SECTION 7

7 ECOLOGY

7.1 Introduction

7.1.1 This Section presents the ecological assessment of the proposed WCR based on information from previous studies and preliminary field surveys. Potential impacts have been identified, assessed and mitigation measures recommended, where necessary.

7.2 Government Legislation and Standards

7.2.1 The criteria for evaluating both ecological and fisheries impacts are laid out in *Annexes 8-9* of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM).

Terrestrial Ecology

7.2.2 There are a number of international and local regulations, legislation and guidelines which provide the framework for the protection of species and habitats of ecological importance, those related to the WCR Project are:

- *Forests and Countryside Ordinance (Cap 96)*, 1994;
- *Wild Animals Protection Ordinance (Cap 170)*, 1994;
- *Town Planning Ordinance (Cap 131)*;
- *Hong Kong Planning Standards and Guidelines (Chapter 10)*;
- *Technical Memorandum for Environmental Impact Assessment (EIA) Ordinance* (Cap. 499); and
- *United Nations Convention on Biodiversity*, 1992.

7.2.3 *The Forests and Countryside Ordinance (Cap 96)* prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on government land. Related subsidiary regulations prohibit the selling or possession of listed rare and protected plant species.

7.2.4 *The Wild Animals Protection Ordinance (Cap 170)* prohibits hunting of all wild animals in Hong Kong. Additional protection is provided for protected wild animals (including most mammals, all birds and turtles, and some snakes, amphibians and insects). No person should possess, buy, sell, export or wilfully disturb any protected wild animal or a nest or egg of any protected wild animal.

7.2.5 *The Town Planning Ordinance* (TPO) provides for the drawing up of statutory plans to control development and the designation of areas including Coastal Protection Areas, Sites of Special Scientific Interest (SSSIs), Conservation Areas and Green Belt which promote conservation or protection of the environment.

7.2.6 *Chapter 10* of the *Hong Kong Planning Standards and Guidelines* (HKPSG), 1994 covers "Conservation". This chapter details the principles of conservation,

the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities.

7.2.7 The EIAO TM *Annex 16* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating ecological importance of a site and the species found, as well as ecological impact.

7.2.8 The People's Republic of China (PRC) are Contracting Parties to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The Hong Kong SAR has stated that it will be "committed to meeting the environmental objectives" of the Convention in 1996.

Marine Ecology

7.2.9 The criteria for evaluating both marine ecological and fisheries impacts are laid out in the EIAO-TM which comprises part of the EIA Ordinance.

7.2.10 *Annex 16* sets out the general approach and methodology for assessment of marine ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential marine ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating marine ecological impacts.

7.2.11 *Annex 17* sets out the general approach and methodology for assessment of fisheries impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential fisheries impacts. *Annex 9* recommends the criteria that can be used for evaluating fisheries impacts.

7.2.12 Other legislation which applies to marine species includes:

- *The Wild Animals Protection Ordinance (Cap. 170)* 1980 which protects all cetaceans;
- *The Fisheries Protection Ordinance (Cap. 171)* 1987 which provides for the conservation of fish and other aquatic life and regulates fishing practices; and,
- *Marine Fish Culture Ordinance (Cap 353) 1983* regulates and protects marine fish culture and other related activities.

7.3 Terrestrial Ecology Baseline Conditions

Methodology

7.3.1 Ecological field visits were undertaken between March and September 1997 to investigate the ecological condition of the Study Area, and the key terrestrial ecological issues and constraints for the Study Area were identified and examined.

7.3.2 According to the *Outline Zoning Plan (Plan No. S/TKO/6 & Plan No. S/K15/10)*, most of the Study Area is zoned as "Green Belt" area, except for the urbanised area of Cha Kwo Ling, Yau Tong and Lei Yue Mun and the Tseung Kwan O Cemetery. No Country Park or SSSIs are found to be located either within or close to the Study Area.

7.3.3 There are no previous studies that cover the Project Study Area. A review of the latest aerial photographs and the vegetation map prepared by World Wide Fund for Nature, Hong Kong (WWF HK), which are the only sources of existing information, was undertaken. Most of the Study Area falls within highly developed urban areas of Cha Kwo Ling, Yau Tong and Lei Yue Mun. No natural habitats were identified within these urban areas, with only roadside weeds and other vegetation associated with landscaped planting.

7.3.4 The other part of the Study Area which comprises the lower portion of the southern and southeast hillslope of the Devil's Peak are well vegetated and composed of different habitat types including grassland, scrubland grassland mosaic, and woodland.

7.3.5 Ecological field surveys were undertaken in between March and September 1997 and descriptions for each habitat type (*Figure 7.3a* and *7.3b*) are presented below. The plant species recorded for each habitat type are shown in the *Annex G*.

Habitats and Wildlife

Woodland

7.3.6 There are two woodland types within the Study Area, one area is a patch of open secondary woodland that is composed of mainly pioneer tree species behind the Lei Yue Mun Tsuen. The other area is an orchard formed woodland amongst the villages along the western coastline of TKO (see Annex G).

7.3.7 The open secondary woodlands are all small in size and hence fragmented. The height of the trees found within this habitat type range from 4 to 6 m and are dominated by planted *Acacia spp.* and other pioneer tree species such as *Macaranga tanarius*, *Mallotus paniculatus*, *Sapium discolour* and *Litsea glutinosa*. Within the woodland are a number of common hillside shrubs, such as *Litsea rotundifolia*, *Rhodomyrtus tomentosa*, *Rhaphiolepis indica* and *Dalbergia hencei*. Fifty-five species were recorded in this habitat, and the open nature and vigorous understorey growth of scrubby species and young tree saplings indicate that this woodland is quite young in successional stage.

7.3.8 The orchard formed woodland is an anthropogenic habitat dominated by patches of fruit tree, such as *Litchi chinensis*, *Dimocarpus longan*, *Citrus spp.*, *Clausena lansium* and *Musa paradisiaca*. The trees range from 3 m to 10 m in height, and the understorey growth is limited to weedy species such as *Mikania micrantha*, *Ipomoea carica*, and *Polygonum chinens*is possibly attributed to human activities from the nearby villages. Nonetheless, pioneer tree species including *Litsea glutinosa*, *Bredelia tomentosa*, and *Macaranga tanarius* can also be found at the edge of this woodland habitat. A total number of 27 species were recorded in this planted woodland habitat.

Scrubland-Grassland Mosaic

7.3.9 The scrubland-grassland mosaic is located on the southern and southeast upper slope of the Devil's Peak, forming a dense vegetation cover with average height of about 1 m to 2 m. This type of habitat results from natural succession process and is a typical community structure found in Hong Kong. Dominant species for each vegetation life form include the trees *Cratoxylum cochinchinense*, *Litsea glutinosa* and *Schefflera octophylla*; the shrubs *Rhodomyrtus tomentosa*, *Eurya japonica* and *Rhaphiolepis indica*; the climbers *Gnetum montanum* and *Millettia nitida*; the herbs *Dianella ensifolia* and *Asparagus cochinchinensis*; as well as the grasses *Ischaemum spp.* and *Cymbopogon spp.*

7.3.10 Sixty-five plant species were recorded in this habitat including two protected plant species listed under the *Forestry (Amendment) Regulation* 1993, (*Cap 96, Section 3*) which are the Chinese New Year Flower *Enkianthus quinqueflorus* (see *Figure 7.3a and 7.3c*) and Bamboo Orchid *Arundina chinensis* (see *Figure 7.3d and 7.3c*). Several patches of the Chinese New Year Flower were scattered on the lower slope of the northern end of the Study Area, along the western coastline of Junk Bay; while few patches of the Bamboo Orchid are located on the upper slope of the southern Devil's Peak. Although these two species are protected in Hong Kong, they are quite widely distributed throughout Hong Kong on undisturbed scrubland and hillslope with moist habitat.

Grassland

7.3.11 Two grassland areas of different origins are located on the lower part of the southern slope of the Devil's Peak. The grassland behind Lei Yue Mun Village is established on a heavily disturbed area that only supports limited number of plant species, while the other area is a typical fire maintained grassland on the lower part on the southern slope of the Devil's Peak. A total of 42 species were recorded within these areas.

7.3.12 As with other highly disturbed areas in Hong Kong, the soil condition, habitat heterogeneity and structural complexity of the disturbed grassland are very poor, and hence the species supported is limited. The disturbed grassland is dominated by only a few common, widely distributed species, including the tall grasses *Panicum maximum*, *Miscanthus floridulus*, and *Neyraudia reynaudiana*; as well as some pioneer trees *Ficus hispida*, *Leucaena leucocephala* and *Macaranga tanarius*. In addition, several individuals of orchid *Habenaria linguella*, which

is protected under the *Forest and Countryside Ordinance (Cap 96)*, were found by AFD officers in July 1999.

7.3.13 The fire-maintained grassland is typical to most of the hillside slope in Hong Kong that suffered frequent burning. This grassland area supports a higher number of species compared with the disturbed grassland area, and the dominant species of this habitat are *Ischaemum spp.*, *Cymbopogon spp.* and *Rhynochora rubra* (See Annex G). The site visits between March and November 1997 found that different parts of this grassland were burnt and under recovery.

Other Wildlife

7.3.14 The field visits found that the orchard formed woodland along the southeast coastline supports a few avifauna species which are mostly common or widespread species either well adapted to disturbed conditions including Tree Sparrow, Spotted Dove and Long-tailed Tailorbird, or confined to semi-natural or natural areas including Chinese Bulbul, Magpie Robin and Black Kite. A Black Kite nest (*Figure 7.3c*) was found in this woodland habitat (see *Figure 7.3a* for location). Except common avifauna, no sign of other animal wildlife groups were noted during the field surveys.

7.3.15 However, the ecological value of the area to provide ecological resources to other wildlife of recognised ecological importance is limited because of the disturbed nature and frequent human activities within and in the surrounding of the Study Area, as well as the simplicity of species composition and structure of the habitats. No signs or evidence of the presence of wildlife of recognised ecological value within the Study Area had been identified during the site visits.

7.3.16 Altogether, three ecological important plant species were found within the Study Area (see *Figure 7.3a*) and the evaluation of these species according to the EIAO TM are given below.

Table 7.3a Evaluation of Ecological Important Species

Species	Protection Status	Distribution	Local Rarity
Enkiantus quinqueflorus	Protected	Pat Sin Range, Sai Kung, the Peak, Siu Lam	Common
Arundina chinensis	Protected	Tai Mo Shan, Sai Kung, Pat sin Range, the Peak	Common
Habenaria linguella	Protected	Mount Parker, Sai Kung, Tai Mo Shan, Ma On Shan, Luk Wo	Restricted

7.4 Marine Ecology Baseline Conditions

Intertidal Habitat - TKO Section

7.4.1 Preliminary field visits and a quantitative field survey were undertaken in March 1997 and November 1997, respectively, on the intertidal rocky shore community present at the Study Area in Junk Bay (*Figure 7.4a*). The shores are open to the influence of direct oceanic fetch from the Tathong Channel and as such can be regarded as semi-exposed.

Preliminary Survey

7.4.2 The intertidal community is very typical of that found on shores of medium exposure[10] *(Table 7.4a)*, such as those found on the Eastern Shores of Hong Kong, eg Clearwater Bay, Po Toi, Tung Lung Chau and Cape d'Aguilar[11] (an AFD designated Marine Reserve). Organisms which typically inhabit both exposed and sheltered shores, were found in the Study Area. The shores appear to support high abundances of fauna with a large number of juvenile individuals, often a reflection of a healthy community. The survey was undertaken in March when algal growth is most abundant in Hong Kong due to the favourable climatic and wave conditions [12]. Consequently, there was high coverage of algae on the shore (> 70% on the lower shore) and a total of 12 species were identified.

7.4.3 As with all hard shores in Hong Kong, clear patterns of vertical zonation of the community were observed at the Study Area. The lowest zone is termed the infralittoral fringe and on a semi-exposed shore this is found below 0.75 m above chart datum (CD). Further up the shore between 0.75 and 1.75 m CD is the midlittoral zone. The highest zone is referred to as the supralittoral fringe[13].

7.4.4 The infralittoral fringe at the bottom of the shore supported close to 100% algal cover. The algal assemblage was composed of 6 different species of algae belonging to 4 different groups. These were erect coralline (*Corallina sessilis*), encrusting red (*Peysonnelia sp*), encrusting brown (*Ralfsia expansa* and *Endoplura aurea*) and red turf algae (*Gelidium pusillum* and *Gymnogongrus flabelliformis*). Large numbers of juvenile fauna were observed; the most abundant were the limpet; *Cellana toreuma* and the chiton *Acanthopleura japonica*. In patches where the algal cover was lower there were small colonies of the barnacle, *Tetraclita squamosa*.

7.4.5 In the midlittoral zone a slightly lower cover of algae but a much higher abundance of herbivorous molluscs was observed. There were 13 species of limpets, chitons, coiled gastropods and mussels recorded. The brown turf alga *Hincksia mitchelliae*, alone, was estimated to constitute over 50% of the shore cover.

[10] Morton B & Morton J (1983) The seashore ecology of Hong Kong. Hong Kong University Press
[11] Morton B & Harper E (1995) An introduction to the Cape d'Aguilar Marine Reserve. Hong Kong University Press
[12] Kennish R, Williams GA, Lee S Y (1996) Algal seasonality on a exposed rocky shore in Hong Kong and the dietary implications for the herbivorous carb *Grapsus albolineatus*. Marine Biology 125: 55-64.
[13] Kaehler S & Williams GA (1996) Distribution of algae on tropical rocky shores: spatial and temporal patterns of non-coralline encrusting algae in Hong Kong. Marine Biology 125: 117-188.

7.4.6 Algal assemblages in the supralittoral fringe of the site were typical of that found in Hong Kong in that only one species was identified (*Kyrtuthrix maculans*) and its cover was estimated at below 10%. The abundance and diversity of fauna in this zone was also reduced in comparison with the lower zones with only 6 species recorded.

7.4.7 A second preliminary survey (shown in *Figure 7.4a*) was conducted on a more sheltered shore, further along the shoreline. This second site was situated behind a large rock outcrop and supported assemblages typical of less exposed shores. The algal species were similar to those found at the first site but appeared to occur in much lower abundances. In contrast to the first site examined, the lower shore supported a large assemblage of the rock oyster *Saccostrea cucullata* instead of barnacles. Rock oysters are rarely found on exposed shores being more common on sheltered shores eg in Tai Tam or Tolo Harbour[14]. The second site also differed in respect to the first since coiled gastropods (especially *Nerita albicilla* and *Monodonta labio*) were observed to be more abundant than limpets.

[14] Morton B & Morton J (1983) *op cit.*

Table 7.4a Species Found During Preliminary Intertidal Surveys at the Study Site

	Zone	Species
INFRALITTORAL FRINGE		
Algae	Erect Coralline Alga	*Corallina sessilis* *
	Encrusting Red Alga	*Peysonnelia sp*
	Encrusting Brown Alga	*Endoplura aurea* *Ralfsia expansa* *
	Red Turf Algae	*Gelidium pusillum* * *Gymnogongrus flabelliformis*
FAUNAL ORGANISMS	Limpets	*Siphonaria atra* *Cellana toreuma* *
	Chitons	*Ischnochiton comptus* *Acanthopleura japonica* *
	Coiled Gastropods	*Chlorostoma argyrostomus*
	Barnacles	*Tetraclita squamosa*
	Anemone	*Anthopleura sp.*
MIDLITTORAL ZONE		
Algae	Green Foliose Alga	*Ulva fasciata*
	Brown Turf Alga	*Hincksia mitchelliae*
	Brown Encrusting Alga	*Ralfsia expansa* *Hapalospongidion gelatinosum*
	Red Encrusting Alga	*Hildenbrandia prototypus*
Fauna	Limpets	*Cellana toreuma* * *Cellana grata* * *Patelloida pygmaea* *Patelloida saccharina* *Siphonaria japonica*
	Chiton	*Acanthopleura japonica* *
	Barnacles	*Tetraclita squamosa* * *Capitulum mitella*
	Coiled Gastropods	*Nerita albicilla* *Monodonta labio* *Thais clavigera* *Nodilittorina vidua* *
	Mussel	*Septifer virgatus (in rockpools)*
SUPRALITTORAL FRINGE		
Algae	Cyanobacteria	*Kyrtuthrix maculans*
Fauna		
	Coiled Gastropods	*Nodilittorina vidua* * *Nodilittorina radiata* * *Nodilittorina trochoides* *
	Limpet	*Cellana grata*
	Rock Crab	*Grapsus albolineatus*
	Barnacle	*Capitulum mitella*
Notes:* denotes the most abundant species in the respective zones (determined visually).		

7.4.8 The preliminary surveys of the intertidal shores at the Study Area indicated that the shores have a high cover of a diverse algal assemblage. This assemblage supports a large number of herbivorous gastropods. The population does not appear to be suffering from any pollution induced stress as there were a large number of juveniles, indicating that recruitment had recently occurred. The community present was typical of that found on semi-exposed shores on the eastern side of Hong Kong. Faunal abundances and algal cover appeared to be very high.

Quantitative Survey

7.4.9 A representative area was selected (*Figure 7.4a*) on the southern shore represented in the map. The substrate of the site was very homogeneous as it was mainly composed of large stretches of natural bedrock. The shore was gently sloping and was open to slight wave action from Tathong Channel.

7.4.10 A 10 m long belt transect was deployed at heights of 1.0 m, 1.5 m, 2.0 m and 2.5 m above chart datum. Ten cross string quadrats (50 x 50 cm) were located at random along the transect. All mobile organisms within the sampling quadrat were counted and the percentage cover of sessile organisms and encrusting algae determined.

7.4.11 All flora, sessile organisms (% cover) and mobile fauna (individuals 0.25 m^2) found in each quadrat were identified and recorded, to determine the zonation and abundance of intertidal organisms at each site (*Table 7.4b*). In total 24 species of animals and 5 species of algae were recorded at the selected sites. Most abundant organisms were herbivorous molluscs, including in the infralittoral fringe, the chiton, *Acanthopleura japonica*, the limpets, *Cellana toreuma, Patelloida pygmaea and P. saccharina;* and in the supralittoral fringe the littorinids, *Nodilittorina trochoides, N. radiata* and *N. vidua*. Predatory gastropods, the common dogwhelk, *Thais clavigera* were also recorded in the infralittoral fringe. There was high abundance of the sessile filter feeding acorn barnacle, *Tetraclita* species. Five species of algae were recorded in the infralittoral fringe.

7.4.12 In the supralittoral fringe, the assemblages were numerically by littorinids particularly *Nodilittorina trochoides, N. radiata* and *N. vidua* and the limpet, *Patelloida pygmaea*. No algae were recorded at this level. In the midlittoral zone, the highest number of animals were noted while the highest number of algal species were recorded in the infralittoral fringe. The two levels were dominated by herbivorous gastropods and a high abundance of filter feeders, ie bivalves and barnacles. Of the algae present, encrusting algae were the most abundant, with *Ralfsia expansa*, recording the highest percentage cover.

Table 7.4b Intertidal Flora and Fauna Recorded During the Quantitative Survey at WCR

Intertidal Flora/Fauna	Height above C.D. (m)			
	1.0	1.5	2.0	2.5
Animal				
Littorinids				
Nodillitorina trochoides				
Nodilittorina trochoides			0.3 ± 0.9	6.5 ± 6.26
Nodilittorina radiata			1.7 ± 4.47	10.5 ± 7.31
Nodilittorina vidua		1.5 ± 4.5	13.4 ± 5.46	
Littoraria articulata			0.3 ± 0.46	
Peasiella roepstorffiana			0.3 ± 0.9	
Topshells				
Chlorostoma argyrostomus	0.4 ± 1.0			
Lunella coronata	0.6 ± 0.84	0.2 ± 0.4		
Nerita albicilla		0.4 ± 0.8	0.1 ± 0.3	
Monodonta labio		0.1 ± 0.3	0.1 ± 0.3	
Limpets				
Cellana grata		1.8 ± 2.32	0.1 ± 0.3	
Cellana toreuma		5.2 ± 8.0		
Patelloida saccharina	0.3 ± 0.90	24.3 ± 16.2		
Patelloida pygmaea	0.1 ± 0.32	8.4 ± 8.9	7.3 ± 5.85	
Siphonaria sirius	2.1 ± 3.73	0.3 ± 0.9	0.4 ± 1.2	
Siphonaria japonica		0.1 ± 0.3		
Chiton				
Acanthopleura japonica	4 ± 4.20	4.9 ± 4.61	0.2 ± 0.4	
Dogwhelks				
Thais clavigera	2.4 ± 5.52			
Morula musiva		0.1 ± 0.3		
Bivalves				
Barbatia virescens	0.2 ± 0.42			
Septifer virgatus		0.2 ± 0.6		
Saccostrea cucullata	0.5 ± 1.58	3 ± 6		
Barnacles				
Tetraclita sp	26 ± 31.0	1 ± 3		
Capitulum mitella		0.1 ± 0.3	0.3 ± 0.9	0.2 ± 0.63
Sea anemone				
Unknown sp	0.8 ± 1.14			
Algae				
Ralfsia expansa	29 ± 19.7			
Hildenbrandia prototypus	10 ± 13.33			
Green turf	11 ± 12.9			
Encrusting coralline	7.5 ± 7.17			
Kyrtuthrix maculans		2 ± 4		
Total number of animals species	**11**	**16**	**12**	**3**
Total number of algal species	**4**	**1**	**0**	**0**

Mean number (for mobile animal species) and % cover (for sessile animal and algal species) per quadrat with ±1 S.D. were presented.

7.4.13 The intertidal community is typical for semi-exposed shores found on the eastern side of Hong Kong Island and the New Territories, with high abundance of grazing gastropods, low density of predatory dogwhelks. No rare species were recorded during the survey.

Artificial Seawalls - Yau Tong Coastal Section

7.4.14 Artificial seawalls including those of typhoon shelters comprise a large amount of shoreline along the Yau Tong Coastal Section of the WCR. Few comprehensive surveys have been conducted on the colonization of organisms on artificial seawalls either within the proposed site or around Hong Kong (but see [15] and [16] for examples). Fouling organisms were, however, documented as common on artificial sea walls, wharf piles and other marine structures. Various species of algae, coelenterates, ascidians, bryozoans, sponges, crustaceans, molluscs and polychaetes are commonly observed on these artificial structures (*Table 7.4c*).

Table 7.4c Common Organisms Present on Artificial Seawalls in Hong Kong

Group	Species
Algae	*Ulva fasciata, Enteromorpha prolifera, Codium cylindricum, Colpomenia sinuosa*
Polychaete	*Hydroides elegans, Spirorbis foraminosus*
Bryozoan	*Bugula neritina*
Bivalve	*Perna viridis, Septifer virgatus, Saccostrea cucullata*
Barnacle	*Balanus amphitrite, Capitulum mitella, Tetraclita squamosa*
Ascidian	*Ascidia sydneiensis, Ciona intestinalis, Styela plicata*

Subtidal Habitat & Benthic Communities

7.4.15 Soft Substrate Habitats: Information regarding the benthic communities in the Lei Yue Mun Channel and adjacent areas is available from a Territory wide Study of benthic community structure conducted in 1976 and 1977 and the recent CED studies of dredging and disposal areas in Hong Kong. Sediment grain size in the Lei Yue Mun area is dominated by sands, unlike many other regions of Hong Kong which are primarily silt and clay. This is likely to be due to the fast currents in the area preventing the deposition of smaller particles[17]. Shin and Thompson[18] characterised the Hong Kong seabed, at 200 locations, according to sediment and benthic characteristics. The sediment in the vicinity of Lei Yue Mun was described as typical of scoured tidal channels, dominated by coarse sediments and benthic communities which had a high number of individuals (182.6 m^{-2}) and, in comparison with other areas in Hong Kong, low species diversity (17.5 0.5m^{-2}). Polychaetes and molluscs were equally dominant taxa

[15] Hon SL (1978) Aspects on marine fouling and anti-fouling in Victoria Harbour, Hong Kong. Mphil Theses, The University of Hong Kong.

[16] Morton BS & Morton J (1983) The Seashore Ecology of Hong Kong. Hong Kong University Press.

[17] REMOTS survey of Tathong Channel Borrow Pits and Surrounding Bottom Areas. May 5 - June 6, 1994. Binnie Consultants & SAIC. !2 September 1994.

[18] Spatial Distribution of the Infaunal Benthos of Hong Kong Shin and Thompson. Marine Ecology Progress Series Vol 10: 34-47, 1982.

comprising 48.3% and 45.3%, respectively. This differed from communities in the rest of Hong Kong waters where molluscs seldom represented more than 10% and polychaetes less than 70% of the total species.

7.4.16 Two recent studies have described the environmental conditions in Tathong Channel utilising sediment profile imagery (SPI) to assess the ecological status of the benthic environment. The first, conducted in 1993 collected images along a transect running from the Tathong Channel Borrow Pit, west of Tung Lung Chau, north to Lei Yue Mun point[19]. Reduced Redox Potential Discontinuity (RPD) values were recorded from the Lei Yue Mun Channel and were considered to be the result of enhanced sediment oxygen demand thought to be due to high organic loading. Habitat quality was reported to decrease with increasing proximity to Victoria Harbour. The second survey was conducted in 1994[14], during environmental monitoring of the Tathong Borrow Pits. Again, benthic environment conditions were described as poor in the Lei Yue Mun Channel and sediments were close to an anoxic state. For the purpose of the second survey observed benthic communities were divided into three successional stages depending upon the community structure. Stage 1, early successional assemblages, comprising dense communities of near surface polychaetes, dominated the entire Lei Yue Mun Channel area. It is expected that the assemblages in the vicinity of the WCR TKO Section and those in the vicinity of the Yau Tong Coastal Section are of similar ecological value to those described above.

Hard Substrate Habitats

7.4.17 The main areas of coral occurrence in Hong Kong are in eastern and southern waters. Until recently no surveys had been conducted within the Study Area, the closest undertaken along the east coast of Tung Lung Chau. The surveys at Tung Lung Chau recorded high hard coral abundance and diversity and two of the three sites were regarded as being of high conservation value[20]. It has to be noted, however, that these surveys were undertaken at a distance of 5 km SE of the WCR TKO Study Area. Limited information regarding the subtidal hard surface habitats within the Study Area is available from a series of dive surveys conducted for the EIA for Road P2 Connecting Tseung Kwan O Town Centre and Western Coast Road[21]. Full results of the dive surveys are not available at present, however, preliminary results indicate that coral species (both hard and soft) are patchily distributed throughout Tseung Kwan O Bay. The seabed along the shoreline was mainly rocky with occasional large boulders. Below -5mPD mud and silt were the predominant substrates. Isolated coral colonies were observed during the surveys with a cover estimated at between 0 - 10%, the main species of which was the orange soft coral *Dendronephthya gigantea*. The main organisms present on the hard substrate silt covered rocks were the rock oyster, *Saccostrea* sp and encrusting coralline algae. Occurrence of corals (including soft

[19] REMOTS Survey of Soft-Bottom Environments in Coastal Waters of Hong Kong, October 5-13, 1993. Binnie Consultants & SAIC. June 7, 1994.
[20] BCL (1995) Fill Management Study - Phase IV Investigation and Development of Marine Borrow Areas, Marine Ecology of Hong Kong, Report on Underwater Dive Surveys (October 1991 - November 1994) Volume 1 for Geotechnical Engineering Office Civil Engineering Department.
[21] SWK (1999) Tseung Kwan O Phase III, Road P2 Connecting Town Centre and Western Coast Road. Final IEIA Report.

corals, gorgonians and some favid hard corals) has also been reported by a further study, conducted for the Area 131 associated works, in the vicinity of the Western Coast Road alignment (information was not available at the time of reporting). Comparison with an area of known high conservation value, ie the coral colonies at Ping Chau emphasises the lower ecological value of the assemblages in Tseung Kwan O Bay. The surveys at Ping Chau recorded coral covers (both hard and soft) of 55.9 % and 61.9 % in different areas[22].

Fisheries Resources

Commercial Fishing Operations

7.4.18 The most up to date information on the Hong Kong fishery is available from the AFD 1996-7 Port Survey which contains data on the catch value and weight of five fishing zones in the vicinity of the WCR TKO (0157 - Chai Wan, 0169 - Lei Yue Mun, 0170 - Junk Bay West, 0171 - Junk Bay East and 172 - Tin Ha Wan) (*Table 7.4c*). Although the total production of the zones is not very high compared with other areas in Hong Kong, the rankings for production per hectare are high for all of the zones except Chai Wan. Catch value per hectare is very high with all of the zones except Chai Wan in the top 35 zones of the Hong Kong fishery. No fry were reported in catches from Chai Wan or Lei Yue Mun and the other zones ranked low when compared to other zones in Hong Kong that reported fry collecting.

Table 7.4c Total, adult and fry catch value and rank in comparison with other areas in Hong Kong from the AFD 1996-7 Port Survey

Zone (AFD Code)	Area (ha)	Total Production			Production (ha^{-1})			Rank (Production ha^{-1})		
		Weigh (kg)	Value (HK$)	Fry (tails)	W	V	F	W	V	F
0157 Chai Wan	184.1	12,502	519,852	-	67.9	2,824.4	-	115	89	-
0169 Lei Yue Mun	39.6	7,380	298,833	-	186.3	7,545.5	-	51	28	-
0170 Junk Bay W	301.1	50,310	2,038,105	8,812	167.1	6,769.7	29.3	59	30	62
0171 Junk Bay E	294.5	52,563	1,967,579	8,812	178.5	6,681.2	29.9	54	31	61
0172 Tin Ha Wan	353.1	73,681	2,624,033	4,078	208.6	7,430.6	11.6	46	29	77

7.4.19 The data presented in *Table 7.4d* below indicate that the Study Area contributes 1,257 kg to the total Hong Kong catch of fisheries resources. The values presented in the table indicate that the area to be reclaimed at the TKO Section of the WCR accounts for 0.007% of the total annual catch of the Hong Kong fishery.

[22] Binnie Consultants Limited (1996) Ping Chau Quantitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department.

Table 7.4d Fisheries Production in the Study Area taken from the AFD 1996-7 Port Survey

Catch Statistic	Reclamation Area (Total)	Study Area (Ha^{-1})	% Contribution to Hong Kong Fishery
Catch weight (kg)	1,257	167.1	0.007%
Value of Catch ($)	50,908	6,769.7	0.015%
Fry Catch (tails)	220.3	29.3	0.003%

7.4.20 According to the 1997 AFD Vessel Count there are seven home ports in the vicinity of the WCR TKO Study Area. The largest, Shau Kei Wan and Chai Wan, provide a base for 380 and 148 vessels respectively, of which the majority are large ocean going trawlers (Shau Kei Wan) or P4/7 vessels (Chai Wan) of under 10 m. The remaining home ports consist of those located at Causeway Bay, Yau Ma Tei, Po Toi O, Lei Yue Mun and Tin Ha Wan, with the main vessels operating from these ports also consisting mainly of vessels under 10 m. Mostly small scale fishing operations are carried out in these waters such as purse seining and gill netting (AFD personal communication). An analysis of the use of the area by fishermen reveals that only those working from the Lei Yue Mun home port are largely dependent on the waters adjacent to the WCR TKO Study Area for their catches. Data on fishing operations from the AFD 1996-7 Port Survey indicate that no vessels over 15 m in length operate in the WCR TKO Study Area.

Fisheries Resources

7.4.21 The marine waters adjacent to the Lei Yue Mun coastline are heavily used for shipping and information from the Marine Department indicates that trawl fishing activities in the region are restricted (*Regulations 68 of the Shipping and Port Control Reg. Cap 313*). As a result, the catches in all of these zones derive mainly from gill netting and other small scale fishing operations. Consequently, the catches are comprised primarily of low value species. The only species of any commercial value caught within the area was the three spot crab *Portunus sanguinolentus*. The most abundant group in the catches were the crustaceans. The presence of such species as *Siganus oramin*, *Argyrosomus* sp and *Caranx* sp can be explained by the night operating of bright light purse seine vessels working out of the Yau Ma Tei and Chai Wan home ports. The numbers of these species are low may be due to the minimal amount of fishing time spent in the Study Area by vessels working out of these home ports.

Table 7.4e The top five fisheries resources caught adjacent to the WCR Study Area (high value species are underlined) (> $15 kg^{-1})

AFD Fishery Area	AFD Fishery Area Code	Most Abundant Organisms in decreasing order	Common name
Chai Wan	0157	*Siganus oramin* *Portunus sanguinolentus* Mixed Crab Species *Charybdis cruciata* *Portunus pelagicus*	Rabbit fish 3-spot crab Red crab Blue crab
Lei Yue Mun	0169	*Siganus oramin* *Portunus sanguinolentus* Mixed Crab Species *Charybdis natator* *Charybdis cruciata*	Rabbit fish 3-spot crab Red crab
Junk Bay West	0170	*Caranx species* *Argyrosomus species* Mixed Crab Species *Portunus sanguinolentus* *Siganus oramin*	Scad/Crevalle Croaker 3-spot crab Rabbit fish
Junk Bay East	0171	*Caranx species* *Argyrosomus species* *Portunus sanguinolentus* Mixed Crab Species *Platycephalus indicus*	Scad/Crevalle Croaker 3-spot crab Flathead
Tin Ha Wan	0172	*Caranx species* *Portunus sanguinolentus* *Argyrosomus species* *Sardinella jussieui* *Stolephorus zollingeri*	Scad/Crevalle 3-spot crab Croaker Sardine Anchovy

Fish Culture

7.4.22 There is only one Fish Culture Zones (FCZ) in the vicinity of the Study Area, Tung Lung Chau. Information from the AFD Annual Report for 1997 indicates that the FCZ at Tung Lung Chau consists of 69 licensed rafts with a total licensed area of 23,929 m^2 (total gazetted area = 80,000 m^2). There are no figures available for individual production at this FCZ, although Hong Kong production in 1996 totalled 3,000 t valued at $173 million. The main species cultured were the spotted grouper (*Epinephelus chlorostigma*), goldlined seabream (*Rhabdosargus sarba*) and the mangrove snapper (*Lutjanus argentimaculatus*).

Marine Mammals

7.4.23 The Chinese White Dolphin (*Sousa chinensis*) and the Finless Porpoise (*Neophocaena phocaenoides*) are the only species of marine mammal regularly sighted in Hong Kong waters.

Chinese White Dolphin Sousa chinensis

7.4.24 The local population of *Sousa chinensis* is reported to be centred around the Pearl River Estuary and Hong Kong waters are thought to represent the eastern portion of its range[23]. North Lantau represents the major area of distribution of *Sousa* in Hong Kong waters, and is the only place in Hong Kong where dolphins are seen year round. Individuals are most frequently sighted in the western part of these waters around the Sha Chau & Lung Kwu Chau Marine Park and the Chek Lap Kok platform. No sightings of *Sousa chinensis* have been reported east of Green Island and therefore the Study Area cannot be regarded as of importance to this dolphin.

Finless Porpoise Neophocaena phocaenoides

7.4.25 The finless porpoise is a small cetacean endemic to southern and eastern Asia and is protected under CITES *Appendix I*. The porpoises distribution is centred in a narrow coastal band from the Persian Gulf in the west to Japan in the east[24]. The porpoise is also recorded as inhabiting the Yangtze River system in China. The preferred habitat of this porpoise has been reported as including the following[25]:

- inshore waters (within 5 km of the shore);
- waters protected from heavy seas and storm conditions;
- sandy or soft seabed; and
- water depths of less than 50 m.

7.4.26 In Hong Kong, until recently, little information was available regarding the distribution and abundance of the finless porpoise in local waters. Surveys were conducted for 12 months between December 1996 and November 1997[26]. Two line transects were followed through southern waters five times per month covering the sea areas between Cheung Chau and east of Waglan Island. The surveys revealed that the finless porpoise is the most common and most important species of cetacean in the southern and southeastern waters of Hong Kong Although the surveys did not cover the Lei Yue Mun area they did cover the approaches to Tathong Channel and the only sighting to date was at Cape d'Aguilar. The lack of sightings from the inner Tathong Channel, coupled with the reported poor water quality and heavy shipping traffic, indicates that the area is unlikely to be of importance to this porpoise. It can be concluded, therefore, the Study Area is not regarded as of importance to this marine mammal.

[23] Jefferson TA (1998) Population Biology of the Indo-Pacific Hump-backed Dolphin (*Sousa chinensis* Osbeck, 1975) in Hong Kong Waters. Final Report to AFD.

[24] Reeves RR, Wang JY, Leatherwood S (1997) The finless porpoise, *Neophocaena phocaenoides* (G Cuvier 1829): A summary of current knowledge and recommendations for conservation action. Asian Marine Biology 14: 111-143.

[25] Shirakihara M, Shirakihara K, Takemura A (1994) Distribution and seasonal density of the finless porpoise *Neophocaena phocaenoides* in the coastal waters of western Kyushu, Japan. Fisheries Science 60 (1): 41-46.

[26] REM. (1998) EIA of an 1800 MW Gas-Fired Power Station at Lamma Extension: Marine Mammals Survey Report to Hong Kong Electric Company Limited.

7.5 Terrestrial Ecology Impact Evaluation

Methodology

7.5.1 Based on the field surveys and site conditions as described above, the Study Area is considered to have low ecological importance. The evaluation with reference to the criteria in *Annex 8 Table 2* of the *EIAO Technical Memorandum* (EIAO TM) is presented below:

- *Naturalness*: Disturbed habitats.
- *Size*: The size of the different habitats are considered small.
- *Diversity*: Low flora and fauna diversity.
- *Rarity*: Ecological important plants found within the Study Area include *Enkianthus quinqueflorus* within the work site boundary, as well as *Arundina chinensis* and *Habenaria linguella* outside the work site boundary, which are all protected. The former two plants are common locally while the last one is considered restricted in distribution.
- *Recreatability*: Habitats are readily recreatable.
- *Fragmentation*: High fragmentation.
- *Ecological Linkage*: There are no highly valued habitats in close proximity.
- *Potential Value*: The scrubland-grassland mosaic has a potential to evolve into woodland habitat if the physical conditions remain unchanged.
- *Nursery/breeding Ground*: A black kite nest was found in the orchard formed woodland, which is outside the road scheme boundary.
- *Age*: Young habitats.
- *Abundance/Richness of Wildlife*: Low wildlife richness and abundance.

7.5.2 However, based on the EIAO TM *Annex 8 Table 3*, the two plant species Chinese New Year Flower *Enkianthus quinqueflorus* and Bamboo Orchid *Arundina chinensis*, the restricted orchid *Habenaria linguella*, as well as the Black Kite with the nest found within the WCR Study Area but outside the works limit, are important as they are protected under current legislation, although the two plant species and Black Kite are quite widely distributed in Hong Kong.

Potential Sources of Impact

7.5.3 Potential ecological impacts are predicted based on the selected alignment and ecological baseline information gathered. The potential sources of impact in association with the WCR project include:

- There will be direct loss of habitats and associated wildlife from land resumption for the WCR main alignment; and

- There may be indirect impact to the habitats and associated wildlife surrounding the WCR due to increased human activities and trampling of vegetation associated with the WCR, if uncontrolled.

Evaluation of Impacts

7.5.4 The WCR alignment will follow the coastline of TKO then run through a short section of tunnel at the Lei Yue Mun Headland. The alignment will then emerge and run along the back of Ma San Tsuen and Sam Ka Tsuen before connecting to the Yau Tong area.

7.5.5 The ecological impact on terrestrial resources arising from the project will mainly result from direct landtake of ecological habitat and associated wildlife during the construction phase of the Project. However, the WCR may induce other direct and indirect impact to the surrounding habitat and wildlife inhabitants if there were uncontrolled construction activities or extensive landtake.

7.5.6 Based on preliminary engineering information, the terrestrial habitat that would be directly affected include: approximately 1.5 ha of the young open secondary woodland behind Ma San Tsuen; less than 2 ha of grassland at the Lei Yue Mun Headland. Although not directly affected by the Project, there is scrubland grassland mosaic near the northern end of WCR. Given the poor ecological condition of the affected habitats as discussed earlier, as well as the small size of the area affected compared to other similar habitat types present within the Study Area, the ecological impact arising from the direct landtake is considered to be limited. Further the loss of this vegetation is considered to be acceptable with the implementation of planting that is proposed as part of the landscape assessment which would provide more than 4 ha of dense tree and shrub woodland planting and more than 0.4 ha of ornamental planting (see *Section 8.7* and *Figure 8.23*). The planting works should be incorporated into the construction programme as early as possible. These planting works would be undertaken by TDD and maintained by RSD. Tree species used for planting should take reference from the species listed stated in *Section 8.7.5*, and the location of planting is shown in *Figure 8.23*.

7.5.7 Provided the construction activities are adjusted not to affect the protected patches of *Enkianthus*, indirect impact to the surrounding habitats and wildlife should not be significant given the similarly poor ecological condition of the surrounding area. The Black Kite nest recorded is located close to the work site boundary. The construction activities may indirectly affect the Black Kites using the nest but the potential impact is considered low, as the birds are known to be fairly tolerant to disturbance and in the worst case that the birds abandon the nest, alternative nesting sites could be readily found. However, noisy activities should be programmed to avoid as much as practicable the breeding season (approximately between January and April) of the Black Kite to minimise indirect impact on them. The patches of the protected *Arundina* and *Hebenaria* are unlikely to be affected given that construction activities are restricted within the work site boundary.

7.5.8 No adverse ecological impact is anticipated during the operation phase of the project, and no cumulative impact is expected.

7.5.9 Overall the potential ecological impact associated with the WCR development is considered low. An evaluation of the potential ecological impact in accordance with the EIAO TM *Annex 8 Table 1* is presented as follows:

- *Habitat Quality*: All the ecological habitat types including woodland, shrubland-grassland mosaic and grassland within the Study Area are low quality habitats.
- *Species*: The protected orchids *Arundina chinensis* and *Habenaria linguella* are outside the work site boundary and therefore no impact is expected. There may be moderate indirect impact to the locally common protected species *Enkianthus quinqueflorus* found in shrubland-grassland mosaic located within the work site boundary.
- *Size/Abundance*: The size of the habitat loss is small relative to the habitats of the same type in the surrounding.
- *Duration*: WCR alignment will be long term.
- *Reversibility*: Impacts permanent and irreversible, however compensation from planting will occur.
- *Magnitude*: The environmental change will be limited to the coastal area only and the magnitude of change to the remaining habitats on the hill slope is not considered high.

Recommended Mitigation Measures

7.5.10 As discussed in the previous sections, the potential ecological impact from the WCR proposal is considered low. Further the loss of this vegetation is considered to be acceptable with the implementation of planting that is proposed as part of the landscape assessment which would provide more than 4 ha of dense tree and shrub woodland planting and more than 0.4 ha of ornamental planting. The following mitigation measures are recommended to minimise disturbance to the surrounding environment:

- fences should be erected along the boundary of construction sites, before the commencement of works, to prevent tipping, vehicle movements, and encroachment of personnel into the scrubland patches on the hill slope where the protected plant species are located.

- regular checks to ensure that the work site boundaries are not exceeded and that no damage to surrounding areas.

- wild and uncontrolled open fires should be prohibited within the work site boundary, and install fire fighting equipment in the work area.

- the alignment of temporary works area should avoid the scrubland grassland mosaic area in the northern end of the Study Area, where practicable, so as to protect the Chinese New Year Flower and maintain the integrity of the habitat.

- survey and collect individuals of the protected Chinese New Year Flower *Enkianthus quinqueflorus* prior to work commencement for transplanting to unaffected scrubland grassland mosaic area outside the work site boundary if, during the delineation of the work site areas, the scrubland grassland mosaic area will be affected. The survey should be undertaken by qualified personnel (eg botanist), while the transplanting works should be carried out by Government listed Landscape Specialist Contractor. The survey area should include areas within 10 m of the proposed work site areas.

- noisy activities should be programmed to avoid as much as practicable the breeding season (approximately January to April) of the Black Kite to minimise indirect impact on them.

- planting works should be incorporated into the construction programme as early as possible. These planting works would be undertaken by TDD and maintained by RSD. Tree species used for planting should take reference from the species listed in *Section 8.7*, and the location of planting is shown in *Figure 8.23*.

7.5.11 The mitigation measures should be included into contract clauses for the WCR development. The implementation of the measures should be checked as part of the environmental monitoring and audit procedures during the construction period, the procedures of which are presented in the separate Environmental Monitoring and Audit Manual. With the implementation of these measures, no residual impacts are expected to occur.

Residual Impacts

7.5.12 With implementation of the recommended mitigation measures, it is considered that there would be no adverse residual ecological impacts. Potential impacts due to loss of 1.5 ha of young open secondary woodland and less than 2 ha of grassland is considered to be acceptable, particularly with the implementation of planting proposed as part of the landscape assessment which would provide more than 4 ha of dense tree and shrub woodland planting and more than 0.4 ha of ornamental planting.

7.6 Marine Ecology Impact Evaluation

Sensitive Receivers

7.6.1 Based upon the above review of baseline ecological conditions at the WCR Study Area, marine ecological sensitive receivers which may be affected by the proposed development has been identified as the Tung Lung Chau Fish Culture Zone.

7.6.2 Presently mariculturists will be eligible for exgratia allowance when the suspended solids at the FCZ, as a result of the dredging or dumping works of the project, is detected to reach 50 mg L^{-1} or 100% more than the highest level recorded at the zone during the 5 years before commencement of the works in the vicinity. When such criteria are exceeded, appropriate mitigatory measures, including stop works if necessary, should be adopted to keep the impact within acceptable levels.

7.6.3 The highest suspended solids level, detected by EPD during five years of water quality monitoring at Tung Lung Chau, prior to October 1992, when sand borrowing commenced in the Tathong Channel, was 11 mg L^{-1}. Therefore the exgratia payment would be initiated when the levels of suspended solids at Tung Lung Chau FCZ, resulting from the project works, reach 22 mg L^{-1} which 100% above background at the zone. Potential impacts due to the WCR have been

discussed previously in *Section 5* Water Quality.

Ecological Importance

7.6.4 Based on the field surveys and discussion presented above, the current ecological assessment shows that the soft bottom subtidal marine ecological resources present within the WCR Study Area are considered of low ecological value. The intertidal hard bottom resources are, however, abundant and diverse and classified as of medium ecological value. Although the subtidal hard bottom resources have been classified as of medium ecological value they consist of low diversity and low abundance hard and soft coral assemblages. The ecological importance of the WCR site is determined based on the following considerations, in accordance with the EIAO-TM *Annex 8 Table 2* criteria (*Table 7.6a*).

Table 7.6a Ecological Value of Marine Habitats in the WCR TKO Study Area - TKO Section

Criteria	Intertidal	Subtidal-Hard Substrate	Subtidal-Soft Substrate
Naturalness	Undisturbed shores with assemblages typical of undisturbed locations.	Degraded through poor water quality.	Degraded through poor water quality.
Size	Total length of undisturbed coastline is 1.2km warranting classification as an important habitat.	Hard and soft corals are present within a 3ha area but in isolated patches.	Small area (<1.5ha), though TM not specific on the size.
Diversity	Typical of other semi-exposed rocky shores in Hong Kong.	Diversity of the assemblages has been reported as low.	Low diversity of organisms, polychaete dominated.
Rarity	No species were found that are considered as rare.	Hard corals are considered rare in Hong Kong. Although the species of soft corals and gorgonians are not rare they are of ecological interest.	No species present are regarded as rare.
Recreatibility	Given that the seawall designs satisfy the ecological requirements of the assemblages, colonisation should occur.		The habitat cannot be recreated on site.
Ecological Linkage	Can be considered as low. The surrounding environment contains few other natural rocky shores as the majority are manmade seawalls.	Can be considered as low. The surrounding environment contains few other natural hard substrate areas.	The surrounding environment contains many other areas of perturbed soft substrate.
Potential Value	Unlikely that the site can develop conservation interest as anything but one of the last remaining natural rocky shore areas in that part of the harbour.	The site has conservation interest due to the presence of patches of hard corals, soft corals and sea whips.	Unlikely that the site can develop conservation interest.
Nursery Area	None identified during the literature review or field surveys.		
Age	n/a for rocky shores as the lifespan of organisms is very short (< 2 years).	Hard corals are long lived.	n/a for these assemblages as the lifespan the of organisms is very short.
Abundance	Abundances appear to be similar to other semi-exposed shores in Hong Kong.	Abundance was reported as being low compared to areas of conservation value.	Low abundance.
SUMMARY	The shores support diverse assemblages that are typical of undisturbed semi-exposed shores. **Ecological Value Medium.**	The subtidal hard substrate habitats support isolated low diversity patches of hard and soft corals. **Ecological Value Medium.**	The soft bottom assemblages are dominated by a few species of polychaete. **Ecological Value Low.**

Table 7.6b Ecological Value of Marine Habitats in the WCR TKO Study Area (Yau Tong Coastal Section)

Criteria	Intertidal	Subtidal-Hard Substrate	Subtidal-Soft Substrate
Naturalness	Artificial seawall habitat degraded through poor water quality.	Artificial seawall habitat degraded through poor water quality.	Degraded through poor water quality associated with the inner harbour and typhoon shelter.
Size	Total length of artificial seawall is approximately 500m.	Total length of artificial seawall is approximately 500m	Total area of soft bottom habitat to be reclaimed is 6.4ha.
Diversity	Diversity of the assemblages is expected to be low.	Diversity of the assemblages is expected to be low.	Low diversity of organisms, polychaete dominated.
Rarity	Literature indicates that rare species are unlikely to be present.	Literature indicates that rare species are unlikely to be present.	No species present are regarded as rare.
Recreatibility	The habitat can be recreated on site.		The habitat cannot be recreated on site.
Ecological Linkage	Can be considered as low.	Can be considered as low.	The surrounding environment contains many other areas of perturbed soft substrate.
Potential Value	Unlikely that the site can develop conservation interest.		
Nursery Area	None identified during the literature review or field surveys.		
Age	Manmade artificial seawalls are unlikely to support long established assemblages.	Manmade artificial seawalls are unlikely to support long established assemblages.	n/a for these assemblages as the lifespan the of organisms is very short.
Abundance	Low abundance.	Low abundance.	Low abundance.
SUMMARY	The artificial seawalls support assemblages that are of low abundance and diversity. **Ecological Value Low.**	The artificial seawalls support assemblages that are of low abundance and diversity. **Ecological Value Low.**	The soft bottom assemblages are dominated by a few species of polychaete. **Ecological Value Low.**

7.6.5 The locations of these habitats are depicted on *Figure 7.6a*.

Potential Sources of Impact

7.6.6 Impacts to ecological components of the marine community will be in two forms:

- Direct impacts will be permanent and will affect the intertidal and near shore subtidal assemblages as a result of habitat loss during the reclamation in the TKO Section.

- Indirect impacts to the subtidal assemblages of Tseung Kwan O Bay are likely to occur during the construction phase of the Project as a result of perturbations to water quality.

- Indirect impacts to the fisheries resources of Tseung Kwan O Bay are likely to occur during the construction phase of the Project as a result of perturbations to water quality.

- Direct impacts will be permanent and will affect the low ecological value intertidal and subtidal artificial seawalls and soft bottom assemblages as a result of habitat loss during the reclamation for the Yau Tong Coastal Section.

Intertidal Habitats - Direct Impacts

7.6.7 As a result of the TKO section reclamation the coastline of western Tseung Kwan O Bay will be lost and replaced by artificial seawalls. A total of 1.2 km of natural coastline will be directly removed during the construction works. The replacement seawalls can, however, support a rich assemblage of intertidal fauna and flora. Organisms present on intertidal shores in Hong Kong rely on larval settlement for recruitment. Assuming that there is a regular supply of larvae brought to the area, recolonisation of new seawalls resulting from the reclamation will occur. The design of the seawall will be critical in determining the extent to which the community reestablishes post reclamation. The more heterogeneous (high surface area: volume ratio) the seawall, the more diverse a community the habitat will support. As a result of the Yau Tong Coastal Section reclamation the artificial seawalls in the area between Yau Tong Bay and Sam Ka Tsuen Typhoon Shelter will be reclaimed and replaced by similar vertical seawalls. A total of 500 m of artificial seawalls will be lost during the construction works. However, they will be replaced by 800 m of artificial seawalls on which it is expected assemblages of similar ecological value will colonise. Assuming successful recolonisation of WCR seawalls no adverse impacts are predicted during the operation phase of the WCR.

Intertidal Habitats - Indirect Impacts

7.6.8 The natural intertidal habitats of the Study Area that will not be reclaimed could be affected during the construction of the reclamation through perturbations to water quality. The intertidal habitat is almost fully submerged at high tide and increases in suspended sediments can affect the habitat in a variety of ways. The abundant filter feeding barnacles present on the low shore may be impacted by increases in SS levels in the water column through clogging of their delicate filter feeding mechanisms which can reduce their feeding efficiency and may inhibit respiration. Deposition of sediment on the shore may cause scouring which could inhibit the survival coralline and other algae and long term residence of the sediment may alter the species composition of the algal assemblage. Higher than normal sediment loads arising from nearby dredging works were deposited on an assemblage of coralline algae at Cape d'Aguilar. This resulted in overgrowth of the coralline assemblage by the red turf alga, *Gelidium pusillum*, which became

the most abundant species[27].

7.6.9 Information presented in *Section 5 - Water Quality* indicates that suspended sediment is not predicted to disperse far (<1 km) during construction of the TKO Section through recommended measures to mitigate impacts to water quality to acceptable levels (discussed further in *Section 7.6.20*). Consequently impacts to intertidal assemblages outside of the reclamation site are not predicted to be impacted.

7.6.10 Construction phase and operational phase impacts to intertidal habitats are not, based on this assessment, predicted to be severe based on the likely reestablishment of a similar habitat through implementation of a suitable seawall design (see *Section 7.6.21*).

Subtidal Habitats & Benthic Communities - Direct Impacts

7.6.11 The total area that is set to be reclaimed for the TKO Section of the route alignment is 7.52 ha, 1.52 ha of which is subtidal muddy seabed of low ecological value. However, small isolated patches of hard and soft corals located on the subtidal sections of the existing natural shores will also be lost during the reclamation works (total hard surface substrate is approximately 3 ha[28]). The subtidal part of the seawalls constructed after the reclamation has been completed will offer potential surfaces for colonisation by benthic organisms. The seawall will be designed to maximise substrate heterogeneity and as water quality will be maintained there is the possibility for the area to become more productive and of higher ecological value post-reclamation (hard surface habitats are known to be more productive than soft bottom habitats).

7.6.12 The total area that is set to be reclaimed for the Yau Tong Section of the route alignment is 6.4 ha all of which is subtidal muddy seabed of low ecological value. As the benthic assemblages are located within Victoria Harbour and adjacent to the Typhoon Shelter they are likely to be perturbed through pollution. The low ecological value of these assemblages and polluted nature of the habitat reduces the severity of these impacts to acceptable levels.

Subtidal Habitats of Benthic Communities - Indirect Impacts

7.6.13 During the construction phase the subtidal assemblage of the WCR area, both hard and soft substrate could potentially be affected as a result of changes in water quality. Suspended sediment generated during the dredging and filling constructional stage will cause an increase in turbidity in the water column and higher rates of deposition on the seafloor. Such elevated suspended sediment concentrations may cause smothering of filter feeders such as bivalves and clogging of gill filaments in fish and other organisms. Another potential indirect impact involves reduction in dissolved oxygen concentration caused by elevated concentrations of suspended sediments. An increase in solids in the water column

[27] Kaehler S & Williams GA (1996) Distribution of algae on tropical rocky shores: spatial and temporal patterns of non-coralline encrusting algae in Hong Kong. Marine Biology 125: 177-187.
[28] This value has been estimated using the findings of seismic profile geophysical investigations along the TKO section.

will result in the following effect on dissolved oxygen, reduced sunlight penetration, lowered rate of photosynthesis of phytoplankton (primary productivity) and thus lower rate of oxygen production in the water column.

7.6.14 Information presented in *Section 5 - Water Quality* indicates that suspended sediment is not predicted to disperse far (<1 km) during construction of the TKO Section through recommended measures to mitigate impacts to water quality to acceptable levels (discussed further in *Section 7.6.20*). Consequently impacts to subtidal assemblages outside of the reclamation site are not predicted to be unacceptable.

7.6.15 Suspended sediment elevations are not expected to exceed the WQOs and consequent depletions of dissolved oxygen are also predicted to be within acceptable levels. Indirect impacts to ecological assemblages through dispersion of SS are, therefore, predicted to be acceptable.

7.6.16 Construction phase and operational phase impacts to subtidal habitats are not, based on this assessment, predicted to be severe:

- The loss of 1.52 ha of soft substrate benthic assemblages during construction is not considered to be unacceptable due to their low ecological value and the small area to be reclaimed (7.52 ha).

- The loss of the 3 ha of subtidal hard surface habitat that supports medium ecological value hard and soft coral assemblages during construction is not considered to be unacceptable due to their low abundance and diversity, patchy distribution and likelihood that they will colonise the seawalls once construction works have ceased.

Commercial Fisheries - Direct Impacts

7.6.17 Only part of the Western Coast Road will result in loss of fishing grounds (TKO Section reclamation). The construction of the TKO Section will result in the permanent loss of 2.5% of the Junk Bay West fishing zone (0171). The fishing grounds that will be lost appear to be used frequently by purse seine and gill net fishermen. It is likely, therefore, that there will be some effects on the fisheries resources due to the construction of the WCR TKO. The total catch derived annually from the area to be reclaimed equates to 1,257kg, representing 0.007 % of the total catch from Hong Kong waters.

Commercial Fisheries - Indirect Impacts

7.6.18 Suspended sediment (SS) fluxes occur naturally in the marine environment, consequently fish have evolved behavioural adaptations to tolerate increased SS loads. These include clearing their gills by flushing water over them. Where SS levels become excessive fish will move to clearer waters. Susceptibility generally decreases with age, with eggs the most vulnerable and adults the least sensitive to effects from sediments. The rate, season and duration of SS elevations will influence the type and extent of impact upon fish. The information reviewed

indicates that the area does not appear to be an important spawning and nursery area and, therefore, impacts to Hong Kong's fishery as a whole are unlikely to occur as a result of the WCR reclamation.

Marine Mammals

7.6.19 Underwater noise and disturbance from reclamation activities and marine traffic can have a disruptive effect upon behaviour of marine mammals. However, based on the apparent low - no utilisation of the area by mammals (based on sighting records) impacts as a result of the WCR Study are not predicted to occur.

Evaluation of Impacts

Marine Ecology

7.6.20 An evaluation of the ecological impact in accordance with the EIAO-TM *Annex 8 Table 1* is presented as follows:

- *Habitat Quality*: Low quality perturbed soft substrate subtidal habitats, artificial seawalls of low ecological value, hard substrate subtidal habitats of medium ecological value due to presence of low density soft and hard coral isolated colonies, and. intertidal habitats typical of semi-exposed shores.

- *Species*: The only organisms of ecological interest recorded on hard bottom habitats in the vicinity of the TKO Section of the WCR were corals (hard and soft). These corals were recorded at lower densities than colonies at sites that are recognised as important to corals (refer to discussion in *Section 7.4.17*). No species of conservation importance are expected to occur along the Yau Tong Coastal Section.

- *Size/Abundance*: The TKO Section reclamation area is small and the habitats to be lost include medium ecological value hard substrate assemblages (both intertidal and subtidal = 1.2 km ie 6 ha) and low ecological value seabed (1.5 ha) (total reclamation area = 7.52 ha). The hard substrate assemblages are expected to recolonise post reclamation. The Yau Tong Section reclamation area is also relatively small and the habitats to be lost are of low ecological value (artificial seawalls = 500m, soft bottom habitats = 6.4 ha).

- *Duration:* Although the entire reclamation process is expected to be completed within 22 months the final stage (backfilling) will be conducted behind completed seawalls. This indicates that works with the potential to impact the marine environment will proceed for a period of approximately 12 months (refer to Work Programme in *Section 2* of this report).

- *Reversibility*: Impacts to the seabed are permanent and irreversible, impacts to the hard substrate habitats are reversible through recolonisation of the seawalls.

- *Magnitude*: The impacts to the ecological assemblages defined in this review will be of low magnitude during both construction and operation of WCR.

Fisheries

7.6.21 Following the information presented above, the fisheries impact associated with the WCR development is considered low. An evaluation of the impact in accordance with the EIAO TM *Annex 9* is presented as follows:

- *Nature of Impact*: Permanent impact to demersal fisheries resources within the reclamation area for the WCR in the TKO Section, temporary and low magnitude impact to pelagic and demersal fisheries resources within the western portion of Tseung Kwan O Bay, as a result of perturbations to water quality.

- *Size of Affected Area*: The reclamation area for the WCR in the TKO Section constitutes a small (2.5%) of one of the three fishery zones in Junk Bay (0170 Junk Bay W).

- *Size of Fisheries Resources/Production*: High ranking compared to other areas in Hong Kong in terms of catch weight and value per hectare. However, total amount fished from the area to be reclaimed is very small in context with the total annual catch in Hong Kong.

- *Destruction and Disturbance of Nursery and Spawning Grounds*: The closest spawning grounds are located at the Ninepins Islands which are greater than 1 km away and therefore not predicted to be impacted by the WCR.

- *Impact on Fishing Activity*: There are seven home ports in the area which operate mainly small scale activities. Average dependency on the area by the Hong Kong fleet is low (0.06 %). The area to be reclaimed for the TKO Section translates into the loss of 2.5% of the Junk Bay West fishing zone and a potential loss of 1,257 kg annually of fish catches worth HK$50,908. Thus equates to a 0.015% decrease in the annual value of the Hong Kong fishery and is regarded as low. These permanent losses may be subject to claims for ex gratia allowances which are administered by the Planning Environment and Lands Bureau.

- *Impact on Aquaculture Activity*: No impacts to the FCZ at Tung Lung Chau are expected as elevations in suspended solids are not predicted at the FCZ.

Recommended Mitigation Measures

7.6.22 Operational constraints during construction of the TKO Section have been recommended in order to avoid impacts to marine ecological and fisheries resources by minimising impacts to water quality. This has been achieved through the following (detailed in full in *Section 5.5*):

- the use of containment structures such as silt curtains or screens around the construction site;

- the use of closed clamshell grab dredgers to remove seriously contaminated (Class C) material;

- the prohibition of stockpiling of any moderately or seriously contaminated (Class B and C) material, and careful control of stockpiling of any uncontaminated (Class A) material to prevent runoff, resuspension and odour nuisances;

- at times when the tidal currents are too high (>0.5 m s^{-1}) for effective deployment of silt curtains the works should be suspended; and,

- mitigation measures should also include, but not limited to, construction method and phasing, control over dredging and filling rates, restriction on fine content of fill materials, filling and reclamation to be conducted behind completed seawall, pretreatment of effluent arising from construction activities for compliance with TM standards, provision of proper covering to stockpiles and so on.

7.6.23 Should adverse impacts to water quality be detected during the construction activities then the appropriate mitigation measures will be introduced (ie a reduction of the allowable dredging rate). These constraints, recommended to control water quality impacts to within acceptable levels, are also expected to control impacts to marine ecological resources.

7.6.24 In order to assist in post-construction rehabilitation of the WCR seawalls tetrapods will be used. The total surface area provided by the tetrapod seawalls along the length of the WCR will exceed 6 ha in area. Tetrapod seawalls offer a highly heterogeneous habitat which will provide a large surface area and a wide variety of habitats for marine organisms to colonise. It has been demonstrated that marine organisms have recolonised such seawalls after construction[29]. The "HJack" structure on the seaward side of the High Island Reservoir has recently been surveyed as part of an ongoing Study on Hong Kong's coral communities by Hong Kong University. The site has a well established coral community dominated by two species, *Montipora* and *Acropora*. The latter species has become rare in Hong Kong and this represents one of the last remaining mature and reproductive populations. This indicates that seawalls of this design would be useful in recreating habitats lost through development of the WCR. It is anticipated that assemblages of soft corals, gorgonians and hard corals will settle on and recolonise the newly constructed seawalls, as environmental conditions would be similar to existing conditions that have allowed the growth of the hard and soft corals, and gorgonians reported from field surveys in the area. The habitat provided by the total surface area of the tetrapod seawalls is expected to effectively mitigate the loss of 3 ha of low density assemblages of gorgonians and soft and hard corals within the reclamation area. The location of these tetrapod

[29] Binnie Consultants Ltd (1997) Chek Lap Kok Qualitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department, December 1997.

seawalls is shown on *Figure 7.6b*.

7.6.25 The Fish Culture Zone is not predicted to be impacted by the Yau Tong or TKO reclamations, therefore, specific mitigation measures for this area are not required.

Residual Impacts Marine Ecology

7.6.26 Taking into consideration the ecological value of the habitats discussed in the previous sections and the resultant mitigation requirements the residual impact can be determined. The residual impacts occurring as a result of construction and operation of the WCR are:

TKO Section

- The loss of the 1.52 ha of low ecological value subtidal assemblages present within the reclamation site; and
- The loss of 3 ha of intertidal and 3 ha of hard bottom subtidal habitats, both of medium ecological value, present within the reclamation site.

Yau Tong Coastal Section

- The loss of the 6.4 ha of the low ecological value subtidal assemblages present within the reclamation area; and,
- The loss of 500 m of artificial seawalls supporting intertidal and subtidal assemblages of low ecological value.

7.6.27 The loss of the 3 ha hard substrate subtidal and 3 ha intertidal assemblages present within the TKO Section reclamation site can be mitigated through the provision of approximately 6 ha (3 intertidal and 3 subtidal assemblages) of tetrapod seawalls on which soft corals and gorgonians assemblages can colonise and grow. Their loss is considered to be acceptable as although the habitat is of medium ecological value the abundance and density of corals is low and the corals are expected to colonise the seawalls after construction. The potential habitat provided by the total surface area of the tetrapod seawalls is expected to effectively mitigate for the loss of low density assemblages of corals within the reclamation site.

7.6.28 The loss of the assemblages within the Yau Tong Coastal Section present on the artificial seawalls and within the soft bottom habitat us considered to be acceptable as the assemblages are of low ecological value and expected to be perturbed by the poor water quality of the harbour and neighbouring typhoon shelter.

7.6.29 Based on the value to the fishery of the areas discussed in the previous sections and the specified mitigation requirements the residual impact (ie remaining after mitigation) can be determined. The identified residual impact occurring during the construction include the permanent loss of 7.52 ha of the Junk Bay West

Fishing Area. The Evaluation of Impact Section (*Section 7.6*) has identified that this loss will impact few fishermen. The loss of this part of the fishing ground, although potentially detrimental to some fishermen is unlikely to cause a noticeable reduction in fish catches. Although not implemented specifically to mitigate for the loss of fishing grounds, the provision of tetrapod seawalls on which more diverse and abundant ecological assemblages than present on the existing flat muddy seabed can colonise and grow, has the potential to provide habitat and shelter for juveniles or audits. The combination of the small area lost, the low dependency on the area by local fishermen and the potential environmental benefits of the seawall combine to reduce the magnitude of this residual impact to acceptable levels. It should be noted however, that permanent loss of fishing ground may be subject to claims for exgratia allowances which are administered by the Planning Environment and Lands Bureau.

7.7 Conclusion

Terrestrial Ecology

7.7.1 The terrestrial ecological resource of the Study Area has been identified through field surveys. Given the poor ecological conditions of the Study Area, the potential ecological impacts arising from the WCR proposal is considered low and it is considered that there would be no adverse residual terrestrial ecology impacts, particularly with the implementation of planting as proposed as part of the landscape assessment which would provide more than 4 ha of dense tree and shrub woodland planting and more than 0.4 ha of ornamental planting. However, recommendations have been made to minimise disturbance to the surrounding habitats during construction, particularly the scrubland /grassland mosaic habitat near the northern end, the Black Kite nest and the patches of protected Chinese New Year Flower (*Enkianthus quinqueflorus*). No impact is expected on the protected orchid species *Arundina chinessis* and *Habenaria linguella* since they are outside the work site boundary.

Marine Ecology

7.7.2 Literature reviews of existing information coupled with field surveys of marine ecological resources have been undertaken for this impact assessment. Information on baseline conditions indicate that intertidal and subtidal hard surface habitats are of medium ecological value. Soft bottom habitats identified in the review were regarded as of low ecological value. The only marine ecological sensitive receiver identified in the review was the Tung Lung Chau Fish Culture Zone. The impact assessment indicated that impacts to this location were predicted to be within acceptable levels as defined by the Water Quality Objectives. No sightings of marine mammals have been reported in the vicinity and therefore the area is not considered as an important habitat for Hong Kong's resident dolphin and porpoise populations.

7.7.3 Potential impacts to marine ecological and fisheries resources and sensitive receivers during the construction phase of the Project may arise from direct

disturbances to habitats, or through changes to key water quality parameters, as a result of the reclamation for the Western Coast Road. The natural coastline inside Junk Bay along the Western Coast Road will be lost as a result of the reclamation activities which will cover a total area of 7.52 ha. This will result in the loss of 3 ha of medium ecological value intertidal habitat, 3 ha of medium ecological value subtidal hard bottom habitat and 1.52 ha of low ecological value soft bottom habitat.

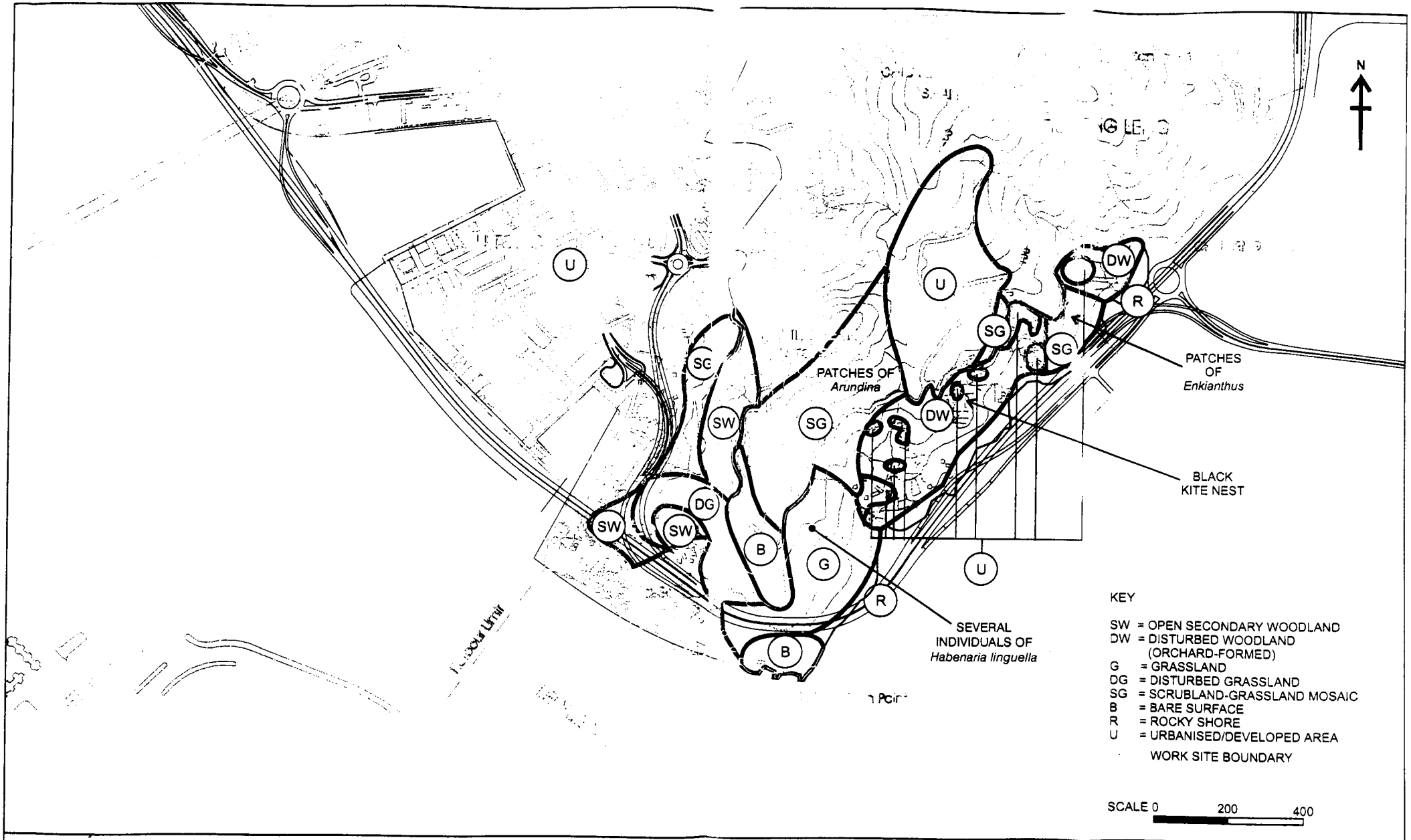
7.7.4 The reclamation in between Yau Tong Bay and the Sam Ka Tsuen Typhoon Shelter will result in the loss of 500 m of artificial seawalls that support low ecological value assemblages. However, they will be replaced by 800 m of artificial seawalls on which it is expected assemblages of similar ecological value will colonise. The reclamation will also involve the loss of 6.4 ha of low ecological value soft bottom assemblages. The low ecological value of these assemblages and polluted nature of the habitat reduces the severity of these impacts to acceptable levels.

7.7.5 Mitigation measures specific to marine ecology include the provision of 6 ha (3 intertidal and 3 subtidal) of tetrapod seawalls along the reclamation to facilitate colonisation by soft and hard corals, low density assemblages of which will be lost as a result of the construction of the reclamation. Other mitigation measures designed to mitigate impacts to water quality to acceptable levels (compliance with water quality objectives), including constraints on dredging and filling operations, are also expected to mitigate impacts to marine ecological and fisheries resources.

7.7.6 The residual impacts occurring as a result of construction and operation of the Western Coast Road are the direct loss of the low ecological value soft bottom subtidal assemblages, medium ecological value intertidal and subtidal hard bottom assemblages present within the reclamation site. The loss of the habitat within the reclamation site can be partially mitigated through the provision of tetrapod seawalls on which soft and hard coral assemblages (lost during the reclamation) can colonise and grow. This mitigation measure coupled with the finding that the habitat ranges from low to medium ecological value combine to reduce the magnitude of the residual impact to acceptable levels. In the light of this the residual impact is not considered to be unacceptable.

7.8 Environmental Monitoring and Audit

7.8.1 The mitigation measures should be included into contract clauses for the WCR development. The implementation of the measures should be checked as part of the environmental monitoring and audit procedures during the construction period, the procedures of which are presented in the separate Environmental Monitoring and Audit Manual (EM&A). Monitoring activities specific to terrestrial ecology, marine ecology and fisheries are not deemed necessary. The monitoring and audit activities to be conducted to detect and mitigate any unacceptable impacts to water quality will serve to protect against unacceptable impacts to marine ecological and fisheries resources.



TERRESTRIAL HABITAT MAP OF THE STUDY AREA

FIGURE No. 7.3a	
SCALE:	DATE: June 98

Maunsell

FILE: C1609/C1609k

OPEN SECONDARY WOODLAND

SHRUBLAND-GRASSLAND MOSAIC

GRASSLAND

HABITAT TYPES WITHIN THE STUDY AREA AT LEI YUE MUN HEADLAND OF WESTERN COAST ROAD

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DATE: Aug 99

FIGURE No. 7.3b

SCALE: NTS

Maunsell

FILE: C1609v5

FIGURE 7.3c

THE PROTECTED SPECIES CHINESE NEW YEAR FLOWER ***Enkianthus quinqueflorus*** FOUND IN THE STUDY AREA

FILE:C1609f1
DATE: 18/06/98

Environmental
Resources
Management

ERM

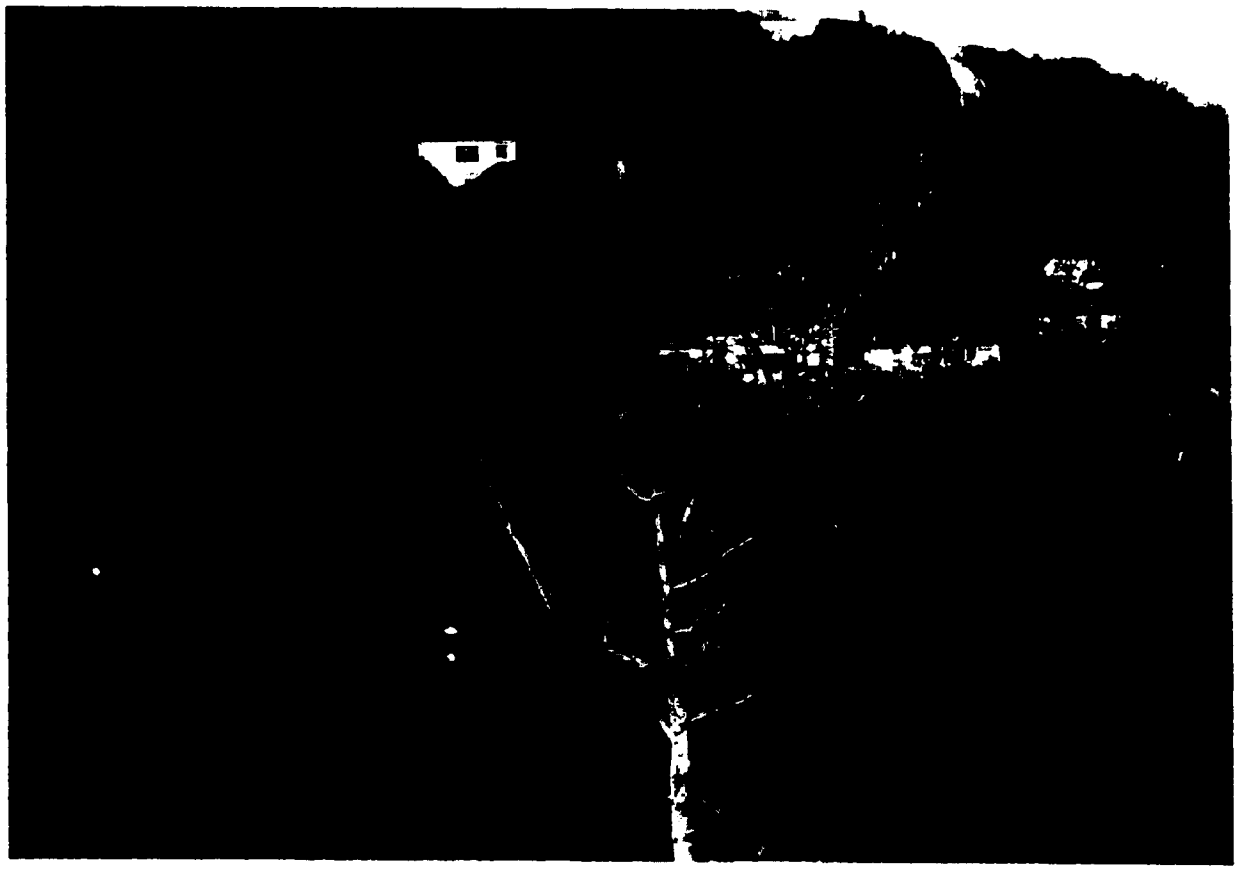
FIGURE 7.3d

THE PROTECTED SPECIES BAMBOO ORCHID ***Arundina chinensis*** FOUND IN THE STUDY AREA

FILE: C1609f
DATE: 18/06/98

Environmental Resources Management

ERM



BLACK KITE NEST IN ORCHARD FORMED WOODLAND

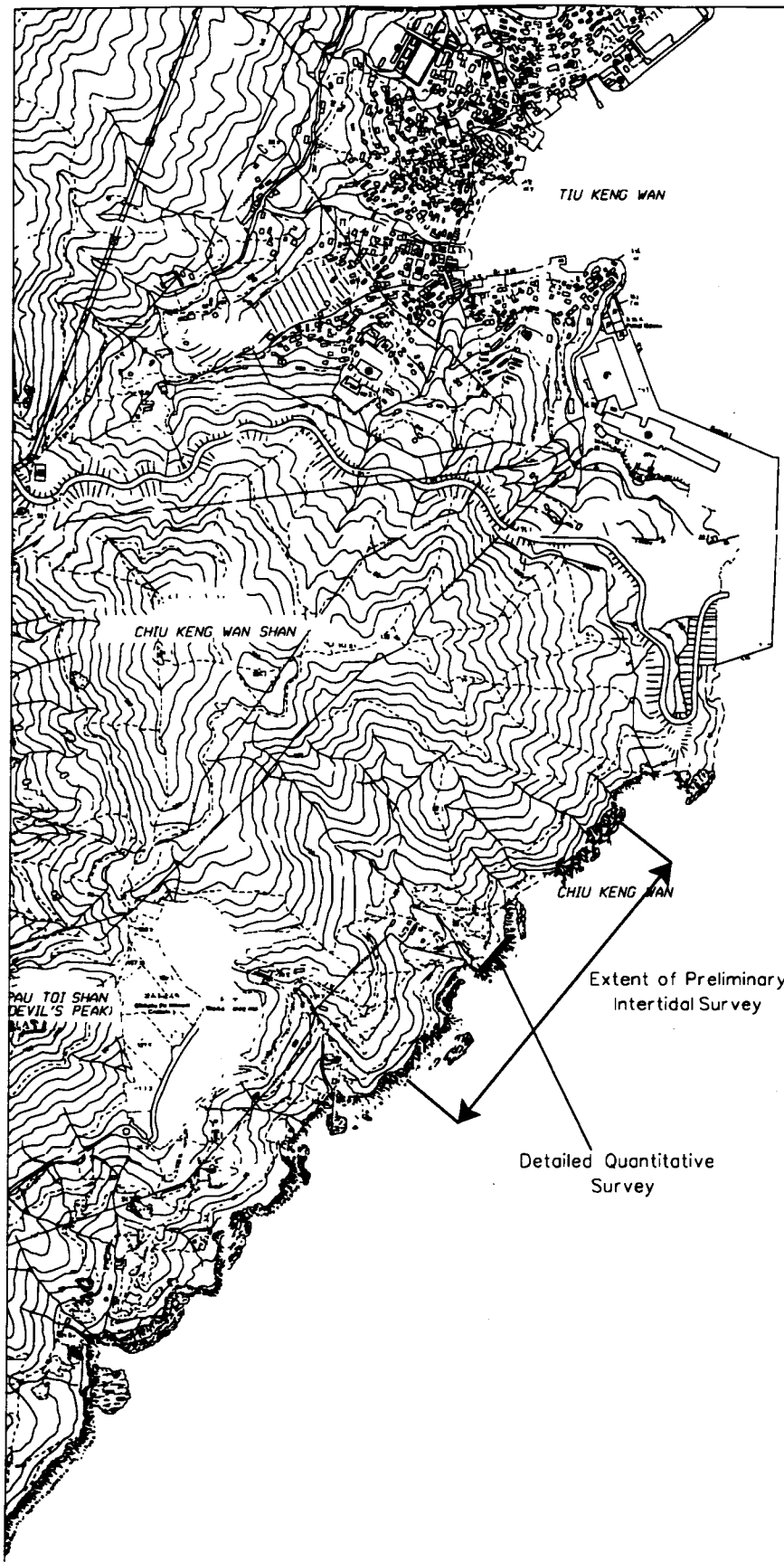
FIGURE No. 7.3e

SCALE: NTS

DATE: AUG 99

Maunsell

FILE: C1609v4



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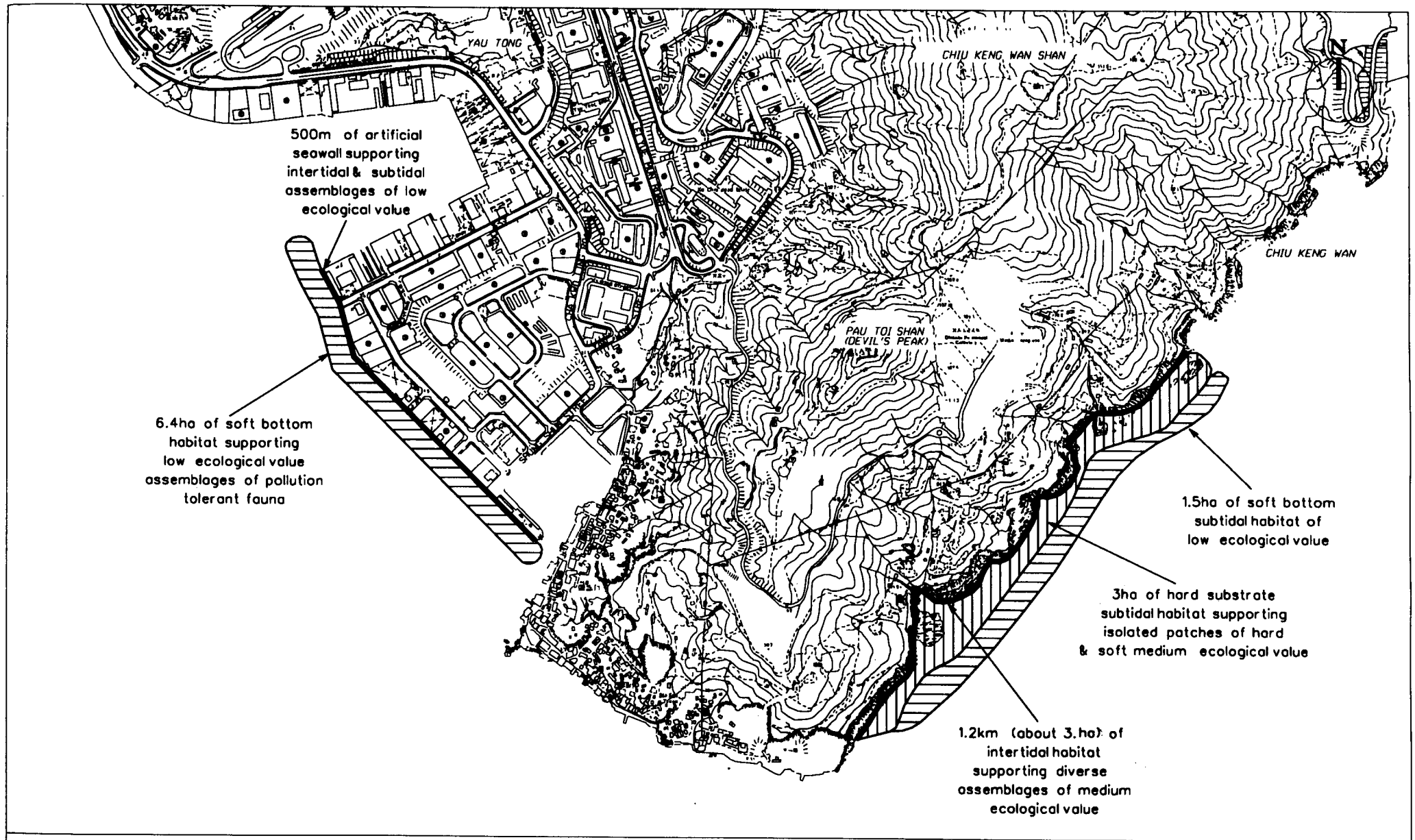
WCR, TKO SECTION – INTERTIDAL SURVEYS

DATE: MAR 99

SCALE: 1 : 11000

FIGURE No. 7.4a

Maunsell



LOCATION OF HABITAT TYPES AFFECTED BY THE WESTERN COAST ROAD DEVELOPMENT

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DATE: AUG 99

FIGURE No. 7.6a

SCALE: 1 : 11000

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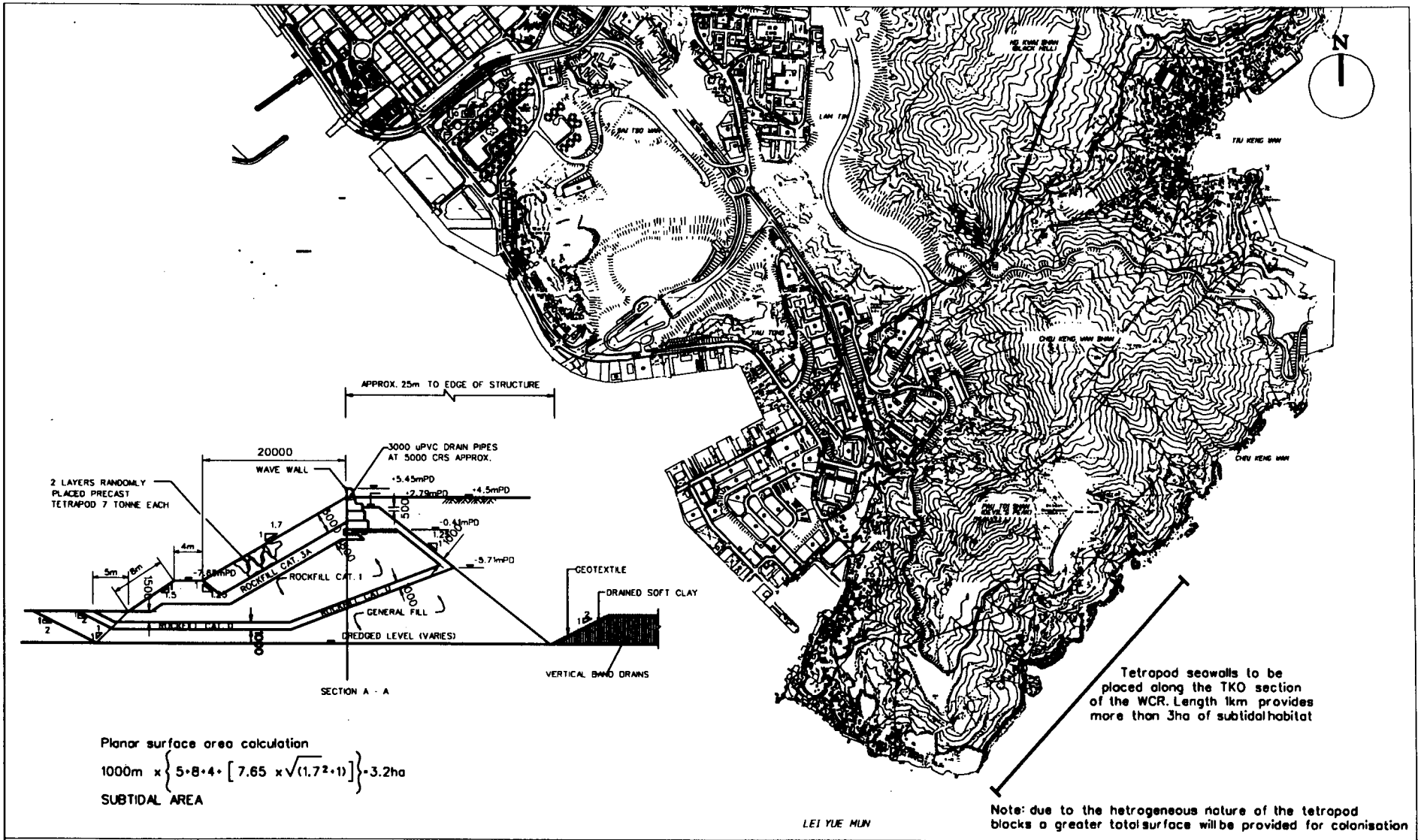

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LOCATION OF TETRAPOD SEAWALLS AS MITIGATION FOR LOSS OF SUBTIDAL HABITAT

DATE:	FIGURE No.
AUG 99	7.6b
SCALE: 1 : 20000	

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