9. MARINE ECOLOGY

9.1 INTRODUCTION

9.1.1 This chapter assesses the impacts of the Project upon marine ecology.

9.1.2 The nature and scope of the Project are described in **Section 2** of this Report. The Project consists of the construction of an extension of the golf course on Kau Sai Chau, Sai Kung from the existing 36 holes to a total of 54 holes. The golf course would be constructed on hill slopes on the east side of the island. Thus it is a terrestrial rather than a marine project. No component of the Project would cause a permanent loss of subtidal marine habitat. The Project does, however, include three components that could affect the marine environment. These are a desalination plant to provide irrigation water, a temporary barging point for transport of materials during construction, and runoff from the golf course during construction and operation.

9.1.3 The objective of this assessment is to describe existing marine ecology in the Marine Ecology Assessment Area and to evaluate any impacts of the Project at both construction and operation phases and, where required, to propose mitigation measures to minimize adverse impacts. The assessment follows the criteria and guidelines listed in Annexes 8 and 16 of the EIAO TM and the EIA Study Brief No. ESB-064-2000, identifies and assesses the marine ecological impact associated with the Designated Project described in Section 2..

9.1.4 The assessment is mainly focused on (i) the two marine structures at the proposed golf course, i.e. desalination plant and the temporary barging point; (ii) surface runoff during both construction and operation phases, and the receiving water body. The impacts from site formation works within the project site are covered by the chapter for terrestrial ecological assessment (**Section 8**) in this report.

9.1.5 There would be no scheduled concurrent designated projects (DP) in the vicinity of the proposed golf course extension, temporary barging point or desalination plant during the construction or operation phase of the proposed golf course.

9.2 Environmental Legislation, Standards and Guidelines

9.2.1 The following Hong Kong SAR Government legislation, standards and guidelines are relevant to the assessment of impacts to marine ecology 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);
- Marine Parks Ordinance (Cap. 476) and associated subsidiary legislation;
- Wild Animals Protection Ordinance (Cap. 170); and
- Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187).

9.2.2 This study also takes note of the following relevant international agreements:

- The Ramsar Convention, under which Hong Kong SAR is obliged to sustainably use coastal wetlands less than 6 m deep;
- Convention on International Trade in Endangered Species of Wild Fauna and Flora ("CITES"); and
- Convention on Biological Diversity.

9.3 Baseline Methodology

9.3.1 The proposed new golf course is located on eastern Kau Sai Chau, Sai Kung, in Port Shelter Water Control Zone (WCZ) of HKSAR. (**Figure 9.1**). The assessment area for marine ecology is based on the golf course boundary and the EIA Study Brief requirements. The assessment area for marine ecology includes all areas within 500 m of the project site including the shore line and the subtidal zone (**Figure 9.2**).

9.3.2 Literature, including Government and private sector reports, independent and Government published literature and academic studies, was reviewed to gather information on existing conditions in the assessment area, and to identify habitats and species of potential importance that may be affected by the Project. Recognised sites of conservation importance are identified (**Figure 9.3**). Literature review included but not limited to the following:

- Marine Ecology of Hong Kong: Report on Underwater Dive Surveys (October 1991 - November 1994) (Binnie 1995). Dive surveys at 86 sites in central and eastern Hong Kong waters.

- Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals (AFCD 2004a). A territorial-wide dive survey in Hong Kong.

- Marine Benthic Communities in Hong Kong. Centre for Coastal Pollution and Conservation, City University of Hong Kong prepared for Agriculture, Fisheries and Conservation Department (CCPC 2002). A territorial-wide benthic study in Hong Kong.

9.3.3 Literature review was supplemented by field survey. Field surveys were designed to fill data gaps which would prevent an adequate assessment of the project's impacts upon intertidal and subtidal ecology, and/or development of appropriate mitigation measures. Intertidal surveys and dive surveys were first conducted between September 2000 to April 2001. The EIA study was however suspended in 2001. The study was resumed in 2004 and field surveys for intertidal and subtidal habitats were conducted again between October 2004 to June 2005.

9.3.4 Intertidal surveys were performed on 18 October, 10 November, 17 November 2000, 13 February and 26 April 2001, 29 October 2004, 13 February, 19 March and 20 June 2005, to describe the intertidal coastal ecology within the assessment area. Natural coastlines, including rocky shores, sandy beaches and sandflats, were surveyed (**Figure 9.4**). Inter-tidal fauna survey was undertaken. Line transects were established on the rocky shore at three sites R1, R2 and B2. The transect started at the low tide mark and extended to the high tide level. The transects run at the rocky shore habitat were approximately 7 m to 10 m in length. Due to the topography of the rocky shores on Kau Sai Chau (mostly narrow and steep intertidal zones, with small platforms of bedrock at some locations), five 0.5 m x 0.5 m quadrat samples were taken at two tidal levels along the transects (Low at 0.5 m from low tide mark and High at 3 m from low tide mark) and used to count and record the epifauna. All slow-moving epifauna (e.g. snail) and sessile fauna (e.g. Barnacles and Oysters) were observed and counted during the survey. Whiel fast-moving epifauna were observed. For the sandflats S1 and S2, ten 0.5m x 0.5m quadrats were arbitrarily deployed on the exposed sandflats. All fast moving epifauna (e.g. crabs) and slower fauna (e.g. snails) were also observed and counted during the survey. Intertidal species were identified to the lowest identifiable taxon, and their relative abundance was recorded, with special attention to rare or protected species. Photos of selected locations were taken.

9.3.5 A preliminary coral survey was conducted in November 2000 along the east coast of Kau Sai Chau to locate coral communities. Locations supporting corals were recommended for detailed coral surveys. Detailed dive surveys were conducted between March to May 2005, to cover the sites recommended in the preliminary survey, potential sites for marine structures, and the east coast of Kau Sai Chau. The methodology and results of subtidal surveys are provided in **Appendix A9.1** (Dive Survey Report) and **Appendix A9.2** (Coral Mapping Survey Report) of this report.

9.4 Assessment Methodology

9.4.1 Impacts to habitats, species or groups were assessed based on the guidelines in Annexes 8 and 16 of the TM, the consultants' local knowledge and international standards and practice in conservation biology.

9.4.2 The significance of ecological impacts is evaluated based primarily on the criteria set forth in Table 1, Annex 8 of the TM:

- habitat quality;

- species affected;

- size/abundance of habitats/organisms affected;
- duration of impacts;
- reversibility of impacts; and
- magnitude of environmental changes.

9.4.3 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 judgement is involved in the evaluation of impacts.

9.5 BASELINE CONDITIONS

9.5.1.1 Kau Sai Chau, where the proposed golf course is located, lies within the Port Shelter WCZ. Kau Sai Chau is Hong Kong’s fifth largest island and is uninhabited except for a small village named Kau Sai at the south tip of the island. Although there is no recognized/designated site of marine conservation importance within the 500 m marine ecological assessment area, some distant sites are located within Port Shelter WCZ.

Recognized Sites of Conservation Importance

9.5.2 The following recognized sites of conservation importance are located at or near the project site and are shown in **Figure 9.3**:

- Bluff Island & Basalt Island SSSI: two islands of 72 ha area each. The scientific subjects of interest are the vegetation on the two islands and the geologic features along the coasts.
- Pak Sha Wan Peninsula SSSI: an peninsula of about 119 ha. It supports a diversity of habitats which provide excellent educational opportunities.
- Potential Marine Park around Shelter Island: The waters around Shelter Island were proposed as a potential marine park in the “Study on South East New Territories Development Strategy Review”.
- Marker buoys were installed at Ung Kong Wan, Sharp Island and Port Island by AFCD to demarcate areas with high coral cover and advise boat operators to avoid anchoring within the marked area.
- Artificial reefs were deployed by AFCD at outer Port Shelter.

9.5.3 The focal features of the first two sites are land-based, though coastlines were included in their boundaries. The remaining three sites are marine in nature, but all are far away (at least 3 km) from the proposed golf course. No other designated, proposed or recognised sites of conservation importance lie within the assessment area or Port Shelter WCZ.

Intertidal habitats

9.5.4 The intertidal ecology of Hong Kong was well studied even in the mid-1980s (Morton and Morton 1983). Some recent publications on the intertidal fauna and flora include Tam and Wong (2000), Williams (2003) and Chan and Caley (2003). Intertidal habitats in Hong Kong are comprised of two major types, hard shores such as rocky shore, and soft shores such as sandflats, mudflats and mangroves.

9.5.5 Intertidal mudflats, together with the mangroves and seagrasses, are considered to be the most ecologically important intertidal habitats in Hong Kong. Ecological functions provided by these communities include energy cycling, coastal stabilisation, and habitat for wildlife such as coastal birds.

9.5.6 Mudflat is important because it provides a habitat to infauna which are in turn the prey items of many waterfowl. It is also a suitable substrate for the colonization of mangroves and seagrasses, both of which are important habitat types in Hong Kong. The seagrass beds are also important spawning and nursery grounds of horseshoe crabs (Fong 1999). Mangrove communities are under threat from urbanisation and reclamation, and because many stands have been destroyed in Hong Kong they are considered to be a conservation priority (Tam and Wong, 2000). The structure of the mudflat habitat is diversified by the colonizing vegetation. A large variety of microhabitat types may contribute to a diverse intertidal fauna. The high species richness of crabs at Mai Po, where 32 species of crabs were recorded, was also attributed to the large variety of microhabitats there (Lee & Leung 1999).

9.5.7 Soft shore intertidal habitats are concentrated in northwest and northeast Hong Kong. In Port Shelter, there are few stands of isolated mangroves (and mangrove fringes). Major softshores are sandy beaches (such as Clear Water Bay) and sandflats (such as the shores along Tai Mong Tsai Road), both are less productive than the intertidal mudflats.

9.5.8 On Kau Sai Chau, mangrove fringes were found along the sheltered bay/estuaries of the island within the assessment area (see **Figure 8.3** of this report). A total of 40 plant species were recorded in the mangals. Although trees were few, the mangals were composed of many representative species, including *Kandelia obovata*, *Avicennia marina, Bruguiera gymnorhiza, Excoecaria agallocha,* and *Lumnitzera racemosa*. Backshores were also colonised by mangrove-associate and upland species, including *Scaevola taccada (S. sericea) Hibiscus tiliaceus*, *Pandanus tectorius*, *Atalantia buxifolia*, and *Lepidosperma chinense* (Details are provided in **Section 8 Terrestrial Ecology** of this report). Due to the limited areas of these mangals, the mangrove fauna was combined with the sandflat fauna described below.

9.5.9 There is no natural mudflat on Kau Sai Chau, but two small sandflats were located at the estuaries of Stream B and Stream D (i.e. S1 and S2 in **Figure 9.4, Photo Plate 9.1**). Results of the surveys were shown in **Annex 9.1** and summarised in **Table 9.1** below. Mudskippers (*Periophthalmus cantonensis*) were common epifauna, especially near the tidal channels. Grapsid crabs *Perisesarma bidens* were abundant among mangroves, while *Parasesarma pictum* was abundant near the backshore. On the outer regions where the substrates were softer, *Uca* sp. and *Macrophthalmus* sp. were dominant. Crab burrows were found all over the sandflats.

9.5.10 *Cerithidea rhizophorarum* show an affinity to muddy substrata. They were most abundant at the seaward limit of the sandflats. In contrast, *Terebalia sulcata* was more abundant in the inner area of the sandflats. These two species of snails are common in Hong Kong (Chan & Caley 2003; Fong *et al*. 2005). *Macrophthalmus* sp. also showed affinity to muddy substrata and the Grapsid crab *Perisesarma bidens* is a very common crab in Hong Kong (Fong *et al*. 2005). None of the recorded coastal species is of conservation concern.

Table 9.1 Species and Abundance in the Two Sandflats in Kau Sai Chau

Species	Abundance	
	S1	S2
Mollusca		
Cerithedia rhizophorarum	Abundant	Abundant
Terebalia sulcata	Abundant	Abundant
Planaxis sulcatus	Common	Common
Crustacea		
Perisesarma bidens	Abundant	Common
Uca spp.	Abundant	Common
Macrophthalmus sp.	Common	Common
Macrobrachium sp.	Common	Occasional
Scylla serrata	Occasional	\
Thalamita crenata	\	Occasional
Pisces		
Periophthalmus cantonensis	Common	Common

Occasional = 0-10 individuals; Common = 10 – 100 individuals; Abundant = over 100.

9.5.11 As opposed to extensive sandflats such as those at Shui Hau and Starfish Bay, exposed sandy shore (i.e. sandy beach) in general is not considered of high ecological value in Hong Kong due to its unstable nature and lack of species of conservation concern. Mobile sandy beaches are much less productive than sandflats and are sometimes described as

"Biological Deserts" (Morton & Morton 1983). A sandy beach on Kau Sai Chau is located at Kau Chung Wan. Other than burrows of Ghost crab, no intertidal fauna was found on this beach. A small section of sandy beach was also found next to the existing ferry pier. There was also no intertidal fauna recorded at this location.

9.5.12 There was no previous record of seagrasses on Kau Sai Chau. But a seagrass bed of *Halophila ovalis* was found during dive surveys at western Kau Sai Chau at the estuary of Stream D (Site D3, see **Appendix A9.1**) between the low intertidal to shallow subtidal zones. Over 50% of the surveyed area was occupied by seagrass beds in which the coverage was estimated to exceed 70%. Among the four species of seagrasses in Hong Kong, *H. ovalis* is the most widespread and abundant species, recorded at 16 locations from previous studies (Fong 1999, Kwok *et al*. 2005). It is considered an annual and opportunistic plant. Within Port Shelter, it was recorded in Sheung Sze Wan, Ho Chung, Tsam Chuk Wan, in patches ranging from 30 m^2 to 1 ha. The size of the seagrass bed recorded in this study was estimated to be close to 0.5 ha. Although seagrass beds are known as spawning and nursery grounds for horseshoe crabs, no horseshoe crab juveniles were found at this seagrass bed.

9.5.13 There are over 9 km of coastline with intertidal habitats within the assessment area. The majority of the natural intertidal zone on Kau Sai Chau, and even in Port Shelter, is rocky shore. Rocky shores are not rare in Hong Kong, and are not characterized by high productivity, species richness or diversity as are intertidal mudflats or mangroves.

9.5.14 Many rocky shores at different locations in Hong Kong have been studied in various EIA studies, including Sok Kwu Wan (Maunsell 2003), Junk Bay (ERM 1999), Green Island (TDD 1998) etc. Most of these rocky shores are similar in community structure and species composition. These studies demonstrated that the descriptions of rocky shore communities in Morton and Morton (1983) are basically still valid for most areas in Hong Kong.

9.5.15 For example, the intertidal communities on the rocky shores in Sok Kwu Wan were studied (Maunsell 2003) and were found similar to those found on other semi-exposed coastlines in Hong Kong. Fauna of both wave exposed shores, such as littorinid snails (*Littorina scabra*, *Littorina brevicula* and *Nodilittorina millegrana*), *Grapsus albolineatus* (Crustacea, Brachyura), *Eriphia smithii* (Crustacea, Brachyura) and *Septifer bilocularis* (Bivalvia, Lamellibranchia), and on boulder shores, such as *Polycheir rufescens* (Echinodermata, Holothuroidea), *Petrolisthes japonicus* (Crustacea, Anomura) and *Gaetice depressus* (Crustacea, Brachyura), were recorded (*ibid*.). As with most shores of Hong Kong, zonation patterns were evident, but no rare fauna was found. Overall the fauna appeared to be lacking in diversity and abundance.

9.5.16 Most of the rocky shores on Kau Sai Chau are natural, and very steep and inaccessible, and therefore very narrow with little space for rock pools which could enhance the diversity. Zonation was observed, in particular at the southeast part of the island where the coastline is facing the open sea and is more exposed. The dominant organism was Acorn barnacle *Tetraclita squamosa*, which formed a band on the middle to low tidal level on rock surfaces.

9.5.17 Two locations of intertidal hard shores on eastern Kau Sai Chau were less steep and studied in more detail in the present EIA. One was opposite Tai Tau Chau (**R1**), and the other was at Kau Chung Wan (**R2**) (**Figure 9.4** & **Photo Plate 9.1**). Results of the surveys were shown in **Annex 9.2** and summarised in **Table 9.2** below.

9.5.18 The substratum at R1 was a mixture of boulders and bed rock. The dominant intertidal species was rock oyster. Stalked barnacle was also common in this site. R2 is a section of coastline of natural bedrock. It is located at a more exposed location than R1. It is less steep than the nearby coastline. Some rock pools were formed on the areas with a gentler gradient, but very few organisms were found inside these pools. Fauna recorded are listed in **Table 9.2** below. All recorded species are common and typical of rocky shore fauna. No rare species were found.

Table 9.2 Species and Abundance in the Two rocky shores

Species	**Abundance**	
	R1	**R2**
Mollusca		
Saccostrea cucullata	Abundant	Common
Littorina spp.	Abundant	Abundant
Monodonta labio	Common	\
Cellana sp.	Common	Common
Crustacea		

Pollicipes mitella	Abundant	Abundant
Tetraclita squamosa	Common	Abundant
Grapsus albolineatus	\	Common

Occasional = 0-10 individuals; Common = 10 – 100 individuals; Abundant = over 100.

9.5.19 Besides R1 and R2 sites, the rocky shore adjacent to the abandoned pier at Tiu Cham Wan (B2 Site in **Figure 9.4**, the recommended site for the temporary barging point of the Project) was also studied by quadrat method. Only 10 species were recorded (**Table 9.3**). Other than Littorid snails, Rock Oyster *Saccostrea cucullata* and Stalked barnacle *Pollicipes mitella* were the most abundant species. Numbers of species varied from 1 to 8 and numbers of individuals ranged from 13 to 64 among quadrats. Recorded species are common and characteristic of intertidal habitats throughout Hong Kong. Both Rock Oyster and *Pollicipes mitella* are typical organisms of exposed shores (Morton and Morton 1983). Both species are considered very common rocky shore species (Williams 2003). Both the species richness and abundance of intertidal fauna at the site were low.

Table 9.3 Results of intertidal quadrat sampling at B2 site

Scientific name	**Low intertidal**					**High intertidal**					**Total**
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	
Saccostrea cucullata	8	5	10	2	9						34
Cellana sp.	3	2	5								10
Siphonaria sp.	2		8		5						15
Nerita sp.	2		4	1							7
Littorid snails						14	6	15	10	26	71
Monodonta labio	2			1			1				4
Septifer bilocularis	1	3	6		1						11
Pollicipes mitella	6		21	12			3		6		48
Tetraclita squamosa	6	2	10	2	4						24
Ligia exotica		1					3		1		5
Taxon	8	5	7	5	4	1	4	1	3	1	
Individuals	30	13	64	18	19	14	13	15	17	26	

Soft Bottom Benthos

9.5.20 The first comprehensive study of Hong Kong subtidal benthos was conducted in 1976 to 1977 by Shin and Thompson (1982). They studied benthic grab samples collected from 200 stations throughout Hong Kong waters. Data from these stations, however, were not treated separately, but pooled with other stations with similar species composition.

9.5.21 In 2001, AFCD commissioned a second territory-wide benthic survey (CCPC 2002). Up-to-date information on the subtidal benthic communities with respect to spatial distribution, abundance, and species composition, was collected at 120 sampling stations over the territorial waters of Hong Kong, which were divided into 5 strata (regions). The cephalochordate *Branchiostoma belcheri* is the only known benthic macrofauna species of conservation concern in Hong Kong. The species is regarded as living fossil link in the evolution of marine invertebrates to vertebrates and is, therefore, considered an important species. A residential population of this species was recorded in Tai Long Wan, Sai Kung (CCPC 2002). Its distribution is related to the fine sand nature of the sediment, which provides an ideal habitat for the animal to filter feed on the seabed. Recently this species was also found to the south of Cheung Chau (Mouchel, 2003). Both areas are distant from the location of the present Project (over 7 km to Tai Long Wan and over 30 km to Cheung Chau). No other benthic species of conservation concern have been recorded in Hong Kong.

9.5.22 Stations 91 and 92 of the AFCD benthic survey sampled areas southwest and east of Kau Sai Chau (**Figure 9.3**), and might represent the benthic conditions in the vicinity of the island. Stations 91 and 92 lie in the Eastern Stratum which covers Tathong Channel, Port Shelter, Po Toi, and Nine Pins and includes 23 stations. A low total organic matter (TOM) content (1.91%) was recorded in inner Port Shelter, whereas the average TOM content of marine sediments in Hong Kong was 6.04%. Species diversity in Hong Kong ranges from 0.38 to 3.92 during summer and from 0.63 to 3.73 during winter, while greatest diversity was recorded in outer Port Shelter in both summer and winter.

Table 9.4 Summary of benthic sampling results at two stations near Kau Sai Chau

Station	Season	Spp.	No.	Biomass	d	*H'*	J

91	Summer	27	112	6.74	6.46	2.87	0.87
	Winter	26	130	19.06	5.99	2.81	0.86
92	Summer	24	146	184.92	5.36	2.56	0.81
	Winter	32	176	45.06	6.92	3.23	0.93

9.5.23 In summer, 27 and 24 species were recorded, while in winter 26 and 32 species were found at Stations 91 and 92 respectively. The recorded density and biomass were also low at this station, i.e. 112 individuals/m^2 and 6.74 g/m^2 for Station 91 and 146 individuals/m^2 and 184.92 g/m^2 for Station 92 in summer, and 130 individuals/m^2 and 19.06 g/m^2 for Station 91 and 176 individuals/m^2 and 45.06 g/m^2 for Station 92 in winter.

9.5.24 Species richness, diversity and evenness indices are inter-related. A diversity index integrates two components: the total number of species (d) and the distribution of individuals among species, into a single number (H'). H'is usually high (e.g. >3 or 4) in environmentally undisturbed benthic communities, and low (e.g. <1) in highly disturbed communities (Gray 1989). Values for richness, diversity, and evenness would be high, with d>10, *H*'>3 and J (evenness) >0.8 for a diverse community structure. In benthic habitats where organic matter is concentrated or dissolved oxygen is low, such values are low, with d<5, *H*'<2, and J<0.5. Results in **Table 9.4** show that Station 91 and 92 are of moderate species richness and diversity, and high evenness in both summer and winter seasons. No species of conservation concern was recorded at both stations. This area is therefore not of special conservation importance in terms of benthic communities.

Corals and hard bottom benthos

9.5.25 Established coral communities of any size are regarded as important habitat types in Hong Kong as defined in Annex 8 of the EIAO-TM. Among the corals, however, hard corals are more vulnerable than soft corals. Many of the soft corals can survive at greater depths (Morton and Morton 1983; Morton 1994). They are more widely distributed in Hong Kong and can be found in areas of higher turbidity such as south Tsing Yi, where sea pens and gorgonians were recorded during a trawl survey for epibenthic fauna (ERM 1995).

9.5.26 All hard corals are protected in Hong Kong by the Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187). The geographical distribution of hard corals in Hong Kong is affected by the salinity of the water. The Hong Kong waters can be broadly divided into estuarine, transitional and oceanic zones in accordance with the distance from the Pearl River estuary (Morton and Morton 1983). Hard corals are vulnerable to sediments and prefer clear oceanic water. Hard corals in Hong Kong therefore exhibit strong gradients in distribution, species diversity and abundance, with the cover and diversity decreasing from east to west, toward the influence of the Pearl River (Scott 1984).

9.5.27 The Port Shelter WCZ is within the oceanic zone. In contrast to the low abundance and low diversity of corals in western Hong Kong waters, the oceanic environment of the eastern waters is suitable for the existence of scleractinians (reef-building corals)(Scott 1984). Eastern waters are thus characterized by domination of hermatypic corals.

9.5.28 AFCD conducted intensive underwater surveys in 2001-2002 to survey corals at 240 sites covering about 70 km of coastline in territorial waters (AFCD 2004). Five sites were located within the Port Shelter WCZ, i.e. Sharp Island, Tai Pai, Shelter Island, Tai She Wan and Pak A. Among these, the second highest coral coverage of the 240 REA sites was recorded at Sharp Island (> 50 %). Corals here were mainly agariciids (*Pavona decussata*), faviids (*Platygyra*, *Favites*, *Leptastrea* and *Cyphyastrea*) and poritids (*Porites*, *Goniopora*). Pak A and Shelter Island had high coverage of dead corals (11-30%). Tai Pai was found to be one of the sites with deepest incised reefs and best developed coral communities. Kau Sai Chau, however, was not covered by this study.

9.5.29 During an extensive dive survey in Hong Kong waters for CED (Binnie, 1995), only one site at Port Shelter WCZ was surveyed, the north end of Kau Sai Chau (see **Figure 9.3**). Medium abundance of hard corals was recorded at Kau Sia Chau (Site 39). Other invertebrates in Kau Sia Chau were also recorded as medium in abundance. However, the diversity of both hard corals and invertebrates, as well as the abundance and diversity of soft corals and gorgonians were all considered low. This site was assigned a medium conservation value in terms of the abundance and diversity of hard and soft corals.

9.5.30 A preliminary dive survey was conducted along the east coast of Kau Sai Chau in November 2000 to locate coral communities and recommend locations for detailed coral surveys. Results from the preliminary survey found that the majority of the eastern coast of Kau Sai Chau, in particular within the major embayment at Tiu Tam Wan and to the north of this embayment, had a very low coral coverage, i.e. below 5%. But the most southern part of the coastline had higher coral coverage. Coral found included *Favia*, *Acropora* and *Tubinaria*. The low diversity and abundance of corals in most parts of the eastern coast may be attributed by the stream flows at several locations along the shore. One location at the southern part of the coastline (Kap Lo Kok) had high coral coverage. Detailed coral surveys are recommended at the impact sites of the project and Kap Lo Kok.

9.5.31 A detailed dive survey programme was conducted for the present EIA study in 2005 to examine the subtidal communities at the potential sites at the east and west Kau Sai Chau proposed for a desalination plant and a temporary barging point. Additional sites along the eastern coastline of Kau Sai Chau were also surveyed where the proposed golf course would be located. The objective was to identify the locations and quantify the abundance of marine species of conservation concern (**Appendix A9.1**). The topography of the subtidal habitats along eastern Kau Sai Chau is generally steep, reaching -7mC.D. within 50 m of the tideline at some locations. Underwater visibility was fair (about 5 m). Western Kau Sai Chau has a gentler gradient and poorer visibility (about 2 m). Details of the profiles of the subtidal habitats at Kau Sai Chau are presented in **Appendix A9.1**.

9.5.32 A site selection survey was conducted at five potential sites which were engineering-feasible for the desalination plant and the temporary barging point in March 2005 (Sites B1, B2, D1, D2 & D3 in **Figure 9.4)**. REA (Rapid Ecological Assessment) method was applied at the 5 sites. The results are detailed in **Appendix 9.1** and summarised below.

9.5.33 In B1 Site, the hard substrate extended only a short distance from the coastline. Some hard coral colonies were found on the hard substrate, but the coverage was estimated to be below 5%. Recorded coral species included *Favia speciosa*, and *Turbinaria peltata*. Beyond the hard substrate the seabed was covered by mud and no more coral colonies were found.

9.5.34 Similar to B1, B2 site had the hard substrate at the shallowest part and muddy substrate at the deeper part. The extent of hard substrate was only slightly greater than that at B1, but the coral coverage on hard substrate was again less than 5%. Recorded coral species included *Pavona descussata* and *Platygyra acuta*. No coral colony was found on the mud substrate.

9.5.35 D1 site has the highest coral coverage among the five potential sites surveyed. From the coastline to about 30 metres offshore the seabed was of hard substrate and the coral coverage was estimated to be about 20% within site D1. Recorded corals included *Lithophyllon undulatum* , *Goniastrea aspera* , *Acropora tumida, Psammocora superficialis, Goniopora columna,* and *Platygyra acuta*. Among these, *Acropora tumida* is considered uncommon in Hong Kong. The size of these colonies might reach 30 to 40 cm. The substrate turned muddy beyond 30 m from the shore.

9.5.36 D2 site was immediately adjacent to the existing ferry pier. Most of the survey site had a sandy and muddy-sandy substrate, with the sandy substrate at the shallower part and the muddy-sandy substrate further seaward. At the southern part of the site (starting from approximately 80 m south of the pier), the seabed was covered by bedrock. The bedrock cover continued to over 100 m south from the pier. There were also some large boulders near the coastline approximately 40 m south of the dyke. Less than 5% coverage of corals was found on the bedrock area, but these colonies were fairly large (some reached 30 cm, although smaller than those recorded at site D1). Recorded species included *Favia speciosa*, *Favites abdita*, and *Goniastrea aspera*. There was no coral found on the large boulders near the coastline. Some seagrasses (*Halophila ovalis*) were scattered on the sandy substrate at low density in the south part of the surveyed area (about 70 m south of the pier). But the density was low and not forming a seagrass bed.

9.5.37 D3 site was also located on the west coast of Kau Sai Chau just offshore from the outlet of a stream. It is of the highest conservation importance among the 5 sites surveyed as it harbours extensive seagrass beds. Almost the entire area covered by the survey had a muddy-sandy substrate. No coral colony was found. However, over 50% of the site was occupied by seagrass beds (*Halophila ovalis*) in which coverage sometimes exceeded 70%.

9.5.38 Based upon the observations and results of the site selection surveys, construction at D1 or D3 would cause significant impacts on corals (about 20% coverage at D1) and seagrasses (seagrass beds at D3) respectively, therefore these sites were excluded from further consideration. Site B2 was chosen as the preferred site for the temporary barging point. Among the 5 sites surveyed, the coral coverage at both Site B1 and B2 was low (below 5%). Although the extent of hard substrate at B2 was slightly larger than at B1, B1 would be closer to an occupied fish culture zone that might be more sensitive to water quality impacts during the operation of the barging point. Furthermore, there was an abandoned pier near B2, making the coastline there less natural than at Site B1.

9.5.39 In terms of ecology, D2 is a better site for the desalination plant. It also had low coral coverage (less than 5%) among the 5 sites surveyed. The majority of Site D2 was muddy-sandy bottom. Although some coral colonies of common species including *Favia speciosa*, *Favites abdita*, and *Goniastrea aspera,* and little seagrasses were found at Site D2, they were both of low coverage or density, and concentrated at the southern end of the surveyed area (at least 80 m and 70 m away from the pier respectively). Therefore it is still possible to avoid or reduce direct impacts by laying the two pipelines closer to the existing pier.

9.5.40 A coral mapping survey was then conducted at B2 and D2 in May 2005. The mapping areas at the two sites were larger than the marine structures (barging point and pipelines) to be proposed. 303 coral colonies including some on bedrock were recorded in Site B2, while 79 were recorded on scattered boulders at a larger mapping area at Site D2. In total 18 species were recorded. B2 has more coral species (all 18 species) and more coral colonies (303 colonies), while only 79 individuals from 10 species were recorded at Site D2. Among all the coral colonies recorded during the coral mapping survey (382 colonies in total), the majority of them are common to dominant in Hong Kong. Only one individual of *Acropora tumida* found at Site B2 is considered uncommon. But this colony was small (6 cm) and would not be affected by the Project (see **Section 9.7.7** below). The results are presented in detail in **Appendix A9.2**.

9.5.41 Other than the site selection survey and coral mapping survey, the eastern coastline of Kau Sai Chau was also studied by bounce dives and REA at selected locations (**Figure 9.4** and **Appendix A9.1**) in 2005. Basically, the marine communities showed a trend of increasing diversity and abundance of corals from north to south along eastern Kau Sai Chau. The northern part (Site M, Site B1 and Site B2) is near several freshwater inputs and the coral coverage there was below 5%. The southern coastline is more exposed to the open sea and higher coral coverage was found there (Site C, over 30%). This trend also matched the higher coral coverage found at D3 site during the site selection surveys. Site C (**Figure 9.4** and **Appendix A9.1**) was the location with highest coral coverage and abundance among all sites at Kau Sai Chau. Corals recorded along eastern Kau Sai Chau included *Acropora tumida, Cyphastrea serailia, Favia speciosa, Favites abdita, Goniastrea aspera, Goniopora columna, Hydnophora exesa, Leptastrea purpurea, Lithophyllon undulatum, Montipora peltiformis, Pavonna descussata, Platygyra acuta, Porites lobata, Psammocora superficialis*, and *Turbinaria peltata*. Except one uncommon species (*Acropora tumida*), all other coral speices found during the REA surveys were common, abundant or dominant in Hong Kong (Chan *et al*. 2005). The detailed results are presented in **Appendix A9.1**.

Cetaceans

9.5.42 There are fifteen recorded cetacean species from Hong Kong waters although only two of these species, the Chinese White Dolphin (*Sousa chinensis*) and Finless porpoise (*Neophocaena phocaenoides*) are resident (Parsons *et al*. 1995).

9.5.43 In Hong Kong, Chinese White Dolphin is concentrated in the more estuarine-influenced waters, i.e. western Hong Kong waters (**Figure 9.5**). Dolphins are found in all the waters of western Hong Kong and throughout the Pearl River Estuary (Parsons *et al*. 1995; Jefferson 2000; Jefferson & Hung 2004). They are present commonly year-round in the waters north and west of Lantau, and also occur seasonally or in small numbers south and east of Lantau Island, as well as in southern Deep Bay and west of Lamma Island (Jefferson 2000, Jefferson & Hung 2004). Normally they are not present in the eastern waters of Hong Kong. The only exception was an individual which stayed in Hebe Haven for several months during 2001 and 2002. This dolphin was a vagrant that later left the area. No Chinese White Dolphin has been seen in Port Shelter during continuous transect surveys since 1995 (**Figure 9.5**) (AFCD 2004b). Even the vagrant at Hebe Haven did not come near the waters around Kau Sai Chau. Port Shelter is not considered to be used by Chinese White Dolphin.

9.5.44 Finless Porpoise occurs in Hong Kong's eastern and southern waters, including Mirs Bay, Sai Kung, Po Toi, Ninepins, south of Lamma Island, south of Hong Kong Island, in the waters south and east of Lantau Island, and in particular southwest of Lamma Island at Ha Mei Tsui. But they have never been sighted north or west of Lantau during continuous transect surveys since 1995 (**Figure 9.6**)(Parsons *et al*. 1995; Jefferson & Braulik 1999; Jefferson *et al*. 2002; AFCD 2004b). There is no sighting record of Finless Porpoise in the vicinity of Kau Sai Chau or in all of Port Shelter. Port Shelter is not considered to be used by Finless Porpoise.

9.6 EVALUATION OF ECOLOGICAL IMPORTANCE OF HABITATS AND SPECIES

9.6.1 The "Important Habitats Types in the Territory" listed in Note, Table (1), Annex 8 to the TM-EIAO existing in or near to the assessment area are:

- Undisturbed natural coastal areas longer than 500 metres;
- Established coral communities of any size; and

- Established seagrass beds of any size.

9.6.2 Habitats found within the assessment area were evaluated in terms of ecological importance using the criteria set forth in Annex 8, Table 2 of the TM-EIAO. Details are listed in **Tables 9.5** to **9.6** below.

Table 9.5 Evaluation of ecological importance of intertidal habitats within the assessment area.

Criteria	Remarks	
	Soft shore	Hard shore
Naturalness	Basically high, except some locations such as the small sandy beach next to the ferry pier, which had been disturbed before by ferry pier construction works nearby	Basically high. The majority was steep rocky shores. Except some locations such as the proposed temporary barging point, where had been disturbed before by pier construction works for nearby FCZ. .
Size	At isolated locations, e.g. Kau Chung Wan, Stream B outlet, Stream D outlet and next to the existing ferry pier.	Over 9km in total within assessment area.
Diversity	Medium for sandflats. 10 species of fauna recorded. Low for sandy beaches	Medium. 10 species of fauna recorded.
Rarity	Common habitat in Hong Kong. No protected or rare fauna recorded.	Common habitat in Hong Kong. No protected or rare fauna recorded.
Re-creatability	Not re-creatable.	Not re-creatable.
Fragmentation	Unfragmented.	Unfragmented. Continuous within the assessment area.
Ecological linkage	Generally, it is linked with open sea and streams. But not functionally linked to any highly valued habitat in close proximity.	Generally, it is linked with open sea and upper shore shrubland. But not functionally linked to any highly valued habitat in close proximity.
Potential value	Low (as most is already natural)	Low (as most is already natural)
Nursery/breeding ground	Potentially for some marine organisms.	Potentially for some inter-tidal animals such as snails, crustaceans and other invertebrates.
Age	N/A	N/A
Abundance/ Richness of wildlife	Low to moderate for sandflats Low for sandy beaches	Low
Overall Ecological value	Low to moderate for sandflats Low for sandy beaches	Low

Table 9.6 Evaluation of ecological importance of marine habitats in the vicinity of the project area

Criteria	Remarks	
	Subtidal habitats	Marine waters as cetacean habitats
Naturalness	Basically natural. Some areas were designated as fish culture zones and typhoon shelter.	Basically natural. Some areas were designated as fish culture zones and typhoon shelter.
Size	Over 300 ha within the assessment area.	Over 300 ha within the assessment area.
Diversity	Moderate.	Low
Rarity	Common habitat in Hong Kong. A patch of seagrass, which is uncommon in Hong Kong, was recorded.	Common habitat in Hong Kong. But not used by local cetaceans.

	Corals were found, mostly common to dominant species in Hong Kong.	
Re-creatability	Not re-creatable.	Not re-creatable.
Fragmentation	Unfragmented.	Unfragmented.
Ecological linkage	Generally, it is linked with open sea. But not functionally linked to any highly valued habitat (e.g. mudflat) in close proximity.	It is linked with open sea.
Potential value	Moderate.	Low (out of the distribution ranges of local cetaceans)
Nursery/breeding ground	Breeding/nursery ground for marine species (the nearby Urn Island has high fish fry production).	Not a breeding ground for local cetaceans
Age	N/A	N/A
Abundance/ Richness of wildlife	Moderate	None except one single record of Chinese White Dolphin at Hebe Haven
Overall Ecological value	Moderate	Low

9.6.3 In accordance with the criteria set forth in Table 3, Annex 8 of the EIAO-TM, the ecological importance of species within the study areas was assessed in terms of:

- Protection status;
- Species distribution; and
- Rarity.

9.6.4 Fauna recorded during the dive survey (sea urchin) are typical of disturbed areas, while those recorded during the intertidal field survey are very common in rocky shore habitats. They are not of special conservation importance.

9.6.5 The list and evaluation of the fauna species of ecological concern, according to the TM-EIAO, are shown in **Table 9.7**.

9.6.6 Though not presently protected under local law, Horseshoe crabs have recently been identified as a species of potential conservation concern in Hong Kong.

9.6.7 Established coral communities and seagrass beds of any size are regarded as important habitat types in Hong Kong as defined in Annex 8 of EIAO-TM.

Table 9.7 Evaluation of fauna/flora species of ecological importance recorded within the Study Area

Species / Group	**Protection Status**	**Distribution**	**Rarity**
Corals	Cap. 187, and CITES	Exhibit strong gradients in distribution, species diversity and abundance in Hong Kong, with the cover and diversity decreasing from east to west, toward the influence of the Pearl River.	An uncommon species of coral *Acropora tumida* (Chan *et al*. 2005) was found at the eastern Kau Sai Chau. All other corals recorded during the present study are common, abundant, or dominant in Hong Kong waters.
Seagrass	N/A	Could be found at various areas in Hong Kong, including Deep Bay, North Lantau, Crooked Harbour, and Port Shelter.	Uncommon in Hong Kong

9.7 IMPACT ASSESSMENT

Identification of Environmental Impacts

9.7.1 This section of the report considers the potential impacts of project construction and operation on intertidal and subtidal ecology.

9.7.2 Two components of the Project could cause direct impacts on marine and intertidal habitats. These are the desalination plant, and the temporary barging point. The construction activities at the desalination plant will include dredging in the seabed, installation of 2 pipelines, and backfilling, while the temporary barging point would not involve subtidal works.

9.7.3 Potential sources of impact during construction phase include:

- Temporary habitat loss at the site of the area to be dredged for desalination pipelines; and
- Marine water quality impacts caused by dredging of the seabed and earth works to form the site for the golf course.

9.7.4 During the operation phase, concerns would be any water quality degradation due the operation of the desalination plant and the golf course. Potential sources of impact during operational phase include:

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

Construction phase

1) Habitat loss

1-a) Subtidal

9.7.5 In order to reduce the traffic burden on the only road on the existing golf course, a temporary barging point will be constructed at the east side of Kau Sai Chau (**Figure 9.7**). It will be used for the transportation of construction equipment and materials to and from the construction site. Among the five potential sites surveyed by REA during the site selection dive survey, three were on the eastern shore of Kau Sai Chau (i.e. Sites B1, B2 & D1). But Site D1 was excluded due to higher coral coverage. The site-selection dive survey showed the coral coverage at both Sites B1 and B2 was below 5%. But Site B1 would be closer to an occupied fish culture zone that might be more sensitive to water quality impacts during the building, demolition and operation of the barging point. In addition, there was an abandoned pier near Site B2, making the coastline there less natural than at Site B1. Site B2 was therefore chosen as the recommended location for the temporary barging point (see **Section 9.5.39** above and **Appendix A9.1**).

9.7.6 The site-selection dive survey showed that most of the seabed area at Site B2 is a muddy-sandy substrate with boulders, and of low conservation concern. But hard corals were still found, in particular at the most shallow water depths.

9.7.7 A coral mapping survey covered an area of 40 m wide (along the coastline) by 100 m long (seaward), which included the prospective barging point location and its vicinity. A total of 303 corals from 18 species were recorded within the mapping area at Site B2. Among all the coral colonies recorded during the coral mapping survey, all except one are common to dominant in Hong Kong, and they are generally small in size and of low coverage. Their ecological values were thus very low. Only one colony of uncommon species of corals *Acropora tumida* was recorded. The colony was also small (6cm) in size (see **Appendix A9.2**). The temporary barging point will be of floating-pontoon form (see **Figure 9.8**), to replace a pile-supported design from the early stage of this study (see **Figure 9.7**). Thus encroachments on coral colonies due to piling works were avoided. As the temporary pier would be a floating 20m wide x 40m long platform with no supporting structures in the marine environment but attached by a ramp to a supporting footer on-shore, no subtidal filling works would be required for the barging point. As all the coral colonies at Site B2 were within 40m from the shore and most of them concentrated within the first 15m seaward from the coastline (see **Appendix A9.2**), all anchoring points/structures of the floating pier could be located on the shore and/or to deeper water to avoid the corals

(**Figure 9.8**). Though no direct impacts on corals is anticipated, to further protect the corals at Site B2, the location of the floating pier would be shifted from the original location for barging point at Zone 2 and Zone 3 of the mapping area in Site B2 (see **Figure 2** in **Appendix A9.2**), to Zone 5 which had the least corals. The protection on corals at Site B2 would be further enhanced. No impact on corals is anticipated. Construction of the proposed golf course would require about 1 year, but the majority of the earth works would be finished in the 2005-2006 dry season. On completion of the golf course the temporary barging point would be removed. The area occupied by the temporary barging point would remain available for marine wildlife use during the golf course construction period. No impacts on subtidal marine ecology is anticipated.

9.7.8 Besides the temporary barging point, a desalination plant will be constructed on the west side of Kau Sai Chau beside the existing ferry pier. The desalination plant itself would affect terrestrial habitats (backshore of coastal habitat) only, as would the pumping station to be constructed on shore. The only components of the desalination plant that would affect subtidal marine ecology are two pipelines that would extend from the pumping station into the sea. The two pipelines would collect seawater and discharge the effluent form the desalination plant, respectively. They would be installed beneath the seabed by first dredging pipe trenches, then laying the pipe, and finally backfilling to bury the pipelines. There would be a short-term and temporary seabed loss during construction. The dimension of the pipelines would be (i) 110 m in length by 60 cm in diameter, and (ii) 40 m in length by 30 cm in diameter. A dredging area of about 1,500 m^2 would be required for the installation of the pipelines. The same area of shallow subtidal zone would be disturbed. Construction of the pipelines would be finished within 3 months (for dredging, installation and backfilling). The area disturbed by the dredging works would not be available for wildlife use during this period.

9.7.9 Among the five potential sites surveyed by REA method during the site selection dive survey, Site D2 was selected based upon the results of the dive survey (see above Sections 9.5.32 – 9.5.40 and **Appendix A9.1**). Furthermore, Site D2 is immediately adjacent to the existing ferry pier, which is the coastal area on Kau Sai Chau subject to the highest level of disturbance from previously the construction of the pier and currently the regular ferry traffic.

9.7.10 The site-selection dive survey showed that most of the seabed at Site D2 has a muddy-sandy substrate. Hard corals and sparse seagrasses were found in the southern part of the site, distant (at least 70m away) from the existing pier. Two prospective pipeline alignments were considered based upon the results of the site selection dive surveys (**Figure 9.9** & **9.10**). In the first plan (**Figure 9.9**), the two pipelines would be separated by about 50 m and run in parallel in a southwestly direction. In the second plan (**Figure 9.10**), the intake pipeline would be alilgned in a westerly direction and the outfall pipeline would be aligned in a southwesterly direction. The site selection survey results showed that coral colonies were found at least 70 m south of the pier. If pipeline alignement plan 1 were selected, coral colonies and sparse seagrasses there might be impacted. The majority of corals there were also un-transplantable. Because it would avoid impacts, the second plan was preferred with respect to coral conservation.

9.7.11 Shifting the pipelines further southward from the D2 site was also considered. However it was observed from the site selection survey that the sea bottom further south was also covered by hard substrates with coral colonies. If the locations of the pipelines at D2 were to be shifted some distance further southward, there would still be potential for direct impacts on un-transplantable corals. Furthermore seagrass beds at Site D3 would then be closer to the dredging area. So there was no obvious ecological advantage to be gained by shifting the pipeline location further southward from Site D2.

9.7.12 A coral mapping survey was conducted to verify whether corals would be affected by the dredging area of the second plan. The survey covered an area 40 m wide (along the coastline) and 125 m long (seaward) including the entire dredging area. Although the site selection survey results showed that the majority of this site was muddy and sandy bottom, some scattered boulders however were found during the mapping survey in the further seaward area with some corals on top. In total 79 individuals of 10 species were recorded at Site D2. All the coral colonies recorded at Site D2 are common to dominant in Hong Kong. The species of corals include *Favia speciosa, Favites abdita, Porites lobata, Lithophyllon undulatum, Montipora peltiformis, Psammocora superficialis, Pavona descussata,* and *Cyphastrea serialia.* No uncommon or rare species was found. They were also of small-sized. About 60% of them (46 colonies) were ≦10cm in size, 35% (28 colonies) were ≦20cm, and only 6% (5 colonies) were larger than 20cm but smaller than 30cm (see **Annex 2** in **Appendix 9.2**). The mapping results showed that 25 coral colonies were located within the proposed dredging area and would be directly impacted and require mitigation (see **Appendix A9.2**). In spite of the commonness of the species and their small sizes, further refinement of the pipeline alignment has also been considered to further reduce the impacts on these corals, but it was found that the length of the intake pipeline (the longer pipeline) could not be reduced as the opening had to be constructed at a tidal level low enough to supply seawater to the desalination under all tide conditions. Further it requires to be constructed with its a sufficient height above the seabed such that it does not become silted up. Based on these constraints and the seabed topography at KSC pier the intake pipe requires to be 100m long. While swinging the intake pipeline alignment to a more southward direction or swapping the intake and outfall pipelines would place the dredging area closer to the bedrock with corals as well as sparsely distributed seagrasses, which were considered necessary to be avoided before when the two alignment options were rated, and other water quality sensitive receivers as well. The steep natural terrain and the poorer marine water quality on the north side of the pier also prevented to locate the intake pipeline there. Due to the potential impacts on the structural stableness of the existing pier dyke, it was also not feasible to build the intake pipeline along the dyke. The present selected pipeline alignment is therefore the most practical option on a site previously disturbed during the construction of the existing pier. Besides the direct impacts caused by the dredging works, there would be indirect impacts on other coral colonies within the mapping area due to water quality deteriorations during dredging (see below sections). Therefore, the 79 corals within the mapping area including the 25 subject to direct impacts would require transplantation as mitigation measure. The corals subject to transplantation are all considered common, dominant or abundant in Hong Kong (Chan *et al*. 2005), and have been recorded elsewhere in Hong Kong, including eastern Kau Sai Chau. Moreover, these coral colonies were small (from 5 cm to 30 cm) and were all on boulders and thus transplantable. A coral transplantation programme would be needed as a mitigation measure (see below sections).

9.7.13 Port Shelter is not used by Chinese White Dolphin or Finless Porpoise. No impacts on these species are anticipated.

9.7.14 The ecological value of the seabed habitat near the barging point and the dredging area is moderate in both cases. But the marine benthic communities in the waters around Kau Sai Chau were not of special conservation concern. The areas of marine habitat to be affected are small (1,500 m^2 at the dredging area). While there would be no seabed loss at the barging point, and the majority of the earth works would be finished during the 2005-6 dry season. The dredging area would represent an insignificant percentage of the shallow coastal zone area around Kau Sai Chau and an even smaller proportion of that in Port Shelter. The duration of the impact would be about 3 months at the dredging site. For these reasons the impact of seabed loss is ranked as minor. Mitigation in the form of a coral transplantation project is required.

1-b) Intertidal

9.7.15 The intertidal zone at the proposed temporary barging point (B2 site) is a rocky shore habitat, while that at the proposed desalination plant (D2 site) is a small section of sandy shore.

9.7.16 An area of 40 m^2 of rocky intertidal habitat (the barging point of 20 m in width and assuming the tidal range to be 2 m) would be potentially occupied by the landing portion of the floating barging point during the construction phase (i.e. about 1 year). On the nearby natural intertidal zone, both abundance and diversity of fauna were low. Considering the low ecological value, the small size involved, and the availability of similar habitat in the vicinity, the impact of temporary intertidal habitat loss is ranked as minimal. Mitigation is not needed but the affected intertidal habitat will be reinstated to the original condition at the end of the construction phase.

9.7.17 The pumping station of the desalination plant would be located on a narrow strip of sandy substrate on the coastline immediately next to the ramps of the exiting pier. An area of 130 m^2 of sandy intertidal zone would be occupied by the pumping station and permanent intertidal habitat loss is anticipated.

9.7.18 This site was disturbed during the initial golf course construction project in 1994-5. No macrofauna or even crab burrows were found on this location. The impact of this permanent intertidal habitat loss is therefore ranked as minimal and mitigation is not needed.

2) Marine water quality

2-a) Desalination plant

9.7.19 Installation of the two pipelines for the desalination plant will involve dredging of approximately 1,500 m^3 of seabed materials, and may potentially lead to re-suspension of sediments. Without controls or mitigation measures, the suspended particles could increase water turbidity and thus reduce the amount of light reaching the sea bed. As suspended particles settled to the seabed they could bury sessile organisms, or settle on the surface of other benthos. Resuspension of sediments would also potentially reduce oxygen levels and release pollutants into the water column. All these consequences may affect the health and survival of marine organisms. These impacts are short-term (total about 3 months, but dredging period about 50 days, see below sections), small-scale and localised in nature, and are mitigatable.

9.7.20 As discussed in **Section 6.9** of this report, 0.1 kg/m^2/day is adopted as the criteria for sediment deposition rate for corals. This standard has been applied in many other studies in which impacts on hard corals in eastern Hong Kong waters were assessed (ERM 2001, 2003). 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 hard corals in eastern Hong Kong waters (i.e. SS elevation of 10 mg/L, see ERM 2003). Seagrasses are often found in the low to middle intertidal area, especially where the sediments are silty or sandy (Kowk *et al*. 2005). Seagrasses are therefore expected to be less sensitive to and more tolerant of suspended solids and sediment deposition than are hard corals, which prefer oceanic waters. For this reason, the threshold values adopted for hard corals (i.e. SS elevation of 1.485 mg/L and sediment deposition rate of 0.1 kg/m^2/day) may also be applicable to seagrasses.

9.7.21 The nearest location of significant ecological value would be the seagrass bed about 200 m south of the pier. In Site D2, there are also some small-sized and common species corals within the mapping area but outside the dredging area, as well as a piece of bedrock about 80m south of the pier with less than 5% coverage coral colonies on top and sparsely distributed seagrasses adjacent. As shown in **Table 6.10** in **Section 6.9**, the actual 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 seagrass bed as well as the bedrock with sparse seagrasses and low coverage of corals would be lower than 1.094 mg/L, which is below the proposed SS criteria of 1.485 mg/L. As the SS level would decrease with distance from the source, the elevation of SS at other receivers would be much lower than 1.094mg/L. While for the sediment deposition rate, the daily deposition rate at the bedrock and the seagrass bed would be lower than 0.047kg/m^3/day, which is also below the adopted criteria (0.1 kg/m^2/day). Again, the sedimentation rate would be much lower at other receivers. Furthermore, the DO depletion due to dredging would be smaller than 0.00421 mg/L which is undetectable. However, for other coral colonies within the mapping area, there would be indirect impacts on them due to water quality deteriorations during dredging works. Efforts were also made to reduce the indirect impacts on those corals by different silt curtain deployment plans (see **Appendix A6.6**). It was found that even extra silt curtains were deployed, the suspended solid and the sedimentation rate would still exceed the WQO requirements for those corals within mapping area but not directly impacted. Therefore, further to the 25 corals subject to direct impacts, the remaining corals within the mapping area (this made a total of 79 corals within the mapping area) would require transplantation as mitigation measure.

9.7.22 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 **Section 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 the above mentioned water quality mitigation measures (closed grab dredging, backhoe excavation, & silt curtains) are properly implemented, the residual impacts would not be significant on the marine communities of western Kai Sai Chau, and would be largely self-correcting after project completion without active restoration efforts. Due to the small scale of the works and the mitigable nature of the impact, the potential impact is ranked as minor. Other than the implementation of the mentioned water quality mitigation measures, no mitigation is needed.

9.7.23 As the nearest water sensitive receiver, the corals on the bedrock 80 m from the pier, would not be impacted by water quality during dredging for pipeline installation, other recognised sites of conservation concern in Port Shelter would also not be affected by the above construction phase water quality issue due to their greater distances from the dredging area (1.5 km for the coral buoy area in Sharp island , at least 4 km for others).

2-b) Golf course site

9.7.24 Siltation caused by construction works on the new golf course site is a potential impact upon water quality. Cut and fill earth works could cause site runoff. Construction site runoff can contain sediments, organic substances, oil, grease and solvents. Without appropriate controls, site runoff off might enter the sea, where these substances could increase turbidity, decrease dissolved oxygen and introduce contaminants, potentially injuring or killing benthic organisms and driving mobile organisms away from the vicinity and thereby causing short-term degradation of habitat quality. Marine ecology could be affected. Although impacts would be short-term (during construction phase only) and would be largely self–correcting after project completion without active restoration efforts, corals were found at various locations along the eastern Kau Sai Chau, and therefore the potential of impacts on corals from water quality deterioration should be investigated.

9.7.25 If construction site runoff were to enter the sea, it would go through either existing water courses 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 (**Section 6**) and terrestrial ecology section (**Section 8**) of this report that only minimal disturbance would result to the watercourses. Most of the stream courses within the proposed golf course would be preserved, and protected by buffer zones (see **Section 8.6**). Separating earth works from the streams would prevent the site runoff from entering the stream courses. The temporary drainage system would receive flows from all areas subject to earth works and would collect all site runoff (see **Section 6.11**). The collected runoff would be retained and re-cycled for turfgrass irrigation. In addition, there would be measures to control sedimentation, including silt traps and sedimentation tanks for main discharge routes form works area (see **Section 6.11.9**). To further reduce potential runoff impact to the marine environment, the majority of the earth works would be conducted during non-rainy season, this could further reduce the potential of marine water quality impact. Unacceptable water quality impacts are therefore not expected.

2-c) Temporary barging point

9.7.26 Because the barging point would float, no dredging or filling works are required, only short-term and small scale land-based works are required to construct a footer to receive a landing ramp. No water quality impacts are predicted during construction and operation of the temporary barging point. The impacts to subtidal ecology would be ranked as minor and no mitigation measures would be required.

3) Noise and disturbance

9.7.27 Noise and disturbance from underwater and coastal construction could cause disturbance-sensitive marine fauna to migrate from the area, or cause secondary effects such as reduced feeding efficiency. However, no dolphin or porpoise, which are known to be sensitive to noise, was recorded near the golf course site location, while other mobile fauna such as fish which are sensitive to noise and disturbance would most likely have vacated the area earlier during the course of the underwater works. Impacts would therefore be ranked as minimal.

9.7.28 There is no disturbance-sensitive receiver in the intertidal zone. Due to the limited area of intertidal zone that would be affected the impact would be expected to be minimal.

4) Marine Traffic

9.7.29 Construction equipment and materials will be transported to and from Kau Sai Chau by vessels. Marine traffic volume will thus increase. The sea around the floating barging point would be affected by the periodic vessel traffic. The speed of working vessels (mainly barges) would be much lower than the general high-speed outboard engine vessels. Port Shelter is not a habitat for local cetaceans, and cetaceans are not generally subject to collision with low-speed vessels. Increased vessel traffic is ranked as insignificant as a potential impact to cetaceans. Furthermore, the floating pier would be 40m in length while the coral colonies at Site B2 are concentrated in the first 15m seaward from the coastline. Working vessels would utilize the seaward end of the barging point as they need deeper water. Corals thus would not be affected by the vessels utilizing the temporary barging point.

Operation phase

1) Marine water quality change by the desalination plant

9.7.30 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.

9.7.31 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 (6-7 months of the year) the plant would not operate except for routine maintenance and contingencies. Seawater would be taken in (about 3,816 m^3/d) and the freshwater 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 a return flow. The discharge flow rate would be 0.0168 m^3/s. Seawater is used for various purposes including flushing, fire extinguishing, and cooling exchange in Hong Kong. Seawater is used as the heat exchange fluid for the cooling system at HKUST within Port Shelter. HKUST is licensed by the Hong Kong Environmental Protection Department (EPD) to operate a pumping system year round for the seawater and the daily usage averages 50,000 cubic meters (HKUST 1993). The desalination plant of the proposed Project is small in scale, it will operate less than half of the year, and the intake volume is less than 10% of the intake volume of HKUST. The intake pipeline for the proposed desalination plant would be covered by a screen of 2 mm mesh size. Given the slow intake rate and the protective screen mesh, marine organisms would not be taken into the pipeline together with seawater.

9.7.32 The main difference between the discharge and normal seawater would be elevated salinity. It was reported in the water quality assessment of this report that about 40% of the freshwater will be extracted from 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. According to the dilution factor (**Table 6.11** in **Section 6** on Water Quality Assessment), this increase in salinity would dilute very quickly, dropping to 2.643 ppt above ambient (7.75 %) at the edge of the near field region (about 5.06 m away from the discharge point), to 1.228 ppt above ambient (3.6%) about 80m away (at the area of bedrock and coral at Site D2), and to 1.103 ppt above ambient (3.2%) about 200 m away and south of the pier, where the seagrass bed was found. 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 in Port Shelter also fluctuates greatly with varying amounts of rainfall. At an estuarine area (where the seagrass bed is located), the fluctuation would be even greater as the salinity is also affected by the flow of the stream. The change in salinity that would be caused by the proposed desalination plant at this location would be insignificant. 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.

9.7.33 The active ingredient in the anti-scalant proposed for use in the desalination plant would contain no hazardous substances. None of the substances in this product are carcinogenic and their potential toxicity is low. The concentration of anti-scalant prior to discharge is predicted to be 3mg/L. According to the dilution factor (**Table 6.11** in **Section 6** Water Quality Assessment), this concentration would drop to 0.168 mg/L at 50 m distance, i.e. before the discharge reaches the coral colonies on the bedrock south of the pier (see **Appendix A9.1**), and further dilute to 0.146 mg/l at 200m (seagrass bed at Site D3). With reference to the ecotoxicology data of the anti-scalant, it is not likely to have adverse impacts on aquatic biota given the low toxicity and low initial concentration (**Appendix 6.3** in **Section 6** Water Quality Assessment). Minimal impact is predicted and mitigation measures are not required.

<u>2) Marine water quality change by the golf course</u>

9.7.34 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**). The proposed 18-hole golf course would be managed by the same personnel and to the same high environmental standards as is the existing 36-hole golf course. Based on the outstanding performance history at the existing golf course , it is unlikely that detectable concentrations of turfgrass chemicals would enter the sea or affect marine ecological or fisheries resources at the proposed golf course. This prediction is substantiated by improvements in technology and in the resistance of turfgrass to pest infestations, as described below.

9.7.35 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 (9 years of monitoring data analysed in **Section 6** Water Quality). 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 on handling and application of pesticides at Kau Sai Chau, this threat has not been found as shown by the long-term water monitoring data.

9.7.36 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 pesticides applied on the new golf course can be reduced by 20-30 % due to the higher pest resistance of the proposed Paspalum turfgrass. Pesticides will also be applied mainly around the tee and green areas, which account to a small proportion of the total turfgrass area. The Turfgrass Management Plan will specify a response to any exceedance of normal levels of chemicals and pesticides in the water. This would include reducing applications of chemicals and pesticides, and increasing the intensity of water quality monitoring. Thus the TMP provides a contingency plan for dealing with this unlikely situation (see **Section 6** of this report for more details).

9.7.37 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 that is rapidly absorbed by the soil. Based on the marine water quality monitoring results of the existing course during the last 9 years, the absorption by turfgrass of nitrogen and phosphorus is as high as 97% and 99%, respectively. In the existing golf course, 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 before reaching marine waters. 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 in part the absence of any impact of golf operations on nutrient levels in marine waters.

9.7.38 Under the current drainage plan, most runoff from the fairways of the proposed golf course 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 the primary source of irrigation water and it would be supplemented by the desalination plant during the dry season when rainfall is not adequate to recharge the reservoir. The closed drainage system will divert surface runoff into surface channels or underground culverts, into constructed ponds or tank storages, and finally to the reservoir within the existing golf course. From there the water will be pumped back to irrigate turfgrass on both the existing and new golf courses. The irrigation and drainage system, together with the golf course lakes, reservoir, and associated catchments were designed as far as practicable as a closed water management system to optimise re-cycling of irrigation run-off within the project area and to minimise potential environmental impacts on marine and mariculture areas around the Island. This approach, based on a concept of self containment and effluent re-cycling, has been well proved successful in the existing golf course. The closed low flow drainage system involves intercepting runoff from the greens, fairways and tees from all holes (except Hole 5 and part of Hole 6 which will discharge to an existing marsh, see below sections), and recirculating the flow through the irrigation system. There are three main components of the closed low-flow drainage system: a number of underground storage tanks/pumping stations, an irrigation buffer lake (first temporary collection of surface runoff from proposed third golf course) and the existing reservoir (receives overflow and storage for irrigation purpose). Runoff from greens, tees and fairways will be collected by catchpits or the perforated sub-soil drainage system from where it will be conveyed along pipes to the underground storage tanks or open storage ponds. Each pond and tank shall have a set of pumps that are automatically operated by level control and will pump the runoff to the irrigation buffer lake (a new artificial lake). A total of 10 pumping stations coupled with either lake or tank storage would be required to intercept runoff from the course and direct it to the irrigation buffer lake, then it will further divert to the existing reservoir where the runoff would be re-circulated through the irrigation system. When the irrigation buffer reservoir is full it also overflows to the existing reservoir at Kau Sai Chau. Under this design irrigation water to the new course would be supplied via the irrigation buffer lake, supplemented by the desalination plant during dry periods.

9.7.39 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. This practice has not been caused any water quality deterioration in the last 10 years as shown by the long-term water quality monitoring results. 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 in 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 of 7.3% of runoff flow volume to the marsh. Furthermore, there would also be a reduction of the concentration of the chemicals in the runoff collected by the marsh because chemical applications on the new golf course (including Hole 5 and Hole 6) would be reduced (as explained in the sections above, the amount of chemicals applied in the new golf course per hectare could be reduced by 20-30% due to the higher pest resistance of the proposed turfgrass). As reported in the dive survey (**Appendix A9.2**), no corals or other important marine species were present at the small embayment receiving marsh overflow. In addition, the monitoring results at Marine Station B (immediately offshore from the marsh, see **Figure 6.2**) 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 concentrations of chemicals, no impact on the water quality from the discharge of the marsh is anticipated.

9.7.40 The future water quality monitoring programme for the proposed golf course will be tailored to the practices on the golf course, e.g. monitoring will focus on those chemicals that are used to maintain the golf course. 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.

9.7.41 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.

9.7.42 In the case of heavy rainfall, the proposed closed drainage system might overflow. The frequency of overflow would be low (the design of the closed drainage system would be able to retain a 1 in 2 year design flow, based upon the estimation from the past 10-year rainfall records). Even when the temporary storage of the closed drainage system (a new artificial lake in the proposed new golf course) is full, it will overflow to the existing reservoir only and not to the sea. Because the predicted water quality from the proposed drainage system would be better than that in the existing reservoir, no water quality impact is anticipated from overflowing.

9.7.43 The nearest water sensitive receiver (the corals on the bedrock 80 m south of the pier) would not be impacted by water quality during the operation of the golf course or the desalination plant. Therefore other, more distant sites of conservation concern in Port Shelter would also not be affected by operation phase water quality issues due to their greater distances from the desalination plant and the proposed golf course (1.5 km for the coral buoy area in Sharp island , at least 4 km for others). While adverse water quality impact is not predicted, some precautionary measures are suggested to further protect the nearby marine ecology (see **Table 9.8**).

Table 9.8 Summary of construction and operational phase impacts

Impacts	Due to	Duration	Receiver	Severity	Need for mitigation
Construction phase					
Permanent Intertidal Habitat Loss (130 m^2)	Pumping station for the desalination plant	Permanent	Intertidal communities	Minimal	No
Temporary intertidal habitat loss (about $40m^2$)	Temporary berthing point	Temporary	Intertidal organisms	Minimal	No. But reinstatement on the affected intertidal habitat will be conducted after the temporary barging point is removed.
Temporary Seabed loss (none at the barging point, and $1,500m^2$ at the dredging area for three months)	Pipeline installation	Temporary	Marine organisms	Minor	Yes. Coral transplantation at Site D2 will be conducted. Anchoring points of the floating barging point would avoid corals. Shifting the floating barging point to Zone 5 instead of Zone 2 & Zone3 to further protect corals.
Marine water quality	Resuspension during dredging;; Site runoff	Temporary	Marine organisms	Minor	Only water quality mitigation measures (major construction in non-rainy season, closed grab dredging, backhoe excavation, silt curtains, temporary drainage system, stream buffer zone, and site practices). Avoid dredging in breeding seasons for corals and seagrasses, & monitoring on natural corals as precautionary measures (see below Section 9.8 & 9.10).
Construction Noise and Disturbance	Construction activities	Temporary	Intertidal and marine organisms	Minimal	No
Marine traffic	Vessel traffic associated with construction	Temporary	Local cetaceans	Insignificant	No

Operational Phase					
Marine water quality	Increase in salinity	Permanent	Marine organisms	Minimal	No But precautionary measures (Filter & biological method for runoff, and monitoring of natural corals) and Contingency plan by Turfgrass management plan. would be provided (see Section 9.8).

Cumulative impacts

9.7.44 This section of the report considers the potential cumulative impacts from other concurrent projects in the vicinity of the project site.

9.7.45 There are no scheduled concurrent designated projects (DP) in the vicinity of the proposed golf course during the construction and operation phase.

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

9.8 MITIGATION MEASURES

9.8.1 In accordance with the guidelines in the EIAO-TM on ecological impacts, the general policy for mitigating impacts to 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 constraints on the intensity of works operations (eg dredging rates) or timing of works operations; 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

Design phase

9.8.2 Impacts to marine ecology have largely been avoided in the present Project through the following avoidance measures:

- Site selection: 5 potential sites for the two marine components (desalination plant and temporary barging point) were studied by dive surveys, two locations were recommended and the sites of higher ecological value were avoided (Site D1 with higher coral coverage & Site D3 with seagrass beds);

- Design of the temporary barging point: to avoid impacts on hard coral colonies, a floating barging point was proposed to replace the original design (baring point supported by piles). This, together with shifting the floating barging point to location with least corals, could avoid any construction or damage on the shallow waters where the corals are located. Impacts on corals were thus avoided; and

- Pipeline alignment: two options of pipeline alignments were considered. As site selection survey results showed that coral colonies and some sparsely distributed seagrass individuals were found about 80 m south of the pier. The option which was close to the existing pier but away from the bedrock was adopted. Potential impacts on the corals on bedrock were therefore minimised

- Further refinements including shifting the intake pipeline to the north side of the pier and building the pipeline on the pier dyke, were also be considered.

- Temporary drainage system during construction phase: the temporary drainage system would receive site runoff flows from all areas subject to earth works. The collected runoff would be retained for turf grass irrigation.

- Establishment of stream buffer zones: Sedimentation in the sea from discharges via stream courses have been avoided during the design stage by designating buffer zones. Except locations of culverting and crossings, the majority streams and tributaries will remain intact and away from earth works.

- Closed low flow drainage system during operation phase: A closed low flow drainage system is proposed to capture runoff by collecting surface water from the majority of the proposed third golf course and pump it back to the existing reservoir for reuse in irrigation. The drainage system design and concept approach for the proposed third golf course is similar to the existing golf course, which has been seen as successful, to minimize the impacts to nearby sensitive receivers as far as possible.

Construction phase

9.8.3 As shown in **Table 9.8**, only construction phase mitigation measures for coral and marine water quality impact are needed for marine ecology.

9.8.4 Coral colonies within silt curtain at Site D2, in particular the 79 colonies identified during the coral mapping survey (**Table 9.9**, also see **Appendix A9.2** and the above paragraphs), would be transplanted. All these corals are common species, small in size and of low ecological value. Prior to commencement of any marine construction works for the proposed project, the affected coral colonies would be tagged using plastic labels and a number would be assigned to each. The tagged corals in the dredging area will be transplanted to the bedrock area about 80 m south of the ferry pier. All these transplantation works should be conducted by experienced marine ecologist(s) to be approved by AFCD and should be completed before the commencement of marine construction works.

9.8.5 All anchoring points/structures of the floating pier would be located on the shore and/or at least 40m seaward to avoid the coral colonies at Site B2 which are concentrated within the first 15m seaward from the coastline and none recorded over 35m seaward (see **Appendix A9.2**). Though no direct impacts on corals is anticipated, to further protect the corals at Site B2, the location of the floating pier would be shifted from the original location for barging point at Zone 2 and Zone 3 of the mapping area in Site B2 (see **Figure 2** in **Appendix A9.2**), to Zone 5 which had the least corals. The protection on corals at Site B2 would be further enhanced. No impact on corals is anticipated.

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

- Site runoff;

- Suspended solid during dredging;

9.8.7 In addition to the temporary drainage system which would collect site runoff for re-use for irrigation, site runoff will be controlled by general site practices during construction. Potential impacts due to site runoff would be reduced by scheduling most of the bulk site formation works during the dry season of 2005-6 in order to avoid excessive erosion. At locations of existing stream courses where there would be construction works, including the underground pipe culvert at tributary A2 and old tributary B3, the two small pipe culverts at the upstream part of tributary B2 and the culvert bridge at the upstream part of tributary B1 (**Table 9.9**, also see **Figure 6.6a** and **Section 8.7**), bypass flow channel or pipes would be provided before the commencement of construction. These would maintain the stream flow until the crossings and the underground pipe culvert are finished. Construction materials must be stored at locations away from the stream courses. Site runoff would be desilted in settling ponds to reduce the potential for suspended sediments, organics and other contaminants to enter stream and marine environment.

9.8.8 Besides mitigation measures, monitoring of natural corals and seagrass would be adopted as a precautionary measure (See **Section 9.10** below for details).

9.8.9 Although adverse impacts on corals and seagrasses are not predicted, scheduling the dredging period to avoid the reproductive seasons of corals and seagrasses would also be adopted as a precautionary measure, in view of the higher sensitivity during breeding seasons (**Table 9.10**). Dredging for the two pipelines for the desalination plant would require 50 days and would be scheduled to the extent possible from January to April 2006. This would avoid the flowering season for the seagrass *Halophila ovalis*, i.e. November and December (Fong *et al*. 2005) and the spawning season for corals, i.e. July to October (Lam 2000; Storlazzi, C. D. 2004). Silt curtains will be deployed during dredging for the desalination plant. With the deployment of silt curtains around the dredging area for the desalination plant, adverse water quality impacts associated with the dredging and backfilling would be controlled to acceptable levels.

Operation phase

9.8.10 No mitigation measures are needed during the operation phase, but some precautionary measures would be adopted.

9.8.11 Runoff from Hole 5 and part of Hole 6 would discharge into a marsh and might enter the sea. Although the water quality assessment has demonstrated that the marine water quality is unlikely to be affected by the runoff, some precautionary measures would be adopted to further protect the nearby marine ecology.

9.8.12 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%.

9.8.13 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 (**Table 9.10,** also see **Section 6** Water Quality Assessment). 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.

9.8.14 Furthermore, the Turfgrass Management Plan (TMP) provides a contingency plan (**Table 9.10,** see **Section 6** of this report for more details). The TMP will respond to any exceedance of the normal levels of chemicals and pesticides. The application of chemicals and pesticides would be further controlled, and more frequent water quality monitoring will be conducted.

9.8.15 Besides mitigation measures, monitoring of natural corals and seagrass would be adopted as a precautionary measure. (See **Section 9.10**)

Table 9.9 Mitigation measures recommended for Construction and Operational phase impacts of the project

Impacts	**Mitigation measures**
Construction phase	
Direct impacts on coral colonies	Coral transplantation plan and follow-up monitoring of transplanted corals. Avoidance of corals at the anchoring points of the floating barging point Shifting the floating barging point to the location with least corals (Zone 5).
Site Runoff	Major construction in non-rainy season. 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 closed grab dredging, backhoe excavation and silt curtains

Table 9.10 Precautionary measures during construction and operational phases of the project

Impacts	**Precautionary Measures**
Construction phase	
Site Runoff	Monitoring of natural corals
Water quality impact from dredging at desalination plant	Conduct dredging to the extent possible between February to April to avoid reproductive seasons of corals (July to October) and seagrasses *Halophila ovalis* (November and December) Monitoring of natural corals and seagrass
Operational phase	
Runoff from the third golf course	Filter system and biological methods to further reduce the chemical concentrations in runoff from Holes 5 and 6. Contingency plan of the Turfgrass Management Plan. Monitoring of natural corals and seagrass

9.9 RESIDUAL IMPACT

9.9.1 The construction of the pumping station will result in some loss of sandy intertidal habitat and direct impacts on coral colonies. However, the size of the habitat loss is small and the ecological value is low, and a transplantation plan is proposed for the corals. This habitat loss is not expected to have a significant negative impact on the marine ecology. Temporary habitat losses are small-scale and short-term. The marine soft bottom benthic communities were not of special conservation concern. Residual impacts on habitat loss are acceptable.

9.9.2 One important residual benefit can be predicted. It is a reiteration of a prediction made in the 1994 EIA for the initial golf course project on Kau Sai Chau. The turfgrass areas were predicted to serve as a fire-break between the many graves on the northeast tip of the island and the natural habitats to the south. This was predicted to enable natural succession of habitats from the grasslands and short-shrublands that dominated in 1993 to taller shrublands and woodlands. That prediction proved true for the first 36-hole golf course with the result that sedimentation of the marine environment by runoff from Kau Sai Chau declined during 10 years of golf operation. This is also predicted to be the case for the proposed 18-hole golf course.

9.10 ENVIRONMENTAL AUDIT AND MONITORING

9.10.1 Adverse impacts to corals and marine ecology are not predicted to occur during the construction or operation phase, and the water quality monitoring programme will further safeguard marine ecology by providing management actions and supplemental mitigation measures to be employed should unforeseen impacts arise. The environmental acceptability of the project will thus be ensured. Despite these measures, an EM&A programme for marine ecology is proposed as a proactive and precautionary measure. The programme would concentrate on natural corals at eastern and western Kau Sai Chau as well as seagrasses at the western Kau Sai Chau, to verify that the project will have no adverse ecological impact on the corals and seagrasses. Details of the EM&A programme are provided in the EM&A Manual.

9.11 CONCLUSION

9.11.1 The construction of the desalination plant and temporary barging point will result in minor losses of intertidal (40 m^2 temporary at the barging point, 130m^2 permanently at the desalination plant) and subtidal (1,500 m^2 at the dredging area) habitats. However, the size of the loss is small and the duration is short (about 3 months at the desalination pipelines). This loss is not expected to have a significant negative impact on marine ecology. In the silt curtain for the desalination plant, all corals in particular the 79 colonies identified during the mapping survey were found and would be transplanted. All of these colonies are common species, small in size and their transplantation is feasible. The marine benthic communities in the waters around Kau Sai Chau were not of special conservation concern, and the intertidal zone was basically natural and typical. Mitigation and precautionary measures would be provided for construction phase and operation phase to avoid/minimize water quality impact. The residual impacts are acceptable.

9.11.2 The above assessment should make it apparent that the construction and operation of the Project has no insurmountable impacts on marine ecology. A well-planned program of site practices and suggested mitigation measures should be able to maintain the impacts to acceptable levels.

9.12 REFERENCE

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Annex 9.1 Results of sandflat quadrat sampling

Species	Abundance									
	S1									
Quadrats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mollusca										
Cerithedia rhizophorarum	24	13	20	6	2	0	15	11	26	2

Terebalia sulcata	16	10	9	11	5	13	12	14	10	10
Planaxis sulcatus	3	5	0	0	2	0	0	4	4	0
Crustacea										
Perisesarma bidens	Over 100 observed									
Uca spp.	Over 100 observed									
Macrophthalmus sp.	About 25 observed									
Macrobrachium sp.	About 12 observed									
Scylla serrata	One observed									
Thalamita crenata	None									
Pisces										
Periophthalmus sp.	About 20 observed									
	S2									
Quadrats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mollusca										
Cerithedia rhizophorarum	16	27	16	31	18	29	41	10	8	14
Terebalia sulcata	12	11	5	13	4	18	14	10	10	2
Planaxis sulcatus	4	2	1	0	3	0	0	2	5	0
Crustacea										
Perisesarma bidens	About 70 observed.									
Uca spp.	40 observed									
Macrophthalmus sp.	18 observed									
Macrobrachium sp.	Three observed									
Scylla serrata	\									
Thalamita crenata	Two observed									
Pisces										
Periophthalmus sp.	About 15 observed									

Annex 9.2 Results of rocky shore quadrat sampling

Species	**Abundance**									
	R1									
Tidal level	**Low**					**High**				
Quadrats	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Mollusca										
Saccostrea cucullata	56	67	85	26	45	3	0	7	0	0
Littorina spp.	0	0	0	0	0	16	35	24	30	59
Monodonta labio	9	2	12	5	9	2	0	0	0	0
Cellana sp.	4	5	2	6	0	0	0	0	0	0
Crustacea										

Pollicipes mitella	25	20	16	31	26	5	2	0	0	0
Tetraclita squamosa	10	12	6	3	5	0	0	0	0	0
Grapsus albolineatus	None observed									
	R2									
	Low					**High**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Mollusca										
Saccostrea cucullata	12	6	11	9	21	0	0	0	0	0
Littorina spp.	0	0	0	0	0	26	37	54	16	18
Monodonta labio	\	\	\	\	\	\	\	\	\	\
Cellana sp.	3	5	4	2	2	0	0	0	0	0
Crustacea										
Pollicipes mitella	15	24	11	15	25	10	6	7	16	14
Tetraclita squamosa	26	31	19	38	27	0	0	0	0	0
Grapsus albolineatus	Over 10 crabs observed.									