

7. TERRESTRIAL AND MARINE ECOLOGY

7.1 Introduction

The terrestrial ecology assessment, field surveys were undertaken between July and December 1998 to establish the baseline ecological conditions of the Study Area. A review of the existing terrestrial ecological information, including the *Sham Tseng Link Feasibility Study EIA Report (STLFS)* was also conducted to identify and collate information on the ecological conditions. The marine ecology assessment focuses on an identification and evaluation of impacts on marine mammals, intertidal communities and subtidal hard bottom and soft bottom assemblages. Potential sources of impacts associated and the construction have been identified and, where appropriate, assessed and requirements for mitigation and monitoring recommended.

7.2 Environmental Legislation and Criteria

A number of international and local regulations, legislation and guidelines provide the framework for the protection of species and habitats of ecological importance. Those related to the Project are:

- *Country Parks Ordinance (Cap 208)*;
- *Forests and Countryside Ordinance (Cap 96)*;
- *Wild Animals Protection Ordinance (Cap 170)*;
- *Town Planning Ordinance (Cap 131)*;
- *Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG)*;
- *Technical Memorandum for the Environmental Impact Assessment Ordinance (EIAO TM)*; and
- *United Nations Convention on Biodiversity (1992)*.

The *Country Parks Ordinance (Cap. 208)* provides for the designation and management of Country Parks and Special Areas. Country Parks are designated for the purpose of nature conservation, countryside recreation and outdoor education. Special Areas are created mainly for the purpose of nature conservation.

The *Forests and Countryside Ordinance* prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on Government land. Related subsidiary Regulations prohibit the picking, felling or possession of listed rare and protected plant species. The list of protected species in Hong Kong which comes under the Forestry Regulations was last amended on 11 June 1993 under the *Forestry (Amendment) Regulation 1993* made under Section 3 of the *Forests and Countryside Ordinance*.

Under the *Wild Animals Protection Ordinance*, designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals are protected under this Ordinance. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1992. All cetaceans are protected under this Ordinance.

The recently amended *Town Planning Ordinance* provides for the designation of coastal protection areas, Sites of Special Scientific Interest (SSSIs), Green Belt or other specified uses that promote conservation or protection of the environment, eg conservation areas. The authority responsible for administering the *Town Planning Ordinance* is the Town Planning Board.

Chapter 10 of the *HKPSG* covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong and Government departments involved in conservation.

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

The Peoples' Republic of China (PRC) is a Contracting Party 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 Government of the Hong Kong Special Administrative Region has stated that it will be 'committed to meeting the environmental objectives' of the Convention (PELB 1996).

7.3 Terrestrial Ecology

7.3.1 Assessment Methodology

The establishment of the baseline terrestrial ecological profile of the Study Area and assessment of potential impacts is based on recent field surveys as well as a review of the STLFS. The terrestrial ecological study area generally covers 500m from either side of the proposed alignment but focuses on the areas to be directly affected by the Project. Representative areas of each habitat type were surveyed on foot by an experienced ecology team.

Areas of ecological interest identified in preliminary field surveys were subsequently surveyed in more detail. Field surveys focused on the ecological resources expected to be affected either directly or indirectly by the proposed alignment with the dominant flora or fauna of each habitat/land-use type being identified. For freshwater habitat surveys, five sites including Tso Wan Stream and Pond, Fa Peng Stream, Tai Lam Chung Stream, and So Kwun Wat Stream were visited by a stream ecologist. The freshwater sites were visited during September 1998.

All of the field data collected between July and December 1998 were used to update and field-check the terrestrial ecological conditions within the project limit, as well as to verify the validity of the information presented in the STLFS. The potential impacts due to the construction of Route 10 (NLYLH) are assessed in detail following TMEIA *Annex 16* guidelines and the impacts evaluated based on the criteria in TMEIA *Annex 8*. Descriptions of the general ecological conditions of the identified habitats are given below.

7.3.2 Baseline Condition

For ease in presenting the terrestrial ecological conditions, the Route 10 (NLYLH) (Southern Section) has been split into the following sections:

- North Lantau
- Tai Lam Chung to So Kwun Wat
- So Kwun Wat Interchange

Based on the information gathered from the field surveys, the Project will mainly go through habitats that are grassy or scrubby nature. Habitat types within the project limit included secondary woodland, shrublands of various heights, grassland-shrubland mosaic, plantation/orchard, artificial grassland, abandoned agricultural field, rocky shore, beach and freshwater habitats. Habitat maps showing the locations of various habitat types in North Lantau and the section from Tai Lam to Siu Lam are shown in *Figures 7.1 - 7.7*. Photos of the representative habitat types and plant of ecological importance are presented in *Figures 7.8 - 7.12*. Species lists of flora and fauna are given in *Annex F*.

Habitat/Vegetation

Woodland

Woodland found within the project limit included secondary woodland at the North Lantau Section (*Figures 7.2 & 7.3*) and the *fung-shui* woodlands at So Kwun Wat area (*Figure 7.7*). No woodland habitat was identified at Tai Lam Chung (*Figures 7.5 & 7.6*).

The secondary woodlands at Fa Peng, Tso Wan and near Yi Chuen are confined to the low-altitude area next to the villages and ravine and usually cannot be distinguished from the orchards behind the villages. The plant diversity is considered moderate, with a total of 38 species recorded. Most species are common and typical of secondary woodland in Hong Kong. The pioneer trees *Macaranga tanarius*, *Mallotus paniculatus*, *Celtis sinensis* and some fruit trees are dominant. Besides the restricted *Amorphophallus variabilis*, no rare or protected species were found. It is considered that the structural variety is high and may provide habitat and food source for wildlife.

The woodlands in the So Kwun Wat area are continuous with an average height more than 6m. There are four patches of woodland: behind the graveyard to the north of Ching Uk Tsuen (FSW1), behind Li Uk Tsuen (FSW2), east of Tin Hau Temple (FSW3) and behind Ching Uk Tsuen (FSW4). Based on the surrounding

environment, the woodlands behind Li Uk Tsuen, Ching Uk Tsuen and near the Tin-Hau Temple are regarded as "*fung-shui*" woodland⁴.

The woodland behind the graveyard to the north of Ching Uk Tsuen (FSW1) is lowest among the four patches in terms of species diversity and ecological importance. Only 14 tree species and a total of 37 plant species were recorded inside the woodland. This woodland is dominated mainly by introduced tree species such as *Casuarina stricta*, *Eucalyptus robusta* and *Lophosteman confertus* all of which are of relatively low ecological value. Although the exotic trees reach about 15m in height, the native tree species are relatively shorter (<10m) suggesting that the woodland is of recent age. Only one restricted species (*Celtis timorensis*) was observed. This woodland is therefore considered of low naturalness and high re-creatability.

The Li Uk Tsuen and the Tin-Hau Temple *fung-shui* woodlands (FSW2 and FSW3) are the largest woodland patches within the project limit (both are approximately 1 hectare in area). The species diversity of these woodlands is high. The Li Uk *fung-shui* woodland has 23 tree species and altogether 59 plant species, whereas the Tin Hau Temple *fung-shui* woodland has 25 tree species and altogether 65 species. These woodlands have trees ranging in height from 6-15m with girths more than 50cm, suggesting that these two woodland patches are of considerable age. The understoreys of these two woodlands are well developed and the inter-mingled liana community gives them high structural variety.

The Li Uk *fung-shui* woodland (FSW2) is dominated by the trees *Antidesma bunius*, *Dimocarpus longan*, *Microcos paniculata*, *Ficus variegata* var. *chlorocarpa* and *Sterculia lanceolata*. A few large individuals of the restricted plant *Celtis timorensis* and one individual of the rare tree *Ficus gibbosa* (*F. tinctoria* spp. *gibbosa*)⁵ (see Figure 7.7), were also seen there. In addition, the protected plant *Pavetta hongkongensis* was also recorded. Although this species is protected it is common in Hong Kong.

Despite the proximity of the Tin Hau Temple *fung-shui* woodland (FSW3) to the Li Uk Tsuen, it is dominated largely by *Ixonanthes chinensis*. This species is endemic to South China (Hainan, Guangdong and Guangxi) and has a restricted distribution in Hong Kong. It is under second class National Protection in Mainland China although it is currently not protected in Hong Kong. This species is restricted to Ma On Shan and Pokfulam Country Park in Hong Kong where only small individuals were found. *Ixonanthes chinensis* in this woodland reached a height of 15m with dbh>40cm and thus is considered unusual in Hong Kong and China and therefore deserves protection.

The *fung-shui* woodland behind Ching Uk Tsuen (FSW4) is about 0.6 hectare with 27 species of trees and 65 plant species recorded, which indicates that a species rich community has been established. The heights of trees range from 6-15m and the woodland habitat is high in structural variety with species composition resemble the Tin-Hau Temple woodland. It is dominated by the trees *Ixonanthes chinensis*, *Antidesma bunius*, *Microcos paniculata* and *Ficus microcarpa*. In addition to the

⁴ Chu, W. H. & Xing, F. W. (1997) *A checklist of vascular plants found in fung shui woods in Hong Kong*. - Memoirs of the Hong Kong Natural History Society 21: 151-157.

⁵ Zhuang, X. Y., Xing, F. W. & Corlett, R. T., 1997. The tree flora of Hong Kong: distribution and conservation status. - Memoirs of the Hong Kong Natural History Society 21: 69-126.

Ixonanthes chinensis, three rare species, *Ormosia semicastrata*², *Lithocarpus litseifolius*, and *Castanopsis concinna* were seen. *Castanopsis concinna* is under third class National Protection in China. This species is globally rare and is narrowly restricted to southern Guangdong, Guangxi and Hong Kong. Individuals were found scattered in lowland woodland at Sai Kung, Shing Mun Reservoir and Hong Kong Island. Three large trees of this species were found within the project limit (see Figure 7.7), each with 4 to 10 trunks, with dbh ranging from 20-60cm.

It should be noted that these three *fung-shui* woodlands (FSW2-4) are not only rich in species diversity and inhabited with rare and protected species but their plant species composition and community structure are also very distinctive from the surrounding tall shrubland and shrubland. Compared with the general plant community in the Western New Territories, which is largely dominated by secondary shrubland and plantation woodland, these three *fung-shui* woodlands are considered to have high ecological and conservation value. The presence of very large tree individuals like *Antidesma bunius*, *Ficus variegata* var. *chlorocarpa* and *Ficus microcarpa* suggests that these woodlands are mature.

Shrubland

Shrubland is the dominant habitat type within the project limit. The shrubland habitats possess species composition typical of similar habitats elsewhere in Hong Kong.

A total of 38 plant species were recorded in shrubland on North Lantau with the shrubs *Arundinaria cantorii*, *Baeckea frutescens*, *Melastoma sanguineum* and *Dioscorea bulbifera* being dominant. The average height of vegetation ranges from 1-2 m. This habitat is relatively low in structural variety and moderate in species diversity. No rare or protected plants were found.

A total of 36 plant species were recorded in shrubland at Tai Lam Chung. The species composition is similar to vegetation in the surrounding area, with bamboo *Arundinaria cantorii*, grass *Gahnia tristis*, and shrub *Rhodomyrtus tomentosa* and *Baeckea frutescens* being dominant. The height of vegetation ranges from 1-2 m. Species diversity is considered moderate and plants recorded are mostly common species with the exception of the pitcher plant *Nepenthes mirabilis* (see Figure 7.6) which is protected under the *Forestry Regulations* and which has a restricted distribution locally.

Shrubland at So Kwun Wat is dominated by woody plant species with a height less than 1.5m. Despite the presence of the tree species *Pinus massoniana*, which reached a height of 4-5m, the habitat is open as a result of needle shaped leaves of the *Pinus* species. This habitat type is dominated by the shrub *Baeckea frutescens*, *Rhodomyrtus tomentosa* and the fern *Dicranopteris linearis*. Grassy species such as *Cymbopogon goeringii*, *Miscanthus sinensis* and *Gahnia tristis* were also frequently observed. Dominance of *Dicranopteris* species suggests that hill fires had frequently disturbed the habitat. The habitat is moderate in structural variety and plant species diversity. No rare plants were recorded. The habitat is considered of moderate importance to wildlife by providing food and habitat.

Tall Shrubland

Tall shrubland is a transitional stage in ecological succession between shrubland and woodland. Species composition is similar to that found in secondary woodland and shrubland. They occur in scattered patches in North Lantau and Tai Lam Chung and in larger continuous patches in the So Kwun Wat area.

A total of 34 plant species were recorded in tall shrubland on North Lantau with the average height of the plants range from 2-4m. Most plant species found are common in Hong Kong with shrubs *Acronychia pedunculata*, *Arundinaria cantorii*, *Dalbergia benthamii* and *Melastoma sanguineum* being the examples of dominant species. The exception is *Rhapis excelsa* which has a rather restricted distribution locally. Both plant diversity and structural variety are considered moderate.

A total of 33 plant species were recorded in tall shrubland at Tai Lam Chung with the average height of the plants range from 2-6m. The plant community is similar to the vegetation in the surrounding area which has a moderate species diversity. The trees *Schefflera octophylla* and *Rhus succedanea*, shrub *Rhaphiolepis indica*, *Litsea roundifolia* and climber *Dalbergia benthamii* are dominant. Tall shrubs dominated at low altitude and around village houses, where they are difficult to distinguish from plantations around the villages. Except *Enkianthus quinqueflorus* (see Figure 7.6) which is protected under the *Forestry Regulations*, other plants found are common species. The habitat is of moderate structural variety and species diversity.

Large patches of tall shrublands were found north to Li Uk Tsuen and east to Ching Uk Tsuen at So Kwun Wat. Such habitat comprises woody vegetation with a height of 1.5 to 5m. This habitat type is similar to shrubland in species composition. However, it has different dominant species and tends to have less grassy species and more woody plants and climbers that characterize woodland. A total of 78 plant species were recorded in this habitat which is dominated by the tree *Cinnamomum parthenoxylon*, *Cratoxylum cochinchinense*, *Eurya nitida* (*E. japonica* in HK Checklist) and *Litsea glutinosa*. The structural variety is high and with moderate species diversity. *Celtis timorensis* (*C. philippinensis*) which has a restricted distribution in Hong Kong was found here. This species is locally abundant in lowland woodland at Tung Chung and Shek O. In addition, the protected pitcher plant, *Nepenthes mirabilis* (see Figure 7.7), was found along a stream near to the proposed alignment.

Grassland/Shrubland Mosaic

This is another dominant habitat type within the project limit on North Lantau (Figures 7.2 & 7.3) and at Tai Lam Chung (Figure 7.5 & 7.6). This habitat is similar to shrubland vegetation in terms of species composition but with reduced height (0.5-1.5m). This may be a result of frequent disturbance in terms of hillfires.

On North Lantau, a total of 36 plant species were recorded with the dominant herb species such as *Miscanthus sinensis*, *Cymbopogon goeringii*, *Dicranopteris linearis* and *Ischaemum barbartum*, as well as the shrub *Baekkea frutescens*. The dominance of fern *Dicranopteris linearis* and shrub *Baekkea frutescens* suggested that such habitat has been recently disturbed by frequent hillfires. Both species diversity and

structural variety of this habitat are considered low, and neither rare nor protected species were found.

This habitat type is also dominant within the Tai Lam Country Park Area with moderate species diversity. A total of 29 plant species were recorded, with most species common in Hong Kong and no protected species noted. However, the rare shrub *Lespedeza cuneate* (*L. juncea* var. *sericea*) (see Figure 7.6) and a restricted herb species *Hedyotis pinifolia* (see Figure 7.6) were recorded. The former species are usually seen on small islands and near the coast (Ping Chau and San Tau) while the latter are usually found on exposed grassy hillsides. This habitat is considered of low species diversity and structural diversity, and no signs of wildlife were noted during the survey.

Grassland

The small patches of grasslands on the reservoir dam and around the mountain top radar station were dominated by exotic grass species *Paspalum* sp. which is commonly planted on artificial cut-slopes as well as weedy species such as *Panicum maximum* and other common grassland species. Since this habitat is probably created to protect the slopes, it is considered of little botanical and ecological value owing to the low species diversity (12 species) and naturalness.

Plantations

The plantation in the northwest at Tai Lam Chung is mainly composed of fruit trees and ornamental species with an average height 6-15m. A total of 10 species were recorded, with most of them being introduced species. There are a few tree species such as *Acacia confusa*, *Lophosteman confertus* and *Melaleuca leucadendron* that are commonly used for plantation purpose. The plant species noted were of low conservation interest and this habitat is of low species diversity and structural variety.

A small plantation is located in the Tsing Lung Tau portal area. This comprises 6 ornamental species such as *Acacia confusa* and *Lophosteman confertus* with an average height of 5-12m. Given the low conservation interest of the species and simple structural diversity, this habitat is not considered to be ecologically important.

Plantations at So Kwun Wat are established on the engineered slope north to Tuen Mun Road and Perowne Camp, as well as around wasteland to the west of the So Kwun Wat area. A total of 11 species were recorded and trees of similar height (5-6m) characterize the vegetation. As a result, this habitat is of low structural variety comparing to natural woodland. Species planted were mainly introduced species such as *Lophosteman confertus* and *Acacia confusa* that in general have lower ecological importance to wildlife.

Orchards

The plantation on North Lantau is a typical plantation of fruit trees and commercial crop species, with a total of 7 species noted. The average height of the trees range from 3-7m, including the dominant fruit trees *Clausena lansium*, *Dimocarpus longan* and *Syzigium jambos*. The plant species are of little conservation interest and thus this habitat is of little ecological interest in addition to possessing low species diversity.

Vegetation of this habitat type at So Kwun Wat are dominated by fruit trees such as *Dimocarpus longan*, *Litichi chinensis* and *Clausena lansium* and ornamental trees such as *Michelia alba* and *Aleurites moluccana*. Some plant species that are usually found in secondary woodland were also recorded, for instance, *Bridelia tomentosa* and *Litsea glutinosa*. This habitat type has moderate to poor floristic diversity and no rare wild plants were recorded. The presence of some tall trees (about 6-12m tall) may provide habitat for birds but the habitat in general is low in structural variety. As a result of intense human activity in this area, this habitat type is unlikely to be of any ecological importance to any important wildlife other than common birds.

Coastal Area

The coastal area on North Lantau is mostly fringed with typical back-shore vegetation, including shrubs and tall shrubs, similar to the other rocky shores in Hong Kong. Altogether 42 species were recorded and the plant diversity is considered moderate. A few species that have restricted distribution in Hong Kong are protected whilst most are common and are not among the protected plant species, *Phymatodes scolopendria*, *Fimbristylis complanata* and *Vitis balanceana* are particularly important. The former is very rare and has only been found in a few very isolated sites. The latter two are not recorded in the HK checklist and both have a restricted distribution. The height of the plants range from 1-5m on average, and such habitat is considered too open to be important to animal wildlife.

Beaches

The vegetation found on the beach near Fa Peng at North Lantau is typical of similar habitats in Hong Kong. The diversity is low, with only 18 plant species recorded. The vegetation ranges from 0.5-4m in height, and is dominated by the spiny climber *Caesalpinia bonduc* as well as shrubs such as *Hibiscus tiliaceus* and *Pandanus tectorious*. Most plants found are common species except *Thespesia populnea* (see Figure 7.3) which has a restricted distribution in Hong Kong. No sign of animal wildlife was observed during the survey.

Agricultural field

The agricultural fields found on North Lantau are mostly abandoned and covered by common weeds such as *Branchiaria mutica* and *Panicum* sp.. Only 9 common species were recorded. This habitat is low in naturalness and species diversity and therefore of low ecological value. No sign of animal wildlife was observed during the survey.

The abandoned terrace agricultural field at Tai Lam Chung is dominated by the weed *Panicum maximum* and other crop plants, with a total of 8 species recorded. Due to the low species diversity, this habitat is of limited botanical and ecological interest. No wildlife was observed during the survey.

Agricultural fields at So Kwun Wat area are still actively managed and planted with vegetables. This habitat is low in floristic diversity and structural diversity is poor. Weedy species, such as the climbers *Mikania micrantha* and *Ipomea batatas*, were commonly seen on the margin of this habitat.

Wasteland

Wasteland was found at So Kwun Wat. This habitat is defined as man-made habitat free of development which has suffered severe human disturbance. Therefore it includes all abandoned agricultural land that are not actively farmed as well as flat areas on the hills between So Kwun Wat and Siu Lam that were recently formed. A total of 48 plant species were recorded, with dominance by weedy species including the grasses *Neyraudia reyaudiana*, *Miscanthus floridulus*, *Pennisetum purpureum* and the climber *Mikania micrantha* and unattended crop plants including the trees *Clausena lansium* and *Dimocarpus longan*, and the herb *Colocassia esculenta*. Such habitat is poor in floristic diversity and also has simple structure. Only one restricted species *Andrographis paniculata*, which is a wasteland weed, was found here.

Freshwater habitats

Fish ponds at San Po Tsui and Fa Peng

There is a small patch of ravine freshwater pond with an area of approximately 150m² near San Po Tsui at North Lantau. This is a man-made fishpond and is still in operation. Owing to its small size, the species richness is relatively low (13 species). However, the locally rare grasses *Fimbristylis complanata* and *Diplarcum caricinum* were found. The structural variety of this habitat is considered low and no sign of animal wildlife was observed during the survey.

The pond at Fa Peng is a small active fish pond with gold fish, approximately 50m² in area. Common wetland species including *Cyperus haspans*, *Fimbristylis dichotoma* and *Scleria ciliaris* were noted at the edge of the pond. No animal wildlife was observed.

Tso Wan (TW stream) and Fa Peng (FP stream) Streams

There is a permanent mid-gradient stream that runs through the village of Tso Wan. Due to the difficulty of access, the stream remains clean without human disturbance. The stream is fed by two tributaries, with streambeds composed of coarse and fine pebbles as well as rocks of medium to large size. Shading is confined to the upper reaches of the stream course and become more exposed as the stream empties towards the sea. Vegetation along the stream banks consists of low-lying shrubs and grasses. Water flow is slow with mostly riffles and a few backwater pools.

Fa Peng stream was not sampled due to access problems. However, the habitats are expected to be similar to the Tso Wan stream because of their close proximity and similarity in geological and environmental factors.

Tso Wan Pond (TW pond)

There is an abandoned man-made fish pond near the western tip of Tso Wan village at approximately 40 m elevation. It is a medium-sized pond approximately a third of a hectare in size. It is fed by a stream, which passes through a small wetland before filtering into the pond. The wetland is dominated by water hyacinth (*Eichhornia crassipes*) but only in limited coverage.

Tai Lam Chung Stream and Wetland (TLC stream, TLC wetland)

Tai Lam Chung Stream arises from the hills behind Tai Lam Chung village and flows towards a wetland. It is a high-gradient permanent stream that is used for water abstraction. It is exposed in the upper reaches with algae dominating the water course. Large volcanic boulders line the stream bed and banks. The stream flows into a mid-sized wetland approximately 1 ha in size which is dominated by the herb *Alocasia odora*. Given that both Tai Lam Chung wetland and stream are small and disturbed to a certain extent, the ecological value of these two habitats is considered low.

So Kwun Wat Streams (SKW streams)

There are a few permanent mid-gradient streams near So Kwun Wat Sun Tsuen. The upper reaches of these small streams were quite dry, with flow mostly restricted to the lower portions and the lower stream course were semi-exposed. Riparian vegetation comprised mostly shrubs. Sediments consisted of fine-grains with mid-sized to large boulders. The upper courses of these streams remain natural, while human disturbance such as presence of garbage was observed in the lower course.

Animal Wildlife

Mammals

During the field surveys signs of mammals were found within the project limit. These included burrows (50cm x 30cm) at the *fung-shui* woodland at So Kwun Wat, which it is suspected were made by wild boar. The presence of cages set up by villagers for trapping wild boars provide further evidence of the presence of these animals. Wild boar is a wide-ranging animal that utilizes habitats from grassland to well-grown woodland. No signs of other mammals (such as trails or burrows) were observed or noted during the surveys. Nevertheless, the secondary woodland and tall shrubland habitats are likely to support other common mammal species such as civets and barking deer by providing shelter and food sources as stated in the STLFS. For the agricultural fields, plantations and grasslands, it is not expected that the low species diversity and poor structural complexity supports any mammal of ecological importance.

Avifauna

A total of 40 species of birds were recorded within the project limit. The species noted are all common and typical to rural Hong Kong. This corresponds with the findings of the STLFS. Several bird species such as Little Egrets and Chinese Pond Herons were observed foraging along the Tai Lam Chung Stream as well as utilizing the adjacent shrubland. No bird nesting sites were observed during the field surveys.

Amphibian/Reptile

One changeable lizard (*Calotes versicolor*) was recorded near the tall shrubland at So Kwun Wat. Although only one reptile species and no amphibians were observed during the field surveys, there are likely to be common species typical of shrubland, grassland, agricultural field and stream habitats within the project limit. It was reported in the STLFS EIA Report that only common amphibians including Asian Common Toad *Bufo melanostictus* and Gunther's Frog *Rana guentheri* were recorded in May 1996.

Invertebrates

The STLFS EIA Report stated that butterfly species recorded previously were all common species including Common Jay (*Graphium doson*), Small Yellow Butterfly (*Eurema brigitta*), Lemon/Lime Butterfly (*Papilio demoleus*), Small Brown (*Mycalesis* spp.), Common Dart (*Potanthus confusius*), Dark-veined Tiger Butterfly (*Danaus genutia*), Common Sailor (*Neptis hylas*), Common Tree Brown Butterfly (*Lethe confusa*). No other invertebrates of conservation importance were observed during the current field surveys.

Stream Fauna

No fish were found in the identified freshwater habitats during the field surveys. The stream invertebrates in Tso Wan Stream are of high abundance and diversity. The presence of pollution-sensitive fauna such as *Neoperla* sp. (Perlidae) and *Eulichas* sp. (Ptylodactilidae) showed that the stream is clean. However, the diversity and abundance of invertebrates in Tso Wan Pond is limited probably due to limited coverage of vegetation. At the Tai Lam Chung wetland the invertebrate diversity is low which may be a consequence of low vegetation diversity and density. Among the So Kwun Wat streams, the one flowing between *fung-shui* woodland 1 and 2 was sampled. Although there was limited water flow it was found to harbour a moderate diverse and abundant invertebrate assemblage, especially caddisflies (Trichoptera). Overall, no rare, endangered, or endemic animals were found in any of the stream sites sampled.

7.3.3 Ecological Importance

The ecological importance of the habitats identified has been evaluated against the criteria recommended in Annex 8 of the TMEIA. This evaluation is presented below.

Fung-shui Woodland at So Kwun Wat

- *Naturalness*: Among the four *fung-shui* woodlands at So Kwun Wat, the woodland behind the graveyard (FSW1) is considered of low naturalness due to disturbance, and the other three *fung-shui* woodlands: Li Uk Tsuen, the Tin Hau Temple and Ching Uk Tsuen (FSW2-4), are considered natural with only limited human disturbance.

- **Size:** Both Li Uk Tsuen and the Tin Hau Temple *fung-shui* woodlands (FSW2 & 3) are approximately one hectare while both the *fung-shui* woodlands behind the graveyard (FSW1) and behind Ching Uk Tsuen (FSW4) are approximately 0.6ha.
- **Diversity:** The species diversity of *fung-shui* woodlands at Li Uk Tsuen, the Tin Hau Temple and Ching Uk Tsuen (FSW2-4) is high, while the one behind the graveyard (FSW1) is relatively low.
- **Rarity:** Restricted *Ixonanthes chinensis* was found in the *fung-shui* woodland behind the graveyard (FSW1) and at the Tin Hau Temple (FSW3), while rare *Ficus gibbosa* and protected *Pavetta hongkongensis* were found in Li Uk Tsuen *fung-shui* woodland (FSW2). Rare/protected plant species found in Ching Uk Tsuen (FSW4) *fung-shui* woodland include *Ixonanthes chinensis*, *Celtis timorensis*, *Pavetta hongkongensis*, *Castanopsis concinna*, *Ormosia semicastrata* and *Lithocarpus litseifolius* (see Figure 7.7 for location).
- **Re-creatability:** The *fung-shui* woodland behind the graveyard (FSW1) would be relatively easy to re-create, but it would take a long time for the other three *fung-shui* woodlands: Li Uk Tsuen, Tin Hau Temple and Ching Uk Tsuen (FSW2-4) to be re-created. There is no guarantee that the rare plant species in the *fung-shui* woodlands could survive in the re-created woodlands.
- **Fragmentation:** The *fung-shui* woodlands are generally not fragmented except a small part of FSW4.
- **Ecological Linkage:** The present habitats are not functionally linked to any highly valued habitat in a significant way. However, they may provide movement corridors for wildlife.
- **Potential value:** Apart from the *fung-shui* woodland behind the graveyard (FSW1), which has a low potential value, the potential value of the other three well established *fung-shui* woodlands: Li Uk Tsuen, Tin Hau Temple and Ching Uk Tsuen (FSW2-4) is high regarding the naturalness, high species diversity and structural diversity, hence provide a range of resources for wildlife.
- **Nursery/Breeding Ground:** No record of significant breeding ground is found in this EIA.
- **Age:** The *fung-shui* woodland behind the graveyard (FSW1) is of recent age, while, taking account of the large size of trees (see Section 7.3.2 Woodland), the other three *fung-shui* woodlands: Li Uk Tsuen, Tin Hau Temple and Ching Uk Tsuen (FSW2-4) have been established for a considerable period.
- **Abundance/Richness of Wildlife:** Low to moderate wildlife richness and abundance according to the survey results as presented in Section 7.3.2 Animal Wildlife.

Secondary Woodland at Fa Peng and Tso Wan

- *Naturalness*: The secondary woodlands next to the village at Fa Peng and Tso Wan have been modified and subjected to human disturbance.
- *Size*: Small patches of secondary woodlands near Tso Wan and Fa Peng villages are approximately 0.6ha in total.
- *Diversity*: The diversity of secondary woodlands is moderate.
- *Rarity*: The restricted plant species *Amorphophallus variabilis* was found in the secondary woodlands.
- *Re-creatability*: It will take some time for the secondary woodlands to be re-created.
- *Fragmentation*: The secondary woodlands are generally not fragmented.
- *Ecological Linkage*: The present habitats are not functionally linked to any highly valued habitat in close proximity in a significant way.
- *Potential value*: The potential value of the secondary woodlands is considered low to moderate.
- *Nursery/Breeding Ground*: No record of significant breeding ground was found in this EIA.
- *Age*: The secondary woodlands are relatively mature.
- *Abundance/Richness of Wildlife*: Low to moderate wildlife richness and abundance according to the survey results as presented in Section 7.3.2 Animal Wildlife.

Shrubland, Tall Shrubland & Grassland/shrubland Mosaic

- *Naturalness*: Shrubland, tall shrubland and grassland/shrubland mosaic remains natural owing to their remoteness.
- *Size*: Grassland/shrubland mosaic and shrubland/tall shrubland are the majority habitat types within the Study Area.
- *Diversity*: The species diversity of shrubland, tall shrubland and grassland/shrubland mosaic is low.
- *Rarity*: At Northern Lantau, the restricted plant species *Rhaphis excelsa* was found in tall shrubland, at Tai Lam Chung, the protected plant species *Nepenthes mirabilis* (pitcher plant) and *Enkianthus quinqueflorus* were found in shrubland and tall shrubland respectively, the rare plant *Lespedeza cuneate* (*L. juncea* var. *sericea*) and restricted *Hedyotis pinifolia* were recorded in the grassland/shrubland mosaic. At So Kwun Wat, *Nepenthes mirabilis* was found in tall shrubland. Figures 7.3, 7.6 & 7.7 show the locations of these plant species.

- *Re-creatability*: The predominant vegetation type (shrubland and grassland community) is secondary and readily re-created naturally or artificially and would recover easily from disturbance.
- *Fragmentation*: The predominant habitat types are not fragmented.
- *Ecological Linkage*: The present habitats are not functionally linked to any highly valued habitat in close proximity in a significant way.
- *Potential value*: Low value for terrestrial habitats.
- *Nursery/Breeding Ground*: No record of significant nursery or breeding ground was found in this EIA.
- *Age*: Predominant habitats are frequently disturbed and therefore are secondary in nature.
- *Abundance/Richness of Wildlife*: Low wildlife richness and abundance according to the survey results as presented in Section 7.3.2 Animal Wildlife.

Freshwater Habitats

- *Naturalness*: The stream habitats at Tso Wan and Fa Peng are natural, while Tai Lam Chung stream and wetland, as well as So Kwun Wat streams are disturbed to a certain extent. The pond at Tso Wan, fish ponds at San Po Tsui and Fa Peng are man-created habitats.
- *Size*: The length of the natural streams at Tso Wan and Fa Peng are approximately 1300m and 1700m respectively, while Tai Lam Chung is approximately 250m. Streams in So Kwun Wat extend for approximately 2km. The Tso Wan Pond and Tai Lam Chung Wetland are approximately 1/3ha and 1ha respectively. The fish ponds at San Po Tsui and Fa Peng are 150m² and 50m² respectively.
- *Diversity*: Except for the Tso Wan Stream, which has a relatively higher diversity of stream invertebrates, wildlife observed in freshwater habitats was low to moderate.
- *Rarity*: Except for the locally rare grasses species *Fimbristylis complanata* and *Diplarcum caricinum* found in pond at San Po Tsui, no rare or endangered species were found.
- *Re-creatability*: The stream habitats can be re-created but colonisation by stream fauna is not guaranteed. The man-made ponds and fishponds can be re-created easily.
- *Fragmentation*: Not applicable.
- *Ecological Linkage*: The present habitats are not functionally linked to any highly valued habitat in close proximity in a significant way.

- *Potential value:* The natural Tso Wan and Fa Peng streams may provide potential habitats for aquatic wildlife such as amphibians, as well as a potential fresh water source for a wide range of wildlife, and thus possess a relatively higher potential value.
- *Nursery/Breeding Ground:* No records of significant nursery or breeding grounds were found in this EIA.
- *Age:* Not applicable.
- *Abundance/Richness of Wildlife:* Tso Wan Stream harbours relatively abundant and diverse invertebrate assemblage, while the invertebrate abundance and diversity at So Kwun Wat stream is moderate and that for Tso Wan Pond and Tai Lam Chung Wetland are relatively low. No wildlife was observed at fish ponds at San Po Tsui and Fa Peng.

Plantation/Orchard/Agricultural Field/Fishpond/Wasteland

- *Naturalness:* Plantation, orchard, agricultural fields, the pond at San Po Tsui and wasteland are all man-created habitats.
- *Size:* These habitats occur in small patches at village areas within the project limit.
- *Diversity:* The species diversity of the man-made habitats is low.
- *Rarity:* Except for the locally rare plant species *Fimbristylis complanata*, found in the pond at San Po Tsui, no rare/protected plant species were recorded in these habitats (see *Figure 7.3* for location).
- *Re-creatability:* The man-made habitats including agricultural field, orchard, plantation, wasteland can be re-created easily.
- *Fragmentation:* These habitat types are not fragmented.
- *Ecological Linkage:* The present habitats are not functionally linked to any highly valued habitat in close proximity in a significant way.
- *Potential value:* Low value for man-made habitats.
- *Nursery/Breeding Ground:* No record of significant nursery or breeding ground was found.
- *Age:* Not applicable.
- *Abundance/Richness of Wildlife:* Low wildlife richness and abundance according to the survey results as presented in Section 7.3.2 Animal Wildlife.

Coastal Area/Beach

- *Naturalness*: The coastal areas and sandy beach demonstrate limited human disturbance.
- *Size*: The natural coastline on Northern Lantau which will be affected is approximately 2.8km long.
- *Diversity*: Species diversity of the coastal areas and beach is low.
- *Rarity*: The rare plant species *Fimbristylis complanata*, restricted plant species *Phymatodes scopendria* and *Vitis balanceana* were found in the coastal areas, as well as the restricted plant species *Thespesia populnea* found on the beach (see *Figure 7.3* for location).
- *Re-creatability*: These habitats can be re-created.
- *Fragmentation*: These habitats are not fragmented.
- *Ecological Linkage*: The present habitats are not functionally linked to any highly valued habitat in close proximity in a significant way.
- *Potential value*: Relatively low value.
- *Nursery/Breeding Ground*: No record of significant nursery or breeding ground was found in this EIA.
- *Age*: Not applicable.
- *Abundance/Richness of Wildlife*: No terrestrial animal wildlife was recorded in this coastal area/beach.

Based on the ecological conditions presented in the above sections, it is considered that the *fung-shui* woodlands FSW2, 3 and 4 at So Kwun Wat possess high ecological value. The FSW1 and secondary woodlands are considered to have moderate value. The other terrestrial habitats along the alignment in North Lantau, Tai Lam Chung and So Kwun Wat, predominantly grassland and shrubland, have mostly common, widespread plant species typical of similar habitats elsewhere in Hong Kong. These habitats are therefore considered to be of low ecological importance.

The two streams at Tso Wan and Fa Peng, natural and undisturbed, provide potential habitats for aquatic wildlife and are considered to have moderate ecological value whereas the other disturbed stream courses are considered to have low importance.

A total of 22 ecological important plant species were found within the project limit and the evaluation of these species according to the TMEIA are given in *Table 7.1* below:

Table 7.1 Evaluation of Ecological Important Species within Project Limit

Species	Growth Form	Location	Protection Status	Distribution	Rarity
* <i>Vitis balansaeana</i>	Climber	*Kwai Shek at North Lantau, San Po Tsui at North Lantau	Not protected	Yuen Long, Sha Chau, Peng Chau, Tai O and Tung Chung	Restricted
<i>Fimbristylis complanata</i>	Grass	San Po Tsui Yi Chuen at North Lantau	Not protected	Lai Chi Wo, Ngoon Ping at Ma On Shan and Tai Ho	New and rare
<i>Diplaricum caricinum</i>	Grass	San Po Tsui	Not protected	Sham Chung and Nine Pin Island	Rare
<i>Phymatodes scolopendrai</i>	Herb	San Po Tsui	Not protected	Sha Chau, Chek Chau and Round Island	Restricted
<i>Alpinia galanga</i>	Herb	San Po Tsui	Not protected	Pat Sin Leng	Restricted
<i>Eriocaulon merrillii</i>	Herb	Yi Chuen	Not protected	Tung Chung, Sai Kung and Lai Chi Wo	Restricted
<i>Rhapis excelsa</i>	Shrub	Yi Chuen	Not protected	Wu Kau Tang	Restricted
<i>Amorphophallus</i> sp.	Herb	Tso Wan	Not protected	No information	Rare
<i>Scleria lithosperma</i>	Herb	Fa Peng	Not protected	Ap Lei Chau, Middle Island, Hei Ling Chau and San Tau	Restricted
<i>Thespesia populnea</i>	Tree	Fa Peng	Not protected	Starling Inlet, Tung Chung and Shui Hau	Restricted/rare
<i>Nepenthes mirabilis</i>	Herb	Southeast to Ching Uk Tsuen at So Kwun Wat	Protected	North Lantau and northwest New Territories	Restricted
* <i>Enkianthus quinqueflorus</i>	Shrub	Tai Lam Chung	Protected	Pat Sin Range, Sai Kung, Peak	Common
* <i>Celtis timorensis</i> (<i>C. philippinensis</i>)	Tree	So Kwun Wat	Not protected	Tung Chung, Aberdeen and Shek O	Restricted
* <i>Ficus gibbosa</i>	Tree	Li Uk <i>fung-shui</i> woodland at So Kwun Wat	Not protected	Tai Long Wan at Sai Kung and Lamma Island	Rare
* <i>Pavetta hongkongensis</i>	Shrub	Li Uk <i>fung-shui</i> woodland	Protected	Widely distributed	Common

Species	Growth Form	Location	Protection Status	Distribution	Rarity
<i>*Ixonanthes chinensis</i>	Tree	Tin Hau Temple and Ching Uk Tsuen <i>fung-shui</i> woodland	Not protected locally; Second class National Protection in China	Ma On Shan, Pokfulam Country Park and in hillside woodlands in Hong Kong; distribute in Guangdong, Guangxi and Hainan in China	Restricted in Hong Kong; endemic and vulnerable in China
<i>*Castanopsis concinna</i>	Tree	Ching Uk <i>fung-shui</i> woodland	Third Class National Protection in China	Scattered plants seen in Sai Kung, Hong Kong Island, Shing Mun Reservoir in Hong Kong; restricted to south Guangdong and south Guangxi in China	Endangered species; Rare in Hong Kong; restricted in China; rare globally
<i>*Ormosia semicastrata</i>	Tree	Ching Uk <i>fung-shui</i> woodland	Not protected	Ma On Shan, Pak Mon at Lantau and Tai Lam	Rare
<i>Lespedeza cuneate</i>	Shrub	Tai Lam Chung	Not protected	Small islands and near coast, e.g. Ping Chau and San Tau	Rare
<i>Hedyotis pinifolia</i>	Herb	Tai Lam Chung	Not protected	Exposed grassy hills	Restricted
<i>Andrographis paniculata</i>	Herb	So Kwun Wat	Not protected	No information	Restricted
<i>*Lithocarpus litseifolius</i>	Tree	Ching Uk <i>fung-shui</i> woodland	Not protected	Ma On Shan, Pat Sin Leng and Aberdeen	Rare

Note: * Species to be lost directly due to road construction

* Species which may be disturbed by construction activities

Mitigation measures for important plant species are recommended in Section 7.3.5

7.3.4 Impact Assessment

Potential Sources of Impact

Potential sources of impact associated with the Project are:

Construction Phase

- direct habitat loss including tall shrubland, shrubland, grassland, grassland/shrubland mosaic, freshwater stream course, coastal area, plantation woodland and lowland woodland, as well as loss of rare/protected plants, as a result of road construction and the related temporary work sites (see *Table 7.2* and *Figures 7.3, 7.6 & 7.7*).
- indirect impact to the surrounding habitats and associated wildlife because of increased human activities/disturbance such as storage or dumping of construction material, construction site runoff, and fragmentation of habitats such as the shrubland in the So Kwun Wat area;

Operational Phase

- indirect impact due to increased human activities as well as potential restriction of wildlife movement due to the presence of the highway.

Ecological impact resulting from the proposed road alignment is mainly associated with landtake. Estimated areas of habitat loss are presented in *Table 7.2*.

Table 7.2 Summary of Terrestrial Habitat Loss (ha) (*Loss due to temporary work site)

Habitat Loss	Northern Lantau	Tsing Lung Tau	Tai Lam Chung	So Kwun Wat
<i>Fung-shui</i> woodland				0.2
Secondary woodland	0.8			
Shrubland/Tall shrubland	8 (0.5*)		3.6 (1.2*)	4.5
Grassland/shrubland mosaic	9 (4.4*)		6	
Freshwater stream			130m in length	
Man-made habitats: plantation/orchard/agricultural fields/fishpond/wasteland	0.1	0.3		4

Impact Evaluation

Potential impacts on terrestrial ecology evaluated according to *Table 1* of *Annex 8* of the *TMEIA* are given below:

Fung-shui Woodland

- *Habitat quality*: There will be direct loss of moderate to high importance *fung-shui* woodlands at So Kwun Wat (FSW1 & 4), constituting moderate to high impacts.
- *Species*: There may be potential direct or indirect impact to the wildlife inhabiting the areas. For the So Kwun Wat area, the encroachment of the alignment into the *fung-shui* woodland behind Ching Uk Tsuen (FSW4) may lead to some loss of the rare *Ixonanthes chinensis* which is the dominant species in the woodland. The other rare/protected species found in the *fung-shui* woodlands at So Kwun Wat include *Celtis timorensis*, *Ficus gibbosa*, *Pavetta hongkongensis*, *Castanopsis concinna*, *Ormosia semicastrata* and *Lithocarpus litseifolius*. Although outside the project limit these may be disturbed by construction activities if these activities are not well controlled.
- *Size/Abundance*: Direct woodland loss at So Kwun Wat area includes approximately 0.2ha of woodland (including 0.1ha of FSW1 and 0.1ha of FSW4 behind Ching Uk Tsuen).
- *Duration*: The duration of impact will persist during construction and operational phases.
- *Reversibility*: The impact of direct habitat loss is irreversible. The impact on other animal wildlife could be alleviated after completion of the construction phase. The loss of *fung-shui* woodland at So Kwun Wat and restricted plants is permanent and irreversible.
- *Magnitude*: The scale of habitat loss is low to moderate given the relatively small size of the woodlands.

Secondary Woodland

- *Habitat quality*: There will be direct loss of moderately important secondary woodland.
- *Species*: There may be potential direct or indirect impact to the wildlife inhabiting the areas. No rare/protected species will be affected.
- *Size/Abundance*: Loss of area of the secondary woodlands on Northern Lantau will be approximately 0.8ha.
- *Duration*: The duration of impact will persist during construction and operational phases.
- *Reversibility*: The impact of direct loss of secondary woodland is irreversible. The impact to other animal wildlife could be alleviated after completion of the construction phase.
- *Magnitude*: The area of habitat loss is small.

Freshwater Stream

- *Habitat quality*: A small section of Tai Lam Chung Stream will be lost due to construction and the water flow will be re-directed in pipes. No impact is expected on the natural streams at Fa Peng and Tso Wan, while no direct impact is expected on disturbed streams at So Kwun Wat where the alignment will be on viaduct. However, there will be indirect impact on stream habitats such as sedimentation during construction. These streams are considered of low ecological importance given that they have been disturbed and harbour low to moderate diversity of stream fauna.
- *Species*: There may be potential direct or indirect impact to the wildlife inhabiting the Tai Lam Chung Stream; as well as indirect impact on other stream habitats.
- *Size/Abundance*: The upper section of Tai Lam Chung Stream (approximately 130m) will be lost due to construction. No direct impact is anticipated on other streams within the Study Area.
- *Duration*: The duration of impact will persist during the construction and operational phases.
- *Reversibility*: The impact to other animal wildlife could be alleviated after completion of the construction phase.
- *Magnitude*: The scale of habitat loss and impact is small.

Shrubland/Tall Shrubland, Grassland/Shrubland Mosaic and Other habitats

- *Habitat quality*: There will be direct loss of habitat including natural coastline, shrubland, tall shrubland, grassland/shrubland mosaic and plantation. It is considered that the impact on these habitats will be low owing to their low quality.
- *Species*: There may be potential direct or indirect impact to the wildlife inhabiting the areas. Habitat loss would also lead to the loss of some individuals of the restricted plant species *Vitis balansaeana* at Kwai Shek as well as the protected *Enkianthus quinqueflorus* at Tai Lam Chung, while indirect impact may affect the protected *Nephenthes mirabilis* and the rare *Lespedeza cuneate* at Tai Lam Chung.
- *Size/Abundance*: Approximately 8ha of shrubland/tall shrubland, 0.1ha of pond and 160m of natural coastline will be lost on North Lantau; the loss of habitat plantation will be 0.3ha at the Tsing Lung Tau portal area; habitat loss of shrubland and grassland/shrubland mosaic will be 3.6ha and 6ha respectively at Tai Lam Chung; at So Kwun Wat, 4.5ha of shrublands and 4ha man-made habitats will be lost. Habitat loss due to temporary work sites will include approximately 4.4ha of grassland/shrubland mosaic, 0.2ha shrubland and 0.3ha tall shrubland at North Lantau, as well as 1.2ha shrubland at Tai Lam Chung.
- *Duration*: The impact will persist during the construction and operational phases, except for temporary work site areas which will be re-instated.

- *Reversibility*: The impact of direct habitat loss is irreversible and the impact to other animal wildlife could be alleviated after completion of the construction phase. The majority of the habitats (grassland and shrubland) is readily re-created and will recover easily.
- *Magnitude*: The scale of the habitat loss is small in the context of the surrounding similar habitats.

Besides the primary impact from direct habitat loss due to project landtake, the other potential indirect impacts to the surrounding habitats and associated wildlife during construction phases are not expected to be high owing to the temporary nature of the construction work given that regular checks on good construction practice will be conducted. During the operational phase, given the low abundance and richness of animal wildlife recorded as presented in Section 7.3.2 Animal Wildlife, the impact due to increased human activity and restriction to wildlife movement is expected to be low.

In conclusion, the impact on the *fung-shui* woodland at So Kwun Wat is expected to be moderate to high, while the impact on the remaining low-quality secondary habitats including shrubland/tall shrubland, shrubland-grassland mosaic, disturbed freshwater stream course, and other human-modified habitats as well as animal wildlife is considered low.

7.3.5 Mitigation Measures

As discussed in Section 7.3.4, the potential impact due to landtake will affect the *fung-shui* woodlands, while ecological impact on the other low quality habitats will be limited. The impact due to the loss of the low quality Tai Lam Chung Stream will be low and therefore mitigation measures are not considered. No impact is expected on streams at Fa Peng and Tso Wan, and only indirect impact is expected on stream habitats at So Kwun Wat, where the alignment will be on viaduct. The measures below are recommended as a means of mitigating ecological important *fung-shui* woodlands and plant species:

- Adjust the construction area to avoid/minimize encroaching into the *fung-shui* woodland FSW4 and FSW1, as well as where the locally rare/protected plant species are present. A Tree Survey (see also Section 11.11 Plantation) is recommended, particularly for the affected *fung-shui* woodlands, to investigate the amount of individual important tree affected and to provide information for any compensation planting. If avoidance of important plant species (see *Figure 7.7* for location) is not possible due to engineering constraints, transplanting should be undertaken to similar habitats in the immediate vicinity.
- On-site planting should be provided for a total loss of approximately 1ha of high to moderate important *fung-shui* woodlands, as well as the moderate important secondary woodlands. There is a total area of approximately 10ha within the project limit, such as work sites, underneath high viaducts at So Kwun Wat and Siu Lam, and portal areas, which can be used for native woodland planting (see *Annex I Landscape Drawings for location*). Species used for planting should take reference from the species identified in the Tree Survey and be native to the Hong Kong or South China region. The trees should bear fruits preferred by birds and/or

which are larval or adult butterfly food plants. Subject to geotechnical acceptability, there will also be large areas of cut slopes or embankment areas for tree shrub or grass planting.

- Erect fences along the boundary of construction sites before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel into adjacent areas, particularly near the *fung-shui* woodlands and the areas where rare/protected plant species are located.
- Any damage that may occur to individual major trees in the adjacent area should be treated with surgery.
- Temporary work sites/disturbed areas should be reinstated immediately after completion of the construction by on-site tree/shrub planting. Tree/shrub species used should take reference from those in the surrounding area.
- Stream sedimentation during construction should be prevented by erection of sediment barriers and operation of stilling ponds in streams which could be potentially affected.
- Select the exact location of haul routes, storage and works areas etc. to avoid or minimize disturbance to secondary woodland, *fung-shui* woodland and stream habitats as far as possible.
- Regularly check the work site boundaries to ensure that are not exceeded and that no damage occurs to surrounding areas.
- Prohibit and prevent open fires within the site boundary during construction and provide temporary fire fighting equipment in the work areas.

With the implementation of the above recommended mitigation measures, it is considered that there would be no adverse residual ecological impacts. The 10ha of compensation planting is considered to be adequate for the 1ha loss of woodland. The potential impact due to loss of low quality habitats including 16.1ha shrubland/tall shrubland, 15ha grassland/shrubland mosaic, 4.4ha man-made habitats, 130m disturbed stream course and 200m natural coastline is considered low.

7.3.6 Environmental Monitoring & Audit

The implementation of the terrestrial ecological mitigation measures stated in Section 7.3.5 should be checked as part of the environmental monitoring and audit procedures during the construction period. These procedures are presented in the separate Environmental Monitoring and Audit Manual.

7.3.7 Conclusion

The ecological resources within the Study Area comprises a variety of habitat types including shrubland, tall shrubland, grassland/shrubland mosaic, secondary woodland, *fung-shui* wood, wetland, freshwater stream, agricultural field and orchard. Field surveys conducted between July and December 1998 indicated that shrubland and grassland/shrubland mosaic, which are typical of similar habitat elsewhere in Hong

Kong, are the main habitat type. Tall shrubland, wetland and coastal habitats were found to support a few rare/restricted/protected plant including *Amorphophallus variabilis*, *Diplarcum caricinum*, *Rhaphis excelsa*, *Fimbristylis complanata*, *Phymatodes scopendria*, *Vitis balanceana*, *Thespesia populnea*, *Nepenthes mirabilis* (pitcher plant), *Enkianthus quinqueflorus*, *Lespedeza cuneate* (*L. juncea* var. *sericea*) and *Hedyotis pinifolia* and fung shui wood at So Kwun Wat also support plants of ecological interest including *Ixonanthes chinensis*, *Vitis balansaeana*, *Celtis timorensis*, *Ficus gibbosa*, *Pavetta hongkongensi*, *Castanopsis concinna*, *Ormosia semicastrata* and *Lithocarpus litseifolius*. Besides the *fung shui* woodland which possess high ecological value, the other habitat types are mostly disturbed with low ecological importance according to the criteria stated in EIAO TM.

Mitigation measures for the construction are recommended to minimise or avoid the potential impacts on the *fung shui* woods as well as the rare/restricted/protected plant species. No residual impact is expected.

7.4 Marine Ecology

The marine ecological impact assessment has been performed using relevant information from the literature and field surveys (conducted for other projects). Although the construction site has not been surveyed, it should be stressed that the majority of field surveys referenced in this report, especially those for the coastal habitats, were conducted during the wet season of 1998 and the dry season of 1999 and thus have direct relevance to this EIA Study. Information on the use of the Study Area by marine mammals has been taken from the latest reports and documents produced by the Ocean Park Conservation Foundation.

The marine ecological habitats in the Study Area are mainly categorised into subtidal and intertidal. A habitat map showing the natural intertidal rocky shore, artificial seawall, natural intertidal sandy shore and subtidal habitats (hard bottom and soft bottom) is presented in *Figure 7.13*. The figure also presents photos of the habitats as taken during site visits conducted during the summer of 1998 and winter of 1999.

7.4.1 Baseline Information

The following review of habitats/species is separated into subsections: subtidal, intertidal, artificial seawalls, and marine mammals. Assemblages of the benthos in the subtidal soft-bottom habitats are separated into subsections: infauna and epifauna artificial seawalls. Independent studies involving grab sampling and trawling were undertaken and their locations are shown in *Figure 7.14*.

Subtidal

The only subtidal hard bottom habitat directly affected is that located in the upper subtidal portions of the rocky shore at Tsing Lung Tau. Due to the nature of the coastline in this area, it is anticipated that this gives way to a soft bottom habitat almost immediately from the shore and thus forms a narrow strip below the extreme low tide mark. At the Toll Plaza, the construction works will directly affect only soft bottom subtidal habitat.

Subtidal Hard-Bottom Habitat

Apart from its southern and eastern shores, where the shallow subtidal area is initially rocky and coral-encrusted, the sea bed of Hong Kong is soft and comprises an admixture of sand and mud which varies in detailed composition from place to place and under differing degrees of current scour^{2a}. In northwestern areas, as shown in the Study Area, under the influence of the Pearl River large quantities of silt are deposited regularly. The subtidal hard-bottom habitats are mainly fringed at these exposed areas (ie Northeast of Lantau and West of Ma Wan, see *Figure 7.13*). The benthic assemblages may probably be a continuum of those found in the lower shore of the littoral zone. No coral is expected but some gastropods and algae would be present.

Subtidal Soft-Bottom Habitat - Infaunal Benthic Assemblages

Infaunal benthic communities have been studied mainly through the use of grab samples. Five replicates of 0.1 m² Smith-McIntyre grab samples were collected at 200 stations around Hong Kong in July, August, September and November 1976 and January 1977³. The particle size distribution of the benthos between Tsing Yi and Ma Wan had a mean silt content of 74 % and an organic content of 1.6 % (*Table 7.3*). In terms of faunal abundances, a mean value of 107 individuals m⁻² was recorded, which ranked the area intermediate in comparison with other areas in Hong Kong. Polychaetes were the most abundant organisms, comprising 83 % of the total animals sampled (*Tables 7.3 and 7.4*). The study's main finding was that the assemblages were typified by high abundances with low numbers of species and low individual biomass. This pattern is typical of the Hong Kong benthos.

Table 7.3 Physical and Biological Parameters for Sediments in the Study Area.

Parameters	Shin & Thompson 1982	APH Consultants 1992
Physical (%)		
gravel (>2 mm)	2.1	0
sand (0.062-2 mm)	19.4	4.5
silt (2-62 m)	74.0	66.3
clay (<2 m)	4.6	29
organic content	1.62	NA
Biological (%)		
Polychaetes	82.5	83.3
Molluscs	1.7	7.9
Crustaceans	3.7	0
Echinoderms	5.2	0
Other groups	6.8	8.8

^{2a} Morton et al (1995). The Benthic Marine Ecology of Hong Kong: A Dwindling Heritage? In: A Review of Coastal Infrastructure Development in Hong Kong, Proceedings of the Symposium on Hydraulics of Hong Kong Waters held on 28-29 November 1995.

³ Shin P K S and Thompson G B (1982). Spatial Distribution of Infaunal Benthos of Hong Kong. *Marine Ecology Progress Series* 10: 37-47.

Table 7.4 Five Most Abundant Benthic Species Recorded in the Study Area.

Shin & Thompson 1982		APH Consultants 1992	
Polychaete Species	% by number	Polychaete Species	% by number
<i>Paraprionospio pinnata</i>	11.0	<i>Notomastus latericeus</i>	47
<i>Aglaophamus lyrochaeta</i>	5.7	<i>Aglaophamus lyrochaeta</i>	10
<i>Sternaspis scutata</i>	3.4	<i>Paraprionospio pinnata</i>	9.7
<i>Marphysa stragulum</i>	3.3	<i>Glycera chiori</i>	9.7
<i>Terebellides stroemi</i>	3.0	<i>Marphysa stragulum</i>	8

The benthos was also studied by using a 0.05 m² Van Veen grab at 4 stations within the proposed area of the Lantau Port & Western Harbour Development study⁴. The first survey was carried out in December 1991 and the second survey took place during June 1992 with station 5 in the Study Area being investigated (Figure 7.14). The bottom sediment was fairly homogeneous, with a silt content of 66 %. As in the Shin & Thompson (1982) study, polychaetes were the most abundant group of organisms found at the study site, comprising 83 % of the total species recorded (Table 7.3). The species composition was similar to the previous study with polychaete species most abundant. *Notomastus latericeus*, was the most abundant of all species, composing 47% of the samples, with *Paraprionospio pinnata* (most abundant in the previous study) ranked third (Table 7.4).

During the Baseline Performance Monitoring and Verification for the SSDS Stage I Outfall a number of benthic surveys were undertaken⁵, of which one grab sampling station lies within close proximity of the Study Area and is considered as representative of its benthic communities (Figure 7.14). The five most abundant benthic species recorded at this site are presented below in Table 7.5.

Table 7.5 Five Most Abundant Benthic Species recorded at the site S03

Station	Phylum	Species	% of total by number
S03	Hemichordata	<i>Balanoglossus</i> sp	47
	Annelida	<i>Aglaophamus dibranchia</i>	11
	Annelida	<i>Prionospio malmgreni</i>	5
	Annelida	<i>Prionospio</i> sp	4
	Annelida	<i>Mediomastus californiensis</i>	2

The results from this survey demonstrate that the benthic communities within the Study Area are primarily made up of polychaetes (Phylum Annelida) in common with the majority of Hong Kong's benthos. The most striking feature of the results is the

⁴ APH Consultants (1992) Lantau Port & Western Harbour Development Studies, Environmental Survey Data Report, for Civil Engineering Department, Port Development Office.

⁵ Mouchel Asia Limited (1998) Strategic Sewage Disposal Scheme Stage I Baseline Monitoring and Performance Verification. First Annual Report for Environmental Protection Department, July 1998.

abundance of the species *Balanoglossus* sp (Phylum Hemichordata) within nearly all of the stations sampled. This highly primitive species is typically found within muddy seabeds where there is a mixture of sand and fine sediment⁶. The abundance of this species in this study is in contrast to the low records of this species recorded by other benthic surveys undertaken within the Study Area. In order to investigate the community structure further, the results have been presented below in terms of total number of individuals and total biomass for each phylum (Table 7.6).

Table 7.6 Summary of Organisms recorded from the Mouchel SSDS Sampling

Station	Phylum	Total Number of Individuals Recorded	Total Biomass (g)
S03	Hemichordata	83	14.7
	Annelida	62	41.6
	Arthropoda	22	3.1
	Echinodermata	2	0.009
	Chordata	2	6.9
	Nemertea	1	0.007

Although the Hemichordate *Balanoglossus* sp is the most abundant species sampled, the Annelid polychaetes are the major component of the benthic assemblages. As stated previously this is in common with the majority of Hong Kong's benthos which are primarily characterised by soft bottom sediments dominated by polychaetes.

In summary, findings from the majority of these studies were that the benthos of the seabed within or proximal to the Study Area was dominated by polychaetes and characterised by low species diversity and low species biomass. All species recorded had been previously reported in Hong Kong and no environmentally sensitive nor rare species were found. This pattern was also observed by the REMOTS studies⁷.

Subtidal Soft-Bottom Habitat - Epifaunal Benthic Assemblages

Trawl surveys were conducted to collect epifaunal benthic community data in South Tsing Yi in January 1995⁸. One of the three trawl surveys (T1, Figure 7.14) was located near the Study Area. A total of 16 species and 40 individuals were recorded from three replicates of the trawl. Five colonies of gorgonians (*Junceella juncea* and *Gorgonacea* sp) were recorded but crab and shrimp species were dominant in the trawl samples. The demersal community was diverse but with low abundance. Of the species identified, gorgonian soft corals were considered in that study to be of ecological value. The study concluded that compared to other areas in Hong Kong, the diversity of fish and macroinvertebrate communities found in the trawl surveys at South Tsing Yi was low.

⁶ Morton B & Morton J (1983) *The Sea Shore Ecology of Hong Kong*. Hong Kong University Press, First Edition.

⁷ Science Applications International Corporation (1993) REMOTS Survey of Soft-bottom Environments in Coastal Waters of Hong Kong, for Binnie Consultants and Civil Engineering Department.

⁸ ERM Hong Kong Ltd (1995) Backfilling of South Tsing Yi and North of Lantau MBAs: Final Environmental Impact Assessment, for Civil Engineering Department.

A benthic community study by trawling at North of Lantau⁹ showed that the habitats were dominated by gastropods. Therefore, it is unlikely that there are any large hard coral colonies in the Study Area due to the ambient conditions of high levels of suspended solids, low light penetration and the influence of low salinity waters of the Pearl River.

Intertidal

The hydrodynamic characteristics of the Study Area are determined to a large extent by the influence of tidal currents and flows from the Pearl River Delta. Ebb tides flow down through the Urmston Road into the Ma Wan Channel which diverts the flows southward. This flow pattern reverses during the flood tides. The circulation pattern creates a variety of intertidal habitats. When exposed to the current flows, the shorelines mainly consist of boulder or rocky habitat (eg North of Lantau and West of Ma Wan). However, in sheltered areas, mainly sandy shores are found (eg beaches near Sham Tseng).

Rocky Shores

Rocky shore organisms originated in purely marine habitats and have evolved and adapted to live on intertidal shores. The extent of their adaptations to this habitat will dictate where they are found on the shore. The more adapted the species is to terrestrial conditions, the higher it will be found. This causes zonation patterns. Their recruitment period and the primary productivity of the shore will affect the abundance of intertidal organisms. Typical exposed rocky shore communities consist of periwinkles, barnacles and limpets. Encrusting algae are common in the low intertidal zone.

The Tsing Lung Tau coastline, where the Tsing Lung Bridge North Tower will be constructed, consists of a 160m stretch of natural coastline and an equivalent length of artificial seawalls. Although surveys were not conducted at Tsing Lung Tau recent intertidal surveys near Kwai Shek and Fa Peng (location of the Toll Plaza) undertaken in September 1998 and January 1999¹⁰ (see *Figure 7.14*) showed that the assemblages were typical of exposed rocky shore communities with high quantities of barnacles (*Capitulum mitella* and *Tetraclita squamosa*), chitons (*Acanthopleura japonica*), limpets (*Cellana toreuma* and *Patelloida saccharina*) and periwinkles (*Nodilittorina radiata* and *N. trochoides*). Bivalves and sea anemones were also found in low abundance. Of the algae present, encrusting species were dominant in the wet season. As Tsing Lung Tau, Kwai Shek and Fa Peng are in close proximity and experience similar exposure to wave action, the benthic assemblages in both intertidal hard bottom habitats are expected to be the same.

⁹ Wu RSS and Richard J (1981). Variations in Benthic Community Structure in a Sub-tropical Estuary. *Marine Ecology*:64: 191-198.

¹⁰ Surveys were conducted by ERM as part of the Northshore Lantau Feasibility Study for CED.

Natural Sandy Shores

In the lee of headlands or within shallow bays, wave action is reduced and there is an accumulation of sand and detrital material. Exposed sandy beaches are relatively unstable environments and the fauna is sparse. However, with increasing shelter substrate stability allows for the development of a rich community of burrowing animals. Where a river or stream discharges to a sandy shore, forming an estuary, a greater percentage of very small particles are found, due to the deposition of terrigenous material eroded by the river. Such shores retain water more readily and the beach comprises black, organic-rich or compacted mud. Typical sandy shore communities consist of numerous species of burrowing crabs, potamid gastropods (eg *Batillaria multiformis*), bivalves and worms.

Previous surveys have been undertaken at two of the intertidal soft shores in the Study Area at Pa Tau Kwu Pak Wan and Yam Tsai Wan on Northeastern Lantau. Results indicated that these sandy shores supported benthic assemblages of low diversity. The lower shore was bordered by cobbles, which provided habitats for snails (*Monodonta australis*), limpets (*Notoacmaea concinna*) and polychaetes (*Hydroides elegans*). The sand-hopper *Orchestia* sp was the most abundant species observed on the shore. These survey results are taken as representative of the baseline information for the intertidal sandy shore habitats. The Study Area contains many very small sandy shore areas which are illustrated on the habitat map presented in *Figure 7.13*. The impact assessment has been performed on the assumption that the many small sandy shores in the area support similar assemblages to those reported during the surveys of Pa Tau Kwu Pak Wan and Yam Tsai Wan.

Modified Sandy Shores (Gazetted Beaches)

Along the coastlines of Sham Tseng and Tsing Lung Tau, there are sheltered sandy beaches including Anglers Beach, Lido Beach, Casam Beach, Ho Mei Wan Beach, Gemini Beach and Dragon Beach. Of the gazetted beaches, Anglers Beach has been closed due to extremely poor water quality and will be reclaimed under the development of Sham Tseng¹¹. Lido Beach, Casam Beach, Ho Mei Wan Beach, Gemini Beach are categorised as "Grade 3" beaches of poor water quality under EPD's monitoring system¹².

Artificial Seawalls

Few surveys have yet been conducted on the colonization of organisms on artificial seawalls in Hong Kong^{13,14}. However, fouling organisms have been anecdotally recorded as common on artificial seawalls, wharf piles and other marine structures¹⁵. Various species of algae, coelenterates, ascidians, bryozoans, sponges, crustaceans,

11 Scott Wilson (1998). Planning and Engineering Feasibility Study for Development on Sham Tseng Further Reclamation: Draft EIA - Stage I Report.

12 Extracted from Daily Information Bulletin dated 26 September 1997 which was released on government website (www.info.gov.hk/isd/news).

13 Binnie Consultants Limited (1996). Fill Management Study - Phase IV Investigation and Development of Marine Borrow Areas: Coral Growth at High Island Dam. Report submitted to CED GEO, July 1996.

14 Binnie Consultants Limited (1997). Chek Lap Kok Qualitative Survey. Final Report to CED GEO, December 1997.

15 Morton B & Morton J (1983). *op cit*.

molluscs and polychaetes are commonly observed on these artificial structures (Table 7.7). Therefore, it can be presumed that species commonly found on these surfaces in Hong Kong waters will be found on the artificial seawalls of the established complexes at Sham Tseng, Tsing Yi and the new airport at Chek Lap Kok.

Table 7.7 Common organisms present on artificial seawalls in Hong Kong. (Adapted from Morton and Morton 1983⁽⁵⁾)

Group	Species
Algae	<i>Ulva fasciata</i>
	<i>Enteromorpha prolifera</i>
	<i>Codium cylindricum</i>
	<i>Colpomenia sinuosa</i>
Polychaete	<i>Hydroides elegans</i>
	<i>Spirorbis foraminosus</i>
Bryozoan	<i>Bugula neritina</i>
Bivalve	<i>Perna viridis</i>
	<i>Septifer virgatus</i>
	<i>Saccostrea cucullata</i>
Barnacle	<i>Electroma liratium</i>
	<i>Balanus amphitrite</i>
	<i>Capitulum mitella</i>
Ascidian	<i>Tetraclita squamosa</i>
	<i>Ascidia sydneyensis</i>
	<i>Ciona intestinalis</i>
	<i>Styela plicata</i>

Marine Mammals

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. Sightings of the Finless Porpoises have mainly been in southern waters of Hong Kong and thus are not an issue of concern for this Study. The 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 range¹⁶. North Lantau represents the major area of distribution of dolphins in Hong Kong waters, and is the only place in Hong Kong where dolphins are seen year round. Schools of dolphins are most frequently sighted in the western part of these waters around the Sha Chau, Lung Kwu Chau Marine Park and the new Airport (Figure 7.15). Although the Study Area is situated at the northeastern corner of Lantau, a notable number of dolphins are sighted there.

The East Lantau waters show a seasonal pattern in sightings of the dolphin. During spring and early summer months few dolphins have been observed near the Study Area. However, during autumn and winter they have been regularly sighted¹⁷ (Figure 7.15).

¹⁶ Jefferson TA (1998). Population Biology of the Indo-Pacific Hump-backed Dolphin (*Sousa chinensis* Osbeck, 1765) in Hong Kong Waters. Final Report to AFD.

¹⁷ Jefferson TA (1998). *op cit.*

7.4.2 Ecological Importance

According to the Technical Memorandum of the EIAO (EIAO TM) *Annex 8* the ecological value / importance of a habitat can be evaluated using the following criteria:

- naturalness;
- size;
- diversity;
- rarity;
- re-creatability;
- ecological linkage;
- potential value;
- nursery ground;
- age; and
- abundance.

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the intertidal hard bottom and subtidal soft bottom habitats at the proposed Tsing Lung Bridge North Tower area and the subtidal soft bottom habitat at the proposed Toll Plaza area. The application of these criteria has led the intertidal hard bottom habitat at Tsing Lung Tau to be classified as medium, whereas, the subtidal habitats at both Tsing Lung Tau and the Toll Plaza are classified as low (*Table 7.8*).

Table 7.8 Ecological Value of Habitats within the Construction Sites

Criteria	Tsing Lung Tau		Yi Chuen , Toll Plaza
	Intertidal Hard Bottom Habitat	Subtidal Habitat (Mainly Soft Bottom, see Section 7.4.1)	Subtidal Soft Bottom Habitat
Naturalness	The habitat is disturbed by human impacts through development of residential area and some areas of artificial seawalls (160m). Natural coastline of approximately 160m will be affected.	The subtidal area is almost entirely in its natural state.	The subtidal area is almost entirely in its natural state.
Size	The affected area covers a coastline of 320m.	The area to be dredged/ reclaimed is approximately 2.6 hectares.	The affected area at Yi Chuen is negligible; the area to be dredged/ reclaimed at Toll Plaza is approximately 5.5 hectares.
Diversity	The intertidal communities appear to be typical of semi-exposed shores in Hong Kong.	Benthos of low diversity.	Soft bottom benthos of low diversity.
Rarity	None.	None.	None
Re-creatability	The habitat can be recreated.	The habitat cannot be recreated on site.	The habitat cannot be recreated on site.
Ecological Linkage	Is considered as low. The surrounding environment mainly contains gazetted beaches and man-made seawalls.	The surrounding environment contains similar subtidal habitats.	The surrounding environment contains similar subtidal soft bottom habitats.

Criteria	Tsing Lung Tau		Yi Chuen , Toll Plaza
	Intertidal Hard Bottom Habitat	Subtidal Habitat (Mainly Soft Bottom, see Section 7.4.1)	Subtidal Soft Bottom Habitat
Potential Value	High levels of human disturbance signify that it is unlikely that the habitat could develop conservation interest.	It is unlikely that the site can develop conservation interest.	It is unlikely that the site can develop conservation interest.
Nursery Area	None identified during the literature review.	None identified during the literature review.	None identified during the literature review.
Age	Not applicable for these assemblages as the life cycle of the fauna is very short.	The subtidal fauna is generally short lived.	The subtidal fauna is generally short lived.
Abundance	Intertidal assemblages appear to be typical of other semi-exposed shores in Hong Kong	Reviewed literature indicates that assemblages contain high abundance of organisms but are of low diversity and biomass*.	Reviewed literature indicates that assemblages contain high abundance of organisms but are of low diversity and biomass*.
SUMMARY	The natural hard bottom assemblages are of medium ecological value and the artificial seawalls are of low ecological value .	The seabed habitats support low diversity and abundance of infaunal and epifaunal organisms that are typical of Hong Kong's benthos. Ecological Value - Low.	The sediments support low diversity and abundance of infaunal and epifaunal organisms that are typical of Hong Kong's benthos. Ecological Value - Low.

* Only three piers are proposed to be bore-piled into the seabed at Yi Chuen.

* Surveys undertaken near South Tsing Yi and northeastern Lantau showed that the Study Area was dominated by high abundances of polychaetes and characterised by low species diversity and low species biomass (see Section 7.4.1).

Based on the field surveys conducted for other studies presented in Section 7.4.1, it has been shown that the marine ecological resources of the Study Area are dominated by soft bottom assemblages of low ecological value and hard bottom assemblages of medium ecological value. The same assessment criteria have been applied to these habitats in the Study Area (Tables 7.9 and 7.10).

Table 7.9 Ecological Value of Soft Substrate Habitats in the Study Area (Construction Sites Excluded)

Criteria	Natural Sandy Shore	Beach (near Tsing Lung Tau)	Subtidal Soft Bottom Habitat
Naturalness	Sandy shores at northeastern Lantau are natural habitats.	Some of the shores are highly disturbed by human impacts through development for recreation as gazetted beaches.	Some parts of the Study Area serve as navigation channels that are dredged for maintenance periodically. This indicates that the assemblages present there at some point in the past been disturbed.
Size	Based on the small-scale dredging/reclamation works, area indirectly impacted will be small and located in the vicinity of the construction sites.		
Diversity	The intertidal communities appear to be typical of sandy shores in Hong Kong.	Reviewed literature indicates that beaches that are frequently used for recreational purposes support low diversity assemblages.	Soft bottom benthos of low diversity.
Rarity	None.	None.	None.
Re-creatability	The habitat cannot be re-created on site.		

Criteria	Natural Sandy Shore	Beach (near Tsing Lung Tau)	Subtidal Soft Bottom Habitat
Ecological Linkage	The surrounding environment contains similar intertidal habitats.	The surrounding environment contains similar intertidal habitats.	The surrounding environment contains similar subtidal soft bottom habitats.
Potential Value	It is unlikely that the site can develop conservation interest.	High levels of human disturbance signify that it is unlikely that the habitat could develop conservation interest.	It is unlikely that the site can develop conservation interest.
Nursery Area	None identified during the literature review.		
Age	Not applicable for these assemblages as the life cycle of the fauna is very short.	Not applicable for these assemblages as the life cycle of the fauna is very short.	The subtidal fauna is generally short lived.
Abundance	Reviewed literature indicates that low abundance of intertidal organisms are supported.	Reviewed literature indicates that beaches that are frequently used for recreational purposes supporting low abundance of intertidal organisms.	Reviewed literature indicates that assemblages contain high abundance of organisms but are of low diversity and biomass*.
SUMMARY	The sandy shores support low diversity and abundance of intertidal organisms that are typical of Hong Kong's benthos. Ecological Value - Low.	Literature reviews indicate that gazetted beaches support low assemblages typical of other recreational beaches in Hong Kong. Ecological Value - Low.	The sediments support low diversity and abundance of infaunal and epifaunal organisms that are typical of Hong Kong's benthos. Ecological Value - Low.

* Surveys undertaken near South Tsing Yi and northeastern Lantau showed that the Study Area was dominated by polychaetes and characterised by low species diversity and low species biomass (see Section 7.4.1).

Table 7.10 Ecological Value of Hard Bottom Habitats in the Study Area (Construction Sites Excluded)

Criteria	Natural Rocky Shore	Subtidal Hard Bottom Habitat
Naturalness	The habitat is undisturbed by human impact due to the steep rocky terrain of much of the intertidal zone and remoteness of the shore.	As no dredging or other human activities have been performed in the Study Area, the assemblages are expected to be undisturbed.
Size	Based on the small-scale dredging/reclamation works, area indirectly impacted will be small and located in the vicinity of the construction sites.	
Diversity	The intertidal communities are typical of exposed rocky shores in Hong Kong.	Patchy epifaunal diversity with most valuable areas rated as medium compared to other areas in Hong Kong.
Rarity	No species recorded are considered rare.	No species recorded are considered rare.
Re-creatability	The habitat can be re-created.	The habitat can be re-created on site.
Ecological Linkage	The surrounding environment contains similar intertidal habitats.	The surrounding environment contains similar hard bottom substrate.
Potential Value	In terms of typical undisturbed exposed shores in Hong Kong, the shores have conservation interest.	Unlikely that the site can develop conservation interest.
Nursery Area	None identified during the literature review or field surveys.	None identified during the literature review.
Age	Not applicable for these assemblages as the life cycle of the fauna and flora is very short.	
Abundance	Assemblages appear to be typical of other exposed shores in Hong Kong.	Abundances appear to be lower than elsewhere in Hong Kong.
SUMMARY	The fauna of the intertidal region appear to be typical of exposed shores in Hong Kong. The sites appear to have suffered little human disturbance. Ecological Value - Medium.	The fauna of the subtidal hard bottom habitats appear to be patchy epifaunal assemblages of no rare species. Ecological Value - Medium.

The same assessment criteria have been applied to the marine waters off the construction sites. These habitats have been classified as of medium ecological value depending largely on the use of the areas by Chinese White Dolphin *Sousa chinensis* (Table 7.11).

Table 7.11 Ecological Value of the Marine Waters off Construction Sites

Criteria	Marine Waters off Tsing Lung Tau	Marine Waters off Toll Plaza
Naturalness	Disturbed through residential discharges. Close proximity to one of the busiest shipping lanes in Hong Kong.	Close proximity to some of the busiest shipping lanes in Hong Kong.
Rarity	The Chinese White Dolphin (<i>Sousa chinensis</i>) has been recorded in these waters.	
Re-creatability	The habitat cannot be recreated.	The habitat cannot be recreated.
Ecological Linkage	Preferred marine mammal habitats occur to the west of this area (around the Sha Chau, Lung Kwu Chau Marine Park and the new airport).	
Potential Value	Limited value due to heavy navigational use of the area.	
Nursery Area	No nursery areas were identified in the review of marine ecology baseline conditions.	
Abundance	Seasonal changes in the distribution patterns of dolphins were observed, with comparatively higher abundances in autumn and winter. However, these abundances are low when compared with preferred habitats to the west.	
SUMMARY	Sightings of the Chinese White Dolphin (<i>Sousa chinensis</i>) have been made in both of these areas. However, the number of sightings varies seasonally and neither area is regarded as preferred habitat. Both of the areas are heavily used by marine traffic at present. Ecological Value - Medium.	

7.4.3 Sensitive Receivers

Based on the preceding review of the available information on baseline ecology of the waters in the Study Area (see Section 7.4.1) and an assessment of ecological importance of the habitats (see Section 7.4.2), the subtidal soft bottom habitats have been classified as of low ecological value. The natural intertidal rocky shores at Tsing Lung Tau have been classified as medium, whereas, the intertidal sandy shores have been classified as of low ecological value. For the marine mammal habitats, waters off the two construction sites have been classified as medium ecological value. Ecological sensitive receivers are considered to be those habitats or species of medium or high ecological value. The sensitive receivers which may be affected by the proposed project have been identified as intertidal rocky shore at Tsing Lung Tau and the Chinese White Dolphin, *Sousa chinensis*.

7.4.4 Potential Impacts from Construction and Operation

Impacts to marine ecological resources may arise during the construction and operational phases. They may be derived from direct disturbance to the habitat and indirect disturbance through changes to key water quality parameters.

Construction Impacts

Direct Impacts

Direct Impacts include habitat loss of areas being dredged or reclaimed at the construction sites and killing of marine organisms through underwater blasting, piling and marine traffic near Tsing Lung Tau. It should be noted that the direct/indirect

impacts due to pillar construction for Yi Chuen viaduct are likely to be negligible and will not be addressed further in this EIA, as only three piers are proposed to be bored into the seabed.

Habitat Loss

Habitat loss will be effected by:

- reclaiming areas of hard-bottom intertidal habitat (160 m natural coastline) of medium ecological value and soft-bottom subtidal habitat (2.6 hectares, see *Figure 6.3*) of low ecological value near Tsing Lung Tau for the construction of Tsing Lung Bridge North Tower; and
- dredging and reclaiming an area of soft bottom subtidal habitat of low ecological value (5.5 hectares, see *Figure 6.5*) between the outer edges of the headlands at Tso Wan and Fa Peng for the construction of the Toll Plaza and seawalls.

The affected hard-bottom intertidal habitat (160 m natural coastline) at Tsing Lung Tau covers a small area. Seawall design such as rubble mounds as adopted at Chek Lap Kok, is recommended as a mitigation measure to enhance the recolonisation of benthic organisms. The impacts due to this habitat loss are therefore not unacceptable. The impacts from the loss of the soft bottom subtidal habitats at Tsing Lung Tau and the Toll Plaza will also be minimal because these habitats (a total area of 8.1 hectares) are of low ecological value (see Section 7.4.2).

Underwater Blasting

The construction of the Tsing Lung Bridge North Tower will involve the use of blasting for the foundations of the bridge tower (*Figure 7.16*). The Toll Plaza will, however, be constructed without the use of blasting or percussive piling into the bedrock.

The size of the lethal zone of underwater blasting depends upon numerous factors¹⁸, including:

- the type of explosives;
- the magnitude of the explosion;
- the dimensions of the body of water, that is, its areal extent and its depth;
- the nature of the bottom;
- the depth at which the charge is set off; and
- the nature and sensitivity of potentially impacted organisms.

Shock Waves: Impacts from an underwater explosion can cause the swim bladder of fish species to be ruptured. A study¹⁹ showed that under similar blast conditions (about 16 m from a 4 kg charge of dynamite), all species without swim bladders survived unharmed, whereas four of the five species with swim bladders were killed.

¹⁸ Westing A H (1978). Military Impact on Ocean Ecology, from Military Activities, The University of Chicago, pp 337-466.

¹⁹ Aplin J A (1947). Effect of Explosives on Marine Life. California Fish and Game 33: 23-30.

Therefore, fish are more susceptible to underwater blasting as they usually possess a swim bladder. However, direct, and possibly fatal, impacts could potentially impact other species, including marine mammals, if the organisms were located in close proximity to an underwater explosive charge.

Noises: Cetaceans are animals that rely heavily on acoustic information to communicate and to explore their environment. Therefore, any noise that disrupts communication or echolocation channels would be potentially harmful. High explosives produce pulses with a very rapid onset (shock waves), which change to conventional acoustic pulses as they propagate. The reactions from impacted cetaceans can range from brief interruption of normal activities to short- or long-term displacement from noisy areas. Strong sound may cause temporary or permanent reductions in hearing sensitivity.

As cetaceans are protected under the Wild Animals Protection Ordinance (Cap 170) 1980 any lethal or sublethal impact on marine mammals as discussed above would be unacceptable. Mitigation measures are proposed in Section 7.4.6 to reduce impacts on dolphins to acceptable levels. No unacceptable impacts through noise disturbance are expected as a result of the construction of the Toll Plaza as the reclamation will not involve any blasting activities or percussive piling.

Indirect Impacts

Indirect impacts to marine ecology during construction include sediment release associated with the above construction works and noise from underwater blasting. Potential impacts to water quality from sediment release are listed below:

- increased concentrations of suspended solids (SS);
- a resulting decrease in dissolved oxygen (DO) concentrations; and
- an increase in nutrient concentrations in the water column.

Suspended Solids

Soft corals and anemones may be injured by both high suspended sediment concentration and high deposition rates. Damage (sublethal effects) or mortality (lethal effects) occur as the deposition of sediment onto the organisms surface physically blocks the respiratory and feeding apparatus.

Sessile organisms within the benthos will be susceptible to the effects of increased sediment loads. Effects can be lethal or sublethal (eg reduction in reproductive potential due to stress incurred by constantly having to flush out the depositing material). The effects of sedimentation on organisms will also depend on other factors, such as an organism's tolerance, growth orientation of sessile organisms and water movement.

Based on the prediction that only a small amount of marine deposits are present in the Tsing Lung Tau area and dredging works are restricted to the construction of seawalls at the Toll Plaza between Fa Peng and Tso Wan (see Sections 6.5.3 and 6.5.4), the release of suspended sediment is expected to be negligible.

Sediment testing results showed that sediments to be dredged from the Toll Plaza are uncontaminated (see Section 5). Average Tributyltin (TBT) concentrations in sediments at Tsing Lung Tau and Toll Plaza were 8 and 39 $\mu\text{gSn kg}^{-1}$ respectively. As there is no evaluative criterion for TBT concentration in sediment, the average values were compared with data from a previous Study²⁰. In that study, TBT concentrations in sediments from 26 samples varied greatly from 0.15 to 720 $\mu\text{gSn kg}^{-1}$ in the Rambler Channel. When compared to the Rambler Channel, although the areas at Tsing Lung Tau and Toll Plaza are in close proximity to some of the busiest shipping lanes in Hong Kong, average TBT concentrations (8 and 39 $\mu\text{gSn kg}^{-1}$) are relatively small and thus likely to exert minimal impacts to marine ecology. As inorganic and TBT contaminants are in low concentrations and a minimal amount of suspended sediment will be released from dredging/reclamation, the desorption of heavy metals and TBT from sediments into the surrounding waters is predicted to be negligible.

Section 6.9 concluded that there are no insurmountable water quality impacts associated with either construction or operation phases. Therefore, the water quality impacts should be in compliance with the WQO at the ecological sensitive receivers. The SS elevations are predicted to be low and acceptable to intertidal benthic assemblages, subtidal soft benthos and marine mammals in the Study Area.

Dissolved Oxygen

The relationships between SS originated from construction works and DO are complex, with increased SS in the water column combining with a number of other effects to reduce DO concentrations in water. Elevated SS (and turbidity) reduces light penetration, lowers the rate of photosynthesis of phytoplankton (primary productivity) and thus lowers the rate of oxygen production in the water column. This has a particularly adverse effect on the eggs and larvae of fish, as at these stages of development high levels of oxygen in the water are required for growth due to high metabolic rates. Although respiratory responses and tolerance of hypoxia were studied in two marine fish²¹, it is not possible to set critical thresholds for this parameter for other marine organisms due to lack of tolerance data for species in Hong Kong. DO depletions are most likely to affect sessile organisms as they cannot move away from areas where it is low. As SS release due to the construction works will be minimal, impacts derived from DO depletion are predicted to be negligible and therefore acceptable to intertidal benthic assemblages, subtidal soft benthos and marine mammals in the Study Area.

Nutrients

High levels of nutrients in seawater can cause rapid increases in phytoplankton often to the point where an algal bloom occurs. An intense bloom of algae can lead to sharp decreases in the levels of dissolved oxygen in the water as dead algae fall through the water column and decompose on the bottom. Anoxic conditions may result if DO

²⁰ EVS Consultants (1996) *Classification of Dredged Material for Marine Disposal*. Final Report for the Civil Engineering Department. December 1996

²¹ Wu RSS & Woo NYS (1984). Respiratory Responses and Tolerance to Hypoxia in Two Marine Teleosts, *Epinephelus akaara* (Temminck & Schlegel) and *Mylio macrocephalus* (Basilewsky). *Hydrobiologia* 119: 209-217.

concentrations are already low or are not replenished. This may result in mortality to marine organisms due to oxygen deprivation. As SS release due to the construction works will be minimal, impacts derived from the elevation of nutrients are likely to be negligible and, therefore, acceptable to intertidal benthic assemblages, subtidal soft benthos and marine mammals in the Study Area.

Other Indirect Impacts

The construction of Route 10 (NLYLH) could result in an increase in underwater blasting, piling and marine traffic potentially affecting the Chinese White Dolphin *Sousa chinensis*. Studies have shown that because of the efficient transfer of sound in water, dolphins can detect noises associated with vessels similar to dredgers at distances up to approximately 5 km. Noise disturbance interferes with communication and echolocation pulses which are used for navigation and feeding, leading to behavioural changes. There is evidence suggesting that some cetacean species will minimise their use of areas affected by underwater noise. In addition, increases in marine traffic may disturb normal cetacean movement patterns through potential collision with vessels, increased turbidity generated by propellers and submerged equipment.

Most dolphins can hear within the range of 1-150 kHz though the peak for a variety of species is between 8-90 kHz²². Dredging and large vessel traffic generally results in mostly low frequency noise typically in the range of 0.02-1 kHz²³ which is below the peak range of 8-90 kHz reported for dolphins and therefore, would not likely cause problems. Percussive piling work may be involved in the construction process but only on reclaimed land and will not be used to construct the seawalls. The presence of mud and reclamation fill material will act to dampen noise from percussive piling and prevent any disturbances to the marine environment. Compared to percussive piling work, bore-piling work at Yi Chuen will cause much lower intensity of low frequency noises. These noise impacts are expected to be minimal and therefore acceptable to the few dolphins occurring seasonally in the eastern Lantau waters.

The construction works may cause perturbations to water quality that may potentially impact the fisheries resources in the North Lantau area. *Sousa chinensis* is known to feed on fish species that are abundant in North Lantau waters. These species are generally of low commercial value and are pelagic in nature (Anchovies - Family Engraulidae, Croakers - Family Sciaenidae, Sardines - Family Clupeidae). They are thus likely to be indirectly affected by changes in key water quality parameters (such as SS and DO) arising from the development. A significant deterioration in water quality is likely to cause fish to move out of the impacted area thus interfering with the dolphins normal feeding patterns.

As highlighted in the preceding paragraphs, marine traffic, underwater noise and perturbations to water quality derived from the construction works have the potential to cause *Sousa chinensis* to move away from the Study Area. However, these impacts are expected to be transient (the critical construction activities will last for approximately 6 months) and of low magnitude and therefore acceptable as dolphins

22 Richardson et al (1995). Marine Mammals and Noise. Academic Press.

23 *Ibid.*

will resume their activities in the area once the critical construction activities are complete. Furthermore, as areas near the construction sites are not the preferred locations for the dolphins, these impacts to their activities are likely to be acceptable.

Operational Impacts

During the operational phase, toxic chemicals contained in gasoline oil spilled from vehicles can enter the marine waters via the drainage system and may impact ecological resources. However, the design of the highway and its safety management are expected to prevent such oil spillage from vehicles. It should also be noted that an oil trap is likely to be implemented at locations of potential contamination from oil (eg parking area at Toll Plaza Administration Building Complex) as a preventive measure. As spillage of gasoline oil from vehicles into marine waters is unlikely to occur, its impacts on marine ecology will not be addressed further in this EIA.

7.4.5 Impact Evaluation

The severity of ecological impact associated with the proposed project is considered to be low, with the exception of the Chinese White Dolphin *Sousa chinensis*. An evaluation of the impact in accordance with the TMEIA Annex 8 Table 1 is presented as follows:

- **Habitat Quality:** Small areas covering intertidal and subtidal assemblages of low to medium ecological value will be lost and replaced with artificial seawalls. Soft bottom habitats in the vicinity of the construction sites at the Tsing Lung Bridge North Tower and the Toll Plaza will be perturbed by SS elevations and DO depletion but they are of low ecological value.
- **Species:** Information indicates that no rare species are likely to occur in the areas near Tsing Lung Tau, Tso Wan and Fa Peng. The only ecologically important species recorded periodically in the Study Area is the Chinese White Dolphin.
- **Size:** Intertidal hard substrate assemblages of medium ecological value (160 m natural coastline reclaimed), artificial seawall of low ecological value (160 m artificial coastline reclaimed) and subtidal soft benthos of low ecological value (dredged/reclaimed area of approximately 2.6 hectares) will be directly impacted at Tsing Lung Tau while habitat loss of subtidal soft benthos of low ecological value will occur at the Toll Plaza (dredged/reclaimed area of approximately 5.5 hectares). Based on the small-scale dredging/reclamation works with predicted acceptable SS elevations, the size of the indirectly impacted area is expected to be small. The direct impacts due to underwater blasting are predicted to cover a small area as overpressure of the shock wave will diminish rapidly as an inverse function of the cube of the distance travelled, the indirect impacts (eg noise) will likely affect a larger area.
- **Duration:** Increases in SS levels are expected to be low and temporary (approximately 26-week reclamation at Tsing Lung Tau and 26-week dredging/reclamation at Toll Plaza, see Figure 2.1), and within environmentally acceptable levels (Section 6.9). Underwater blasting will probably be conducted for a period of 8 weeks (only one charge per day) and the direct and indirect impacts are predicted to be intermittent.

- **Reversibility:** Except the habitat loss of the intertidal hard bottom assemblages covering 160 m natural coastline and subtidal soft benthos covering an area of approximately 2.6 hectares near Tsing Lung Tau and subtidal soft bottom assemblages covering an area of approximately 5.5 hectares at the Toll Plaza near Fa Peng and Tso Wan, impact to the benthic communities within the Study Area are expected to be temporary and recolonisation of seawalls at the construction sites is expected to occur after the construction works.
- **Magnitude:** The impacts to the habitats identified will be of low magnitude.

7.4.6 Mitigation Measures

Marine Ecological Resources: General

In accordance with the guidelines in the TM on marine ecology impact assessment the general policy for mitigating impacts to marine ecological resources, in order of priority, are:

Avoidance: Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives.

Minimisation: Unavoidable impacts should be minimised by taking appropriate and practical measures such as constraints on intensity of works operations or timing of works operations.

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.

In general, constraints on controlling impacts to water quality and noise disturbances (see Sections 4 and 6) to within acceptable levels during construction are expected to also control impacts to marine ecology. The following specific measures are to be used to mitigate impacts on marine mammals and intertidal rocky shore at Tsing Lung Tau.

Marine Ecological Resources: Marine Mammals

Direct impacts of underwater blasting²⁴ on the Chinese White Dolphin *Sousa chinensis* have been identified as being of potential concern and the following mitigation measures should be adopted for underwater blasting:

- charges shall be placed in cores within the rock in order that there will be no blast directly into the water. The shock wave pressures will therefore be reduced.
- the installation of an air-bubble curtain created by production of bubbles from a perforated compressed air hose placed on the seabed in the vicinity of the blasting

²⁴ Information on the type and amount of explosives will be provided with reference to the previous Airport Authority projects during the detailed design stage. The preliminary setting is that the maximum charge per day will be 1kg for the east foundation and 5kg for the west foundation, with only 1 charge per day for a maximum of 60 days..

area could mitigate the shock waves²⁵ and noise²⁶ generated from the blast (*Figure 7.16*). The efficiency of the air curtain has been tested with blasts and approximately ten times reduction in shock wave pressures were recorded²⁷. It is therefore likely that the impacts (ie shock wave pressures and underwater noise transmission) due to underwater blasting will be mitigated to acceptable levels.

The surveillance procedures shall be as follows:

- (a) three observers (two on land and one on a small patrolling vessel) shall start looking for marine mammal activity within a 500 m radius of the blast site half an hour prior to blast detonation. Both land observers shall be located where there is an unrestricted view of waters around the blast site. Observers must keep track of radio announcements on the blast (30-minute and 5-minute warnings given);
- (b) small boat patrols within the 500 m zone at 6-8 knots with constant observations being made of the entire area up to and around the 500 m zone. Distance shall be checked with radar or by range finding device;
- (c) if marine mammals are sighted, blasting must be postponed until they have moved outside the 500 m zone;
- (d) after sighting a pod or individual dolphin a survey vessel should follow behind the pod/individual (no closer than 100m) in order to ensure that reports of the dolphins leaving the area are confirmed to be accurate. Blasting shall be postponed until after the marine mammals have cleared the 500m zone. The discovery of one pod/individual dolphin should not preclude a diligent search for other marine mammals present within the 500 m zone. Should further animals be encountered then they should be treated according to the procedure outlined above;
- (e) after the blast and after "all-clear" signal, the observer boat should spend 10 minutes patrolling the 500 m zone to confirm no injured marine mammals are present; and
- (f) The Agriculture and Fisheries Department must agree any changes to this procedure.

The surveillance procedures were successfully adopted as mitigation measures at two areas during the construction of Chek Lap Kok Airport. These mitigation measures should be sufficient and effective to reduce the direct impacts on *Sousa chinensis* to acceptable levels particularly as Tsing Lung Tau is less preferred than the areas around the Airport Platform as a habitat for dolphins.

²⁵ Graves M (1968). Air-bubble Curtain in Sub-aqueous Blasting at Muddy Run. Civil Engineering - ASCE, July 1968, pp 59-61.

²⁶ Wursig B, C R Greene Jr, T A Jefferson (1999). Development of An Air Bubble Curtain to Reduce Underwater Noise of Percussive Piling. Environmental Research 48: 1-15.

²⁷ Graves M (1968) *op cit*.

Other mitigation measures that will be in place to minimise impacts to marine mammals include the following:

- all vessel operators who will be working on the project should be given a briefing, alerting them to the possible presence of marine mammals and the rules of safe vessel operation around marine mammals;
- a policy of no dumping of rubbish, food, oil or chemicals by any of the contractors should be strictly enforced. This should also be covered in the contractor briefing;
- every attempt should be made to minimise the effects of the construction and operation of the Route 10 (NLYLH) on the water quality of the area; and
- as far as possible marine stages of the reclamation works for the Toll Plaza and the blasting works for the Tsing Lung Bridge North Tower should take place in the spring and summer seasons when dolphin density in the area is low.

Marine Ecological Resources: Intertidal and Subtidal Hard Bottom Habitats at Tsing Lung Tau

In order to assist in the post-construction rehabilitation of intertidal and subtidal hard bottom habitat at Tsing Lung Tau it is recommended that a seawall design such as the rubble mound at Chek Lap Kok is used. It has been demonstrated that marine organisms have recolonised such seawalls after construction²⁸. The proposed seawalls will cover a larger area than the impacted 160 m of natural coastline of Tsing Lung Tau (*Figure 7.16*). The potential habitat provided by the total surface area of the rubble mound seawalls is expected to effectively mitigate for the loss of benthic assemblages at the reclaimed site.

7.4.7 Residual Impact

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 impact occurring as a result of construction and operation of the Project is the loss of the intertidal hard bottom assemblages covering 160 m of natural coastline and 160 m of artificial coastline and subtidal soft benthos covering an area of approximately 2.6 hectares near Tsing Lau Tau, and subtidal soft bottom assemblages covering an area of approximately 5.5 hectares at the Toll Plaza near Fa Peng and Tso Wan.

The loss of the intertidal assemblages within the construction sites can be mitigated through the subsequent recolonisation of fauna on the seawalls after construction. The residual impact is considered to be acceptable as the habitat is of low to medium ecological value and only a total area of 8.1 hectares is expected to be impacted.

²⁸ Binnie Consultants Ltd (1997). Chek Lap Kok Qualitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department, December 1997.

7.4.8 Environmental Monitoring & Audit

The monitoring and audit activities designed to detect and mitigate any unacceptable impacts to noise (Section 4) and water quality (Section 6) will also serve to protect against unacceptable direct and indirect impacts to ecologically valuable marine species and habitats. However, it is recommended that monitoring, as outlined in Section 7.4.6, the direct impacts of underwater blasting on *Sousa chinensis* should be carried out as part of the EM&A programme during construction. More detailed information is presented in the EM&A Manual.

7.5 Conclusions

7.5.1 Marine Ecology

A review of existing information supplemented with a summary of the results of a recent intertidal survey near Kwai Shek, Pa Tau Kwu Pak Wan and Yam Tsai Wan undertaken in September 1998 indicate that the Study Area supports intertidal hard surface assemblages and subtidal soft benthos. From the literature review, the Study Area was considered as important to one marine mammal, the Chinese White Dolphin *Sousa chinensis*.

Direct Impacts

Direct impacts will occur through habitat loss in the area that is to be dredged or reclaimed and will affect the soft benthos as well as hard surface assemblages along Tsing Lung Tau, Tso Wan and Fa Peng. However, these assemblages are of low to medium ecological value and the dredging or reclaimed areas are approximately 8.1 hectares, thus the predicted direct impacts are considered to be localised and acceptable. During the construction phase, Chinese White Dolphin *Sousa chinensis* may be susceptible to lethal or sublethal impacts from underwater blasting. Mitigation measures including the use of an air bubble curtain and surveillance procedures are proposed to protect these marine mammals.

Indirect Impacts

Indirect impacts during the construction phase, such as noise from underwater blasting and marine traffic may cause some cetacean species to minimise their use of areas affected by underwater noise. An increase in suspended sediment concentrations and decrease in dissolved oxygen in the water column may impact filter feeders and soft corals living in the intertidal and subtidal habitats. However, these indirect impacts are anticipated to be localised and transient. In addition, any constraints on construction operations recommended to reduce impacts to water quality and noise to acceptable levels are expected to also mitigate for effects on marine ecology.

Residual Impacts

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 impact occurring as a result of construction and operation of the Route 10 (NLYLH) highway is the loss of the intertidal hard bottom

assemblages covering around 160 m natural coastline and 160 m artificial coastline and subtidal benthos covering an area of approximately 2.6 hectares near Tsing Lung Tau, and subtidal soft bottom assemblages covering an area of approximately 5.5 hectares at the Toll Plaza near Fa Peng and Tso Wan.

- For the 160 m natural rocky intertidal shore at Tsing Lung Tau which are of medium value, the loss of the intertidal assemblages within the construction sites can be mitigated through the subsequent recolonisation of fauna on the seawalls after construction. The residual impact is considered to be acceptable as the habitat is of low ecological value and only a total area of 8.1 hectares is expected to be impacted.

EM&A Requirement

The monitoring and audit activities designed to detect and mitigate any unacceptable impacts to noise (Section 4) and water quality (Section 6) will also serve to protect against unacceptable direct and indirect impacts to ecologically valuable marine species and habitats. However, it is recommended that an ecological monitoring as outlined in Section 7.4.6 should be carried out as part of the EM&A programme during Route 10 (NLYLH) construction operations. The monitoring is required to provide feedback to the contractor for the proper operational management in order to ensure the protection of the Chinese White Dolphin *Sousa chinensis*.