

## 10 Ecological Impact

### 10.1 Introduction

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This chapter presents the Ecological Impact Assessment on any direct and indirect potential ecological impacts arising from the construction, operation, restoration and aftercare of the Project. Potential losses, damages, and impacts to flora, fauna and natural habitats, including the aquatic fauna in Lin Ma Hang stream have been mitigated by means of protection, maintenance and rehabilitation of the natural environment. The potential ecological impact on the identified species and habitats was assessed to be minimal and acceptable with the implementation of mitigation measures such as woodland plantation and transplantation of species of conservation value.

The ecological impact assessment has been conducted in accordance with the requirements of Annexes 8 and 16 of the TM-EIAO and the EIA Study Brief for the Project.

### 10.2 Relevant Legislation and Guidelines

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The HKSAR ordinances and regulations relevant to ecological assessment of this Project include the following:

- Forests and Countryside Ordinance (Cap. 96) and its subsidiary legislation, the Forestry Regulations;
- Town Planning Ordinance (Cap. 131);
- Wild Animals Protection Ordinance (Cap. 170);
- Country Parks Ordinance (Cap. 208) and its subsidiary legislation; and
- Environmental Impact Assessment Ordinance ("the EIAO", Cap. 499) and the associated TM (TM-EIAO).

Ecological assessment will also make reference to the following guidelines and standards as well as international conventions:

- Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10, "Conservation";
- Ecological Baseline Survey For Ecological Assessment (EIAO Guidance Note No. 7/2002);
- PELB Technical Circular 1/97 / Works Branch Technical Circular 4/97, "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures";
- Relevant wildlife protection laws in PRC;
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the "Ramsar Convention"), which requires parties to conserve and make wise use of wetland areas, particularly those supporting waterfowl populations;
- United Nations Convention on Biological Diversity, which requires parties to regulate or manage biological resources important for the conservation of biological diversity, to promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
- International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species;

### **10.3 Field Survey Scope and Methodology**

The study area for terrestrial ecological assessment covers all areas within 500 metres of the site boundary of the land based works areas (Project Area), or the area likely to be impacted by the Project. Based on the results of literature review, most of the previous studies covered areas beyond the 500m boundary for the current study, or have been focused on the existing landfill area. Locations of sites and species of conservation importance previously recorded are also outside the current study area. In order to fill this data gap, the field surveys have been focused on the study area (i.e. the Project Area and the area within the 500m of the site boundary (500m-Area)).

The EIA study brief required ecological field surveys of at least 6 months covering wet season to be carried out. An eight-month ecological field survey (covering dry and wet season) was undertaken from March to October 2005 to record ecological data within the study area and establish the ecological profile, for incorporation into the EIA. The ecological survey was completed in October 2005. The flora, fauna and other components of the ecological habitats within the assessment area were examined. In addition to daytime surveys, night time surveys were conducted to record nocturnal fauna including birds, herpetofauna and mammals. Known areas of conservation importance (Lin Ma Hang Stream, Lin Ma Hang Lead Mine SSSI) lie mostly outside the 500m boundary and were covered mainly by literature review, and supplemented by verification surveys. Data analyses and discussions described habitats and species found in the study area, highlighting those that are rare, of conservation importance, or protected by law. Sampling locations of fauna group were included in **Drawing No. 24315/13/701**. Species groups surveyed and the survey methods are described below.

#### **Habitat and Vegetation**

Habitats were mapped (as shown in **Drawing No. 24315/13/702**) based on the latest government aerial photos and field ground truthing. Representative areas of each habitat type were surveyed on foot. Plant species of each habitat type encountered and their relative abundance, with special attention to rare or protected species, were recorded. Colour photographs of all habitats encountered on site and of ecological features of special importance were provided in **Drawing No. 24315/13/703**. Habitat maps of the study area were produced at the required scale using GIS software.

#### **Avifauna**

The birds of selected habitats within the study area were mainly surveyed using the transect count method. Birds within 20 m from the centreline of sampling transects were identified and counted. For birds in habitats occurring as small patches (e.g., woodland, plantation) the point count method was used. Ten minutes were spent counting birds seen or heard within 30 m from the centre of each sampling point. Since some bird species are nocturnal, e.g., owls, nightjars, night surveys were carried out. Bird species encountered outside sampling transects and points but within the study area were also recorded to produce a complete species list. Signs of breeding were recorded. Relative abundance and species richness of birds were computed.

#### **Herpetofauna**

Herpetofauna in the study area were surveyed qualitatively. Both daytime and night time surveys were carried out for herpetofauna. Potential microhabitats of herpetofauna, e.g., litters, rotten logs, were searched. All reptiles and amphibians sighted were recorded. Amphibians were identified by their calls during night surveys.

#### **Non-Volant Mammals**

Mammals in both the study area were surveyed qualitatively. All sightings, tracks, and signs (e.g., scats, footprints, quills) of mammals were recorded, and identified to species as far as possible. Both daytime and night time surveys were carried out.

### **Bats**

Within the study area, bats were surveyed by observations of roosting, flying, or foraging at six point-count stations set at representative habitats (woodlands and riparian zone) during dusk. Abundance data were recorded using two methods. First, bat vocalizations (bat calls) were recorded as files on computer disks using an AnaBat® II Bat Detector (a "detector") linked to an AnaBat zero crossings analysis interface module (ZCAIM) equipped with a compact flash card for data storage. Field data were downloaded from the flash card to a computer for analyses in the office. Second, bats were manually counted whenever the detector indicated bats within its range of sensitivity. The manual counts enable more accurate counting in situations where multiple bats were detected by the detector but the recorded sequence file could not distinguish between them. Species were identified visually. Abundance was indexed as the adjusted number of bat calls or sightings during a 7-minute sampling period at each of 6 sampling points. Adjustments consisted of reconciling the computer record with the manual record, to account for data files that represent more than one bat or multiple calls that represent only one bat. All computer data analyses were carried out using Statistix 7.0® software.

### **Dragonflies and Butterflies**

Dragonflies and butterflies within the study area were surveyed using the transect count or point count method. Dragonflies and butterflies within 10 m from the centreline of sampling transects were identified and counted. When point count method was used, five minutes were spent counting dragonflies and butterflies within 15 m from the centre of each sampling point. Dragonflies and butterflies outside the transects and counting points but within the study area were also recorded in order to produce a complete species list.

### **Aquatic fauna**

Aquatic fauna in channels and stream courses within the study area (e.g. upper tributaries of Lin Ma Hang Stream and Ping Yuen River) were studied. Lin Ma Hang Stream located outside the 500 m boundary area was also visited to verify the information reported in the literature. Sampling methods (including direct observation, focused searching, hand netting) were selected according to the site conditions. Boulders in the stream were overturned to locate aquatic animals beneath if necessary. All encountered organisms were identified to the lowest possible taxon and recorded. Abundance and species richness of aquatic fauna were provided.

## **10.4 Key Ecological Issues**

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Key ecological issues identified during the course of the EIA study include the following.

- Ecologically sensitive areas (**Drawing No. 24315/13/701**):
  - Lin Ma Hang Stream and its catchment;
  - Lin Ma Hang Lead Mines Site of Special Scientific Interest (SSSI);
  - Wo Keng Shan fung shui wood;
  - Robin's Nest Countryside.
- Habitats of conservation interests:
  - woodlands
  - natural stream courses and rivers (e.g. Lin Ma Hang Stream)
- Wildlife groups of conservation interests:
  - vertebrates (e.g. avifauna, mammals including bats, fish, herpetofauna)
  - macroinvertebrates (e.g. butterflies, odonates, crustaceans)

Also, during the public communication meetings some of the Green Groups expressed the importance to preserve the existing trail from Wo Keng Shan Road (near Miu Keng) to Robin's Nest. As explained during these meetings, the proposed landfill extension will not encroach upon this existing trail, nor the main portion of Robin's Nest countryside.

## 10.5 Results of Literature Review

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In accordance with the Study Brief, the ecological baseline shall include the following:

- review and incorporate the findings of relevant studies
- carry out necessary field surveys, the duration of which shall be at least 6 months (covering wet season), and investigation to verify the information collected, fill the information gaps identified and fulfil the objectives of the EIA study
- establish an ecological profile of the study area based on data of relevant previous studies/surveys and results of additional ecological field surveys, and describe the characteristics of each habitat found

The relevant studies include but are not limited to those listed in Section 3.4.8.4 of the EIA Study Brief. These are:

- The on-going EIA study of the Drainage Improvement in Northern New Territories – Package C
- Conservation Recommendations for Fish Communities of Lowland Streams in Hong Kong prepared by Dr. Chan Pui Lok, Bosco and Prof. David Dudgeon.
- Sustainability and biodiversity: the impact, alternative design and prospects of restoration of channelized lowland streams in Hong Kong. (Chan Pui Lok Bosco 2001. Ph. D. Thesis).
- Sustainable Development for the 21st Century (SUSDEV)
- Annual Summary Reports of Terrestrial Monitoring for NENT Landfill Site
- The Pilot Biodiversity Study of the eastern Frontier Closed Area and North East New Territories, Hong Kong, June-December 2003 conducted by Kadoorie Farm and Botanic Garden (KFBG) (2004).
- Final Strategic Environmental Assessment Report on Extension of Existing Landfills and Identification of Potential New Waste Disposal Sites
- Register of Sites of Special Scientific Interest (SSSIs). Loose-leaf document maintained by Planning Department, Hong Kong.
- The Terrestrial Biodiversity Survey conducted by HKU
- Annual report and other publications of The Hong Kong Bird Watching Society
- Memoirs of Hong Kong Natural History Society
- Porcupine! – Newsletter of Department of Ecology & Biodiversity of University of Hong Kong
- Hong Kong Biodiversity - Newsletter of the Department of Agriculture, Fisheries and Conservation

Despite the distance of Lin Ma Hang stream from the study area (mostly beyond the 500m-Area), the study brief requires the potential impacts to the stream and its catchment to be assessed. Lin Ma Hang Stream is a typical lowland freshwater stream and has a rich collection of primary freshwater fish including five rare and uncommon species (Final Strategic Environmental Assessment Report on Extension of Existing Landfills). 15 species of freshwater fish were recorded during a study covering 43 lowland streams in Hong Kong (Chan 2001). The University of Hong Kong has submitted a proposal to the Government in 1999 recommending the designation of Lin Ma Hang stream as an SSSI.

The EIA study brief for the Project highlighted the on-going EIA Study of the Drainage Improvement in Northern New Territories – Package C, which was conducted in 2003-4 and included a 12-month ecology survey. The brief requires incorporation of these survey results into the baseline for the present EIA study.

Kadoorie Farm and Botanic Garden (2004) conducted a biodiversity study on Ling Ma Hang Stream in 2003. During the study, 16 freshwater fish were recorded in the stream, including 2 extremely rare ones (Appendix 10.1). The high species diversity and the healthy and intact fish community confirmed the importance of this stream, and KFBG urged designation of this stream as an SSSI (*ibid.*).

Lin Ma Hang Lead Mines SSSI supports nine bat species (Appendix 10.2) (Shek and Chan 2004) and is one of the most important bat colonies in Hong Kong. The roosting population is 1146 and 898 bats in summer and winter respectively (Shek and Chan 2005). Greater Bent-winged Bat is the most numerous species (81.7% of total bats in summer, 73.3% in winter). All recorded bat species prey on insects that are caught on the wing or are gleaned from vegetation, soil or water. This SSSI is located almost 1 km from the proposed Landfill Extension site. It is unlikely that this SSSI and the nearby riparian foraging areas for the bats would be directly affected by the Project. However, indirect impacts to the bat colonies will be assessed in detail in this study and will include construction noise and potential loss of foraging habitat.

Lin Ma Hang area is well known for its botanical interest. Seven plant species of conservation interest have been recorded at Lin Ma Hang (KFBG 2004, Xing *et al.* 2000). The important wooded ravines and Fung Shui Wood identified so far are located outside the proposed boundary of the Landfill Extension and even beyond the 500 m boundary for the Project. Four rare and one very rare plant species were also recorded in Robin's Nest by the Biodiversity Survey (HKU 2002), but these plants were located at least 2 km away from the proposed landfill extension site. Therefore they are unlikely to be adversely impacted.

Terrestrial fauna in Lin Ma Hang were surveyed between October 2003 and September 2004 during the EIA study of Drainage Improvement in Northern New Territories – Package C. Uncommon/rare fauna species that would utilise stream and wetland habitats included two species of dragonfly (Club-tailed Cruiser *Macromia urania* and Blue Sprite *Pseudagrion microcephalum*) and four species of butterfly (Glassy Bluebottle *Graphium cloanthus*, Small Grass Yellow *Eurema brigitta*, Centaur Oak Blue *Arhopala pseudocentaurus* and Bush Hopper *Ampittia dioscorides*) (*ibid.*).

Some bird species were reported in Robin's Nest by members of The Hong Kong Bird Watching Society between 1996 and 2000. These included Peregrine Falcon *Falco peregrinus*, Collared Scops Owl *Otus bakkamoena*, Oriental Scops Owl *O. sunia* and Savanna Nightjar *Caprimulgus affinis* (Carey *et al.* 1998, 1999, Turnbull *et al.* 2004). Oriental Scops Owl is a scarce migrant in Hong Kong (Carey *et al.* 2001) and is found in areas with scattered trees (Viney *et al.* 2005). Peregrine Falcon is a rare resident, and occurs in a wide range of habitats. Collared Scops Owl is common and widespread in Hong Kong, and mainly occurs in wooded habitats. Savanna Nightjar is an uncommon resident, and is mainly found in hillsides with low vegetation (Carey *et al.* 2001).

The environmental impact assessment and monitoring for the existing landfill described the habitats in the area. Habitats surrounding the existing landfill, other than plantation, are mainly grassland and shrubland. Hillfire disturbance was quite frequent at the site. Species commonly recorded included *Dicranopteris pedata*, *Arundinella setosa*, *Ischaemum spp.*, *Cymbopogon spp.*, and *Panicum sp.* Woody species included *Baeckea frutescens*, *Rhodomyrtus tomentosa*, *Pinus spp.*, *Liquidambar formosana*, and the planted *Acacia mangium* and *Acacia confusa*, *Lophostemon confertus* and *Casuarina equisetifolia* (*ibid.*). Protected species recorded/observed included orchid species such as *Habenaria linguella* (FELT 1999) and *Arundina chinensis* (Cheung, per comm.). The annual monitoring results

showed that the vegetation varied seasonally was of good condition and vegetation cover was high, although some next to the landfill operation site was covered by dust. One exception was *Pinus massoniana*, which was either killed by nematode infection or hillfires. It was concluded that the landfill operation did not cause any adverse impacts on natural establishment of vegetation.

## 10.6 Results of Field Surveys

### 10.6.1 Habitat and vegetation

Major habitats recorded within the study area include natural woodland, plantation, grassland with low shrub, stream, abandoned agricultural fields, and urbanised/disturbed (Drawing No. 24315/13/702 & 703, Table 10.1).

Table 10.1: Habitats recorded within the study area

Habitat	Area (ha)
Natural Woodland	74.18
Plantation Woodland	7.86
Grassland with Low Shrub	155.25
Abandoned Agriculture	12.99
Urbanised/Disturbed	49.84
Stream	2900 m (stream channels inside Project Area) 314 m (channels inside 500m-Area) 250 m (Ping Yuen River inside 500m- Area) 1343 m (Lin Ma Hang Stream inside 500m- Area) 3180 m (Lin Ma Hang Stream outside study area)

In total, 203 plant species were recorded (Appendix 10.3). Seven plant species including 2 trees, 2 shrub, 2 orchid and 1 fern species of conservation interest were recorded within the study area. They were *Aquilaria sinensis*, *Endospermum chinense*, *Rhododendron simsii*, *Pavetta hongkongensis*, *Cibotium barometz*, *Arundina graminifolia* and *Spathoglottis pubescens*.

The tree survey recorded 29 tree species, mostly native. A total of 2,178 trees with diameter at breast height (DBH)>95mm were recorded, 825 of which within the Project area, and 85% of which had a DBH equals to 0.3m or below and the remaining 327 nos. (15%) had a DBH in the range of 0.4m to 0.8m inclusive. The majority of the trees surveyed are young at age and small at size. Trees were mainly recorded in the secondary woodland at northern fringe and a ravine at the centre of the proposed landfill extension.

#### Natural Woodland

Natural Secondary Woodland was mainly located on the hillside of Lin Ma Hang catchment outside the Project area and along major ravines within the Project area. Woodland at Tong To Shan was more mature with a canopy of 12-15m, while woodland within the rest of study area including those within the proposed landfill extension area (Project Area) was relatively younger with a canopy of 5-8m. It was dominated by native pioneer tree species including *Schima superba*, *Machilus chekiangensis*, *Schefflera heptaphylla*, *Cratogeomys cochinchinensis*, *Aporosa dioica*, *Itea chinensis*, and *Castanopsis fissa*. The understory was fairly dense and was composed of a variety of tree, shrub, fern and herb species including *Litsea rotundifolia*, *Psychotria rubra*, *Cibotium barometz*, and *Christella parasitica*.

A total of 117 plant species were recorded in woodland habitat, including two tree species and two shrub species and one fern species of conservation concern. One mature tree of *Endospermum chinense* was recorded in a ravine. It is a tree of restricted distribution in Hong Kong. It is not protected locally or regionally. One mature tree and three seedlings of *Aquilaria sinensis* were seen. It is listed on CITES Appendix II and scheduled under the Protection of Endangered Species of Animals and Plant Ordinance (Cap. 586). It is protected as Category II nationally protected species in China and is listed as vulnerable in

the China Plant Red Data Book and IUCN Red List, but it is quite common in Hong Kong. Two individuals of *Rhododendron simsii* were recorded in the ravines. This is a native shrub commonly found in Hong Kong. The whole genus *Rhododendron* is protected under Forestry Regulations. An individual of *Pavetta hongkongensis* was recorded at Tong To Shan. It is protected under Forestry Regulations but is quite common in Hong Kong. All of these species except *Pavetta hongkongensis* were located within the Project Area. *Cibotium barometz* is a fern as listed on CITES Appendix II and scheduled under the Protection of Endangered Species of Animals and Plant Ordinance (Cap. 586). A few individuals were observed outside the Project Area, and it is commonly recorded in forest and shrubland in Hong Kong.

A fung shui wood was recorded at Wo Keng Shan at the southwest fringe of the study area. It was dominated by *Cinnamomum camphora*, which apparently were planted due to their uniform size and spacing. Other trees recorded include *Dimocarpus longan*, *Ficus microcarpa*, and *Macaranga tanarius*. The plant diversity was low; a total of 15 species was recorded and little understorey was developed.

#### **Plantation Woodland**

Plantation was mainly recorded on the engineering slope along the existing access road inside the landfill and the stockpile area. It was young, about 20 years old, with an 8-12m canopy dominated by exotic species including *Acacia confusa*, *Acacia auriculiformis*, *Acacia mangium*, *Eucalyptus robusta*, *Casuarina equisetifolia*, *Lophostemon conferta* and *Leucaena leucocephala*. The understorey was mostly grassy occasionally with native shrubs and trees including *Neyraudia reynaudiana*, *Bidens pilosa*, *Celtis tetrandra* subsp. *sinensis*, *Macaranga tanarius*, and *Breynia fruticosa*. The plant diversity was low - a total of 43 species with no plant species of conservation concern was recorded in this habitat.

#### **Grassland with Low Shrub**

Grassland with low shrub, probably maintained by hillfires from scattered grave sites, occupied about half of the study area dominating the natural hillside and hydroseeded slope. Major species recorded included *Dicranopteris pedata*, *Neyraudia reynaudiana*, *Rhodomyrtus tomentosa*, *Baeckea frutescens*, and *Rhus chinensis*.

A total of 114 plant species was recorded within the grassland with low shrub habitat, including 2 orchid species of conservation concern. About 10 individuals of *Arundina graminifolia* were found on the engineered slope along the access road to the stockpile area, while about 50 individuals of *Spathoglottis pubescens* were located along the access road to Robin's Nest. While all orchids are protected under the Forestry Regulations, both orchids recorded during the present survey are very common in Hong Kong.

#### **Abandoned Agricultural Field**

Abandoned agricultural field was recorded at Wo Keng Shan and Lin Ma Hang on the southwest and northeast fringe of the study area. It was mainly composed of weedy and grassy species including *Neyraudia reynaudiana*, *Panicum maximum* and *Wedelia trilobata*. A total of 16 species was recorded. No plant species of conservation concern was found.

#### **Urbanised/Disturbed**

The existing landfill site, including the entrance, access road, landfill area, and stockpile area constituted this habitat. Most of the surface was concrete or void of vegetation. This area has little ecological value.

#### **Streams/Channels**

There were channels within the Project Area. The channels included man-made concrete drains and semi-natural channels which were remnants of previous stream courses disturbed during the construction of the existing landfill. Concrete drains were constructed along the boundary of the stockpile area of the existing landfill site. The drains on both sides of the stockpiles then joined a remnant stream course. The remnant stream course ran along the access road and changed into concrete channel near the boundary of the

Project Area. The concrete channel went through a small portion of the study area and finally joined the existing stream courses (Ping Yuen River, see below).

Besides the length of concrete channel originating in the landfill site, there were two major streams within the study area, i.e. Ping Yuen River southwest of the Project Area and Lin Ma Hang northeast of the Project Area. But both streams were completely outside the Project Area.

Ping Yuen River originated on the northwest slope of Wo Keng Shan (to the south of the landfill), and then ran westward, through Ta Kwu Ling area, and finally joined Shenzhen River at HKSAR border near Lo Shue Ling.

Lin Ma Hang originated from several tributaries on the northwest slope of Robin's Nest (Hung Fa Leng). Only one of the Lin Ma Hang tributaries (the most southward) fell within the study area boundary. These tributaries all flowed in a northwest direction and joined near Lin Ma Hang Village. The stream finally joined Shenzhen River to the north of the village.

### 10.6.2 Avifauna

#### Project Area

A total of 16 species was recorded within the Project area during quantitative surveys. The recorded bird community is typical of disturbed areas (e.g., White Wagtail *Motacilla alba*) (Appendix 10.4). Collared Scops Owl *Otus lempiji* was recorded during night surveys. Species richness was low in all habitats within the Project area (Table 10.2). Apart from woodland, bird abundance was low in all habitats. Bird density in woodland was considered medium to high. Apart from an abandoned nest (probably nest of Spotted Dove *Streptopelia chinensis*) in the plantation in the stockpile, there was no sign of breeding within the Project area.

Table 10.2: Bird community of habitats within Project area

Habitat	Urbanised/disturbed	Grassland with low shrub	Plantation	Woodland
Bird density (birds ha <sup>-1</sup> )	4.8	1.8	9.8	27.3
Species richness	5	4	5	5

Grassland with low shrub is the major habitat within the Project area. This type of habitat generally supports low abundance and species richness of birds (Thrower 1984, Dudgeon and Corlett 1994, 2004, Kwok and Dahmer 2002). This may be related to the low food abundance, low concealment and simple habitat complexity (Dudgeon and Corlett 1994).

Woodland and plantation mainly exist as small patches or narrow strips within the Project area. Only the woodland on the southeast corner of the Project area is connected to continuous woodland. The bird species in woodland and plantation within the Project area are those favour open areas, and are basically similar to those in the surrounding grassland with low shrub. No woodland dependent bird species was recorded in woodlands within the Project area. Plantations within the Project area consist mainly of exotic species, which do not bear fruits and have sparse canopies. Hence these plantations are not important foraging and breeding habitats of birds. These plantations are considered of low ecological importance as feeding and nesting habitats for birds.

Bird species of conservation concern within the Project area included Collared Scops Owl and Greater Coucal *Centropus sinensis*. Both are Class 2 Protected Animal of PRC and Collared Scops Owl is listed in Appendix 2 of CITES (Zheng and Wang 1998). Collared Scops Owl and Greater Coucal are common and widespread in Hong Kong (Carey *et al.* 2001). Collared Scops Owl was recorded in roadside plantation near the entry of the NENT Landfill. This species can be found in wooded areas, including plantations and feed mainly on insects and small mammals (e.g., mice, shrews), and is recorded from widespread areas (*ibid.*). Greater Coucal was recorded in grassland in Ngong Tong. This species can be



found in many types of habitats. Greater Coucal has also been observed foraging in refuse (*ibid.*).

#### **500m-Area**

In total, 44 bird species were recorded in the 500m-Area, and were mainly common and widespread in Hong Kong (Appendix 10.5). Significant observations were the recording of woodland dependent species (Emerald Dove *Chalcophaps indica*, Grey-chinned Minivet *Pericrocotus solaris* and Chestnut Bulbul *Hemixos castanonotus*) in woodland on south of Tong To Shan Tsuen. These species are mainly found in large old woodlands in Hong Kong (Carey *et al.* 2001).

Bird species of conservation concern within the 500m-Area included Black Kite *Milvus lineatus*, Emerald Dove, Greater Coucal and Collared Scops Owl. Black Kite and Collared Scops Owl are Class 2 Protected Animal of PRC and listed in Appendix 2 of CITES (Zheng and Wang 1998). Greater Coucal is Class 2 Protected Animal of PRC. Black Kite and Greater Coucal are common and widespread in Hong Kong, and can be found in many types of habitats (Carey *et al.* 2001). Emerald Dove is rare in Hong Kong, and mainly found in well-wooded area (*ibid.*). Collared Scops Owl can be found in many types of wooded areas, including plantations (*ibid.*).

Black Kites were recorded at the existing landfill. Emerald Dove was observed in woodland south of Tong To Shan Tsuen. Collared Scops Owl was recorded in roadside plantation near the entry of the NENT Landfill. Greater Coucals were found in abandoned agriculture in Lin Ma Hang and Wo Keng Shan.

### **10.6.3 Herpetofauna**

#### **Project Area**

Only one species of amphibian was recorded within the Project area. This was the Brown Tree Frog *Polypedates megacephalus*. Both eggs and adults were recorded. This species is common in Hong Kong (Chan *et al.* 2005).

Three species of reptiles were recorded within the Project area. These were the Changeable Lizard *Calotes versicolor*, Long-tailed Skink *Mabuya longicaudata* and Taiwan Kukri Snake *Oligodon formosanus*. Changeable Lizard and Long-tailed Skink are common and widespread in Hong Kong (Karsen *et al.* 1986). Taiwan Kukri Snake is not common but widespread in Hong Kong. This species inhabits a wide range of habitats, including dry and wet ones (*ibid.*). These include grassland, shrubland, woodland and wet cultivation. Taiwan Kukri Snake was found in plantation near the stockpile.

#### **500m-Area**

Five species of amphibian were recorded within the 500m-Area. These were Asian Common Toad *Bufo melanostictus*, Brown Tree Frog, Gunther's Frog *Rana guentheri*, Paddy Frog *Fejervarya limnocharis* and Chinese Bullfrog *Hoplobatrachus chinensis*. All are common in Hong Kong (Chan *et al.* 2005).

Chinese Bullfrog is of conservation concern. This species is a Class 2 Protected Animal of PRC (Zhao 1998). Chinese Bullfrog was recorded in Lin Ma Hang Stream.

Four species of reptile were recorded within the 500m-Area. These were Red-eared Slider *Trachemys scripta*, Changeable Lizard, Chinese Skink *Eumeces chinensis* and Long-tailed Skink. All are common in Hong Kong. Red-eared Slider is an exotic species (Karsen *et al.* 1986).

### **10.6.4 Non-Volant Mammals**

#### **Project Area**

A probable den of Wild Boar *Sus scrofa* was recorded in area immediate outside the existing landfill. Wild Boar is recorded in grassy-shrubland and forest in widespread localities in Hong Kong. This was the only sign of non-volant mammal in the Project area.

**500m-Area**

No other non-volant mammals were recorded within the 500m-Area.

**10.6.5 Bats****Project Area**

Three species, namely, Japanese Pipistrelle *Pipistrellus abramus*, Himalayan Roundleaf Bat *Hipposideros armiger*, and Leschenault's Rousette *Rousettus leschenaultii* were recorded in the Project area. Japanese Pipistrelle was the most numerous species. All are widespread and common in Hong Kong (Shek and Chan 2005, 2006) and common in Mainland China (Zhang 1997). Total numbers of calls-sightings were similar in March and October 2005 (Table 10.3). In both months the total was approximately one fourth of the August total of 144. This probably reflects the seasonal differences in nocturnal insect activity, which causes seasonal changes in bat activity. In colder months bat numbers are typically lower than in the warmer months.

**Table 10.3 : Bat calls and sightings recorded by species at NENT Landfill in 2005**

Date	Site No.	Start Time	End Time	No.	Pipabr	Hiparm	Roules
19-Mar-05	6	1855	1902	0			
	1	1912	1919	5	5		
	2	1923	1930	7	7		
	3	1935	1942	9	9		
	4	1945	1952	8	6	2	
	5	2000	2007	11	10	1	
<b>Survey totals</b>				<b>40</b>	<b>37</b>	<b>3</b>	<b>0</b>
24-Aug-05	6	1830	1837	0			
	1	1845	1852	1		1	
	2	1855	1902	55	35		20
	3	1907	1914	21	21		
	4	1915	1922	28	27		1
	5	1926	1933	39	33	4	2
<b>Survey totals</b>				<b>144</b>	<b>116</b>	<b>5</b>	<b>23</b>
12-Oct-05	6	1840	1847	2	2		
	1	1853	1900	2	2		
	2	1904	1911	5	5		
	3	1913	1920	23	14	9	
	4	1924	1931	3	3		
	5	1933	1940	1	1		
<b>Survey totals</b>				<b>36</b>	<b>27</b>	<b>9</b>	<b>0</b>

\* Pipabr = Japanese Pipistrelle *Pipistrellus abramus*; Hiparm = Himalayan Roundleaf Bat *Hipposideros armiger*; and Roules = Leschenault's Rousette *Rousettus leschenaultii*

In two of the three survey periods, sampling Station 3 had the greatest number of bats. Station 3 is a valley location with a perennial stream (the remnant stream course within the Project Area) to the west and a wooded hillside to the east. This site has produced the only records of insectivorous bats, which were abundant in August, but not so in March or October.

Japanese Pipistrelle and Himalayan Roundleaf Bat are insectivorous, while Leschenault's Rousette is frugivorous. Most of the Hong Kong bats use mines and water tunnels as roost sites, as natural roosts such as inland cave or mature forests are lacking (Ades 1994). Water tunnel, mine or big tree is absent within the proposed extension site. Therefore, bats are thought to forage on the proposed extension site but roost elsewhere, probably in nearby woodlands or in the abandoned lead mine at Lin Ma Hang.

Foraging habitats preferred by bats in Hong Kong included 1) riparian vegetation on stream bank and open water bodies (reservoirs, fishponds); 2) woodland edge (boundary with grassland shrub and abandoned agricultural lands); and 3) agricultural lands (Ades and Reels 1998).

The major vegetation cover within the Project area is grassland with low shrub, which probably supports low insect abundance. Water in the remnant stream course near Station 3 is contaminated and may not provide suitable habitat for nocturnal flying insects, mainly mosquito, which in turn are food base of insectivorous bats. The interface of grassland with low shrub and natural woodland along the ridge of Wong Mau Hang Shan may provide foraging habitat to bats. Bats can fly more easily above the open space above short vegetation cover and prey on insects flying out from woodlands. The woodland on the east slope of Wong Mau Hang Shan will not be affected by the Project.

Kendrick (1998) stated that insect abundance in agricultural lands is higher than in adjacent woodland or shrubland habitats. The abandoned agricultural lands in Wo Keng Shan, Ping Yeung and Lin Ma Hang are therefore considered important foraging habitats of insectivorous bats.

#### Outside the Study Area

A visit to Lin Ma Hang Lead Mine SSSI was made in September 2005. Bat species including Horseshoe Bats *Rhinolophus spp.* were observed inside the cave. The SSSI is still actively used as bat roosts during the survey.

### 10.6.6 Dragonflies and Butterflies

#### Project Area

There was no record of dragonfly in grassland, plantation and woodland. Twelve Wandering Gliders *Pantala flavescens* were recorded in urbanised/disturbed areas in the stockpile. In total, 11 species of dragonfly were recorded in streams/nullahs in the Project area (Appendix 10.6). All recorded species are common and widespread in Hong Kong (Wilson 2004). Abundance and species richness of dragonfly were low in the Project area, as most aquatic habitats are channelised and with simple habitat structure. These aquatic habitats were also contaminated/silted to certain degree, and their value as dragonfly habitat is low.

A total of 24 species of butterfly were recorded in the Project area (Appendix 10.7). Most recorded species are common and widespread in Hong Kong (Yiu 2004). Species richness of butterfly was low in all surveyed habitats within the Project area (Table 10.4). Abundance was low in urbanised/disturbed and grassland with low shrub and medium in plantation and woodland.

The butterfly species of conservation concern was Yellow Coster *Acraea issoria*. This species is very rare in Hong Kong (Yiu 2004). Yellow Coster was recorded at grassland at the Project area near Shek Tsai Ha. This species is only recorded in a few localities in Hong Kong, and is usually found in areas with their larval foodplant *Boehmeria nivea* and Hairy Gonostegia *Gonostegia hirta* (Bascombe *et al.* 1999). The larval foodplant of Yellow Coster were not found within the Project area. The habitat of Yellow Coster is dry abandoned agricultural land, which is not found within the Project area.

Table 10.4 : Butterfly community of habitats within Project area

Habitat	Urbanised/ disturbed	Grassland with low shrub	Plantation	Woodland
Butterfly density (butterflies ha <sup>-1</sup> )	6.5	17.1	45	60
Species richness	4	8	8	13

### 500m-Area

A total of 22 species of dragonfly was recorded in the 500m-Area (Appendix 10.8). All recorded species are common and widespread in Hong Kong (Wilson 2004).

A total of 32 species of butterfly was recorded in the 500m-Area (Appendix 10.9). Most recorded species are common and widespread in Hong Kong (Yiu 2004). Three uncommon species were recorded at the woodlands near Tong To Shan Tsuen. These were Bush Hopper *Ampittia dioscorides*, Banded Awl *Hasora chromus* and Chestnut Bob *Iambrix salsala*. All were recorded at abandoned cultivated lands in Lin Ma Hang.

#### 10.6.7 Aquatic fauna

##### Project Area

While the concrete drains in the stockpile area were not suitable for the establishment of aquatic fauna due to the transient flows, the water in the semi-natural stream remnant was of deep brown colour, possibly due to the geological nature of the nearby soil. No aquatic fauna was recorded in these watercourses (concrete drains and stream remnant) and they had little ecological value.

On the cut slopes along the access road connecting the stockpile area, there were some rocky ditches on the slopes intercepted by concrete channels. Atyid shrimp *Caridina cantonensis* and Freshwater crab *Somanniathelphusa zanklon* were found in these ditches.

All the three species of freshwater crabs found in Hong Kong are endemic. *Somanniathelphusa zanklon* is typical of lowland habitats (Dudgeon and Corlett 1994). They forage in rice fields, irrigation ditches, flooded furrows and slow-flowing stream and rivers. The crabs prey on a wide range of food including freshwater snails (*ibid.*). They are considered of global concern by some local ecologists (Fellowes *et al.* 2001).

The first two pereopods (walking legs) of atyid shrimp are chelate and are characterized by well-developed tufts of setae for the collection of food. In Hong Kong four species of this genus have been reported, namely, *Caridina cantonensis*, *C. apodosis*, *Caridina trifasciata* and *C. serrata* (Yam 2003). They are detritivores feeding mainly on leaf litter from riparian vegetation. Members of this genus are usually found in mountain streams with clean water. Among the four species, *Caridina cantonensis* is the most common and widespread in Hong Kong.

No fish fauna was recorded in the concrete drains, stream remnant nor the rocky ditches within the Project area during the field survey.

##### 500m-Area

A length of concrete channel went through the site office area of the landfill within the study area. This channel drained the drains and stream remnant within the Project area and connected to Ping Yuen River.

During the April, the section of Ping Yuen River within the study area has running water but low flow with little aquatic fauna recorded. Four species of freshwater snails were found in Ping Yuen River and the adjacent agricultural lands, i.e. *Sinotaia quadrata*, *Melanoides tuberculata*, *Radix plicatulus* and Apple Snail *Pomacea lineata* (Table 10.5). They are not considered of conservation importance, while Apple Snail is an agricultural pest. *Sinotaia quadrata* and *Melanoides tuberculata* are native prosobranch freshwater snails, while *Radix plicatulus* is a pulmonate snail. Apple Snail originates from South America. It was first introduced into China as a pond culture species, but has become naturalised. In Hong Kong, there is no rearing of this snail and they are not taken as food. *Pomacea lineata* are considered an agricultural pest known to damage vegetables. None of these snails is of special conservation concern.

Greater flow volume was found in Ping Yuen River during the July survey. Three species of common exotic fish species, i.e. Mosquito Fish, Guppy and Swordtail were found.

Freshwater crab *Somanniathelphusa zanklon* and Atyid shrimp *Caridina cantonensis* were also recorded. *Somanniathelphusa zanklon*, as mentioned above, is considered of global concern by some local ecologists (Fellowes et al. 2001).

Upstream reaches of the Lin Ma Hang Stream (including the most southward tributary which fall within the study area boundary) did not have surface flow during the March survey.

Though there was more surface flow in the Ling Ma Hang village during May 2005, the majority of the upstream reaches of the Lin Ma Hang Stream was still dry or had only very limited surface flow. No aquatic fauna was recorded in this tributary.

Table 10.5: Aquatic fauna species of Ping Yuen River

No.	Scientific Name	Common Name	Rarity*
Fish	<i>Gambusia affinis affinis</i>	Mosquito Fish	Common
	<i>Poecilia reticulata</i>	Guppy	Common
	<i>Xiphophorus hellerii</i>	Swordtail	Common
Snail	<i>Sinotaia quadrata</i> ,	Snail	
	<i>Melanoides tuberculata</i> ,	Snail	
	<i>Radix sp.</i>	Snail	
	<i>Pomacea lineate</i> .	Apple Snail	
Crustacea	<i>Somanniathelphusa zanklon</i>	Freshwater crab	
	<i>Caridina cantonensis</i>	Atyid shrimp	

#### Outside the Study Area

The majority of Lin Ma Hang Stream was outside the study area boundary. Its tributaries joined in the lowland area near the Lin Ma Hang Village.

Lin Ma Hang Stream was studied previously in a biodiversity study by the Kadoorie Farm and Botanic Garden in 2003. During the study, 16 freshwater fish were recorded in the stream, including 2 extremely rare species *Mastacemblus armatus* and *Rasbora steineri* (Appendix 10.1). The high species diversity and the healthy and intact fish community confirmed the importance of this stream, and KFBG urged designation of this stream as an SSSI (KFBG 2004).

No field survey in Lin Ma Hang Stream was conducted for the EIA study on the Drainage Improvement in Northern New Territories – Package C

During the field survey conducted for this EIA study, 15 species of freshwater fishes were recorded in the lowland sections of the Ling Ma Hang Stream (Table 10.6). Among them, Mud Carp *Cirrhinus molitorella*, Common Carp *Cyprinus carpio*, Guppy *Poecilia reticulata*, and Tilapia *Oreochromis mossambicus* were not recorded in the previous surveys conducted by KFBG (2004). Both Mud Carp and Common Carp typically occur in large numbers in reservoirs and fishponds, but are not common in streams. Guppy and Tilapia are originally exotic species but now widespread and breed in local water bodies. The previously recorded rare fish Chinese Rasbora *Rasbora steineri* was also found during the survey.

Freshwater crab *Cryptopotamon anacoluthon* and Atyid shrimp *Caridina cantonensis* were also recorded in the lowland section of Ling Ma Hang Stream. Among the three freshwater crabs in Hong Kong, *Cryptopotamon anacoluthon* is most common, and usually more abundant than the other two species. Although relatively common and widespread in Hong Kong, *Cryptopotamon anacoluthon* is considered of potential global concern by some local ecologists (Fellowes et al. 2001).

Table 10.6 : Freshwater fish species of Lin Ma Hang Stream

No.	Scientific Name	Common Name	Rarity*
Fish			
1	<i>Anguilla japonica</i>	Japanese Eel	Uncommon
2	<i>Carassius auratus</i>	Goldfish	Not common
3	<i>Cirrhinus molitorella</i>	Mud Carp	Not common
4	<i>Cyprinus carpio</i>	Common Carp	Not common
5	<i>Gambusia affinis affinis</i>	Mosquito Fish	Common
6	<i>Hemiculter leucisculus</i>	Wild Carp	Uncommon
7	<i>Misgurnus anguillicaudatus</i>	Oriental Weatherfish	Common
8	<i>Nicholsocypris normalis</i>		Common
9	<i>Parazacco spilurus</i>	Predaceous Chub	Common
10	<i>Poecilia reticulata</i>	Guppy	Common
11	<i>Pterocryptis cochinchinensis</i>	Vietnam Catfish	Common
12	<i>Rasbora steineri</i>	Chinese Rasbora	Rare
13	<i>Rhinogobius duospilus</i>		Common
14	<i>Schistura fasciolata</i>	Striped Loach	Common
15	<i>Oreochromis mossambicus</i>	Tilapia	Common
Crustacea			
16	<i>Cryptopotamon anacoluthon</i>	Freshwater crab	
17	<i>Caridina cantonensis</i>	Atyid shrimp	

\* Follow AFCD 2004.

### 10.7 Evaluation of Habitats and Species

The ecological importance of the habitats within the study area was evaluated in accordance with the criteria stipulated in Annex 8 of EIAO TM.

Table 10.7: Evaluation of natural woodland habitat within the study area

Criterion	Description
Naturalness	Natural habitat
Size	74.18 ha
Diversity	Moderate plant diversity. Low fauna diversity.
Rarity	<i>Endospermum chinense</i> (locally restricted), <i>Rhododendron simsii</i> and <i>Pavetta hongkongensis</i> (locally protected but common), <i>Aquilaria sinensis</i> (protected locally and in China but common in Hong Kong), <i>Cibotrium barometz</i> (protected locally and in China but very common in Hong Kong). No rare terrestrial fauna recorded.
Re-creatability	Difficult to recreate and takes time to mature
Fragmentation	Continuous patch in Lin Ma Hang and scattered along ravines on other hillslopes
Ecological linkage	Linked to Lin Ma Hang Stream
Potential value	High with protection
Nursery/breeding ground	No significant record, but can provide breeding habitats for birds, reptiles and butterflies
Age	More mature at Tong To Shan and Wo Keng Shan, relative younger within the Project Area and elsewhere
Abundance/richness of wildlife	Medium to high bird abundance, low butterfly abundance
Overall ecological value	Moderate to high

**Table 10.8: Evaluation of plantation woodland habitat within the study area**

Criterion	Description
Naturalness	Man made (planted) with some natural colonisation
Size	7.86 ha
Diversity	Low fauna diversity
Rarity	No rare species recorded
Re-creatability	Easy to recreate
Fragmentation	Formed thin belts on engineering slopes
Ecological linkage	Not functionally linked to habitats of conservation importance
Potential value	Moderate with active management including thinning and interplant with native species
Nursery/breeding ground	No significant record. Value as breeding habitat for terrestrial fauna is low due to sparse canopy and made up of exotic tree species.
Age	Young, probably about 20 years.
Abundance/richness of wildlife	Low avifauna abundance, medium butterfly abundance
Overall ecological value	Low

**Table 10.9: Evaluation of grassland with low shrub habitat within the study area**

Criterion	Description
Naturalness	Natural but frequently disturbed by fire
Size	155.25 ha
Diversity	Low fauna diversity
Rarity	Two protected but common orchids ( <i>Spathoglottis pubescens</i> and <i>Arundina graminifolia</i> ) A very rare butterfly Yellow Coster
Re-creatability	Maintained by hillfire
Fragmentation	Continuous stands on hillsides
Ecological linkage	Not functionally linked to habitats of conservation importance
Potential value	Low due to presence of grave sites
Nursery/breeding ground	No significant record. Value as breeding habitat for terrestrial fauna is low due to high level of disturbance and low vegetation cover
Age	N/A
Abundance/richness of wildlife	Low fauna abundance
Overall ecological value	Low

**Table 10.10: Evaluation of stream/channel habitat within and outside the study area**

Criterion	Description		
	Within the Project area	Within the study area	Outside the study area
Naturalness	Channels inside landfill were man-made or semi-natural but disturbed.	Include both artificial (the concrete channel near the landfill site office) and natural (Ping Yuen River and the most southward tributary of Lin Ma Hang Stream) watercourses.	Lower reach of stream near Shenzhen River was highly modified, upper reach was fairly natural.
Size	2,900 m (stream remnant and channels inside existing landfill)	314 m (Concrete channel) 250 m (Ping Yuen River) 1343 m (Lin Ma Hang Stream tributary)	3180 m (Lin Ma Hang Stream outside study area)
Diversity	Low within the Project area and the study area.	Moderate within the study area	High (15 spp. of freshwater fish, and two spp. of crustaceans) in Lin Ma Hang Stream which is outside the study area boundary.

Criterion	Description		
Rarity	The habitat type is not rare in Hong Kong. No rare aquatic fauna was recorded.		One rare fish was found.
Re-creatability	Re-creatable		Not re-creatable
Fragmentation	N/A		
Ecological linkage	No fauna was found in the semi-natural stream remnant during the field surveys. Only hydrologically connected to Ping Yuen River, but no special ecological linkage was identified.	The concrete channel hydrologically connects the Ping Yuen River with the stream remnant and channels inside existing landfill. The upstream part of Lin Ma Hang joins the downstream part outside the study area and ecologically connected (maintaining a complete stream profile from upstream to downstream).	Received water flow from the upstream section within the study area. With riparian habitats in the vicinity.
Potential value	Low for the channels within the Project area	Low for the stream courses within the study area.	Moderate for Lin Ma Hang Stream
Nursery/breeding ground	No nursery/breeding ground of special value was identified, but streams/channels can provide breeding habitats for dragonflies and amphibians.		
Age	N/A		
Abundance/richness of wildlife	Low within the Project area.	Moderate in the study area.	High in Lin Ma Hang Stream outside the study area
Overall ecological value	Low within the Project area.	Moderate in the study area.	High in Lin Ma Hang Stream.

**Table 10.11: Evaluation of abandoned agricultural fields habitat within the study area**

Criterion	Description
Naturalness	Highly modified by human
Size	12.99 ha
Diversity	Low for flora and fauna
Rarity	No rare species recorded
Re-creatability	Easy to recreate
Fragmentation	Small stands near villages
Ecological linkage	Not functionally linked to habitats of conservation importance
Potential value	Low to moderate, may convert to shrubland /woodland through natural succession over time.
Nursery/breeding ground	No significant record.
Age	Young
Abundance/richness of wildlife	Low fauna abundance
Overall ecological value	Low



**Table 10.12: Evaluation of urbanised/disturbed habitat within the study area**

Criterion	Description
Naturalness	Man made habitat
Size	49.84 ha
Diversity	Low fauna diversity
Rarity	No rare terrestrial fauna recorded
Re-creatability	Easy to recreate
Fragmentation	None
Ecological linkage	Not functionally linked to habitats of conservation importance
Potential value	Low
Nursery/breeding ground	No significant record. Value as breeding habitat for terrestrial fauna is low due to high level of disturbance and low vegetation cover
Age	N/A
Abundance/richness of wildlife	Low fauna abundance
Overall ecological value	Low

In accordance with Table 3, Annex 8 of the EIAO-TM, the ecological value of species was assessed in terms of protection status (e.g. fauna protected under WAPO (except birds), and flora and fauna protected under regional/global legislations/conventions), species distribution (e.g. endemic), and rarity (e.g. rare or restricted). The list and evaluation of the flora and faunal species of conservation concern recorded within the study area, according to the TM-EIAO, are given in Tables 10.13 and 10.14.

**Table 10.13: Evaluation of floral species of conservation importance within the study area**

Common name	Scientific name	Locations	Protection status	Distribution	Rarity
Incense Tree	<i>Aquilaria sinensis</i>	In woodland within the Project area	Protected under Protection of Endangered Species of Animals and Plant Ordinance, CITES Appendix II, Category II nationally protected species in China and is listed as vulnerable in the China Plant Red Data Book and by IUCN (2002).	Lowland forests and fung shui woods	Locally common
Endospermum	<i>Endospermum chinense</i>	In woodland within the Project area	Not protected	Lowland forests and fung shui woods	Restricted
Red Azalea	<i>Rhododendron simsii</i>	In woodland fringe within the Project area	Protected under Forestry Regulations	Shrubland and woodland	Very common
Pavetta	<i>Pavetta hongkongensis</i>	In woodland fringe outside the Project area	Protected under Forestry Regulations	fung shui woods and lowland forest	Common
Lamb of Tartary	<i>Cibotium barometz</i>	In woodland outside the Project Area	Protected under Protection of Endangered Species of Animals and Plant Ordinance, also in Appendix II of CITES	Forest and shrubland	Very Common
Bamboo Orchid	<i>Arundina graminifolia</i>	Grassland within the Project area	Protected under Forestry Regulations	grassland and streamsid es	Very common
Buttercup Orchid	<i>Spathoglottis pubescens</i>	Grassland outside the Project area	Protected under Forestry Regulations	grassland	Very common

Table 10.14: Evaluation of faunal species of conservation importance within the study area

Common name	Locations	Protection status	Distribution	Rarity
Japanese Pipistrelle <i>Pipistrellus abramus</i>	Urbanised/disturbed within the Project area	Wild Animals Protection Ordinance (Cap 170)	Widely distributed in Hong Kong,	Common in Hong Kong
Himalayan Roundleaf Bat <i>Hipposideros armiger</i>	Existing landfill within the Project area	Wild Animals Protection Ordinance (Cap 170)	Widely distributed in Hong Kong.	Common in Hong Kong
Leschenault's Rousette <i>Rousettus leschenaultii</i>	Existing landfill within the Project area	Wild Animals Protection Ordinance (Cap 170)	Widely distributed in Hong Kong.	Common in Hong Kong
Black Kite <i>Milvus lineatus</i>	Existing landfill within the study area	Wild Animals Protection Ordinance (Cap 170); Class 2 Protected Animal of PRC; Appendix 2 of CITES	Widely distributed in Hong Kong	Common in Hong Kong
Collared Scops Owl <i>Otus lempiji</i>	Roadside plantations within Project area and near the entry of NENT Landfill	Wild Animals Protection Ordinance (Cap 170); Class 2 Protected Animal of PRC; Appendix 2 of CITES	Widely distributed in Hong Kong	Common in Hong Kong
Emerald Dove <i>Chalcophaps indica</i>	Woodland near Tong To Shan Tsuen within the study area	Wild Animals Protection Ordinance (Cap 170)	Widely distributed in Hong Kong, occurs in well-wooded areas	Rare
Greater Coucal <i>Centropus sinensis</i>	Shrubland in Ngong Tong within the Project area	Wild Animals Protection Ordinance (Cap 170); Class 2 Protected Animal of PRC	Widely distributed in Hong Kong, occurs in many types of habitats	Common
Chinese Bullfrog <i>Hoplobatrachus chinensis</i>	Lowland section of Lin Ma Hang Stream	Class 2 Protected Animal of PRC	Widely distributed in Hong Kong, occurs in lowland wetlands	Common
Yellow Coster <i>Acraea issoria</i>	Grassland at Shek Tsai Ha within the Project area	Not protected	Only found in a few localities in Hong Kong	Very rare
Freshwater crab <i>Somanniathelphusa zanklon</i>	Ditches on slopes inside the Project area and Ping Yuen River	Not protected	Widely distributed in Hong Kong.	Common
*Freshwater crab <i>Cryptopotamon anacoluthon</i>	Lowland section of Lin Ma Hang Stream	Not protected	Widely distributed in Hong Kong.	Common
*Chinese Rasbora <i>Rasbora steineri</i>	Lowland section of Lin Ma Hang Stream	Not protected	North District and Kam Tin	Rare

\* Recorded outside the study area.

## 10.8 Impact Identification and Evaluation

A detailed comparison of the ecological benefits and dis-benefits of all possible extension areas was made in the early stage of this EIA study (e.g. Value Management and the Option Assessment) and the results were summarised in Section 2 of this report, which recommended Option 4 as the preferred extension area to avoid adverse environmental impact to the maximum practicable extent. In particular, consideration was given to avoid or minimize the disturbance to the ecosystems in the adjacent areas including the Lin Ma Hang Stream and Robin's Nest.

The potential terrestrial and aquatic ecological impacts arising from the construction works of the preferred option, including loss of habitats, removal of vegetation, and disturbance to animals were quantitatively assessed in accordance with Annexes 8 and 16 of the TM-EIAO. Particular attention was paid to the following:

- Habitat loss & removal of vegetation
- Disturbance to wildlife.
- Impacts on aquatic fauna due to changes in water qualities, hydrodynamics properties, sedimentation rates and patterns, and hydrology.
- Impacts to hydrodynamic regime of the Lin Ma Hang Stream and its associated water system in the catchment area and aquatic life during the construction and operation stages;
- Impacts to the aquatic life due to the accidental leakage of leachate and/or other wastewater;
- Impacts to the wildlife due to the accidental leakage of landfill gas;
- Impacts of habitat loss in the Robin's Nest and wildlife therein due to the Project;
- Impacts to the bats inhabiting in the nearby Lin Ma Hang Lead Mines because of loss of foraging ground due to the Project; and
- Cumulative impacts due to other proposed development projects in the vicinity for example, the proposed drainage improvement work.

### 10.8.1 During Excavation and Landfill Operation Recognised Sites of Conservation Importance

Among all the recognised sites of conservation importance within and in the vicinity of the study area, none will be directly impacted. Lin Ma Hang Lead Mines SSSI is located about 1km from the proposed landfill extension and therefore will not be affected by the Project. Lin Ma Hang Stream and its catchment would be completely avoided by Option 4 and therefore would not be affected. There will be no reduction in surface flow or change in ground water level at Ling Ma Hang Stream.

Option 4 would encroach the Robin's Nest countryside at the eastern corner of the proposed extension, which is also part of the existing landfill. The impact of loss of habitats as a whole, including the Robin's Nest countryside is assessed below.

#### Habitats and Vegetation

Option 4 would avoid key area of Tong To Shan Archaeological Site (TTSAS) and therefore avoid encroachment to the Lin Ma Hang natural woodland (and also the Lin Ma Hang Stream catchment).

The direct ecological impact of excavation and landfill operation would be loss of habitats. Option 4 would cause losses of 4.01 ha of native woodland, 47.64 ha of grassland with low shrub, 4.76 ha of plantation, 0.12 ha of abandoned agriculture, 6.89 ha of urbanised/disturbed and 2,530m of stream/channel habitat (including 1820m of concrete channel, 2 ditches of 256m and 84m, and a section of natural stream remanant of 370m).

Most of the habitat losses will occur within the existing NENT Landfill boundary (Table 10.15). Loss or disturbance to these habitats within the existing NENT Landfill boundary (e.g. the native woodland at the eastern end of the proposed extension boundary) had been taken into account during the planning and establishment of the existing NENT Landfill, and mitigation measures proposed for this Project would also cover the loss of habitats within the existing landfill boundary.

Table 10.15: Habitat loss due to Landfill Extension

Habitat type	Total	Within NENT Landfill boundary		Caused by Option 4	
	Area (ha)	Area (ha)	Percentage of total loss (%)	Area (ha)	Percentage of total loss (%)
Abandoned Agriculture	0.12	0.01	8.3	0.11	92.7
Grassland with low shrub	47.64	20.95	44.0	26.69	56.0
Natural Woodland	4.01*	2.56	63.8	1.45	36.2
Plantation Woodland	4.76	4.76	100.0	0	0
Urbanised/Disturbed	6.89	6.88	99.9	0.01	0.1
Total	63.42	35.16	-	28.26	
Stream/channel** (length)	2,530m	1,735m	68.5	795m	31.5

\* Only (4.01 – 2.56≈) 1.5ha loss of natural woodland. The 2.56 ha within existing landfill boundary will be disturbed by the stockpile activities anyway.

\*\*including 1820m of concrete channel, 2 ditches of 256m and 84m, and a section of natural stream remanant of 370m.

Amongst the 4.01ha of woodland to be encroached, 2.56ha would fall within the existing NENT Landfill Boundary while 1.45ha falling outside the existing NENT Landfill Boundary would be affected due to the NENT Landfill Extension Project.

According to Table 10.7, these woodland patches to be lost are of moderate ecological values. Compared to the woodland at Tong To Shan and Lin Ma Hang catchment, most of the natural woodland to be lost is relatively younger in age but also has moderate plant diversity. It supports four species of flora of conservation importance (including *Aquilaria sinensis*, *Rhododendron simsii*, *Endospermum chinense*, and *Arundina graminifolia*), 2 bird species (Collared Scops Owl and Greater Coucal) and 3 bat species of conservation interest.

For the 2.56 ha woodland within the existing NENT Landfill, some of them are located at the east near the Stockpile and Borrow Area and will be disturbed during the restoration of the existing landfill. One patch of woodland (1.2 ha) to be lost is located in the centre of the existing landfill and is isolated in nature, while another patch (0.25 ha) is located at the fringe of the existing landfill area. Loss of these woodland patches (4.01 ha) and other habitats would occur in phases due to progressive change in topography of the site during the construction and operation phases of the landfill extension development over 10-12 years and therefore the extent of impacts would be diluted.

Despite the young age, isolated nature and progressive loss of the woodland within the Project area, due to moderate quality of habitat, and irreversible nature, long duration and moderate magnitude of impacts, the overall potential impact due to site formation is considered moderate (Table 10.16). Mitigation measures are required and should include compensatory woodland planting for the natural woodland loss and transplantation of flora of conservation importance.

Landfill gas contains methane and carbon dioxide may have adverse effects on plant growth by suppressing the oxygen level in soil and thus the root establishment. With high quality of composite cap, leachate contamination and landfill gas migration to cover soil is unlikely. Accidental leakage of landfill gas would not affect the vegetation during the excavation and operation phase as the site would be void of vegetation. During the restoration phase the effect of accidental leakage would be temporarily and would not post long term effect on plant growth. Planting of exotic species tolerant to landfill gas during the initial establishment stage and native species more sensitive to landfill gas at the later stage would also alleviate the problem.

Toxic substances in leachate might affect plant growth. Accidental leakage of leachate, if any, would not affect the vegetation during the excavation and operation phase as the site would be void of vegetation. During the restoration phase, in case of accidental leakage the effect would be temporarily and therefore would not cause long term effect on the plants.

### Terrestrial Fauna

Habitats would be lost due to the proposed extension include natural woodland, abandoned agriculture, grassland with low shrub, plantation woodland, urbanised/disturbed and stream/channel. Apart from natural woodland, the affected habitats are highly disturbed and of low fauna abundance. Natural woodland will be lost to the proposed landfill extension are of younger age and are either isolated patches or on the edge of a continuous woodland, and are probably inhabited by habitat generalists. Most of these woodlands are located within the existing landfill. The loss of 4.01 natural woodland from the proposed extension would be a small proportion of all natural woodlands within the study area (4.01 ha out of 74.18 ha, i.e. 5.4 %). The nearest natural woodland would be in close proximity (within 1 km) from the lost woodland. Fauna inhabiting these woodlands should easily locate and utilise the remaining woodlands nearby. In addition, the loss of habitat will be progressive in phases over 10-12 years. The impact to terrestrial fauna due to loss of these habitats is anticipated to be minor.

Although some fauna species of conservation concern were recorded within the Project area (see **Table 10.14**), the affected areas are not optimal habitats of these species. The population of these species that could be supported by the Project area is not likely to be large.

The proposed extension is not going to affect the important habitat of Yellow Coster (dry abandoned agriculture) and Emerald Dove (large old woodland). The impact to these two species will be minimal.

The potential impact to Black Kite is considered minimal as this species forage in disturbed areas, including the existing landfill.

The Project might affect foraging habitats of Collared Scops Owl and Greater Coucal. However, the habitats would be lost from the proposed landfill extension would be mainly disturbed (e.g., urbanised/disturbed, grassland) and are not important habitats for these two species. As areas would be lost do not contain optimal habitats of these species, the number of individuals affected may not be high and alternative habitats are available in nearby area, e.g., Lin Ma Hang, Wo Keng Shan, Robin's Nest, potential impacts to these two species were ranked as minimal.

The potential impact to bats will be the loss of foraging habitats. The perennial stream will be affected by the proposed landfill extension, and associated woodland habitats would be lost to the landfill extension. Loss of habitats due to site formation, however, would be progressive in phases over 10-12 years. Other optimal bat foraging habitats (e.g., cultivated lands) are available immediately outside the proposed landfill extension, such as the areas along Ping Yuen River and those along Lin Ma Hang Stream. This impact to the bats is considered minor. Compensatory planting would also include tree species with berries and figs to provide food sources for fruit bats.

There will be no direct impact to the Lin Ma Hang Lead Mine SSSI. The impact to bats roosting in this lead mine will mainly be potential loss of foraging habitats, which is anticipated to be minimal. The Project area is more than 1.6 km from the Lin Ma Hang Lead Mine SSSI, and might not be important foraging habitats to the bat roosting in there. Optimal foraging habitats of bats discussed in **Section 10.6.5** are present near the Lin Ma Hang Lead Mine SSSI at Lin Ma Hang and San Kwai Tin.

The fauna community utilising the Project area during operating phase will mainly be those typical of disturbed areas, which are of high mobility. It is also anticipated that the fauna abundance will be low due to low vegetation cover, as seen in the existing landfill. The

covering seals in operating landfill will slow down the rate of emission of landfill gas in case any accidental leakage happens. In addition, the chance of accumulation of landfill gas in open areas to the level dangerous/lethal to wild animals must be very low. The animals may also leave the site before they are far too weakened. The potential impact to terrestrial fauna due to accidental leakage of landfill gas is anticipated to be minimal.

#### **Aquatic Habitat and Fauna**

**Direct Loss** : The potential impacts to Lin Ma Hang stream and catchment were considered. The Lin Ma Hang upstream headwater is located at least 100m always from the conforming extension boundary. As the development of the northern boundary of the proposed extension is most sensitive to the Tong To Shan Archaeological Site, Option 4 would completely avoid the Lin Ma Hang natural woodland. There would be no physical encroachment and no drainage impacts to Lin Ma Hang Stream or its catchment. Both the surface flow and groundwater flow of Lin Ma Hang Stream would not be impacted.

There would be a loss of 2,530m of stream/channel within the proposed extension (see **Table 10.15**). Among them, 1,733 would be within the existing NENT Landfill boundary. Loss or disturbance to the habitats within the existing landfill boundary (i.e. the stream remnants, channels and ditches) had been taken into account during the planning and establishment of the existing NENT Landfill, any loss from the existing NENT Landfill Project would not be an additional loss. Furthermore, the stream/channel habitat within the Project area (the boundary of the proposed extension) is of low ecological value (see **Table 10.10**).

The only aquatic fauna of conservation importance within the Project area is the Freshwater Crab *Somanniathelphusa zanklon* found in the rocky ditches on the cut slope. This species however is common in Hong Kong and considered typical of lowland habitats (Dudgeon and Corlett 1994). This crab was also found in Ping Yuen River within the study area (the downstream section of the channels in the Project area). The impact on this species from the loss of the channels inside the Project area was therefore considered acceptable, and impacts from habitat loss to the stream ecology would therefore be minimal.

**Changes in Water Qualities** : During the operation phase of the landfill the tipping face will remain substantially exposed. Due to contact with the waste material, all run-off generated from within it will be collected and treated. Groundwater will be protected by an impermeable barrier fully lined within the landfill. All leachate will be diverted to the leachate treatment plant for treatment within the landfill prior to being conveyed to nearby sewage treatment works. Lin Ma Hang Stream is located in another catchment area separated from the landfill by a ridgeline and thus would not have any potential to be impacted by the runoff (no encroachment to Lin Ma Hang Catchment). Impacts on natural stream habitat due to water quality changes are not anticipated. The rare freshwater fish *Rasbora steineri* and another freshwater crab *Cryptopotamon anacoluthon* which recorded in the lowland reach of Lin Ma Hang Stream also would not be impacted by the Project.

**Hydrology** : The proposed extension boundary is located mostly (over 95%) within the head of the catchment for Ping Yuen River. But currently the majority of surface runoff from this catchment is directed towards engineered surface drainage channels surrounding the proposed extension area and along Wo Keng Shan Road. Compared with other catchments feeding to Ping Yuen River, this affected catchment would be of less importance to the recharging of groundwater table due to its higher proportion of runoff than infiltration caused by the steep hill slopes.

According to the drainage impact assessment, during construction and operation, there would be only slight fluctuation of water level of Ping Yuen River (between 1mm to 9mm) due to change in catchment area and change in extent of impermeable area. The aquatic fauna found in Ping Yuen River was low in both diversity and abundance, and all species are widespread in Hong Kong. Therefore, potential impacts to Ping Yuen River and

associated aquatic fauna were considered minor. Mitigation measures are therefore not required.

Furthermore, Lin Ma Hang Stream is located in another catchment area. There would be no change in surface flow at Lin Ma Hang Stream. No impacts on the freshwater crab *Cryptopotamon anacoluthon* and the rare freshwater fish *Rasbora steineri*, which were recorded in the lowland reach of Lin Ma Hang Stream, were anticipated. No mitigation is therefore required.

**Sedimentation Rates and Patterns :** There is no encroachment to Lin Ma Hang Catchment and there is no influence on existing flow or sedimentation rate. As all runoff at the hill slopes within the landfill will be diverged through surface channel. All the run-off will pass through sedimentation process before discharging into the nearby stream courses into Ping Yuen River. No sedimentation impact on the streams will be caused by the landfill.

**Accidental Leakage of Leachate and/or Other Wastewater :** Leachate is the rain water that passes through the active tipping face of the landfill and picks up dissolved, colloidal, and suspended solids in concentrations that vary widely in different local conditions. It may contain high concentration of ammonia, nitrogen radicals, organic acids, dissolved salts, (sodium in particular), and various heavy metals, e.g. lead, zinc.

All leachate would be collected and conveyed for treatment. The two layers of impermeable barriers (one layer on the bottom of waste filling, while the second layer on the top of the waste filling and beneath the cap soil) could effectively prevent any accidental leakage of leachate in case the collection system failed. There would also be a contingency plan for the accidental leakage of leachate (see below sections). The seepage / leakage of leachate due to damage of liner system has also been addressed in the water quality section (section 5.6.2.2). In practice, an average of 1 defect per ha of liner could be easily achieved by good manufacturing quality and QA/QC programme. The impact on groundwater quality due to seepage / leakage of leachate will be negligible. The leaked leachate reaching the layer will be drained to the leachate treatment works downstream and treated as ordinary leachate before discharge if the corresponding trigger levels have been exceeded. The impact on groundwater quality due to seepage / leakage of leachate is therefore assessed to be unlikely. Therefore, no impact on stream water quality or stream ecology is anticipated.

**Potential Collection of Hazardous Waste in the Future (when SENT landfill is closed) :** Upon closure of SENT landfill, the proposed NENT Landfill Extension may have to receive hazardous waste including ash from Integrated Waste Management Facility (IWMF) and chemical waste. The collection and disposal of all these chemical waste and hazardous waste are properly controlled and documented. These wastes are in general treated by fixation and tested with chemical leakage test (e.g. TCLP) before disposal to landfill site. A special area/trench is designated for the disposal of such waste. The leachate will be conveyed to leachate treatment plant for pre-treatment before diverting to DSD sewage treatment works for final treatment. Heavy metal or toxic substances will be removed within the landfill leachate treatment plant. All the effluent will comply with the condition of the effluent discharge licence. Similar to SENT landfill, bench-scale test in laboratory and special pilot tests within site should be conducted by the DBO Contractor (during detailed design stage when the nature of IWMF waste is materialised) to test the effectiveness of the leachate/surface water collection system before any full-scale operation. So far, no incident of accidental spillage or other environmental problems were caused by disposal of chemical/hazardous waste at SENT and WENT landfills and other international landfills (such as Japan with the implementation of IWMF). Should the treatment and disposal procedure follow international guidelines and comply with the existing health risk standards for human and environmental safety, no potential impact on ecology is anticipated. No mitigation is therefore required.

### **Cumulative impacts with other proposed development projects**

Drainage improvement works were proposed in the lower reach of Lin Ma Hang Stream under the Drainage Improvement in Northern New Territories – Package C. These works would be conducted in a separate catchment area and thus would not have cumulative impacts with the present project. There is no other major development within the study area. Therefore the NENT Landfill Extension Project would not constitute significant cumulative ecological impacts in the surrounding area.

### **10.8.2 Upon Landfill Restoration**

#### **Terrestrial Habitat and Fauna**

Upon completion of operation and during the restoration phase, the landfill site would be restored by planting of woodland, shrubland and grassland species (see **Section 10.9** and LVIA chapter). The planting and maintenance would be implemented by the DBO Contractor, who will take care of the site for 30 years after restoration. No adverse ecological impact to the surrounding terrestrial habitats and associated fauna is anticipated.

#### **Aquatic Habitat and Fauna**

According to the groundwater impact assessment, upon completion of the landfill works, the site would be capped with a second impermeable barrier for afteruse. Any surface run-off generated over the area would then be collected by the surface drainage channels. Given that it would have had no interaction with the underlying waste material, the surface run-off would be of a high enough quality to be discharged directly into the downstream river systems. New drainage channel will be provided along the site boundary to convey all the surface run-off to Ping Yuen River. There will be no encroachment to Lin Ma Hang catchment and thus there will be no impact on Lin Ma Hang Stream.

According to the Drainage Impact Assessment and Water Quality Assessment, there would be no deep infiltration of groundwater following landfill restoration due to the capping layer provided. Although there will be a subsequent reduction in the recharging of the groundwater levels within the extension area, all precipitation however will be mobilised as either surface run-off or interflow through the topsoil material and supplement the surface water flow for the Ping Yuen Catchment, resulting in an increase of water level by 35mm at Ping Yuen River compared to those in existence prior to the landfill development. The ecological impacts due to changes in surface runoff are anticipated to be minor. No mitigation is required during the restoration phase.

The construction, operation and the restoration phase impacts are summarised in Table 10.16 and 10.17.



Table 10.16 Construction and Operation Phases Impacts

Activity	Source	Receiver	Nature of Impacts					Severity	Mitigation Required	
			Habitat quality	Species affected	Size-abundance	Duration	Reversibility			Magnitude
Site formation	Site preparation	Terrestrial habitat and associated flora and fauna	All except woodland habitat are of low ecological importance	Fauna and flora species recorded in the project area, including 4 plant species of conservation interest affected, 2 bird species (Collared Scops Owl and Greater Coucal) and 3 bat species of conservation interest, would be affected	Of the 63,42 ha of the Project area to be affected, 4.01 ha of woodland is of moderate ecological value.	Long term and permanent	Irreversible	Moderate	Moderate	Yes, detailed surveys and transplantation of species of conservation interest (under circumstance technically feasible), compensatory planting
Noise, dust and visual disturbance	Works equipment and human activities	Faunal species on adjacent habitats	Terrestrial habitats affected are of low ecological importance	Disturbance tolerant fauna	Terrestrial habitats affected confined to areas adjacent to work areas.	Temporary	Reversible	Low	Minor	Yes, good site practice
Changes in Water quality	Site runoff and leachate	Aquatic fauna	Low for Ping Yuen River	Common species	N/A	Temporary	Reversible	Low (all runoff and leachate will be transferred offsite for treatment)	Minor	Yes, good site practice
Changes in Hydrology	Site runoff	Aquatic fauna	Low (Ping Yuen River)	Common species	N/A	Temporary (flow to be restored at restoration phase)	Reversible	Significant during construction and operation stages	Minor	No

**Table 10.17 Restoration phase impacts**

Activity	Source	Receiver	Nature of Impacts						Severity	Mitigation Required
			Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude		
Compensatory Planting	Planting activities	New landfill site	Low on finished landfill site	Few/none on new capped surface	Over 30 ha to be replanted	5 years of planting	Irreversible	Moderate	Positive impact	No
Construction of drainage network to redirect surface runoff	Surrounding surface runoff	Ping Yuen River	Low on finished landfill site	Few/none on new capped surface	Increase in water level by 35mm	Permanent	Irreversible	Moderate	Minor	No

## 10.9 Impact Avoidance and Mitigation Measures

Following EIAO-TM Annex 16 guidelines, mitigation measures are discussed in this section to avoid, minimise and compensate for identified ecological impacts.

### 10.9.1 Impact Avoidance

As described in Chapter 2, Option 4 has been carefully selected through the option assessment process to avoid / minimise impacts on most sites, habitats and species of conservation importance. Although Option 4 is not ranked the highest ecologically, it has avoided Lin Ma Hang Stream and its catchment completely. Direct and indirect impacts on Lin Ma Hang Stream and its catchment and associated woodland habitats are therefore completely avoided.

### 10.9.2 Impact Minimisation

Due to the large area required for the Project, loss of important habitats such as woodland is unavoidable. Option 4 has been identified as the preferred design with favourable comparisons on waste management (achieving the target requirement), engineering considerations (no imported fill material required for the site formation works, no drainage impacts on Lin Ma Hang catchment), environmental constraints (no ecological impacts on Lin Ma Hang Stream), and social acceptability (highest landfill areas with gentle slopes/gradient, comparable unit cost for disposal). In comparing with Option 1 (the conforming option), the northern boundary of Option 4 is set back to minimize the impact to mature woodland at Lin Ma Hang.

Option 4 would cause a loss of 4.01 ha woodland of which 2.56 ha is located at the east of the existing stockpile and borrow area. Other options with less woodland loss by adjusting landfill boundary in the east could only result in a minor reduction in woodland loss but resulting in significant reduction of landfill capacity of 10%. This will definitely affect the waste management needs and also increase the unit disposal cost of 13% and therefore is not preferred. In fact, set back the extension boundary at the east would not help to prevent woodland loss. The existing Stockpile and Borrow Area was allocated to the existing NENT Landfill Contractor in 1994 and this area will be disturbed by the existing NENT Landfill Contractor during the restoration period of the existing landfill.

The remaining 1.45 ha woodland being affected is location in the heart of the landfill extension and is also the valley of the landfill bowl, which is unavoidable in any of the proposed layout options.

Impacts on woodland loss would be mitigated by compensatory planting. Although loss of woodland habitat within the existing landfill boundary should have been addressed by the environmental assessment for the existing landfill, the current EIA would also cover the compensation of habitat loss in this area by anticipating a high ratio of woodland compensatory planting (see below).

The surveys conducted under this EIA identified at least four plant species of conservation interest within the Project area that would have been directly impacted by the proposed landfill extension. The group tree surveys recorded 2 no. of *Aquilaria sinensis* and 3 no. of *Endospermum chinense*, while the ecological surveys recorded 2 no. of *Rhododendron simsii* and about 10 no. of *Arundina graminifolia*. To minimise the ecological impacts, the affected individuals would be transplanted to suitable nearby habitats prior to the construction phase as far as practicable. A detailed vegetation survey covered the affected habitats would be conducted prior to the commencement of site clearance works by a suitably qualified botanist / ecologist. The aim of the survey is to update, identify and record the location and number, health condition and suitability for transplantation of the affected individuals in order to provide details for the transplantation scheme. The requirements of detailed vegetation survey will be specified in the NENT Landfill Extension Contract.

According to the LVIA, due to the fact that the habitats are located to slopes inaccessible to vehicles and machineries, the majority of them may not be likely to be preserved by transplanting. However, it is recommended to preserve among them, some which are of rare and precious species (e.g. *Aquilaria sinensis*, *Endospermum chinense*) by transplanting as far as technically and financially feasible. Feasibility and suitability of transplanting the affected plant species of conservation interest would be carefully studied and suitable receptor sites would be identified by the transplantation scheme. Examples of the potential receptor site for *Aquilaria sinensis* and *Endospermum chinense* will be fringe of Ling Ma Hang Woodland immediately to the north of the Project Area, while potential receptor site for *Rhododendron simsii* and *Arundina chinensis* will be grassland habitat along the southeast boundary of the Project Area. Proximity of the receptor sites to the Project Area will allow access for transplantation and monitoring while avoiding potential disturbance inside the Project Site due to earthwork.

To ensure good preparation of the transplantation work, the transplantation scheme should be formulated during the detailed design stage for this Project based on the information collected during the detailed vegetation survey. It should include careful selection of receptor sites, detailed transplantation methodology, and should be implemented and supervised by a suitably qualified botanist / horticulturist. A monitoring programme should be set out to monitor the survival and evaluate the successfulness of transplantation.

Good site practices and precautionary measures should be implemented to avoid encroachment onto the nearby natural habitats, minimise disturbance to wildlife, and ensure good water quality. Examples are detailed in various sections of the EIA report and they include:

- Placement of equipment or stockpile in designated works areas and access routes selected on existing disturbed land to minimise disturbance to natural habitats.
- Restriction of construction activities to the work areas that would be clearly demarcated.
- Reinstatement of the work areas immediately after completion of the works.
- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction programme.
- Machines and plant (such as trucks, cranes) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum.
- Plant known to emit noise strongly in one direction, where possible, be orientated so that the noise is directed away from nearby NSRs.
- silencers or mufflers on construction equipment should be properly fitted and maintained during the construction works.
- mobile plant should be sited as far away from NSRs as possible and practicable.
- material stockpiles, site office and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities.
- use of "quiet" plant and working methods.
- construction phase mitigation measures in the Practice Note for Professional Persons on Construction Site Drainage.
- design and set up of the temporary on-site drainage system will be undertaken by the DBO Contractor prior to the commencement of construction.
- design and incorporation of silt/sediment traps in the permanent drainage channels to enhance deposition rates and regular removal of deposited silt and grit.
- minimization of surface excavation works during the rainy seasons (April to September), and in particular, control of silty surface runoff during storm events, especially for areas located near steep slopes.
- regular inspection and maintenance of all drainage facilities and erosion and sediment control structures to ensure proper and efficient operation at all times and particularly following rainstorms.
- provision of oil interceptors in the drainage system downstream of any oil/fuel pollution sources.

### 10.9.3 Impact Mitigation

#### Habitat Loss

Most of the landscape and visual mitigation measures proposed during the construction and operation phases are temporary, including screening tree planting and boundary Green Belt planting. All the permanent and effective mitigation measures for habitat loss have to be implemented after capping is completed in the restoration and afteruse phases, i.e. in around 2021. A total of 26.83 ha will be planted for mitigating landscape impact and woodland loss. The proposed woodland planting would form a piece of contiguous woodland of substantial size and will join up with the existing natural woodland in the vicinity (see Drawing No. 24315/14/009). Assuming tree seedlings / whips planting at 1.5m spacing in staggered pattern, about 148,100 nos. of tree seedlings / whips will be planted. Details of the woodland planting are described in Table 8.10 of the LVIA and are summarised as follows.

Although the 4.76 ha of plantation would be lost is of low ecological value and does not require ecological mitigation, the compensation planting which serves as a landscape mitigation measure will cover this loss from a landscape viewpoint. Among the 26.83 ha of compensatory woodland planting, 4.76 ha would be regarded as compensation for the plantation loss in a ratio of 1:1 in terms of area. As the proposed tree list would include many native species especially during the second phase of planting (see Table 8.14), the compensatory woodland planting would be of higher ecological value than the original plantation. There would be ecological enhancement in addition to the 1:1 ratio compensating planting.

The remaining 22.07 ha of woodland planting would compensate for the loss of 4.01 ha of natural woodland, resulting in a 5.5: 1 compensation ratio in terms of area. Most native trees had extremely high mortalities on the local test site in the first few years after the capping of landfill. After several years, the pioneer species provide shelter for the native species and the survival rate and growth of native species will improve. Natural ecological succession also takes place as the pioneer species establishes. Therefore, planting of tree seedlings is preferable to be carried out in two phases. The first phase involves planting of landfill pioneers tree species (including 12 exotic species and 3 native species, see Table 8.14). The second phase, 3 – 5 years after the completion of first phase, involves the planting of seedlings of 26 native tree species of higher ecological values (also see Table 8.14). This high compensation ratio (5.5:1) is justified to partly off-set impacts due to (1) the time-lag between the site clearance (habitat destruction) and compensatory planting (to be commenced tentatively in 2021, about 15 years from now, and takes another 15-20 years to develop) when it becomes old enough to provide habitats to wildlife, and (2) availability (which will be planted at a later phase) and survival (higher mortality in landfill site) of native species to be planted. It is anticipated that this compensatory planting proposal would fulfil the requirement set out in ETWB TC No. 3/2006 that implementation of compensatory planting should be of a ratio not less than 1:1 in terms of quality and quantity within the site.

In addition to 26.83ha of woodland mix planting, 19 ha of shrubland mix planting and 17.55 ha of grassland will also be compensated, all implemented in phases. Recommended tree and shrub species are detailed in section 8.6.3.1. The future maintenance parties are mentioned in section 8.6.3.2.

To ensure the survival and establishment of the compensatory planting, a 10 year ecological monitoring is proposed, i.e. 2021-2031. Apart from the standard practices and regular maintenance covered by the landscape contract, monitoring of survival, height, and health condition of species planted will be monitored. Detail requirements will be given in the EM&A manual. The requirement of the 10 year ecological monitoring scheme will be specified in the NENT Landfill Extension Contract and will be implemented by the DBO Contractor.

### **Accidental Leakage of Leachate and Landfill Gas**

As mentioned above, leachate collection facilities and the two layers of impermeable barriers would effectively prevent water quality impacts. Monitoring during landfill operation and after use phase would verify the expected conditions. There would also be contingency plans for the accidental leakage of leachate and landfill gas.

The NENT Landfill Extension will be designed as a containment landfill with LFG collection and management systems to eliminate any off-site migration of LFG. The LFG risk assessment in Section 7.4.5 has identified that the overall risk level of LFG hazards to receivers outside the landfill extension site, which include Tong To Shan Tsuen inside Lin Ma Hang stream catchment, is categorised as "Medium" (Category C), and there will be "semi-active" or enhanced passive gas controls and detection system for the receivers. Future landfill liner, leachate collection and treatment system, LFG control devices, landfill cap design will be designed with reference to the specifications of the existing NENT Landfill which is successful in LFG control throughout the years. Furthermore, the design of suitable level of contingency plans for the potential receivers will be incorporated. An Emergency and Contingency Plan will be devised by the DBO Contractor for implementation of appropriate actions in case any LFG migration detected. Such measures include those currently being adopted in the existing NENT Landfill, e.g. installation of double layer liner, LFG extraction/collection/treatment/export systems, gas sensors, increasing monitoring frequency, connecting the affected monitoring point to the Landfill Gas Extraction System, passive venting of landfill gas, active extraction and flaring of landfill gas, and installation of additional barriers to gas movement. etc. The existing NENT Landfill has been incorporated an efficient and effective LFG management system, in which a coordinated approach to LFG monitoring, collection, extraction, flaring and utilization is being implemented to achieve the elimination of the hazards to flora and fauna due to toxicity or asphyxiation effect of LFG presence external to the landfill site. The records of the compliance of LFG monitoring has proven the success of this LFG management system, and the protection of wildlife outside the NENT Landfill extension is thus guaranteed.

The potential impacts from accidental leakage of leachate on Lin Ma Hang Stream and its catchment and associated woodland habitats are avoided through the complete avoidance of Lin Ma Hang catchment by the current landfill extension option (i.e. Option 4, see Chapter 2). Furthermore, a contingency plan on accidental leakage of leachate, which is based upon the current contingency plan of the existing NENT Landfill and modified for the landfill extension, will be adopted to further protect other streams inside the same catchment of the landfill extension such as Ping Yuen River. The future monitoring programme will include surface and groundwater monitoring within and around the site. In the event that the water quality requirements are exceeded, Corrective Action Programmes will be implemented which include surface water/groundwater extraction and treatment prior to discharge, groundwater interception and diversion, installation of additional groundwater well for monitoring and for extraction of contaminated groundwater for treatment, increased frequency of ground-water quality testing, installation of subsurface barriers, changes of working methods, diversion, etc. Contingency plan on accidental leakage of leachate has been detailed in Section 5.8.2.1.

Though the potential risk is extremely low, with the contingency plans for the accidental leakage of leachate and landfill gas in place, the water quality of nearby natural streams (including Lin Ma Hang Stream), associated aquatic life, and other wildlife will be further protected.

### **10.10 Residual Ecological Impacts**

The residual impact to terrestrial fauna from this Project will be the time-lag between the site clearance (habitat destruction) and compensatory plantation becomes old enough to provide habitats to wildlife. The terrestrial fauna recorded within the Project area were habitat generalists and can utilise habitats other woodlands, the residual impact due to a time-lag of 10-12 years will be acceptable.

To further minimise the residual impacts, advance compensatory planting should be considered. While there will be no room for advance planting on site, it is noted that the

existing landfill operation will be completed shortly, and the afteruse design is underway. It is therefore recommended that the project proponent would liaise with the contractor of the existing NENT Landfill on the possibility of including some woodland planting in the restoration phase of the existing landfill, for example, advanced planting of 4 ha of woodland to compensate for the loss. The plant mix schedule proposed for the current EIA can also be adopted for the restoration of existing landfill. If implementable, advance compensatory planting can offset the time-lag effect of the NENT Landfill Extension Project. It is anticipated that the proponent can get the agreement in principle with the landfill operator for advance planting during detailed design stage.

With the implementation of the above mitigation measures, the residual impacts are considered minimal and acceptable.

### **10.11 Ecological Monitoring and Audits**

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Survival and growth of the compensatory woodland planting will require long term monitoring (at least for two years after the completion of planting programme under the landscape contract and 10 years for ecological monitoring) and should be specified in the planting and maintenance contract and the EM&A manual.

### **10.12 Conclusion**

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The NENT Landfill Extension consists of the existing Stockpile and Borrow Area and haul road of NENT Landfill. It covers 0.12 ha of abandoned agriculture land, 47.64 ha of grassland with low shrub, 4.01 ha of natural woodland, 4.76 ha of plantation, 6.89 ha of urbanised/disturbed land, and 2,530m of stream/channel habitats and its associated flora and fauna. In fact, the selected layout (Option 4) is one of the options that enable the NENT Landfill Extension to avoid Lin Ma Hang Stream and its catchment completely. The existing grassland and woodland are largely disturbed by the construction activities in the existing Stockpile and Borrow Area. The overall ecological impacts are ranked as moderate and would be mitigated by transplantation of species of conservation interest, compensatory planting and good site practice.

Potential ecological impacts caused by LFG and leachate are considered as minor. With adoption of the proposed leachate and landfill gas collection facilities and contingency plans, no residual impacts are anticipated.

Upon completion of operation, the landfill site would be restored by planting of woodland, shrubland and grassland species, and the surface flow of Ping Yuen River would be restored. No adverse ecological impact to the surrounding terrestrial and aquatic habitats and their associated flora and fauna is anticipated.

### **10.13 Reference**

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