease once every two weeks during the first three months of desalination plant commissioning.

10.10.2 Besides the EM&A for water quality, no specific EM&A programme for fisheries would be required for the Project.

10.11 CONCLUSION

10.11.1 The construction of the desalination plant and temporary barging point will result in minor temporary losses of fishing grounds. However, the size of the loss is small (about 1,500 m^2 (0.15 ha) & 800 m^2 (0.08 ha), less than 0.02% of the R10 and S10 Grid Cells) and the duration is short (about one year for the barging point and about 3 months for the desalination plant). This loss is not expected to have a significant negative impact on capture fisheries. The residual impacts of fishing ground losses are acceptable.

10.11.2 The above discussion should make it apparent that the construction and operation of the Project would have no significant impacts on capture fisheries or mariculture. A well-planned program of site practices should be able to maintain the impacts to acceptable levels. Fisheries monitoring during the construction and/ or operation phases will not be needed.

10.12 REFERENCES

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