

12 Ecological Impact

12.1 Overview

This section presents the assessment of potential ecological impacts that may arise during the construction and operational phases. With the implementation of practical mitigation measures, ecological impacts can be reduced to low levels.

The ecological assessment has been conducted in accordance with the requirements of Annexes 8 and 16 of the TM-EIAO as well as the requirements set out under Clause 3.4.13 of the EIA Study Brief.

12.2 Environmental Legislation, Standards and Guidelines

12.2.1 Local Legislation, Standards and Guidelines

The relevant legislation and associated guidelines applicable to the present study for the assessment of ecological impact include:

- Forests and Countryside Ordinance (Cap. 96) and its subsidiary legislation, the Forestry Regulations;
- Wild Animals Protection Ordinance (Cap. 170);
- Environmental Impact Assessment Ordinance (Cap. 499) and relevant annexes 8, 11, 16, 20 and 21 of the associated Technical Memorandum;
- EIA Study Brief No. ESB-238/2011;
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) and its subsidiary legislation.
- Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10, "Conservation";
- Planning, Environment and Lands Bureau Technical Circular 1/97 / Works Branch Technical Circular 4/97, "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures";
- EIAO Guidance Note No. 6/2002 - Some Observations on Ecological Assessment from the Environmental Impact Assessment Ordinance Perspective;
- EIAO Guidance Note No. 7/2002 – Ecological Baseline Survey for Ecological Assessment;
- EIAO Guidance Note No. 10/2004 – Methodologies for Terrestrial and Freshwater Ecological Baseline Survey
- Revised versions of EIAO Guidance Notes 6/2010, 7/2010 and 10/2010 (issued December 2010).

12.2.2 International Conventions and Guidelines

International conventions and guidelines potentially relevant include:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora ("CITES"). This Convention regulates international trade in certain animal and plant species. Their trade is subject to permits or certificates of origin. Hong Kong's obligations under this Convention are enforced via the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586).
- IUCN - The World Conservation Union maintains, through its Species Survival Commission, a "Red List" of globally threatened species of wild plants and animals (see <http://www.iucnredlist.org/static/introduction>).
- United Nations Convention on Biological Diversity. This convention requires parties to regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use. It also requires parties to promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings. The People's Republic of China (PRC) ratified the Convention on Biological Diversity on 5th January 1993. The HKSAR Government has stated that it is "committed to meeting the environmental objectives" of the Convention.

12.3 Ecological Context

12.3.1 Existing Environment

LMC Loop was the disposal site of mud extracted from the training works for the Shenzhen River, some of which were contaminated. With the existence of the potentially contaminated mud, the LMC Loop, in its present form, is not fit for any use or development. It has been left vacant since its formation.

Adjacent areas in HK outside the Loop (i.e. Area B and Added Area B as shown in **Figure 1.1**) are intended to be used to accommodate supporting infrastructure for the development of LMC Loop. A large part of these adjacent areas falls within the Frontier Closed Area (FCA) and is therefore characterised by essentially rural land uses including arable farming and fish ponds.

The eastern part of these adjacent areas falls entirely within the FCA Boundary. Its eastern part is on hilly terrain and mainly consists of unused government land. A few fish ponds are found in the low lying western part at the foothills.

The western part of these adjacent areas falls partly within and partly outside the FCA. Land use inside FCA reflects the restrictive nature of the area and consists essentially of fish ponds together with the facilities for Boundary Control Point (BCP) and the MTR LMC Spur Line.

Active land uses are largely found in the part of the adjacent areas outside the FCA. A few village settlements, including LMC Tsuen, Pun Uk Tsuen and Chau Tau Tsuen and Ha Wan Fisherman San Tsuen are mainly surrounded by arable land and fish ponds.

The area around the San Tin Interchange is occupied for uses closely related to the cross-boundary activities. These include open car parks and open storage compounds for cross-boundary commuters and goods, as well as a public transport interchange for cross-boundary shuttle bus services.

12.3.2 Ecological Assessment Area

The Ecological Assessment Area comprises LMC Loop, LMC Meander and the area initially earmarked for infrastructural links and associated development, the surrounding assessment area, as required by the EIA Study Brief, and the Ma Tso Lung area potentially impacted by the Eastern Connection Road. The actual Ecological Assessment Area in places is more than 500m from the footprint of proposed Project elements due to the fact that the iterative and prolonged nature of project formulation raised a number of development options, assessment of the potential ecological impacts of which required differing survey areas. The overall survey area was, thus, as inclusive as possible, and is considered sufficient for all elements of the Project.

For aquatic ecology, the assessment area is the same as that of water quality impact assessment, i.e. likely to be impacted by the Project and associated works. Of particular relevance in respect of aquatic ecology are the following natural watercourses: LMC Meander, streams draining into the Meander from the nearby hills and fish pond areas (including Ping Hang Stream), the stream system running through the Ma Tso Lung area, and a stream near Lung Hau Road (to the west of LMC Road).

LMC Loop largely comprises grassland, reed marsh and scattered groups of trees. Adjacent areas include fish pond and marsh areas of high ecological value at Hoo Hok Wai/Ta Sha Lok and LMC, as well as the LMC Meander, the original course of the Shenzhen River prior to training, which now surrounds the LMC Loop on three sides.

The area is backed to the south by hilly grassland and shrubland, as well as disturbed village and village edge habitats, small fragmented areas of shrubland and woodland; a number of narrow seasonal and permanent streams flow through the area. Two small areas of wet agricultural fields are present, one at LMC Tsuen and the other at Chau Tau Tsuen. To the west of the LMC Loop lies the major infrastructural linkage combining the access road to LMC BCP and the MTR LMC Spur Line Railway, and beyond a large wetland mitigation area for the latter.

12.3.3 Sites of Conservation Importance

A large part of the Ecological Assessment Area lies within the Inner Deep Bay and Shenzhen River Catchment Important Bird Area¹, which comprises the Mai Po Inner Deep Bay Ramsar Site, outer Deep Bay as far as Sheung Pak Nai, fish pond and associated wetland areas outside the Ramsar Site at Nam Sang Wai, San Tin, LMC and HHW, as well as the Ng Tung and Sheung Yue rivers, including their Long Valley floodplain and the adjacent Ho Sheung Heung Egrettry. The following, more discrete sites of conservation importance are located in or near

¹ <http://www.hkbws.org.hk/archive/IBA/iba1.html>

the Ecological Assessment Area, and are potentially in the range of direct, indirect or cumulative impacts.

12.3.3.1 Reed Marsh inside LMC Loop

An area of 10.96ha of reed marsh lies within the LMC Loop; this comprises 8.7% of reed marsh in the Deep Bay area. Records of Purple Heron, small bitterns, Eastern Marsh Harrier, reed warblers and Chinese Penduline Tit^[12-30] indicate this reedbed² is comparable in ecological value to reedbeds elsewhere in the Deep Bay area, including the long-established reedbed at Mai Po Nature Reserve.

12.3.3.2 Hoo Hok Wai

The area of Hoo Hok Wai (all references to this area include the immediately adjacent area of Ta Sha Lok) lies immediately northeast of the Project Area and largely comprises managed and unmanaged fish ponds and associated wetlands. These wetlands are of high ecological value and form part of an extensive area of wetlands extending from Tsim Bei Tsui on the west side of Inner Deep Bay to the Ng Tung River in the northeast. Significant functional linkages exist with areas of wetland that form the Mai Po Inner Deep Bay Ramsar Site, which extends as far as Tsim Bei Tsui. The area provides foraging and roosting grounds that support a variety of wetland fauna, of which the most significant are waterbirds and Eurasian Otter. The area is a part of the Deep Bay Wetland Outside Ramsar Site Priority Site for Enhanced Conservation.

12.3.3.3 Lok Ma Chau Meander

The LMC Meander is the original course of the Shenzhen River and was restored as a mitigation measure for potential impacts to waterbirds due to the loss of 19ha of fish ponds as part of Shenzhen River Regulation Project Stage 1 Works. The meander's main ecological value appears to arise from its comprising an important element of the ecological corridor that runs through the area, both in terms of bird flight lines and mammal movements. The profile and high water level in the channel appear to limit its ability to function as a foraging area, though the natural vegetation on either side is used as a roosting area by waterbirds. In addition, records of Eurasian Otter from in or near the Meander suggest that it may be of importance to this species.

12.3.3.4 Wetland Conservation and Wetland Buffer Areas

The high ecological value of fish ponds in the Deep Bay area was highlighted in the Study on the Ecological Value of Fish Ponds in Deep Bay Area (Aspinwall 1997), one of the recommendations of which was that an area of fishponds and other wetlands in the northwest New Territories be designated as a buffer area. As a result, the Wetland Conservation Area (WCA) and a Wetland Buffer Area (WBA) of 500m were established. These designations were incorporated into Town Planning Board guidelines (TPB PG-No. 12B). The planning intents of these two zones as described in the guideline are as follows:

² The term reedbed is used to describe a relatively large area of broadly continuous reed marsh habitat.

Wetland Conservation Area

The planning intention of the WCA is to conserve the ecological value of the fish ponds which form an integral part of the wetland ecosystem in the Deep Bay Area. It comprises the existing and contiguous, active or abandoned fish ponds in the Deep Bay Area, which should all be conserved. New development within the WCA would not be allowed unless it is required to support the conservation of the ecological value of the area or the development is an essential infrastructural project with overriding public interest. Any such development should be supported by an ecological impact assessment to demonstrate that the development would not result in a net loss in wetland function and negative disturbance impact. For any redevelopment which requires planning permission from the Board, an ecological impact assessment would also be required. Wetland compensation is required for any development involving pond filling and mitigation measures against disturbance would be necessary. They would be imposed as part of the planning approval conditions.

Wetland Buffer Area

The intention of the WBA is to protect the ecological integrity of the fish ponds and wetland within the WCA and prevent development that would have a negative off-site disturbance impact on the ecological value of fish ponds. A buffer area of about 500m along the landward boundary of the WCA is thus designated as a WBA. As a substantial amount of the fish ponds within the WBA have already been lost over time through filling and certain areas have been degraded by the presence of the open storage use, these degraded areas may be considered as target areas to allow an appropriate level of residential/recreational development so as to provide an incentive to remove the open storage use and/or to restore some of the fish ponds lost.

The fish ponds, wet agricultural land and shrubland in the southern side of the Project Area are included within the WCA and the WBA designated by the Town Planning Board Guideline 12B, though not LMC Loop itself.

12.3.3.5 MTR Lok Ma Chau Spur Line Wetland Mitigation Area

The MTR LMC Spur Line Wetland Mitigation Area (LMC WMA) is located approximately 800m to the west of LMC Loop (see **Appendix 12-12**, plate 39). The LMC WMA occupies an area of approximately 36ha, and comprises managed freshwater wetland habitat. Enhancement of the LMC WMA to provide wetland habitat conforming to criteria set out in the Habitat Creation and Management Plan for the wetland is a requirement of the Environmental Permit for the Sheung Shui to LMC Spur Line project. Ecological monitoring of the LMC WMA to monitor target wildlife species and other species of conservation importance using the LMC WMA in order to demonstrate that mitigation targets are being achieved has occurred since July 2002. The site also includes a wastewater treatment reedbed. **Figure 12.1** shows the location of LMC WMA.

12.3.3.6 Riparian Corridor at Ma Tso Lung

The natural streams of the Ma Tso Lung area include a vegetated riparian corridor from where there is a single record of Three-banded Box Terrapin, made during

fieldwork for NENT NDA PES. Hong Kong supports the world's largest remaining wild population of this critically endangered species (KFBG 2010).

12.3.3.7 San Tin East Main Drainage Channel

Project 73CD San Tin East Main Drainage Channel (STEMDC) comprises a drainage channel 2.2km in length along the west side of San Sham Road (see **Appendix 12-12**, plate 37) from Castle Peak Road to Shenzhen River, a low-flow pumping station, an inflatable dam, associated roads and drainage works, landscaping works and a compensatory constructed wetland between the drainage channel and the access road to LMC BCP. The shortest distance to LMC Loop is approximately 486m. Associated ecological monitoring for the initial three years of the operational period has recorded low numbers of a suite of waterbirds typical of such habitats, including Greater Painted-snipe.

12.3.3.8 Ho Sheung Heung Egretary

Ho Sheung Heung Egretary is one of the largest and longest-lived egrets in Hong Kong, and the number of breeding birds approximately doubled between 1994 and 2007. Previously, the egretry was occupied in order of importance by Chinese Pond Herons, Little Egrets and Cattle Egrets, and supported one of the largest colonies of Chinese Pond Herons in the SAR^[12-7]. However, species composition has changed in recent years. In 2011, it supported 6.5% of Hong Kong's breeding ardeids^[12-13], comprising 38 Little Egret nests, 12 Cattle Egret nests and only two Chinese Pond Heron nests, while in 2012 it supported 5.8% of Hong Kong's breeding ardeids, comprising 33 Little Egret nests, four of Chinese Pond Heron and 12 of Cattle Egret. The nearest distance to LMC Loop is 2860m, though Crest Hill lies between the two closest points.

12.3.3.9 Mai Po Inner Deep Bay Ramsar Site

Lying at its nearest point approximately 2.0km southwest of LMC Loop, the Mai Po Inner Deep Bay Ramsar Site covers about 1,500ha of intertidal, brackish and freshwater wetland, including the Mai Po Marshes SSSI and Inner Deep Bay SSSI. The Ramsar Site was designated as a "Wetland of International Importance" under the Ramsar Convention on 4 September 1995. Comprising extensive intertidal mudflats, mangrove, *gei wai* and fishponds, it supports a variety of habitats and high faunal diversity. The site supports over 100,000 waterbirds each year, and there are records of 36 globally-threatened and near-threatened species (as listed by IUCN and BirdLife International as of December 2011), including four that are Critically Endangered and three that are Endangered, the latter including Black-faced Spoonbill, a substantial proportion of the world population of which forages and roosts largely within the Ramsar Site in the winter months.

12.3.3.10 Mai Po Nature Reserve

The Mai Po Nature Reserve (MPNR) is located approximately 3.5 km southwest of LMC Loop. It lies within the Mai Po Marshes SSSI, which was designated in 1976. Since 1983, World Wide Fund for Nature Hong Kong has managed approximately 380ha of the Nature Reserve in partnership with the HKSAR

Government. The reserve provides valuable foraging and roosting habitat for a variety of fauna, and is especially important to waterbirds, including the globally threatened Black-faced Spoonbill.

12.3.3.11 Mai Po Village Egrettry

The Mai Po Village Egrettry SSSI is located adjacent to the village of the same name, though it has spread to include adjacent and somewhat separate colonies at Mai Po Lung. The shortest distance from LMC Loop to these egretsries is approximately 2386m. Most birds using this egrettry forage in wetlands at Mai Po Nature Reserve and fishponds in the Mai Po and at San Tin, though it is possible some also forage in the area of LMC Loop.

12.3.3.12 Fu Tian National Nature Reserve

Situated along the northern shore of Deep Bay, Fu Tian National Nature Reserve is located about 5 km west of LMC Loop. The Nature Reserve was established in 1984 and comprises 815ha of fish ponds, shrimp ponds, mangrove swamps and mudflats, including the sea grass *Halophila* sp. The faunal species utilizing the area are very similar to those at MPNR and, like the latter, it is important to large numbers of waterbirds. The Reserve also contains a mangrove area that provides feeding and nursery grounds for many commercially important crustacean and fish species for nearby oyster and fish farms in Deep Bay.

12.3.4 Species of Conservation Importance

The composition of species of conservation importance recorded inside the LMC Loop is largely determined by the relative lack of areas of open water, which are the characteristic feature of much of the rest of the Deep Bay area. Lack of human access also results in much lower levels of human disturbance than is present in most of the Deep Bay area. The presence of grassland and, in particular, *Phragmites* reed marsh, means that the focus of faunal interest concerns grassland and reedbed-associated birds. This suite of species includes Purple Heron, small bitterns, Eastern Marsh Harrier, reed warblers and Chinese Penduline Tit, all wetland-associated species of conservation significance. **Section 12.4.4** provides details of bird species known to have been recorded in the Ecological Assessment Area, and indicates which are of conservation concern.

In contrast, the adjacent fish pond wetland areas at HHW and LMC support large numbers of large waterbirds such as Grey Heron, Great, Little and Cattle Egrets, Chinese Pond Heron, Black-crowned Night Heron and Black-faced Spoonbill. In addition, ducks and shorebirds occur in low to moderate numbers in wetland areas near the LMC Loop, primarily the fish pond areas but also in the remaining areas of wet agriculture. Imperial and Greater Spotted Eagles occur in the fish pond area, as do Red-billed Starlings; none of these species frequent the LMC Loop commonly, however, as the habitat appears unsuitable. In the case of the former, LMC Loop is unsuitable due to the lack of open-water habitat that would support its main prey, ducks. In the case of Red-billed Starling, this is an open-country species that forages at fruiting trees, fish ponds, wet agricultural areas, drainage channels and the edge of reed beds where there is open ground (Carey *et al.* 2001); these habitats are absent or hardly present in the Loop. Numbers of the two eagles

at HHW are much reduced, apparently due to a decline in duck farming^[12-22]. Greater Painted-snipe has been reported from LMC Loop, but the habitat appears unsuitable for breeding. Occasional passage migrants are, however, likely to occur throughout the LMC Loop and HHW area.

In the hills between LMC Tsuen and Ma Tso Lung Tsuen there exists an avifaunal community typical of hilly grassland habitats in Hong Kong. Of primary interest in this area is Eurasian Eagle Owl, which is listed by Fellowes *et al.* (2002)^[12-31] as of Regional Concern, and is a second grade protected species in China^[12-73].

In terms of non-bird fauna, four are of particular significance. The first is Eurasian Otter *Lutra lutra*, of which one record from the reedbed in LMC Loop and one from the LMC Meander were obtained during fieldwork carried out for this Study, in addition to its being reported by local people to occur there. It also occurs in adjacent areas, primarily HHW and LMC. Eurasian Otter is of conservation significance ('Near Threatened' - IUCN; 'Endangered' - CSIS), and the Hong Kong distribution of this protected species appears to be confined to the northwest New Territories^[12-66]. Given the paucity of records from adjacent areas in China, the population may be of regional significance.

A network of natural streams flows from the hills into the Ma Tso Lung area. A recent record of Three-banded Box Terrapin here indicates this species may occur in natural stream and woodland/shrubland in the area. This species is near extinction^[12-15], and is regarded as Critically Endangered both worldwide^[12-38] and in China^[12-30]. According to KFBG (2010) Hong Kong supports the last known large wild population of this species in the world.

Burmese Python is listed as Critically Endangered in China by CSIS (2010)^[12-30], as Near-threatened globally by IUCN (2010)^[12-38] and as of Potential Regional Concern by Fellowes *et al.* (2002)^[12-31]. It is a Class I Protected Species in China, but is widely distributed in Hong Kong. ENSR (2009)^[12-30a] recorded an individual in the shrubland alongside the boundary fence road, while local villagers reported that this species appears inside LMC Loop and in LMC Meander. Burmese Python is likely to occur in the Assessment Area, as it has been regularly recorded inside LMC WMA (AEC 2009)^[12-1].

The fish Rose Bitterling has been recorded in a stream next to Lung Hau Road. This is only the third site in Hong Kong where it has been recorded, and the species is listed as of Local Concern by Fellowes *et al.* (2002)^[12-31].

12.4 Ecological Baseline

12.4.1 Pre-existing Data and Information Gaps

There was a limited amount of data regarding the ecology of LMC Loop available prior to the commencement of this Study. The most recent and largest data gathering activity occurred from March 2008 to February 2009^[12-30a], and this provided the primary background reference for the LMC Loop. Surveys for that study were carried out as follows:

- Habitat and vegetation: March, July and December 2008.
- Avifauna: March 2008 to February 2009, monthly.

- Mammals: March 2008 to January 2009, every two months.
- Herpetofauna: March to September 2008, monthly.
- Odonata and butterflies: February to November 2008, monthly.
- Freshwater organisms: July 2008.

In addition, the EIA Study for the Construction of a Secondary Boundary Fence and new sections of Primary Boundary Fence and Boundary Patrol Road [12-52] provided some relevant data, as did data collected for LUPCAFS. Finally, faunal data relevant to the Shenzhen River were provided by SESRC (2009) [12-68].

A greater amount of data are available for the rest of the Ecological Assessment Area, however, as these areas have been the subject of a number of ecological studies, including ecological impact assessment and monitoring for designated projects such as Lok Ma Chau Spur Line and STEMDC, planning studies, ongoing waterbird monitoring as part of the Mai Po Inner Deep Bay Ramsar Site Waterbird Monitoring Programme (WBMP), and other work carried out by academics and amateurs.

12.4.1.1 Avifauna

The data available in ENSR (2009) [12-30a] and Mott Macdonald (2009) [12-52] for avifauna in the Ecological Assessment Area were assessed to be accurate based on the known status and distribution of birds in Hong Kong [12-22] and the Deep Bay area in particular. No unexpected species were recorded. However, in general there was insufficient detail for an ecological impact assessment for such a project as this, and further surveys were deemed necessary regarding certain issues.

12.4.1.2 Mammals

Results documented in Shek (2006) [12-66] and Shek *et al.* (2007) [12-67], based on surveys carried out between 2002 and 2006 represent the most systematic mammal survey data available in HK. Although mammal surveys were also conducted within and around the LMC Loop area by ENSR (2009) [12-30a] from March 2008 to February 2009, no species of high conservation concern, in particular Eurasian Otter, were recorded. In view of this, further investigation of the occurrence of this species in the area was deemed necessary.

12.4.1.3 Herpetofauna

ENSR (2009) conducted a detailed survey for herpetofauna (from April to November 2008 for reptiles and from March to September 2008 for amphibians) in the LMC Loop and areas within 500m. The species recorded in the LMC Loop were typical of the Deep Bay area, with no unexpected records. Given that habitat characteristics of the site remain the same as at that time, and that the area is underlain by potentially contaminated mud that might affect environmental quality, it was considered highly unlikely that the herpetofauna community would have changed in the interim. However, site visits to confirm current site conditions were carried out, as well as surveys to validate that the faunal community remains similar to that previously described.

Herpetofauna surveys were also conducted in areas near the LMC Loop (from May to August 2008 at Ha Wan Tsuen, LMC San Tsuen and HHW and from March to June 2009 at Ma Tso Lung) during the LUPCAFS and NENT NDA PES. All these surveys were conducted at the most appropriate time (i.e. wet season, night-time for frogs) and applied survey methodologies (i.e. detecting mating calls, searching at microhabitats) suggested in the EIAO Guidance Notes 07/2002 and 10/2004. In these studies, nearly all lowland amphibians and certain reptile species that typically appear in lowlands (c.f. Reels *et al.* 1995^[12-61], Karsen *et al.* 1998^[12-40] and Chan *et al.* 2005^[12-27]) were recorded. Consequently, it was considered that herpetofauna data from certain sites of the present Ecological Assessment Area, such as LMC Loop and Ha Wan Tsuen, LMC Tsuen and certain parts of HHW, should be up-to-date and comprehensive.

12.4.1.4 Odonata

As with herpetofauna, the odonate data available for the LMC Loop were assessed as representative and accurate because the data collected are relatively recent and the findings comparable to those of other studies carried out in similar habitats in the Deep Bay area (i.e. Wilson 1995^[12-76], AEC 2008^[12-1]). It was considered that present surveys should be concentrated on areas that have not previously been examined in detail (i.e. HHW and Ma Tso Lung).

12.4.1.5 Butterflies

Habitats contained within LMC Loop comprise reedbed and relatively poor quality and degraded lowland grassland and plantation. These habitats generally support a relatively low diversity of butterfly species in Hong Kong. Based on comparison with data from other parts of the Deep Bay area, including the LMC WMA, it was considered that the results from previous surveys in LMC Loop are representative of the species occurring in the LMC Loop. Consequently, it was not considered necessary to conduct regular surveys in LMC Loop, although surveys to confirm no change in the overall butterfly community were carried out in 2009 and 2010, and butterflies observed during surveys for other groups were recorded where possible. This work confirmed that the butterfly community of LMC Loop remains relatively impoverished, and is, broadly speaking, accurately reflected in ENSR (2009)^[12-30a].

Surveys in adjacent areas have previously been conducted by ENSR (2009)^[12-30a], the EIA Study for the Construction of a Secondary Boundary Fence and new sections of Primary Boundary Fence and Boundary Patrol Road^[12-52] and LUPCAFS. The habitats present in adjacent areas are more suitable for butterflies than those within the LMC Loop itself, and consequently the diversity of butterfly species recorded is also higher.

12.4.1.6 Aquatic Fauna

Given the polluted nature of the water in and around the LMC Loop, the data presented by SESRC (2009)^[12-68], which revealed a highly impoverished aquatic community in the Shenzhen River, and ENSR (2009)^[12-30a], which recorded low

diversity in the LMC Meander, are considered to be representative. Survey efforts were thus concentrated on other aquatic bodies of the Ecological Assessment Area.

12.4.1.7 Data Gaps

Given the predominance of reed marsh and grassland habitats in LMC Loop, more detailed information regarding usage by birds of these habitats was required in order to assess ecological value and predict and evaluate impacts caused by their loss.

The primary data gap was that concerning flight lines used by birds in the area (including the LMC Loop, LMC Meander and adjacent fish ponds). The only relevant data were those relating to Great Cormorants flying toward the HHW area in a 5-year period up to 2005 [12-10]. However, this study only surveyed the number of cormorants, and no other large waterbird species, nor factors such as the area over which birds flew or the height of flight. Accurate assessment of these was required in order to assess the potential impact of development in the LMC Loop and associated supporting infrastructure.

The numbers and distribution of fauna in the potentially impacted fish ponds and associated wetlands at HHW relevant to this Study also required specific survey, as ongoing and previous work did not cover the exact spread of ponds.

While ENSR (2009) [12-30a] carried out surveys for mammals, no records of Eurasian Otter were obtained. This is not surprising as it is a difficult species to effectively survey. Sight records from the area, the presence of suitable habitats and a relative lack of disturbance did, however, suggest there may be a reasonable population. Consequently, further survey work, though of a different nature, was considered necessary.

The LMC Meander constitutes a mitigation area for fish pond loss as a result of the training of the Shenzhen River. However, it does not appear to have been comprehensively surveyed by previous studies, and further fieldwork was considered necessary to determine its importance to birds, in particular.

While the grassy hills between LMC Tsuen and Ma Tso Lung Tsuen were surveyed previously, issues arising from any road connection to the LMC Loop through this area needed to be specifically addressed, especially in relation to natural streams. Consequently, appropriate fieldwork was carried out.

Construction of the Western Connection Road had potential impacts on wet agriculture and marsh near LMC Tsuen and Chau Tau Tsuen. Some of these areas had not been surveyed in recent years, and fieldwork was required to fill this gap. Provision of the Eastern Connection Road through the Ma Tso Lung area also required targeted surveys, particularly with regard to natural stream corridors potentially suitable for Three-banded Box Terrapin.

With regard to butterflies, previous surveys were not sufficient to fully describe the importance of areas outside LMC Loop potentially impacted by road construction. Field surveys were conducted to assess the importance of these areas for butterflies.

Aquatic surveys had been conducted in the natural water bodies in the aquatic assessment area; however, usually only food fishes and exotic species were recorded. Although these results may simply reflect the history of the area as a

centre of fish farming, it was considered necessary to explore natural aquatic habitats, especially natural streams, around LMC Loop.

With regard to wetland habitats west of the LMC BCP, in view of the significant ecological barrier provided by San Sham Road and the MTR LMC Spur Line viaduct, as well as the fact that the LMC WMA is intensively monitored in respect of its EP targets, it was not considered necessary to carry out survey work in this area (see **Appendix 12-16** for list of faunal species recorded). With regard to STEMDC, existing data arising from monitoring work carried out by AFCD and, formerly, by the Study Team, meant that survey work was not considered necessary (see **Appendix 12-17** for list of bird species recorded).

12.4.2 Survey Methodology

The surveys undertaken were designed to provide an ecological baseline description sufficient to meet the requirements of the EIAO that impacts can be predicted, described and, where possible, quantified. Thus, the surveys were designed not only to fill the data gaps listed above, but also collect other relevant baseline data.

Below a summary is provided of the fieldwork carried out. Most surveys were carried out during the period between June 2009 and May 2010 (see **Table 12-2**). Surveys for fireflies, however, were carried out in the 2012 wet season (see **Section 12.4.4.7**). Transect routes and count locations for the various ecological surveys conducted are presented in **Figure 12.2**.

Table 12.2 Schedule of field survey activities (2009-2010).

Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Habitat mapping		x			x	x						
Botanical survey		x			x	x						
Birds	x	x	x	x	x	x	x	x	x	x	x	x
Bats					x							x
Mammals	x	x	x	x	x	x	x	x	x	x	x	x
Herpetofauna	x	x	x	x	x					x	x	x
Dragonflies	x	x	x	x	x					x	x	x
Butterflies	x	x	x	x	x					x	x	x
Aquatic fauna				x			x					

Detailed methodologies and results of ecological baseline field works are provided in **Appendices 12-1 to 12-11**.

12.4.2.1 Avifauna

Surveys of avifauna comprised the following elements:

- in LMC Loop, monthly point counts at 13 locations were carried out along two transects through accessible areas of the key habitats, targeting the reed marsh in particular;
- to obtain a more accurate picture of usage of reedbed and grassland habitats in the LMC Loop, specifically in relation to the Phragmites-associated species

that are most likely to be impacted by reed marsh loss, bird trapping sessions (under licence from AFCD) using mist-nets were carried out;

- c) flight lines through the area were surveyed once monthly from April to September and twice-monthly from October to March;
- d) with regard to LMC Meander, five-minute point counts were carried out at three locations: the two points where the meander meets/approaches the Shenzhen River, and at a point along the southern section;
- e) fish ponds east of the LMC BCP surrounding the LMC Loop were surveyed on foot along a standard transect for birds once-monthly;
- f) monthly transect surveys of the Ma Tso Lung area were carried out.

12.4.2.2 Mammals

Any observations of mammals or their signs, including Eurasian Otter, made while carrying out other surveys were recorded. When carrying out bird surveys in fish ponds and associated wetlands in particular, searching for otters in the field, given its habitat preferences and behaviour, is a natural extension of the field work. However, given the infrequency of sighting animals in the field, it was considered that questioning people frequently present in the area was potentially a productive method for obtaining a better understanding of otter distribution. Consequently, a questionnaire survey of local fish pond operators was carried out in an effort to determine locations that otters might favour.

The placing of camera traps in the area was considered as a method of survey, but based on experience of the Study Team at LMC WMA, it was considered the chances of success were low, especially as the relative homogeneity of wetland (reed marsh) and other habitats in LMC Loop would have made choosing suitable locations for cameras largely a matter of chance. Furthermore, the difficulty of access to the reed marsh meant there were significant safety issues, which were considered sufficient to preclude both the placing of camera traps and searching for otter holts. Camera traps for the HHW area were also considered, but rejected due to the high probability of theft (again, based on experience of the Study Team at LMC WMA). While ponds at HHW are generally relatively undisturbed, there is more human activity near LMC Loop than elsewhere, and the disappearance of cameras was considered a real possibility. In the event, otter was recorded on two occasions during field surveys, which, given the difficulties of surveying this species, is considered reasonably successful.

Surveys of bats using a bat detector were carried out in October and April (the early dry season and early wet season). As far as possible, bats were identified according to echolocation call structure.

12.4.2.3 Herpetofauna

Surveys of herpetofauna followed the methodology described in EIAO Guidance Note No. 10/2004 and 10/2010. These surveys were carried out in the months of March to October.

12.4.2.4 Odonata

Surveys of herpetofauna followed the methodology described in EIAO Guidance Note No. 10/2004 and 10/2010. These surveys were carried out in the months of March to October.

12.4.2.5 Butterflies

Surveys of butterflies followed the methodology described in EIAO Guidance Note 10/2004 and 10/2010. These surveys were carried out between the months of April and October. The hills above Ma Tso Lung and LMC were surveyed to check for hill-topping individuals of species that may be under-recorded in the lowland areas.

12.4.2.6 Aquatic Fauna

Surveys of aquatic fauna mainly relied on direct observation, since most water bodies within the area are polluted. Nevertheless, subject to water quality, netting/trapping was carried out where required. Surveys were conducted once in the wet season (August to October) and once in the dry season (November to February).

12.4.3 Habitats and Flora Baseline

Figure 12.1 illustrates the habitats in the Ecological Assessment Area, **Appendix 12-1** details the methodology and results of field surveys and **Appendix 12-12** provides photos of habitats. Findings are divided into three areas: LMC Loop, the adjacent area in HK outside LMC Loop excluding the third area, Ma Tso Lung. The latter is separated out due to its nature being different from areas outside the boundary fence in lacking extensive areas of pond and reed marsh.

12.4.3.1 LMC Loop

ENSR (2009)^[12-30a] and Mott Macdonald (2009)^[12-52] identified five (grassland, reedbed, watercourse, village/orchard and abandoned fish pond) and two (abandoned agricultural land/low-lying grassland and marsh) habitats within LMC Loop respectively. LMC Loop is mainly dominated by grassland and reed marsh (regarded as “Marsh” in Mott Macdonald (2009)^[12-52]) areas that have developed in the last decade (ENSR 2009)^[12-30a]. In the current ecological baseline study, eight habitats were identified within LMC Loop, as follows: reed marsh, marsh, grassland, grassland/shrubland, orchard, plantation, channelized watercourse and urban/residential area.

a) Reed Marsh

Reed marsh areas generally result from the invasion of *Phragmites* spp. into low-lying areas where water is retained. This is one of the dominant habitats within the LMC Loop, covering an area of 10.96ha. Continuous and extensive areas of reed marsh are located in the central and southern parts of the LMC Loop, mainly along both sides of the channelized watercourse (**Appendix 12-12**, plate 1). This habitat is dominated by reed *Phragmites australis*, but contains a small amount of *P. karka*. A few examples of the herb *Abelmoschus moschatus* were recorded in this habitat. *Abelmoschus moschatus* is regarded as a restricted species found in

lowland forest margins and wasteground [12-77], but is not of conservation significance.

b) Marsh

Three small marshy areas, which appear to have formed as a result of differential settlement of soils, occupy a total of 0.5ha (**Appendix 12-12**, plate 2). Water quality is poor. A few wetland plant species (such as *Ludwigia octovalvis*, *Eleocharis dulcis*, *Phragmites australis* and *Mariscus umbellatus*) are present along the edges, while the water surface is covered with the floating aquatic herb *Pistia stratiotes* and the grass *Brachiaria mutica*.

c) Grassland

LMC Loop is largely covered by extensive grassland (56.56 ha) that has established through natural succession (**Appendix 12-12**, plate 3). Dominated by grassy vegetation (such as *Brachiaria mutica*, *Panicum maximum* and *Imperata koenigii*) and other herbs and creepers (including *Bidens alba*, *Mimosa pudica*, *Sesbania* spp., *Eupatorium catarium*, *Ipomoea cairica* and *Mikania micrantha*), it is of low floral value.

d) Grassland/Shrubland

Grassland/shrubland (14.62ha in LMC Loop) comprising shrubs (such as *Melastoma candidum*, *Ficus hispida*, *Bridelia tomentosa* and *Lantana camara*) and trees (such as *Macaranga tanarius*, *Sapium sebiferum* and *Leucaena leucocephala*) are commonly found in patches in the extensive grassland (**Appendix 12-12**, plate 3). This floristic composition is very similar to that recorded in ENSR (2009) [12-30a].

e) Orchard

A small orchard (0.96ha) planted with low numbers of Common Banana *Musa x paradisiaca* is present at the southern fringe of the LMC Loop, though it has received minimal human management.

f) Plantation

Plantation consists of tree clumps dominated by exotic tree species (primarily *Acacia confusa*, *Leucaena leucocephala* and *Acacia mangium*) and a few self-sown trees (such as *Macaranga tanarius*, *Bischofia javanica*, *Celtis sinensis* and *Melia azedarach*). These tree clumps are scattered across the extensive grassland and occupy a total of 1.70ha of land within the LMC Loop (**Appendix 12-12**, plate 4).

g) Channelised Watercourse

A channelized watercourse is present in the northeast of LMC Loop, running from the reed marsh area toward the Shenzhen River. As noted above, much of it is occupied by reeds.

h) Urban/Residential Area

This refers to the vehicular track that runs along the edge of LMC Loop adjacent to Shenzhen River.

12.4.3.2 Adjacent Area in HK outside LMC Loop

Previous studies^[12-30a] [12-52] did not survey all relevant parts of the adjacent area, and thus only 11 habitats were described, namely ponds, marsh, stream/river/drainage channel, wet agricultural land, hillside grassland, shrubland, plantation, woodland, village/orchard and developed area. No rare or protected species were recorded. In the current study, 18 habitats were identified in adjacent areas in HK outside LMC Loop, near the Western Connection Road, Direct Link to LMC Station and the Flushing Water Service Reservoir.

a) Pond

Pond is the major habitat type in the adjacent area (35.91ha in the Ecological Assessment Area) and is ecologically of the most significance (**Appendix 12-12**, plate 5). However, the botanical significance of these ponds is limited, based on the work of ENSR (2009)^[12-30a], Mott Macdonald (2009)^[12-52] and surveys for the current study, with only common and widespread species present (46 species recorded by Ove Arup (2009)^[12-57]). They are mostly vegetated with herbaceous species (such as grass *Brachiaria mutica*, *Chloris barbata* and *Panicum maximum*, and other herbs including *Ipomoea aquatica*, *Wedelia trilobata* and *Bidens alba*) along the pond bund. A few naturally established trees (including *Ficus hispida*, *Macaranga tanarius*, *Celtis sinensis* and *Sapium sebiferum*) and fruit trees (such as *Dimocarpus longan*, *Litchi chinensis* and *Musa x paradisiaca*) are also present along the pond bund.

Some ponds are overgrown with herbaceous vegetation such as the grasses *Brachiaria mutica* and *Panicum maximum*, and other herbaceous creepers including *Ipomoea cairica*, *Ipomoea aquatica* and *Mikania micrantha*.

b) Reed Marsh

A small reedbed (dominated by *Phragmites australis* and *Phragmites karka*) adjacent to MTR LMC Station is used for polishing effluent from the secondary treatment plant for the station and associated facilities (illustrated in **Appendix 12-12**, plate 38). A few small patches of reed and marsh habitat are present in areas adjacent to San Sham Road, close to LMC Control Point, and to the southeast corner of the LMC Loop, while a continuous strip of annually-cut reeds has developed along the southern bank of the Shenzhen River for much of the length of the Ecological Assessment Area (**Appendix 12-12**, plate 10). This habitat, which occupies a total of 9.36ha of land, is dominated by *Phragmites australis* and *Phragmites karka*, while other wetland vegetation such as *Aster subulatus*, *Alternanthera sessilis* and *Commelina diffusa* were also recorded.

c) Marsh

Marsh areas are present in a low-lying area/pond alongside LMC Meander to the southeast of LMC Loop and northwest of Chau Tau Tsuen (**Appendix 12-12**, plate 7). This habitat occupies 3.35ha of land, and is dominated by herbaceous vegetation (including grass *Brachiaria mutica*, *Leersia hexandra* and *Panicum paludosum*, and other herbs *Cyclosorus interruptus*, *Colocasia esculenta* and *Ipomoea cairica*). Low numbers of wetland herbs such as *Cyperus* spp., *Phragmites australis* and *Ludwigia octovalvis* are also present. The dominance of herbaceous species (such as herbs *Bidens alba*, climbers *Ipomoea cairica*, *Mikania micrantha* and *Wedelia trilobata*, and grasses *Panicum maximum* and

Paspalum conjugatum) indicates that part of these marsh areas have been disturbed and are in the process of drying up (Yip *et al.* 2010).

d) Mitigation Wetland

A section of mitigation wetland for STEMDC lies within the Ecological Assessment Area, occupying 1.27ha of land between LMC BCP and the river channel. The area is dominated by common herbaceous vegetation, such as grass *Brachiaria mutica* and *Imperata koenigii*, and the herbs *Bidens alba*, *Ipomoea cairica*, *Ipomoea aquatica* and *Aster subulatus*. This marshy area is extensively covered by herbaceous vegetation (such as *Commelina diffusa*, *Ipomoea cairica*, *Bidens alba* and *Neyraudia reynaudiana*). Tree groups comprising weedy tree *Leucaena leucocephala* and other common tree species such as *Acacia confusa* and *Macaranga tanarius* are also present.

Mitigation wetland adjacent to MTR LMC Station comprises managed fish ponds, marshes and reedbed. The bunds of the fish ponds are vegetated with the grasses *Panicum maximum* and *Brachiaria mutica*. Wetland plants planted in marshy ponds (including herbs such as *Bacopa monnieri*, *Commelina diffusa*, *Cyperus malaccensis*, *Polygonum barbatum* and *Polygonum glabrum*) at the time of wetland construction have been gradually enriched by self-sown plants (such as herbs *Cyperus imbricatus*, *Cyperus exaltatus* and *Polygonum lapathifolium* and trees *Macaranga tanarius*, *Melia azedarach* and *Sapium sebiferum*). The floristic diversity in this mitigation wetland is comparatively higher than other mitigation wetlands in the area.

e) Natural Watercourse

Natural watercourse includes LMC Meander (**Appendix 12-12**, plate 9), its riparian vegetation and a few overgrown natural streams close to LMC; total area is 17.18ha. Common and weedy grassy vegetation (such as *Brachiaria mutica* and *Panicum maximum*) and wetland herbs (including *Commelina diffusa*, *Cyperus malaccensis* and *Phragmites australis*) predominate. Isolated shrubs and trees (such as *Lantana camara*, *Ficus hispida*, *Leucaena leucocephala* and *Macaranga tanarius*) are present along the Meander. Many of the small streams in this area are polluted to some extent, often with domestic sewage.

f) Channelised Watercourse

Channelised watercourses constituting 23.55ha primarily comprise Shenzhen River and small channels in the area of LMC, as well as STEMDC (**Appendix 12-12**, plate 8). These watercourses are concrete-lined with limited floristic diversity along the channel (dominated by *Phragmites* spp. along the Shenzhen River, and other grassy vegetation including *Brachiaria mutica* and *Panicum maximum* in other channelized watercourses). The Shenzhen River is heavily polluted.

g) Wet Agricultural Land

A small area (1.29ha) of wet agricultural land is present at LMC Tsuen (**Appendix 12-12**, plate 12). This habitat is dominated by common herbaceous vegetation such as *Alocasia odora*, *Colocasia esculenta*, *Ipomoea aquatica*, *Ipomoea batatas* (ENSR 2009^[12-49a]; Mott Macdonald 2009^[12-52]; the current botanical survey). Isolated shrubs (such as *Lantana camara*) and trees (such as *Ficus hispida* and *Macaranga tanarius*) are also present in this habitat.

Adjacent to Chau Tau Tsuen there is a small area (2.77ha) of wet agricultural land. More intensively managed than the area next to LMC Tsuen and with little in the way of inactive fields, it is cultivated with *Ipomoea aquatica*, *Nasturtium officinale* and patches of *Colocasia esculenta*. The bunds are vegetated with common grasses (*Brachiaria mutica* and *Cynodon dactylon*) and herbs (such as *Bidens alba*, *Kyllinga monocephala* and *Portulaca oleracea*).

h) Seasonally Wet Grassland

A small area of seasonally wet grassland is present to the southwest of Chau Tau Tsuen, occupying a total of 1.68ha of land. It is mainly covered with herbaceous vegetation (including grass *Brachiaria mutica*, *Panicum maximum* and *Paspalum conjugatum*, and other herbs *Bidens alba*, *Alocasia odora*, *Ipomoea aquatica* and *Wedelia trilobata*). Limited wetland species were identified, including *Phragmites australis*, *Colocasia esculenta*, and *Ludwigia octovalvis*.

i) Grassland

Fire-maintained hillside grassland (25.61ha) is present at Ping Hang, to the southeast of the LMC Loop (**Appendix 12-12**, plate 13). This grassland is mainly dominated by common and widespread species such as the fern *Dicranopteris pedata* and grasses such as *Miscanthus sinensis*, *Imperata koenigii* and *Neyraudia reynaudiana*. Shrubs/small trees (such as *Rhus hypoleuca*, *Rhus succedanea*, *Rhodomyrtus tomentosa*, *Breynia fruticosa* and *Desmodium heterocarpon*) and trees (such as *Cratoxylum cochinchinense*, *Aporusa dioica* and *Pinus massoniana*) are also present.

j) Grassland/Shrubland

A small, disturbed area of 1.85ha of grassland/shrubland is present to the southeast of Ha Wan Tsuen. It is mainly covered by common grassy vegetation, weedy herbs and common tree species such as *Litchi chinensis*, *Lagerstroemia speciosa*, and *Syzygium jambos*, with *Leucaena leucocephala* at the fringes.

k) Secondary Woodland

Scattered patches of secondary woodland totalling 8.46ha are present in the hillside area behind Chau Tau Tsuen, Pun Uk Tsuen, Ha Wan Fisherman San Tsuen and Ha Wan Tsuen (Mott Macdonald, 2009^[12-52], the current study). Mature trees such as *Ficus microcarpa*, *Mallotus paniculatus*, *Microcos paniculata*, *Schefflera heptaphylla* and *Sterculia lanceolata* are common in these woodlands. The understorey is dominated by common species such as *Psychotria asiatica*, *Ligustrum sinense*, *Uvaria macrophylla* and *Litsea rotundifolia* var. *oblongifolia*. Exotic fruit trees such as *Dimocarpus longan* and *Litchi chinensis* are commonly planted close to the woodland fringe by the villagers.

The secondary woodland behind Chau Tau and Pun Uk Tsuen was regarded as *fung shui* wood in previous studies (Binnie Black & Veatch 2002^[12-18], Babtie Asia Ltd. 2004^[12-16] but not in Chu (1998)^[12-28] or Yip *et al.* (2004)^[12-78]. This woodland supports moderate floristic diversity^[12-18], and is ecologically and botanically linked with woodland fragments in adjacent areas, and share similar botanical features, including saplings of the protected species *Aquilaria sinensis*.

A sapling of the protected native tree *Aquilaria sinensis* was recorded at the fringe of the secondary woodland adjacent to the access road to LMC Tsuen. A few seedlings and mature tree specimens of this protected tree were also recorded in

the secondary woodland close to Pun Uk Tsuen. This species is common in lowland forest and *fung shui* woods, but is locally protected under Cap. 586. Mature, large tree specimens of *Cinnamomum camphora* were identified in the secondary woodland close to Pun Uk Tsuen. These trees lie outside the area of impact for the Project.

i) Plantation

Roadside screening and ornamental plantation stands are present to the northeast of MTR LMC Station and along Castle Peak Road, occupying a total of 1.29ha of land. Common shrubs (such as *Duranta erecta*, *Calliandra haematocephala* and *Hibiscus rosa-sinensis*) and plantation trees (such as *Casuarina equisetifolia*, *Cassia surattensis*, *Lagerstroemia speciosa*, *Hibiscus tiliaceus* and *Acacia confusa*) predominate.

m) Shrubland

A small area of hillside shrubland of 3.68ha is present close to Ping Hang (**Appendix 12-12**, plate 13) and Ha Wan Fisherman San Tsuen. The hillside shrubland is ecologically linked with the adjoining hillside terrestrial habitats (i.e. grassland, secondary woodland and other shrubland fragments) and supports more diverse and abundant shrubby plants than grassland. It contains the common shrubs *Rhodomyrtus tomentosa*, *Clerodendrum cyrtophyllum*, *Callicarpa kochiana*, *Rhus chinensis* and *Rhaphiolepis indica* and some isolated tree species *Cratoxylum cochinchinense* and *Sapium discolor*. A sapling of the protected native tree species *Aquilaria sinensis* was identified at the shrubland fringe next to the vehicular road to LMC Lookout.

n) Village Area

Village areas totalling 3.05ha are present close to Pun Uk Tsuen, at Ha Wan Tsuen (illustrated in **Appendix 12-12**, plate 27) and close to the Police checkpoint along LMC Road. Trees (such as fruit trees *Dimocarpus longan*, *Mangifera indica*, *Musa x paradisiaca* and *Litchi chinensis*, and others such as *Ficus benjamina*, *Albizia lebbeck* and *Bischofia javanica*) have been planted by villagers for landscaping and economic purposes (ENSR 2009^[12-30a]; the current study). Other naturally established grass and woody species were also recorded, but in limited numbers and most are under management.

o) Urban/Residential Area

Urban/Residential area, comprising MTR LMC Station and associated infrastructure (**Appendix 12-12**, plate 40), roads, public facilities and car parks, occupies 45.74ha of land. Ornamental shrubs (such as *Duranta erecta*, *Ixora coccinea* and *Calliandra haematocephala*) and trees (such as *Cassia surattensis*, *Casuarina equisetifolia* and *Spathodea campanulata*) are present. Limited self-sown vegetation was recorded in this urban/residential area, including common shrubs/small trees (such as *Lantana camara*, *Macaranga tanarius* and *Ficus hispida*) and trees (such as *Leucaena leucocephala*, *Ficus microcarpa*, *Celtis sinensis* and *Cinnamomum camphora*). Mature, large tree specimens of *Celtis sinensis* are also present.

p) Waste Ground

A very small area (0.85ha) of waste ground opposite to the Police checkpoint along LMC Road is covered by weedy herbaceous vegetation such as *Bidens alba*, *Mimosa pudica* and grasses *Brachiaria mutica* and *Cynodon dactylon*.

In addition, very small areas of dry agricultural land and orchard are present, in close association with village areas. These are dominated by cash crop species and are of low ecological value.

12.4.3.3 Ma Tso Lung Area

Ten habitats have been identified in the Ma Tso Lung area, near the proposed alignment of the Eastern Connection Road. These comprise secondary woodland, marsh, grassland, plantation, pond, seasonally wet grassland, orchard, village area, urban/residential area and watercourse.

a) Marsh

A small marsh developed from low-lying abandoned agricultural land is present to the southwest of Shun Yee San Tsuen; this is ecologically linked with adjacent seasonally wet grassland. It supports limited but typical floristic diversity, with the marshy area mainly covered by the fern *Cyclosorus interruptus* and grasses (*Panicum maximum* and *Brachiaria mutica*). Other wetland-associated herbs, including *Alternanthera sessilis*, *Commelina diffusa*, *Ludwigia perennis*, *Ludwigia octovalvis* and *Colocasia esculenta*, are also present. In addition, marsh habitat is also present along the boundary fence road between Shun Yee Tsuen and Horn Hill. This marsh habitat has lower quality than the marsh southwest of Shun Yee Tsuen and it has been overgrown by common herbaceous vegetation such as climber *Mikania micrantha* and *Ipomoea cairica*, grass *Brachiaria mutica* and other herbs *Commelina diffusa* and *Colocasia esculenta*.

b) Pond

Several small ponds are present to the south of Ma Tso Lung Tsuen, and the bunds are dominated by common grasses such as *Brachiaria mutica* and herbs such as *Bidens alba* and *Mikania micrantha*. A small number of ponds lie alongside the boundary fence road, and these are typical fish ponds with pond bunds mainly covered by common grasses *Brachiaria mutica* and *Panicum maximum* and herbs *Bidens alba*.

c) Seasonally Wet Grassland

A rather extensive area of seasonally wet grassland developed from abandoned agricultural land is located to the southwest of Shun Yee San Tsuen (**Appendix 12-12**, plate 15). This low-lying area supports limited wetland-associated plant species. It is extensively covered by common weedy grass (such as *Brachiaria mutica*, *Panicum maximum* and *Pennisetum alopecuroides*), other herbs (such as *Commelina diffusa* and *Cyclosorus interruptus*) and herbaceous creepers (such as *Ipomoea cairica* and *Mikania micrantha*). A few isolated shrubs and trees (such as *Ficus hispida*, *Macaranga tanarius* and *Mangifera indica*) are also present. A small number of fruit trees *Musa x paradisiaca* are present within and along the edge of this habitat.

d) Grassland

Hillside grassland to the northeast of Shun Yee San Tsuen is similar in floristic composition and diversity to grassland identified near Ping Hang.

e) Secondary Woodland

Hillside secondary woodland to the north of Ma Tso Lung supports a closed and continuous canopy dominated by mature and large tree species (including *Celtis sinensis* and *Dimocarpus longan*). Common secondary woodland herbs (including *Alocasia odora* and *Liriope spicata*), shrubs/small trees (such as *Psychotria asiatica*, *Ficus hirta*, *Litsea rotundifolia* var. *oblongifolia*, *Ligustrum sinense* and *Bridelia tomentosa*) and trees (such as *Mallotus paniculatus*, *Microcos paniculata*, *Phyllanthus emblica*, *Aporusa dioica* and *Litsea glutinosa*) are present in this secondary woodland, as well as a single sapling of the protected *Aquilaria sinensis* (data from NENT NDA PES and from current study). This secondary woodland is ecologically linked with adjacent terrestrial hillside habitats (i.e. grassland and shrubland) and provides wildlife habitat and a seed source for the succession of other terrestrial habitats.

f) Orchard

A few small-sized orchards are scattered around the Ma Tso Lung area and are mainly associated with villages. These mainly comprise common fruit trees, including *Dimocarpus longan*, *Mangifera indica*, *Litchi chinensis* and *Prunus persica*, for economic purpose. This habitat type is actively managed, with only limited herbaceous vegetation established naturally.

g) Plantation

A number of plantation stands are present in the area. Unlike roadside plantations that are largely planted with ornamental trees and shrubs under intensive management, these are largely dominated by mature fruiting and native trees. The overstorey largely comprises *Dimocarpus longan* and *Syzygium jambos*, and native trees (including *Celtis sinensis*, *Cinnamomum camphora* and *Microcos paniculata*), but the understorey is limited in floristic diversity, comprising a few common herbs *Alocasia odora* and *Mikania micrantha*, grass *Imperata koenigii* and shrubs/small trees *Psychotria asiatica*, *Ficus hispida* and *Ficus hirta*. These plantation stands are usually protected by the villages. Ecologically, it provides semi-closed canopy for wildlife utilization, but its understorey composition is simpler than natural secondary woodland.

h) Village Area

Several village areas (Ma Tso Lung San Tsuen, Shun Yee San Tsuen and scattered village houses in Ma Tso Lung) are present. Vegetation recorded in these villages has usually been planted by villagers (such as fruit trees *Mangifera indica*, *Clausena lansium* and *Musa x paradisiaca*, and ornamental trees *Thuja orientalis* and *Acalypha wikesiana*). Naturally established species are also present, including herbs (*Bidens alba*, *Euphorbia hirta* and *Emilia sonchifolia*), shrubs and trees (such as *Bridelia tomentosa*, *Ficus microcarpa*, *Michelia x alba* and *Microcos paniculata*). Vegetation identified in this habitat is common and widespread.

i) Urban/ Residential Area

Urban/Residential area includes roads, Lo Wu Firing Range, public facility and a school. Vegetation in this habitat is limited and comprises common and ornamental species similar in composition to other anthropogenic areas.

j) Watercourse

Watercourses are found at Ma Tso Lung and Tse Koo Hang. That at Tse Koo Hang is largely natural but the water level can be very low in winter, and it was dry during the dry season survey. In Ma Tso Lung Stream there is always a considerable water level throughout the year. Although this stream is also largely natural, it receives untreated sewage from nearby village houses and contains many exotic species. However, stream water quality is still not very bad and species of high conservation concern were recorded in an upper section during survey for the NENT NDA PES. Riparian zones of these two streams are mostly natural, except for some areas alongside Ma Tso Lung Stream where village houses are located. The lower section of this stream has recently completed channelization by DSD using ecologically-friendly methods (i.e. using stone gabion and maintaining a semi-natural streambed). Both streams drain into marshy areas at Hoo Hok Wai. The streams are mainly vegetated by herbaceous plants, including *Colocasia esculenta*, *Alocasia macrorrhizos*, *Alternanthera sessilis*, *Commelina diffusa* and *Panicum maximum*.

12.4.4 Fauna Baseline

Figure 12.2 shows the transect routes, pond numbers, point count locations and flight line count locations for surveys.

12.4.4.1 Avifauna

Scientific names for avifauna are provided in **Appendix 12-2**, which provides a list of all bird species recorded in the whole assessment area for ecology, together with typical habitat utilisation. Nomenclature and taxonomy follow Carey *et al.* (2001)^[12-22] and subsequent updates published in the HKBR up to 2010.

Flight Line Surveys

a) Literature Review

The only relevant data are those relating to Great Cormorants flying toward the HHW area in a 5-year period up to 2005^[12-10]. During this period, up to 2,627 or 27.5% of the wintering population of Great Cormorants were recorded at LMC Lookout flying to HHW from LMC.

b) Survey Results

Methodology and results of the flight line surveys are contained in **Appendix 12-3**, while **Figures A12-1 - A12-21** in **Appendix 12-3** illustrate the main findings of the surveys. The main conclusions to be drawn from these surveys are as follows:

- in the figures above, it can be seen that the main area of the flight line corridor is concentrated over LMC Meander, an area up to approximately 150m wide in the immediately adjacent part of LMC Loop (170m at the

widest point) and the fish ponds on the opposite side to a width of approximately 50m;

- entry to the LMC Loop area is concentrated in the vicinity of Ha Wan Tsuen in winter and between Ha Wan Tsuen and the junction of Lung Hau Road (see **Appendix 12-12**, plate 22) with LMC Road in the wet season;
- access to the HHW fish pond area is concentrated in the area near Ngau Kok Shan where the eastern section of LMC Meander parallel to the border fence turns northwest toward Shenzhen River;
- the Shenzhen River is used as a minor focus of flight lines, with 8.8% of bird-flights recorded over the channel;
- relatively few birds fly directly over the central part of LMC Loop;
- the overall distribution of flight heights is influenced by the presence or absence of anthropogenic or natural features. Thus, flight heights are in general highest in the southwest, where there is higher ground, the MTR LMC Spur Line and the BCP, and lowest in the east and northeast, where largely only fish ponds lie adjacent;
- the distribution of flight lines to HHW is more concentrated than those in the opposite direction to LMC, though the overall focus on LMC Meander is broadly similar;
- Great Cormorants in particular use the Meander as a strong focus for their flight lines. The distribution of Great and Little Egrets is somewhat broader, with both occurring relatively more often over the interior part of LMC Loop and the Shenzhen River. Chinese Pond Herons show some preference for the Meander, but this may be due to a preference for fish ponds rather than the Meander *per se*, as this species does not generally carry out such long flights to and from foraging areas.
- the distribution of Black-faced Spoonbill flight lines is also focused on LMC Meander, though probably less significantly than other species;
- HHW continues to support an important element of the regionally significant Deep Bay area non-breeding population of Great Cormorant;
- a significant proportion of the Deep Bay population of Great and Little Egrets utilises the HHW area in certain months;
- the HHW area appears to be of greater importance to Great Egrets, possibly because it is relatively undisturbed, which would be attractive to such a large and relatively disturbance-sensitive species.

LMC Loop

a) Literature Review

ENSR (2009)^[12-30a] recorded the following species of conservation significance in the LMC Loop: Purple Heron, Little Egret, Chinese Pond Heron, Imperial and Greater Spotted Eagles, and Chinese Penduline Tit. The dearth of open water habitat explains the lack of large waterbird species such as Great Cormorant, Grey

Heron and Great Egret, despite their abundance in nearby wetland areas. In contrast, species such as Purple Heron, Chinese Pond Heron and Chinese Penduline Tit favour vegetated wetlands and have occurred in appropriate habitats in the LMC Loop, which is dominated by grassland and reed marsh.

The only other species of conservation significance recorded by ENSR (2009)^[12-30a] in habitats common in the LMC Loop is Zitting Cisticola, which occurs in grassland areas. This is a scarce breeding species in Hong Kong, primarily confined to the northwest New Territories^[12-22], and is listed by Fellowes *et al.* (2002)^[12-31] as of Local Concern.

b) Survey Results

Methodology and results of transect surveys, point counts and mist-netting surveys relevant to LMC Loop are provided in **Appendices 12-4 and 12-5**.

The trapping and point count surveys carried out for this Study have confirmed the presence of all the species mentioned in previous literature, as well as other reed marsh-associated species. A list of species of conservation concern recorded utilising LMC Loop (i.e. not simply flying over) and the habitats in which each was recorded is provided in **Table 12.3**, together with an indication of their conservation status.

Table 12.3 Avifauna of conservation concern recorded in LMC Loop and habitat utilisation.

Species	Habitat	Conservation Status		
		Global	HK	China
Great Cormorant 鷺鷥	Plantation		PRC	
Grey Heron 蒼鶲	Plantation		PRC	
Purple Heron 草鶲	Reed Marsh		RC	
Great Egret 大白鶲	Plantation		PRC(RC)	
Intermediate Egret 中白鶲	Grassland		RC	
Little Egret 小白鶲	Pond		PRC(RC)	
Cattle Egret 牛背鶲	Grassland		(LC)	
Chinese Pond Heron 池鷺	Pond		PRC(RC)	
Black-crowned Night Heron 夜鷺	Plantation		(LC)	
Yellow Bittern 黃葦鳽	Reed Marsh		(RC)	
Cinnamon Bittern 栗葦鳽	Reed Marsh		LC	
Black Kite 黑鳶	Plantation		(RC)	
Pied Harrier 鵠鵠	Reed Marsh		LC	
Eastern Marsh Harrier 白腹鵠	Reed Marsh		LC	
Pheasant-tailed Jacana 水雉	Pond		LC	
Wood Sandpiper 林鶴	Pond		LC	
Pintail/Swinhoe's Snipe 針尾/大沙錐	Pond, Grassland		LC*	
Lesser Coucal 小鴟鵟	Grassland			2
Pied Kingfisher 斑魚狗	Pond		(LC)	
White-throated Kingfisher 白胸翡翠	Pond		(LC)	
Red-throated Pipit 紅喉鶲	Pond, Grassland		LC	
Bluethroat 藍喉歌鴝	Reed Marsh		LC	
Pallas's Grasshopper Warbler 小蝗鶯	Reed Marsh		LC	
Zitting Cisticola 棕扇尾鶯	Reed Marsh, Grassland		LC	
Golden-headed Cisticola 金頭扇尾鶯	Grassland		LC	
Chinese Penduline Tit 中華攀雀	Reed Marsh		RC	

Species	Habitat	Conservation Status		
		Global	HK	China
Chestnut-eared Bunting 栗耳鶲	Grassland		LC	
Yellow-breasted Bunting 黃胸鶲	Reed Marsh	V	RC	
Yellow-billed Grosbeak 黑尾蠟嘴雀	Plantation		LC	
Red-billed Starling 絲光椋鳥	Plantation		GC	
White-cheeked Starling 灰椋鳥	Plantation		PRC	
White-shouldered Starling 灰背椋鳥	Plantation		(LC)	
Black-naped Oriole 黑枕黃鸝	Plantation		LC	
Collared Crow 白頸鴉	Plantation		LC	

Note:

[1] Global conservation status assessments are those of IUCN/BirdLife International (www.birdlife.org), Hong Kong assessments are from Fellowes et al. (2002); categories are LC=Local Concern, RC=Regional Concern, GC=Global Concern, P=Potential, while those in parentheses indicate the assessment is on the basis of restrictedness in breeding and/or roosting sites rather than in general occurrence. Listing as 1st or 2nd grade protected species in China is from Wang (1998). * Species generally inseparable in field; conservation status assessment refers to *G. megala*.

Although almost the full suite of egrets and herons regularly recorded in HK was noted during surveys, the number of individuals was low (no more than two individuals of each), and species such as Great Cormorant, Grey Heron and Great Egret were recorded roosting in trees, not foraging. The low number of individuals is due to the lack of open water habitat, and LMC Loop is not considered to be an important site for these species.

Two of the waterbird species listed, however, are reed-associates: Purple Heron, and Yellow Bittern. Purple Heron was recorded twice, once in the reedbed and once foraging in LMC Meander. Yellow Bittern, despite being a fairly common summer visitor and autumn migrant through reedy wetland areas in HK, was only recorded once in the reedbed. The low number of records of these species, in addition to the absence in winter of Great Bittern, indicates that reed marsh in LMC Loop is not as high in terms of ecological value as the managed reedbed at Mai Po NR, which supports higher numbers of all these species.

With regard to non-waterbird species of conservation concern, both trapping (four individuals) and point count (peak count four) surveys recorded good numbers throughout the winter period of Bluethroat, while point counts recorded good numbers (peak count 27) of Chinese Penduline Tit; both of these are passerine species of conservation concern, the former rated as of Local Concern and the latter of Regional Concern by Fellowes et al. (2002)^[12-31].

The two cisticolas were recorded in grassland and reedbed habitats, with Golden-headed favouring grassland and Zitting showing no marked preference in the non-breeding season.

The only globally-threatened passerine species recorded (as defined by BirdLife International) was Yellow-breasted Bunting, of which four were recorded in reed marsh habitat in October (one trapped, the remainder seen). This habitat may be of some significance to this species at a local level.

The mist-netting surveys provided re-trap records (i.e. individual birds trapped again in later trapping periods) that indicated some passage migrants (e.g. Oriental Reed Warbler and Black-browed Reed Warbler) remained in the area, using the reed marsh as a stopover during migration to build up fat reserves before

continuing their migratory journey. In addition, a Dusky Warbler trapped on 21st October was subsequently retrapped on 29th October at Mai Po NR, indicating some degree of connection between the two sites for migrant passerines. This connectivity was also indicated by observations of Pied and Eastern Marsh Harriers that could be individually identified by their plumage leaving a nocturnal roost in the LMC Loop reed marsh and the same birds seen at Mai Po NR around the same time.

In terms of other species listed in **Table 12.3**, the number of individuals recorded was not so high as to suggest habitats in LMC Loop are important.

LMC Meander

a) Literature Review

No records of birds could be traced in the literature that directly referred to LMC Meander, probably because such reports have been subsumed in broader area designations such as HHW or LMC. However, members of the study team have noted in past years its use as both a foraging and roosting area by such species as Little Grebe, Great Cormorant, Grey Heron, Great Egret, Little Egret, Chinese Pond Heron and Black-crowned Night Heron.

b) Field Surveys

Table A12-13 in **Appendix 12-5** lists the species recorded in LMC Meander. It continues to provide roosting and foraging areas for small numbers of the large waterbirds listed above. Fish in the Meander provide foraging opportunities for piscivorous species, while the dense vegetation along the banks provide suitable daytime roosting conditions for species such as Black-crowned Night Heron and Great Cormorant. In addition, a Purple Heron was recorded in October foraging in dense vegetation along the northern section of the Meander, while an Imperial Eagle was recorded there midwinter. Water quality is not poor, as is the case in the Shenzhen River.

Wetlands in the LMC and HHW Areas

a) Literature Review

The fishpond areas that extend east from San Sham Road comprise much of HHW are of particular importance for wetland birds due to a combination of suitable habitat and a relative lack of fragmentation and disturbance. Approximately 140ha or 19% of the Ecological Assessment Area outside LMC Loop comprises fishponds.

The waterbirds of these areas are comparatively well known due to the Mai Po Inner Deep Bay Ramsar Site Waterbird Monitoring Programme (WBMP) carried out by the Hong Kong Bird Watching Society (HKBWS) since the early 1990s (funded by Agriculture, Fisheries and Conservation Department (AFCD) under service contract arrangement). Knowledge of landbird usage of the site has been acquired from Carey *et al.* (2001)^[12-22], various issues of the *HKBR* and by inference from surveys carried out in other fishpond areas of the northwest NT.

Wetland-dependent bird species are the primary constituent of the ecological significance of fishpond areas in the northwest New Territories, and the fishponds located within the Ecological Assessment Area are no different (see **Appendix**

12-5). Of particular note are breeding, passage and wintering populations of large waterbirds, including egrets, herons, duck and spoonbills. Significant numbers of the globally-threatened Black-faced Spoonbill occur at the MTR LMC Spur Line WMA, while smaller numbers occur at HHW. Strong linkages exist between HHW and the wetland areas to the west of LMC BCP, including the intertidal areas of Inner Deep Bay, as confirmed by radio-telemetry studies of Black-faced Spoonbills^[12-8] and flight line counts of cormorants^[12-10].

The WBMP includes surveys of 77 fish ponds that lie in the area from LMC BCP to HHW (survey area ‘Shenzhen River B’). In terms of the total area of fishponds east of the LMC BCP (185.29ha), approximately 50% of these ponds (93.14ha) are surveyed each month.

In terms of overall numbers, the highest counts of waterbirds are made in the winter months, with the five highest counts of birds having occurred in the months January to March. These counts lay in the range 879-1063 birds and constituted 15.7% to 48.7% of the total number of waterbirds recorded in fishpond areas of Deep Bay in the same months (**Table 12.4**).

Table 12.4 The five highest counts of waterbirds at HHW (Shenzhen River B) in the HKBWS/AFCD Mai Po Inner Deep Bay Ramsar Site WBMP since December 1998, and the percentage each count comprises of the total Deep Bay fish pond count of waterbirds.

Date	Deep Bay fish pond area count	HHW Count	Percentage of Deep Bay fish pond count
March 2001	2183	1063	48.7%
February 1999	4430	966	21.8%
February 2004	3523	960	27.2%
January 2005	5920	927	15.7%
January 2002	2889	879	30.4%

From December 1998 to June 2009 the number of waterbirds recorded at HHW averaged 15.1% of the total for all fishponds surveyed in the Deep Bay area. As might be expected given the higher levels of disturbance and smaller pond size, the fishponds lying along the southeast edge of the LMC Loop (pond numbers 1-39 alongside Ha Wan Tsuen Road and the boundary fence road) supported a proportionately lower (by approximately 40%) number of waterbirds than the ponds in the core area of HHW itself, where disturbance levels are lower, pond size is larger and habitat diversity is greater.

As noted above, HHW provides an important foraging area for egrets and herons during both the breeding and non-breeding seasons. Previously, the area was known to be an important foraging area for Chinese Pond Herons breeding at the Ho Sheung Heung egretry^[12-14], although its significance in this respect appears to have declined in recent years, with approximately 25% (compared with 48% in 1995^[12-14]) recorded flying to this area in the 2009 breeding season (field work for NENT NDA PES). During field work conducted for *Agreement No. PLNQ 73/2011 Ecological Field Survey of Hoo Hok Wai* in the 2012 breeding season, approximately 36% of flight lines from the egretry headed toward HHW.

The HHW area is also an important foraging ground for the Hong Kong wintering population of Great Cormorants. The most recent data available concern winter

2004-05, when up to 2627 birds or 27.5% of the then wintering population was recorded flying to forage in fishponds at HHW^[12-10].

Imperial and Greater Spotted Eagles, both listed as globally threatened species by BirdLife International, occur regularly in Hong Kong only in the Deep Bay wetlands. Previously, these birds frequently occurred at HHW; however, apparently as a result of a decline in duck farming in the area, they are now only occasionally recorded there^[12-22]. Both, however, were recorded by ENSR (2009) [12-30a] and during fieldwork for this study in the LMC Loop.

The reedbed-associated species recorded by ENSR (2009)^[12-30a] in the LMC Loop (Purple Heron and Chinese Penduline Tit) also occur in reedbeds at HHW, though less commonly. The reed areas at HHW are in general drier and more fragmented; however, they have strong ecological linkage with adjacent wetland habitats, in particular freshwater marsh.

b) Field Surveys

Data from field surveys confirmed the continued importance of HHW to waterbirds (see **Appendix 12-5**). Black-faced Spoonbill was recorded foraging at ponds during draindown, along with Grey Heron, Great and Little Egrets, and Chinese Pond Heron. There were no records of either of the two globally-threatened eagles during the transect surveys, though an Imperial was recorded over LMC Meander (see above). While these eagles do still occur in the LMC Loop and HHW area, as noted above, their numbers appear to have declined significantly. Bluethroat was regularly recorded in marsh, dense grassy vegetation and reedy areas at the margins of ponds during the winter months, and in Marsh 1 at HHW. Chinese Penduline Tit, however, was recorded only once in Marsh 1, indicating the poorer quality of the reed areas compared with that in LMC Loop.

The overall distribution of waterbirds in the area as recorded during transect surveys is illustrated in **Figures A12-22-25**. Fewest waterbirds were recorded in the fish ponds along Ha Wan Tsuen Road to the southwest of LMC Loop and the boundary fence road to the southeast. These ponds are generally small in size, more disturbed, support less habitat diversity and, in the case of those along Ha Wan Tsuen Road, generally long inactive with a profile unfavourable to waterbird access. The exception were ponds 11, 12 and 21, which regularly held roosting cormorants; in addition, up to 13 Black-faced Spoonbills were regularly reported foraging in pond 12 (illustrated in **Appendix 12-12**, plate 31) in winter 2011-12. Highest numbers of waterbirds in the ponds surveyed were concentrated in fish ponds to the northeast of LMC Loop.

In terms of non-waterbird species in fish pond areas, the typical suite of resident species present is common and widespread throughout HK and regionally, and not of conservation significance. Migrant passerines occurred during the autumn, winter and spring seasons, typically comprising wagtails, pipits, warblers, buntings and starlings. Most of these occurred in the more extensive, open fish pond areas, however, rather than in the area of Ha Wan Tsuen Road and the boundary fence road, where the area of ponds is narrow and rather more closed due to the presence of shrubs and trees. Passerine species (other than the common and widespread species mentioned above) recorded along Ha Wan Tsuen Road comprised Plaintive Cuckoo, White Wagtail, Olive-backed Pipit, Common Stonechat, Yellow-browed Warbler, Little Bunting, Yellow-billed Grosbeak, Scaly-breasted Munia and Red-billed and White-shouldered Starling.

All species of conservation concern recorded at HHW both in the literature and during the current study are listed in **Table 12.5**.

Table 12.5 Species of conservation significance recorded at HHW and their status at HHW and in HK.

Species	BirdLife	Fellowes et al.	Status in HHW (HK)
Little Grebe 小鷦鷯		LC	Common all year (1)
Great Cormorant 鷗鴞		PRC	Common winter visitor (2)
Grey Heron 蒼鷺		PRC	Present all year (1)
Great Egret 大白鷺		PRC(RC)	Common all year (1)
Little Egret 小白鷺		PRC(RC)	Common all year (1)
Cattle Egret 牛背鷺		(LC)	Common all year (1)
Chinese Pond Heron 池鷺		PRC(RC)	Common all year (1)
Striated Heron 綠鷺		(LC)	Rare summer visitor (5)
Black-crowned Night Heron 夜鷺		(LC)	Common all year (1)
Black-faced Spoonbill 黑臉琵鷺	E	PGC	Occ. winter records (2)
Eurasian Wigeon 赤頸鴨		RC	Rare (2)
Falcated Duck 羅紋鴨	NT	RC	Rare (4)
Common Teal 綠翅鴨		RC	Scarce (2)
Chinese Spotbill 斑嘴鴨 #		RC	Rare (4)
Northern Pintail 針尾鴨		RC	Scarce (2)
Northern Shoveler 琵嘴鴨		RC	Scarce (2)
Tufted Duck 凤頭潛鴨		LC	Scarce (2)
Red-breasted Merganser 紅胸秋沙鴨		LC	Rare (4)
Osprey 鴟		RC	Scarce (1)
Black Kite 黑鳶		(RC)	Common all year (1)
Greater Spotted Eagle 烏鵰	V	GC	Previously regular, now rare (4)
Imperial Eagle 白肩鵰	V	GC	Previously regular, now rare (4)
Eurasian Coot 白骨頂		RC	Small numbers in winter (4)
Bonelli's Eagle 白腹山鵟		(RC)	Regular visitor (1)
Eurasian Hobby 燕隼		(LC)	Scarce migrant (6)
Eurasian Coot 白骨頂		RC	Scarce in winter (2)
Pheasant-tailed Jacana 水雉		LC	Scarce migrant (6)
Greater Painted-snipe 彩鸕		LC	Scarce migrant (5)
Black-winged Stilt 黑翅長腳鶲		RC	Regular, winter and passage (3)
Pied Avocet 反嘴鶲		RC	Rare in winter (2)
Oriental Pratincole 普通燕鶲		LC	Passage migrant (6)
Grey-headed Lapwing 灰頭麥雞		LC	Rare migrant (4)
Pacific Golden Plover 太平洋金斑鶲		LC	Scarce (3)
Little Ringed Plover 金眶鶲		(LC)	Present all year (1)
Kentish Plover 環頸鶲		RC	Rare on passage (2)
Greater Sand Plover 鐵嘴沙鶲		RC	Rare on passage (6)
Spotted Redshank 鶴鶲		RC	Scarce (3)
Marsh Sandpiper 澤鶲		RC	Scarce (3)

Species	BirdLife	Fellowes et al.	Status in HHW (HK)
Common Greenshank 青腳鶲		RC	Scarce (3)
Wood Sandpiper 林鶲		LC	Present all year (3)
Pintail/Swinhoe's Snipe 針尾/大沙錐		LC*	Scarce migrant (3)
Red-necked Stint 紅頸濱鷸		LC	Scarce (3)
Temminck's Stint 青腳濱鷸		LC	Scarce (3)
Long-toed Stint 長趾濱鷸		LC	Scarce (3)
Dunlin 黑腹濱鷸		RC	Rare on passage (2)
Ruff 流蘇鶲		LC	Scarce (3)
Black-headed Gull 紅嘴鷺		PRC	Scarce (3)
Pied Kingfisher 斑魚狗		(LC)	Present all year (1)
White-throated Kingfisher 白胸翡翠		(LC)	Present all year (1)
Oriental Skylark 小雲雀		LC	Rare (6)
Citrine Wagtail 黃頭鵝鶲		LC	Rare (3)
Red-throated Pipit 紅喉鶲		LC	Common (3)
Buff-bellied Pipit 黃腹鶲		LC	Rare (3)
Bluethroat 藍喉歌鶺		LC	Scarce (2)
Pallas's Grasshopper Warbler 小蝗鶯		LC	Scarce (3)
Styan's Grasshopper Warbler 史氏蝗鶯	V	GC	One record (Aspinwall 1997) (4)
Zitting Cisticola 棕扇尾鶯		LC	Present all year (1)
Golden-headed Cisticola 金頭扇尾鶯		LC	Scarce (1)
Chinese Penduline Tit 中華攀雀		RC	Regular in winter (2)
Chestnut-eared Bunting 栗耳鶲		LC	Scarce (3)
Yellow-breasted Bunting 黃胸鶲	V	RC	Regular in winter and on passage (3)
Japanese Yellow Bunting 硫黃鶲	V	GC	Rare (6)
Yellow-billed Grosbeak 黑尾蠟嘴雀		LC	Regular all year (1)
Red-billed Starling 絲光椋鳥		GC	Common in winter (2)
Purple-backed Starling 北椋鳥		LC	Scarce (6)
White-cheeked Starling 灰椋鳥		PRC	Common in winter (2)
White-shouldered Starling 灰背椋鳥		(LC)	Present all year (1)
Black-naped Oriole 黑枕黃鸝		LC	Scarce (6)
Collared Crow 白頸鴉	NT	LC	Common all year (1)

Notes:

- [1] BirdLife International: E = Endangered, V = Vulnerable, NT = Near-threatened. Fellowes et al. (2002): RC = Regional Concern, GC = Global Concern, PGC = Potential Global Concern. * species generally inseparable in field, conservation status for *G. megala*. # indicates change in taxonomic treatment since Carey et al. (2001).
- [2] HK status: 1: present all year; 2: winter visitor; 3: winter visitor and passage migrant; 4: scarce winter visitor; 5: present all year, mainly summer; 6: mainly passage migrant.

Wet Agricultural areas at LMC Tsuen and Chau Tau Tsuen

a) Literature Review

There are very few records from LMC Tsuen in the literature, as its location in the Closed Area has restricted access for many years. Chau Tau Tsuen, however, was regularly visited in the 1980s and 1990s (though it was referred to as Lok Ma Chau in the *HKBR*).

Greater Painted-snipe, a rare breeding species in Hong Kong and listed as of Local Concern by Fellowes *et al.* (2002)^[12-31], was recorded in active and inactive wet agricultural fields at LMC Tsuen during fieldwork for the LUPCAFS and by ENSR (2009)^[12-30a]. It was also recorded in similar habitat adjacent to Chau Tau Tsuen up to ten years ago. At the same time were also present a suite of freshwater wetland associated species such as smaller ardeids, snipe, sandpipers, Little Ringed Plover, and pipits and wagtails.

b) Field Surveys

Results of field surveys are provided in **Appendix 12-5**. The wet agricultural area at LMC Tsuen appears to have changed relatively little over the past 20 years, especially in comparison to Chau Tau Tsuen (see below). The suite of species recorded is typical of such areas, while the relatively small size of the area means that the number of birds present is not that high. A total of 31 species were recorded, 12 of which are wetland-dependent. Small numbers of wetland-dependent species typically found in wet agricultural areas such as snipe, sandpipers, Little Ringed Plover and Red-throated Pipit were present at appropriate times of year during this Study.

A significant diminution in the area of wet agricultural fields at Chau Tau Tsuen has occurred since the mid 1990s as a result of village expansion and flood protection works. Further, it now almost entirely comprises actively managed fields and there are no overgrown, inactive or abandoned fields to provide habitat diversity or undisturbed roost sites. Together, these developments have reduced the ecological value of the area significantly. This is reflected in the data from the field surveys, which recorded only 22 species, seven of which are wetland-dependent.

The wet agricultural area at LMC Tsuen is of higher ecological value than that at Chau Tau Tsuen, as it is larger, has greater microhabitat diversity and lies adjacent to the large HHW wetland area, with which it presumably has more substantial functional linkages.

Ma Tso Lung

a) Literature Review

There are very few records from Ma Tso Lung in the literature, as its location in the Closed Area has restricted access for many years. References to this place in previous literature generally referred to the fish pond area now referred to as HHW.

b) Field Surveys

The range of species recorded in the Ma Tso Lung area was typical of the mix of lowland village, village-edge and shrubland habitats present, and largely comprised relatively common and widespread resident and migrant species. Only

five wetland-dependent species were recorded, with that of most interest being those of White-throated Kingfisher in the breeding season. White-shouldered Starlings were recorded probably breeding; however, this species is now a fairly common and widespread breeding species in the Deep Bay area.

San Tin East Main Drainage Channel

a) Literature Review

The San Tin Eastern Main Drainage Channel (STEMDC) project was instigated to alleviate flooding problems in the low-lying areas to the east of San Tin and at Ki Lun Tsuen. The project incorporated environmental mitigation measures including compensatory planting, wetland creation and landscape works, which included the establishment of a 3.70ha Constructed Wetland Area (CWA) comprising ponds and reedbed alongside the channel. Additionally, to facilitate vegetation development and animal foraging and breeding, the embankment of the STEMDC was not lined at the lower reaches of the San Tin Eastern Main Channel. The lined channel is trapezoidal, with a fabridam at its confluence with the Shenzhen River, and whilst it is concrete-lined, open cells allow sediment to collect and vegetation to establish. These are periodically cleared.

The CWA was designed as a linear-wetland composed of a series of cells and ponds planted with aquatic macrophytes, including water lilies *Nymphaea* spp., sedges *Carex* spp. and *Lugwigia* sp., and it supports a range of common amphibian and dragonfly species.

Monitoring of the CWA by AFCD in 2010-11 revealed a total of 53 bird species, including 13 species listed under Fellowes *et al.* (2002)^[12-31] as of conservation importance (see **Appendix 12-17**). Sixteen species are considered to be wetland-dependent.

The STEMDC itself offers opportunities to avifauna, particularly wading birds. The embankments and bed of the channel are subject to siltation and become heavily vegetated at times with ruderal and wetland species (e.g. *Ipomea* sp., *Sesbania* sp.) that require periodic clearance. Juvenile Greater Painted-snipe *Rostratula benghalensis* have been recorded from rafts of floating/emergent vegetation along the water's edge, possibly indicating breeding within the channel itself. The muddy channel bed attracts waterbirds particularly during spring and autumn migration and also provides foraging opportunities for wintering waders. Wood Sandpipers, Black-winged Stilts and Pied Avocets are regularly recorded from the channel upstream of the fabridam. Duck, such as Common Teal and Eurasian Wigeon, commonly exploit exposed mud downstream of the fabridam.

b) Field Surveys

Surveys made between 2009 and 2012 by the Study Team recorded 50 species utilizing the channel (**Appendix 12-17**). The majority (27) of these is wetland-dependent, and 24 species are considered to be of conservation concern based on Fellowes *et al.* (2002)^[12-31].

12.4.4.2 Mammals

a) Literature Review

A total of ten mammal species of potential conservation interest are reported in the literature from the Ecological Assessment Area and adjacent areas^{[12-2] [12-66]}

[12-67] [12-1]. Foremost among these is Eurasian Otter *Lutra lutra*, which is a species of global conservation significance ('Near-threatened', IUCN; 'Endangered', CSIS). The Hong Kong distribution of this protected species appears to be confined to the northwest New Territories [12-66]. There are a number of records from adjacent areas at HHW and LMC WMA (**Figure 12.3**).

Others recorded include Small Indian Civet *Viverricula indica*, Small Asian Mongoose *Herpestes javanicus* (though this species is generally regarded as being introduced by man), Leopard Cat *Prionailurus bengalensis*, East Asian Porcupine *Hystrix brachyura* and Ryukyu Mouse *Mus caroli*. Except for the mouse, all are protected under the Wild Animal Protection Ordinance (Cap. 170), while the porcupine is regarded as of Potential Global Concern by Fellowes *et al.* (2002)^[12-31] due to a marked decline in its global population. Although East Asian Porcupine is also widely distributed in Hong Kong and has been recorded in the Ecological Assessment Area, it does not generally occur in the rather disturbed wetland or village edge habitats that predominate.

Based on interviews with local farmers at Long Valley, Hung & Pang (2008)^[12-37] reported the presence of Ferret Badger *Melogale moschata*, Masked Palm Civet *Paguma larvata* and the historic presence of Red Muntjac *Muntiacus muntjak*.

The remaining mammal species reported comprise bats, all of which are protected under Cap. 170. Short-nosed Fruit Bat *Cynopterus sphinx*, Leschenault's Rousette Bat *Rousettus leschenaulti*, Rickett's Big-footed Bat *Myotis pilosus* and Lesser Yellow Bat *Scotophilus kuhlii* are regarded as of Potential Local Concern by Fellowes *et al.* (2002)^[12-31], although Rickett's Big-footed Bat is also listed as Near-threatened by IUCN. All are widely distributed in Hong Kong. Japanese Pipistrelle, which is also widely distributed throughout Hong Kong, also occurs.

b) Field Surveys

Detailed survey methodology and results for mammals are provided in **Appendix 12-6** (other mammals) and **Appendix 12-7** (Eurasian Otter).

A single Eurasian Otter was heard from the reed marsh inside the LMC Loop on 12th October 2009, and a local fish pond operator stated in questionnaire interview that it occurred in the reedbed and associated small marshy areas. A sighting was also made by the Study Team in the LMC Meander on 19th January 2010; the individual swam across the Meander to land on the bank at the southern side of the Loop, and disappeared in the thick bushes there. In addition, a local fish farmer interviewed also reported having seen otter swimming in the LMC Meander and resting on the bank. Finally, local fish farmers interviewed said that otter occurs in the fish pond area at Horn Hill (Ngau Kok Shan). **Figure 12.3** illustrates the locations of all records of Eurasian Otter collated during this Study.

Mammals of potential conservation interest recorded during field surveys comprised Leopard Cat and Red Muntjac. During the present study, footprints of Leopard Cat were observed inside the Loop, while dung of Red Muntjac was observed on grassy hills at Ma Tso Lung. In the past, Leopard Cat has also been observed at HHW and Small Indian Civet has been observed along the Boundary Fence Road to the southeast of the Loop by the study team. Neither Ferret Badger nor Masked Palm Civet was recorded. The wetland habitats that dominate much of the Ecological Assessment Area are not generally suitable for the latter two species, and it is unlikely the area is of significance to local populations.

Three species of bat were recorded in LMC Loop, including Japanese Pipistrelle, Brown Noctule and a third species that could not be certainly identified. All were

recorded foraging over wetland habitats (especially ponds) and grassland. Numbers of all three species were relatively low, especially compared to the abundance of Japanese Pipistrelle in wetland habitats outside the Loop. Japanese Pipistrelle was also recorded abundantly around fish ponds at HHW. These results were confirmed in July 2012 in a bat survey for *Agreement No. PLNQ 73/2011 Ecological Field Survey of Hoo Hok Wai*, during which Japanese Pipistrelle was recorded abundantly, with one noctule bat recorded at HHW near pond 89.

Both identified species are common in Hong Kong^[12-66], although Brown Noctule is listed as a species of Local Concern by Fellowes *et al.* (2002)^[12-31]. It is unlikely that any large bat roosts exist in the LMC Loop due to the lack of suitable habitat, and most bats probably roost in trees or buildings outside the Loop.

c) Discussion

Although Eurasian Otter is widespread in China, it is considered endangered, mainly owing to habitat degradation and overexploitation, and it has also been listed as a Class II Protected Species^[12-30]. In the Pearl River Delta region away from the Deep Bay area, it has been reported at sites such as Nei Ling Ding Island and San Zhou Tian Forest Park, near Yantian, Shenzhen. However, these populations were considered small, and likely to disappear if management measures were not carried out promptly^{[12-71][12-73]}.

In view of current development pressure in the Pearl River Delta and existing small population sizes, it appears likely that the population of Eurasian Otter in the Deep Bay area, including LMC Loop and HHW, is of regional significance.

The data indicate that Eurasian Otter occurs in the LMC Loop Area, HHW and the LMC Meander. Eurasian Otter is generally reported to occupy a long, linear territory for foraging, though this probably reflects its occurrence in riverine areas elsewhere in its range. In Hong Kong, territories are likely to be less linear in shape given the reliance on fish pond areas.

Otter numbers are usually positively correlated with fish biomass^[12-44]; i.e. the more fish available as prey items, the more otters are likely to occur. In view of the abundance of fish in the LMC Meander and the fish ponds at HHW, it is likely that these two areas constitute an integral part of the species' foraging area.

Dry, land-based refuges are also important to the species, as it needs these for breeding, sleeping, as temporary resting places to escape from heat-absorbing water, or as secure refuges in case of disturbance. Islands, for instance, are highly favoured by Eurasian Otters^[12-44]. In addition, reedbeds are believed to be very important to the species as a resting area or breeding ground^{[12-44][12-45]}. Eurasian Otter also has a preference for riparian habitats, and it usually prefers thick shrubs rather than woodland^[12-44].

Although Eurasian Otter seems to be quite tolerant of human disturbance^[12-44], researchers have also found that some populations are rather disturbance-sensitive and avoid areas of high human activity^[12-58]. In such disturbed habitats, sufficient shelter to allow the animal secure refuge is very important^[12-50].

12.4.4.3 Herpetofauna

a) Literature Review

Based on ENSR (2009)^[12-30a], AFCD (2010)^[12-4], Mott MacDonald (2009)^[12-52] and field work carried out by the study team for the LUPCAFS, NENT NDA PES and LMC WMA, herpetofauna species of conservation concern that inhabit the Ecological Assessment Area are listed in **Table 12.6**, together with their conservation status.

Table 12.6 Herpetofauna species of conservation concern recorded in the ecological Assessment Area.

Species	Conservation Status	Areas/Habitats
Chinese Bull Frog 虎紋蛙 <i>Hoplobatrachus chinensis</i>	Class II Protected Animal in China ¹ , Potential Regional Concern ² .	Abandoned fish ponds and agricultural land at LMC Tsuen, marsh and agricultural land at Ma Tso Lung, also recorded in LMC WMA.
Two-striped Grass Frog 台北蛙 <i>Rana taipehensis</i>	Local Concern ² .	Abandoned fish ponds and marsh at LMC Tsuen and HHW, also recorded in LMC WMA recently.
Three-banded Box Terrapin 三線閉殼龜 <i>Cuora trifasciata</i>	Cap. 170 protected, Class II Protected Species in China ¹ , Global Concern ² , Critically Endangered ^{3, 4} , Appendix II of CITES ⁵ .	Recorded in a hill stream flowing to Ma Tso Lung.
Chinese Soft-shelled Turtle 鱉 <i>Pelodiscus sinensis</i>	Cap. 170 protected, Global Concern ² , Vulnerable ^{3, 4} .	Recorded in LMC WMA and HHW fish ponds.
Many-banded Krait 銀環蛇 <i>Bungarus multicinctus</i>	Potential Regional Concern ² , Vulnerable ⁴ .	Recorded along boundary fence road near LMC Tsuen, village area at Ma Tso Lung and at LMC WMA.
Copperhead Racer 三索錦蛇 <i>Elaphe radiata</i>	Potential Regional Concern ² , Vulnerable ⁴ .	Recorded at Ha Wan Tsuen.
Chinese Water Snake 中國水蛇 <i>Enhydris chinensis</i>	Near Threatened ⁴ .	Recorded at LMC WMA and stream near Ngau Kok Shan.
Chinese Cobra 眼鏡蛇 <i>Naja atra</i>	Potential Regional Concern ² , Vulnerable ⁴ , Appendix II of CITES ⁵ .	Recorded in shrubland and fish ponds close to Ngau Kok Shan, LMC.
Indo-Chinese Rat Snake 灰鼠蛇 <i>Ptyas korros</i>	Potential Regional Concern ² , Vulnerable ⁴ .	Recorded at LMC WMA.
Common Rat Snake 滑鼠蛇 <i>Ptyas mucosus</i>	Potential Regional Concern ² , Vulnerable ⁴ , Appendix II of CITES ⁵ .	Recorded at LMC WMA and a stream at LMC, village area in Ma Tso Lung and a stream at Tse Koo Hang.
Burmese Python 蟒蛇 <i>Python molurus</i>	Cap. 170 protected, Class I Protected Species in China ¹ , Potential Regional Concern ² , Lower Risk/Near Threatened ³ , Critically Endangered ⁴ , Appendix II of CITES ⁵ .	Recorded in fish pond and shrubland next to boundary fence road, and at LMC WMA.

Notes:

[1] <http://www.sepa.gov.cn>

- [2] Fellowes et al. (2002)
- [3] IUCN (2010)
- [4] CSIS (2010)
- [5] UNEP-WCMC (2009).

Chinese Bull Frog and Two-striped Grass Frog inhabit a wide range of wetland habitats^[12-27]. Fish ponds, especially those that are inactive, and marshes in the Ecological Assessment Area provide habitats for these and other amphibian species. In addition, active wet agricultural land and an abandoned pond at LMC Tsuen were also found to support these two species during surveys for the LUPCAFS.

Deep Bay area fish ponds are believed to support the last natural population of Chinese Soft-shelled Turtle in Hong Kong^[12-40]. This species is regularly seen at the LMC WMA, indicating that fish ponds in the Ecological Assessment Area may also provide suitable habitat for this species^[12-40]. During surveys for LUPCAFS, one individual was also seen in a pond at HHW.

A Three-banded Box Terrapin was observed in a hill stream flowing toward Ma Tso Lung Tsuen during surveys for the NENT NDA PES. This species is regarded as critically endangered^{[12-38][12-30]}, and the population in Hong Kong is believed to be the largest in the world^[12-42]. Although it is a hill stream species, individuals have been found at distances up to several hundred metres from streams, and it is considered they roam in the forested riparian zone^[12-40]. The Ma Tso Lung stream and its riparian zone are considered to be suitable habitats for this species of high conservation concern, though it is more likely to occur in the upper sections of the stream where there is more woodland and less seasonally wet grassland. Other streams and associated riparian areas such as those in Tse Koo Hang are also considered to be potentially suitable.

Most snakes are highly mobile, and the species listed in **Table 12.6**, with the exception of Chinese Water Snake, can inhabit a wide range of habitats (including forest, shrubland, grassy fish pond bunds, marsh)^[12-40]. Chinese Water Snake usually inhabits wetland areas, and ponds, reedbed, marsh and lowland streams are suitable habitats for this species. A large, continuous piece of land with a variety of habitats is generally beneficial to most species as compared with fragmented, homogeneous habitats.

b) Field Surveys

Detailed survey methodology and results are provided in **Appendix 12-8**. In LMC Loop, eight frog species and two reptile species were recorded. Except for Two-striped Grass Frog, none is a species of conservation concern and all are common and widespread in Hong Kong^{[12-40][12-27]}. Two-striped Grass Frog was recorded only in the night-time survey carried out in May 2010, when individuals were heard after heavy rainfall from shallow depressions caused by site investigation work in the dry season 2009-10. Given this, and as this species normally inhabits wetland areas such as abandoned ponds and marsh, its occurrence in LMC Loop is likely to be only temporary. Further, other survey work carried out by the study team in the Deep Bay area indicated that this species was particularly widespread that year, occupying areas in which it would not normally be expected to occur. A follow-up survey on 20 May 2011 did not record any Two-striped Grass Frogs, further substantiating the presumed transitory nature of its occurrence.

In addition, a local fish farmer reported having seen Burmese Python inside LMC Loop.

Chinese Bull Frog was recorded in the abandoned ponds and wet agricultural lands at LMC Tsuen. Indeed, based on fieldwork for the present Study and that for the LUPCAFS, wetlands around LMC Tsuen seem to support a healthy population of this species. One individual was also heard in dry agricultural land at Chau Tau. **Figure 12.4** identifies the locations of herpetofauna of conservation significance recorded during surveys.

Two-striped Grass Frog was recorded in an abandoned pond to the southeast of LMC Loop. Individuals were also heard in a marsh and an abandoned pond at Horn Hill (Ngau Kok Shan).

Common Rat Snake, Indo-Chinese Rat Snake and Chinese Cobra were also recorded. At Ha Wan Tsuen, one dead Common Rat Snake was seen at fish pond edge. In the vicinity of Ping Hang along the boundary fence road, one Common Rat Snake and one Indo-Chinese Rat Snake were observed at marsh and at fish pond edge, respectively (**Figure 12.4**). Chinese Cobra was seen on a hill slope behind Pun Uk Tsuen. A local fish farmer reported that he has caught several Burmese Python in the LMC Meander. Other species recorded are not of conservation significance.

At Ma Tso Lung, Common Rat Snakes were frequently recorded during fieldwork for the LUPCAFS and NENT NDA PES. In the present study, this species has occasionally been seen at Tse Koo Hang and Ma Tso Lung. A Chinese Cobra was seen in shrubland at Tse Koo Hang. Chinese Bull Frogs were commonly found in the Ma Tso Lung Stream and dry agricultural land at Ma Tso Lung and Tse Koo Hang.

12.4.4.4 Odonata

a) Literature Review

Odonate species of conservation concern recorded in the Ecological Assessment Area by ENSR (2009)^[12-30a], AFCD (2006)^[12-4], Mott MacDonald (2009)^[12-52] and field work carried out by the Study Team for the LUPCAFS and NENT NDA PES are listed in **Table 12.7**.

Table 12.7 Odonate species of conservation concern present in the Ecological Assessment Area.

Species	Conservation Status	Areas/Habitats
Coastal Glider 高翔漭蜻 <i>Macrodiplax cora</i>	Uncommon ¹ and Local Concern ² .	Recorded in fish pond near Ngau Kok Shan, and LMC WMA.
Ruby Darter 紅胭蜻 <i>Rhodothemis rufa</i>	Local Concern ² .	Recorded in abandoned fish pond near Ngau Kok Shan, marsh at Ma Tso Lung and LMC WMA.
Sapphire Flutterer 三角麗翅蜻 <i>Rhyothemis triangularis</i>	Local Concern ² .	Recorded in abandoned fish pond at Ngau Kok Shan.
Scarlet Basker 赤斑曲鈎脈蜻 <i>Urothemis signata</i>	Local Concern ² .	Recorded in ponds in LMC Loop, near Ngau Kok Shan, and LMC WMA.

Notes:

- [1] Wilson (2004)
- [2] Fellowes et al. (2002)
- [3] IUCN (2010)
- [4] CSIS (2010)
- [5] UNEP-WCMC (2009).

Coastal Glider, Ruby Darter and Scarlet Basker were observed by ENSR (2009) [12-30a]. The latter two species are now considered to be common in Hong Kong, while the first is believed to be one of the most widespread and abundant species in the world [12-76]. Sapphire Flutterer was observed in an abandoned pond at LMC Tsuen during the LUPCAFS. This species was considered to be of conservation concern [12-31], but it is now regarded as common in Hong Kong [12-76].

Wilson (1995) [12-75] pointed out that fish pond areas in Hong Kong support a diverse odonate community (up to 30 species), and abandoned ponds with rich vegetation are of particular importance. In fact, all wetlands, including ponds, marshes and reedbeds, in the Ecological Assessment Area are likely to be of considerable importance to odonates. However, species common in such habitats tend to be widespread and have little or no conservation significance. A total of 29 species has been recorded at the LMC WMA (AEC 2010) [12-1], but of these, only *Anaciaeschna jaspidea*, *Macromiella cora* and *Trithemis pallidinervis* are regarded by Wilson (2004) [12-76] as ‘uncommon’ or ‘rare’ in Hong Kong.

b) Field Surveys

Details regarding the methodology and results are contained in **Appendix 12-9**. Common Evening Skimmer and Scarlet Basker were the only odonate species of conservation concern recorded in LMC Loop. However, as mentioned above, only the first is considered to be uncommon in Hong Kong [12-76]. Other species recorded are common and widespread. **Figure 12.4** identifies the locations of odonata of conservation significance recorded during surveys.

Coastal Glider, Sapphire Flutterer, Ruby Darter and Scarlet Basker were observed, primarily in abandoned ponds at Horn Hill (Ngau Kok Shan) and near LMC Tsuen. Apart from the first, all these species are considered to be common in Hong Kong [12-76]. Other species recorded are not of particular conservation concern.

At Ma Tso Lung and Tse Koo Hang, Ruby Darter was the only species of conservation concern observed, although it is considered to be common in Hong Kong. This species was found in natural streams at Ma Tso Lung and Tse Koo Hang. No other odonate species of conservation concern has been recorded.

12.4.4.5 Butterflies

a) Literature Review

Butterflies in and near the Ecological Assessment Area were surveyed by ENSR (2009) [12-30a], Mott MacDonald (2009) [12-52] and during field work carried out by the Study Team for the LUPCAFS and NENT NDA PES. A total of 84 species have previously been recorded; the species of conservation concern are listed in **Table 12.8**.

Table 12.8 Butterfly species of conservation concern previously recorded in the Ecological Assessment Area.

Species	Conservation Status	Areas/Habitats
Pale Palm Dart <i>Telicota colon</i> 長標弄蝶	Local Concern ² .	Recorded at Ma Tso Lung.
Danaid Egg-fly <i>Hypolimnas misippus</i> 金斑蛺蝶	Local Concern ² .	Recorded at LMC WMA.
Blackvein Sergeant <i>Athyma ranga</i> 離斑帶蛺蝶	Local Concern ² .	Recorded in shrubland near LMC Lookout.
Baron <i>Euthalia aconthea</i> 矛翠蛺蝶	Local Concern ² .	Recorded inside LMC Loop.
Psyche <i>Leptosia nina</i> 織粉蝶	Local Concern ² , Very Rare ⁴ .	Recorded in agricultural land at LMC.
Common Four-ring <i>Ypthima praenubila</i> 前霧覆眼蝶	Local Concern ² , Very Rare ⁴ .	Recorded in fishponds at HHW.

Notes:

- [1] <http://www.sepa.gov.cn>
- [2] Fellowes et al. (2002)
- [3] IUCN (2009); 4. CSIS (2009); 5. UNEP-WCMC (2009).
- [4] Chan et al. (2011).

The records of Psyche and Common Four-ring refer to species that are rare in HK and typically occur in habitat different from that present around the LMC Loop. There is a possibility of confusion between these and other, similar, widespread species; for this reason, these records are disregarded. Danaid Egg-fly is listed by Fellowes et al. (2002) as a species of Local Concern, but has increased in Hong Kong in recent years and is now fairly common and widespread (Lo and Hui 2004).

The results of previous surveys indicate that the LMC Loop supports a relatively low abundance and diversity of butterfly species. Shrubland to the south of LMC Loop, around the LMC Lookout and at Ma Tso Lung, supports a more diverse community, however.

b) Field Surveys

Details regarding the methodology and results are contained in **Appendix 12-10**. The butterfly community within LMC Loop is poorly represented, both in terms of the number of individuals and the number of species present. Baron has previously been reported, but all other species are common and widespread in Hong Kong. The vegetation within the Loop is poor for butterflies, with a low diversity of plant species providing few opportunities for foraging adults or larvae.

Most of the surrounding lowland areas are also fairly low in butterfly diversity, supporting a relatively small number of common species. This is not surprising, as fish pond and agricultural habitats are typically poor for butterflies in HK. As has been found in previous studies, the number of species recorded during surveys was greater in shrubland habitats around LMC Lookout and at Ma Tso Lung. The grassy hills above Ma Tso Lung were used for hill-topping by a number of species, including Danaid Egg-fly and other species that are uncommon in Hong Kong.

These grassy hillsides were also found to provide habitat for Spotted Angle and Small Three-ring, both of which are considered to be of Local Concern in Hong

Kong. The host plant of Small Three-ring, *Ischaemum barbatum*, was found in marsh fringes and shrubland at Ma Tso Lung during field work for NENT NDA PES, and marsh edge may be an important habitat for the species. There was also a single observation of Spotted Angle in the lowlands of Ma Tso Lung, close to these grassy hillsides. Species of conservation concern recorded are presented in **Table 12.9**.

Table 12.9 Butterfly species of conservation concern recorded in and near LMC Loop, 2009-2010 (all present in grassland or grassland-shrubland)

Species	Level of Concern [#]	LMC Loop	Area Adjacent to LMC Loop	MTL
Spotted Angle <i>Caprona alida</i> 白彩弄蝶	LC	-	Y	Y
Small Three-ring <i>Ypthima norma</i> 小三矍眼蝶	LC	-	Y	Y
Danaid Egg-fly <i>Hypolimnas misippus</i> 金斑蛱蝶	LC	-	Y	-

Notes:

Level of Concern follows Fellowes et al. (2002): LC = Local Concern.

12.4.4.6 Aquatic Fauna

a) Literature Review

LMC Meander was surveyed by ENSR (2009)^[12-30a] and the following freshwater species recorded: Freshwater Snail *Brotia hainanensis*, Atyid Shrimp *Caridina cantonensis*, Nile Tilapia *Oreochromis niloticus*, White-spotted Catfish *Clarias fuscus* and Edible Goldfish *Carassius auratus*. These are all widespread and common species in Hong Kong.

Mott MacDonald (2009)^[12-52] recorded seven freshwater fish species from fish ponds, streams and water courses close to LMC Loop, and all are either exotic or common food fish. A total of 12 fish species were recorded in areas near LMC Loop during the LUPCAFS and the NENT NDA PES, but no species of conservation concern was recorded.

Lowland streams and hill streams nearby, however, are generally in a natural state and, based on previous records, are of significance to certain species of concern. A Three-banded Box Terrapin was recorded in the stream network near Ma Tso Lung in June 2009 during field work for the NENT NDA PES. Also, stream sections at Ma Tso Lung and to the southeast of the LMC Loop (i.e. along the boundary fence road) were found to be only lightly polluted and macroinvertebrate communities were still present. Larvae of certain insect groups, such as water moths, caddis flies, and atyid shrimps were found, indicating that these sections are not highly disturbed.

According to a recent survey conducted by SESRC (2009)^[12-68], the aquatic environment of the Shenzhen River is in very poor condition. During benthic surveys conducted in August, October and December 2008, only three organisms were collected (two glass perch *Ambassis gymnocephalus* and one unidentified polychaete) throughout the four sampling stations within the channel, and two of these were collected at the river mouth, not within the section close to the LMC Loop. SESRC (2009)^[12-68] concluded that, due to severe pollution, the aquatic

community of the Shenzhen River has been “completely destroyed”. Although observations of foraging birds in the river channel indicate the channel has some ecological value, based on faecal coliform counts and other data reported by SESRC (2009)^[12-68], the aquatic environment of the Shenzhen River is certainly highly polluted and eutrophic.

b) Field Surveys

Detailed methodology and results of aquatic fauna surveys are provided in **Appendix 12-11**. Species of conservation significance comprise the following.

A group of Paradise Fish *Macropodus opercularis* were recorded in the stream flowing from Ping Hang. This species was considered to be “common” in Hong Kong by Lee *et al.* (2004)^[12-47]. Although Chan (2001)^[12-25] considered it to be ‘conservation dependent’, this species was recorded by AFCD (*in litt.*) throughout HK in recent years, including within protected areas. Since it can also inhabit marshy areas, the marshes alongside streams are also believed to provide suitable habitat for this species.

A small population of Rose Bitterling *Rhodeus ocellatus* was observed in a stream and a pond to the south of Lung Hau Road (illustrated in **Appendix 12-12**, plate 34). According to Lee *et al.* (2004), this species is rare and only appears at two sites (Kam Tin and Sha Tin) in the HKSAR; thus, the site newly found in the present study represents the third for this species in Hong Kong. Rose Bitterling is considered to be of Local Concern^[12-31].

An endemic freshwater crab species, *Somanniathelphusa zanklon*, was observed in streams at Chau Tau and to the southeast of LMC Loop. Although this species seems to be widespread in Hong Kong, it is regarded as endangered by IUCN (2009)^[12-38]. **Figure 12.4** identifies the locations of aquatic fauna of conservation significance recorded during surveys carried out.

Although LMC Meander contains only common or exotic species, it is one of the largest river sections with semi-natural banks and bottom remaining in HK. Unsurprisingly given the poor water quality in Shenzhen River, no species of conservation significance were recorded in this channelized watercourse.

Nymphs of odonates are common in the streams to the southeast of LMC Loop. Certain freshwater invertebrates that appear only in clean environments such as *Caridina cantonensis* were also found inhabiting these streams. All these indicate that these streams are good aquatic habitats.

The streams at Tse Koo Hang and Ma Tso Lung are generally in natural condition (see **Appendix 12-12**, plates 35 and 36). The freshwater crab *Somanniathelphusa zanklon* was also observed in Ma Tso Lung stream. Nymphs of odonates and other invertebrates that usually inhabit clean environments were found in certain sections. A pair of Small Snakehead was also observed in a tributary of Ma Tso Lung Stream. All these indicate that these streams can provide habitats for species, in addition to potentially supporting Three-banded Box Terrapin and Chinese Bull Frog.

In addition, *Nicholsicypris normalis*, a species that mainly occurs in the eastern part of Hong Kong, was found in the stream at Tse Koo Hang.

12.4.4.7 Fireflies

At the time when survey requirements and methodologies were devised, and the during the period when field surveys to establish the ecological baseline were originally carried out (June 2009 to May 2010), the issue of fireflies had not been previously addressed in EIA studies in HK, as the (then) only species known to occur was not considered of conservation significance. Since that time, however, the issue of fireflies has developed and grown more complex. Currently, two species are presumed to occur.

Pteroptyx maipo

Pteroptyx maipo was first found in the mangrove habitat of Hong Kong Wetland Park (HKWP) in 2003^{[12-46] [12-48]}, and preliminarily identified as an unknown species of *Pteroptyx*^[12-81]. A detailed description of this species new to science was published by Ballantyne *et al.* (2011)^[12-17].

P. maipo can be easily identified by its yellowish coloration with darkened and deflexed elytra tips and flashing pattern^[12-17]. The commonly seen *L. terminalis* shows similar pattern and colour but is bigger in size^[12-81].

P. maipo is a mangrove- dependent firefly species mainly reliant on the mangrove ecosystem throughout its life cycle^[12-4]. The most active period is April to September, 30 to 90 minutes after sunset^[12-82]. According to Yiu (2010, 2011a & 2011b)^{[12-80] [12-81] [12-82]} and Green Sense (2011), *P. maipo* is only present at several localities within the Deep Bay area such as Hong Kong Wetland Park, Mai Po Nature Reserve, Tin Shiu Wai, Shan Pui River, Kam Tin River and the mangroves near Fung Lok Wai.

In the Ecological Assessment Area mangrove habitat has not been identified, and the Loop itself is dominated by grassland, grassland/shrubland and reed marsh; hence, it appears to be unsuitable for *P. maipo*. It is believed that the physical environment within the Loop may not be able to provide basic requirement for the life cycle of *P. maipo*^[12-82].

Surveys conducted by the Study Team in the HHW area for *Agreement No. PLNQ 73/2011 Ecological Field Survey of Hoo Hok Wai* from January to August 2012 did not record the species in the fish pond and marsh habitats present in the study area. In addition, a night-time survey for fireflies was conducted in July 2012 from 7:30pm to 9:00pm along LMC meander and adjacent fish ponds (areas not surveyed for this species previously). No *P. maipo* was recorded during the survey period.

Aquatica leii

Aquatica leii was first found in the mangrove habitat of Hong Kong Wetland Park (HKWP) in July 2010. It was confirmed as *Aquatica leii*, the first true aquatic firefly in HK since the discovery of *Aquatica ficta* in 1909^{[12-22] [12-82]}. According to Jeng *et al.* (2003)^[12-39], four aquatic firefly species have been recorded in China: *Luciola lateralis*, *Luciola ficta* (*Aquatica ficta*), *Luciola substriata* and *Luciola hydrophila*^[12-32]. *A. leii* was considered to be the fifth species of aquatic firefly in China^{[12-3] [12-39]}. The discovery of *A. leii* led to a re-assessment of HK records of *A. ficta*, with the result that recent records of the latter are now considered to have been the former.

A. leii is fairly widespread in HK, being found in the northeast and northwest New Territories and at Tai Po Kau, Tsiu Hang and Shui Tsan (Yiu 2012 and Study Team unpub. data). Larvae are recorded on the soft benthic substrates of shallow and slow-flow stream and marsh habitats^{[12-3][12-82]}. Currently, there is no suggestion that *A. leii* is deserving of special conservation status.

In order to search for this species, two supplementary firefly surveys were conducted in August 2012 at streams and marshes along Lung Hau Road, Ma Tso Lung Road and at Hoo Hok Wai between 7:00pm and 9:30pm. A male *A. leii* was found in the riparian area of Ma Tso Lung Stream on 13th August (illustrated in **Appendix 12-12**, plate 35), and a female was found on *Brachiaria mutica* in a marsh area at HHW on 22nd August.

Though *A. leii* is considered a widespread species of relatively low conservation value, its life cycle relies on unpolluted freshwater stream and marsh habitat. Hence, protection against local extinction depends on the same habitat conservation measures that apply to other aquatic fauna. Consequently, potential impacts on this species will be addressed as part of the assessment of potential impacts on other aquatic fauna and marsh habitat.

12.4.4.8 Impact of Site Investigation works

During the ecological baseline fieldwork, there were no concurrent construction works. Minor Site Investigation (SI) works were carried out in LMC Loop from 24 November 2009 to 1 February 2010. A total of 65 vertical drill holes were excavated by rotary drilling with water as the flushing medium, terminating at varying depths in the range 5-50m. Drilling work began in the southwestern part of the Loop, and gradually moved northeast. Two excavators were used to create the access road and transport drill rigs, and a maximum of seven drill rigs were used (see **Chapter 8** for location of sample sites).

In order to avoid impacts on habitats of ecological significance and to ensure the validity of the field surveys, SI works were not carried out within 2 hours of sunrise, and there was no intrusion into reed marsh or access tracks for humans or machinery, except for short sections to the sites of drilling. The main track through the reed marsh area was through a raised, grassy area on which there were no reeds. This grassy vegetation was cut short to facilitate access. However, vehicular movement was highly limited in frequency along these tracks due to the nature of the works, which involved intervals of one or more days between the need to move drill rigs. Usually only one or two personnel were working at each rig, and thus human disturbance was minimal.

In terms of birds, survey work comprised three main elements. Trapping of birds using mist-nets was carried out in September to early November 2009, which is outside the SI work period. Flight line surveys were carried out from LMC Lookout, LMC Police Operational Base at Ngau Kok Shan and a fish pond location next LMC Meander in the first two hours of the morning. Given this early morning timing (i.e. before SI work each day had commenced) and the minor scope of works involved at each rig site, no impact was predicted.

With regard to the third element, transect surveys, these were carried out in LMC Loop monthly from June 2009 to May 2010 along two transects, one of which concentrated on the reed marsh area. Transects carried out prior to December

2009 were unaffected by the SI works (the November survey was carried out on 20th), as were those carried out from January (which was carried out on 28th) to May 2010. The December survey was carried out on the 31st, which was after completion of SI work at all reed marsh sites apart from A-DH03 and A-DH10. With regard to the latter, this was located some distance from the transect route, and so no impact occurred. With regard to A-DH03, this was located in grassland, near the edge of reed marsh. Given the limited scope of the work, and the time of the survey prior to works commencing, no significant impact is estimated to have occurred.

The larger reed marsh-associated species such as Great Bittern and Purple Heron appear not to use the reedbed in LMC Loop. None of the former were recorded (despite visits to look for night-time roosts on 19 November 2009 and 10 February 2010), while only one of the latter was recorded, a migrant in October. Consequently, no impact on these species in respect of surveys is predicted.

Perhaps the species most likely to be susceptible to disturbance arising from SI activities is Eurasian Otter. During fieldwork for the study, at approximately 1100h on 19th January 2010, one was seen swimming in LMC Meander towards the southern margin of the Loop, where it landed. That this record involved an animal that swam across the Meander and landed on the Loop suggests that any disturbance arising from SI activity (which ended on 29 January) was not, at that time, sufficient for deterrence.

In terms of herpetofauna, dragonflies and butterflies, survey work occurred in the warmer months / wet season, and so no impact resulted. Indeed, there was probably a positive ecological impact as the temporary depressions caused by works formed rain-fed pools that subsequently proved suitable for a transient population of Two-striped Grass Frogs in spring 2010.

Apart from reed marsh and marsh, there are no habitats of significant ecological value on LMC Loop, and thus the habitat loss accruing from the work is not predicted to be of significance. The loss of reeds associated with five of these sites (A-SG05, A-DH10, A-S12, A-S13, A-S16) was very limited in extent. Given the restricted nature of habitat loss and the broad avoidance of wetland areas, no significant impact on either vagile (birds) or less vagile (herpetofauna, butterflies, dragonflies) fauna is considered to have resulted.

12.5 Evaluation of Habitats and Species

12.5.1 Habitat Evaluations

12.5.1.1 Reed Marsh

Reed marsh is largely comprised of the Common Reed *Phragmites australis*, a tall perennial and flood-tolerant grass that has a wide distribution worldwide between 10° and 70° latitude. It occurs in seasonally or permanently wet low-lying areas, which range from floodplains and coastal plains to lake margins, estuaries, waterlogged areas and artificial sites such as water treatment ponds.

In practice, reed marshes usually contain a mixture of permanently and seasonally wet areas, especially in areas with marked disparity in seasonal rainfall such as

HK. Long-term variation in rainfall levels may affect which areas are permanently wet, and which seasonally wet, but the mixture of types is a normal feature. The wettest areas generally contain reed and little else, and are of botanically little interest, but potentially support an abundant invertebrate community and are consequently of high value to species that prey on these. The seasonally wet areas may allow for a more diverse presence of flora and fauna.

While certain species may occur at higher densities in permanently wet reed marsh, they also occur in seasonally wet reed marsh, albeit at lower densities. Similarly, some species may occur at lower densities in permanently wet reed marsh than seasonally wet reed marsh. Thus, although the different areas of reed marsh may vary in terms of the duration for which surface water is present, and in the depth of this water, the whole area of both seasonally and permanently wet reed marsh forms an integrated ecological unit supporting a suite of reedbed-associated species at varying densities across the whole area. Indeed, this diversity of conditions results in greater diversity of micro-habitats and species utilisation.

The size, shape and degree of fragmentation may also impact the ecological value of a given area of reed marsh. Larger areas of reed marsh tend to support a greater diversity of fauna and higher abundance of individuals. Less linear reed beds that have a lower edge to area ratio tend to be less subject to disturbance, and thus of higher potential ecological value. Finally, greater contiguity of reed marsh areas generally results in higher ecological value than fragmented reed areas. However, where intervening habitats are natural, seasonally or permanently wet and, in particular, similar in structure (such as grassland or grassland/shrubland), as is the case in LMC Loop, the fragmentation effect of reed marsh areas is much reduced. Further, birds are highly mobile and subject to reduced impacts from fragmentation in comparison with other fauna such as insects. For example, the linkages for certain bird species established during this study with reed marsh at Mai Po NR indicate that despite the relatively large distance between the two areas, they are not isolated from each other.

Reed marsh is a scarce habitat, especially in southern China, and consequently any flora or fauna that rely on it must also be scarce. In HK reed marsh is of most significance in respect of bird species closely associated with this habitat: Purple Heron, Great Bittern, Yellow Bittern, Pied Harrier, Eastern Marsh Harrier, Bluethroat, Pallas's Grasshopper Warbler, Black-browed Reed Warbler, Oriental Reed Warbler, Zitting Cisticola (in winter), Chinese Penduline Tit and Yellow-breasted Bunting. All these species are scarce in HK, and most are either wetland-dependent or of conservation significance (**Appendix 12-2**). All apart from Great Bittern were recorded in the reed marsh area in LMC Loop. Reed marsh also supports a suite of both waterbird and landbird species throughout the year, and particularly during the migration seasons.

A 10.96ha area of relatively unfragmented reed marsh habitat is present in LMC Loop (**Appendix 12-12**, plate 1); this comprises approximately 8.7% of reed marsh in the Deep Bay area. **Figure 12.1** illustrates all areas of reed marsh considered sufficiently large and uncompromised by terrestrial plant species to contribute to the overall ecological value of reed marsh habitat in LMC Loop. The reed marsh in LMC Loop is present in smaller discrete areas than that at MPNR, but the lack of disturbance in LMC Loop and ecological linkages to adjacent

grassland habitats ensure that there is strong linkage between each area of reed marsh, and the ecological function of the reed marsh present is effectively dependent upon the total area present rather than the size of the individual patches. Based on criteria presented in the TM-EIAO (Annex 8), the reedbed qualifies as an ‘important habitat type’ in its own right by virtue of it being a freshwater marsh larger than one hectare.

The ecological value of a habitat can (in part) be deduced from the fauna it supports. The reed marsh in LMC Loop supports a full suite of reed-associated passerine bird species, including species of conservation significance such as Chinese Penduline Tit and Bluethroat. It also provides habitat for Eurasian Otter, which was recorded in the reedbed in this study. However, in comparison with the managed reedbed at MPNR, numbers of larger species such as small bitterns, Purple Heron and Great Bittern appear to be relatively low or, in the case of the latter, absent. This may be due to the greater structural diversity of and variation in age of reeds across the reed marsh at MPNR. While the reed marsh in LMC Loop cannot be rated as highly in terms of ecological value as the area at MPNR, as a relatively large area of reed marsh supporting a suite of wetland-dependent species that includes Eurasian Otter, it can be given a High rating.

The reed marsh next to LMC BCP is very small in size and its main function is as a wastewater treatment reedbed, while the reeds along the HK side of the Shenzhen River channel are narrow in width and highly linear in layout, and appear to be cut at least annually; these factors limit their value to fauna. At HHW, the areas of reeds are largely only seasonally wet, which limits their ecological value compared to the rather larger, less fragmented and wetter reedbed in LMC Loop; as a result, there is greater incursion of terrestrial plant species (**Appendix 12-12**, plate 6). However, this habitat has strong linkages with adjacent wetland habitats, in particular freshwater marsh. The ecological evaluation of reed marsh in different areas is summarized in **Table 12.10**.

Table 12.10 Ecological evaluation of reed marsh

Criteria	Reed Marsh in LMC Loop	Reed Marsh at HHW	Clean-up reed marsh at LMC Station
Naturalness	Semi-natural habitat established through natural succession of reed and marshy vegetation after land formation in the Loop.	Semi-natural areas of largely seasonally wet reeds at HHW (via natural succession) along the Shenzhen River).	Reed marsh for effluent polishing alongside LMC Station.
Size	Moderate at 10.96ha.	Moderate at 9.36ha.	4.52 ha of clean-up reedbed next LMC Station.
Diversity	Moderate in faunal and low in floral diversity.	Low to Moderate faunal and low floral diversity.	Low to Moderate faunal diversity and low floral diversity.

Criteria	Reed Marsh in LMC Loop	Reed Marsh at HHW	Clean-up reed marsh at LMC Station
Rarity	Habitat almost exclusively in Deep Bay area in HK. Supports suite of rare fauna, including Eurasian Otter and reedbed-associated avifauna.	Habitat almost exclusively in Deep Bay area in HK. Supports scarce to rare reedbed-associated passerines and Eurasian Otter.	Habitat almost exclusively in Deep Bay area in HK. Supports scarce to rare reedbed-associated passerines.
Re-creatability	Readily recreated under suitable hydrological conditions.		
Fragmentation	Little fragmentation.	Limited fragmentation	Little fragmentation at LMC Station.
Ecological Linkage	Ecological and hydrological linkage with adjacent grassland and grassland-shrubland habitats, and functional linkages with other Deep Bay wetland areas including HHW and Mai Po NR.	Reed marsh at HHW has linkages with adjacent wetland habitats and likely with reed marsh elsewhere in the Deep Bay area, including LMC Loop.	Limited linkages with other reed marsh areas.
Potential Value	Potential for enhancement with appropriate management regime.		
Nursery/Breeding Ground	May be a breeding site for Eurasian Otter.	Potential nursery/breeding ground for reed-associated species.	None of significance known.
Age	Exact age unknown, but approximately ten years.	At least 20 years at HHW. That along Shenzhen River approximately 10 years.	Approx. 6 years.
Abundance/Richness of Wildlife	Supports a range of Phragmites-associated and wetland-dependent bird species, some of conservation significance, and the globally-threatened Eurasian Otter. Larger bird species limited in number, though abundance of passerines good.	HHW reed marsh supports small numbers of Phragmites-associated passerine bird species, though larger species not present due to disturbance and seasonally wet element. Linear shape of reeds along Shenzhen River reduces value, as well as disturbance.	Small numbers of reed associate species, but abundance limited by management regime.
Ecological Value	High due to utilization by Eurasian Otter and range of reed-associated bird species of conservation significance.	Low to Moderate , along Shenzhen River. High at HHW, as part of a habitat mosaic that is of high ecological value overall.	Low to Moderate .

12.5.1.2 Marsh

In LMC Loop, small areas of marsh have formed in three shallow depressions probably as a result of differential settlement of mud. In addition to water quality being rather poor, the water surface of all three is covered by the floating aquatic herb *Pistia stratiotes* and the grass *Brachiaria mutica* (**Appendix 12-12**, plate 2). Together with their small size, these factors restrict ecological value, and only small numbers of a few wetland-associated species were recorded, primarily Common Moorhen and White-breasted Waterhen, though there was also one record of a migrant Pheasant-tailed Jacana. A local villager reported seeing Eurasian Otter in these areas, and it is possible they are used regularly, if not frequently, by this species, which was recorded in the adjacent reedbed during field work for this study, as part of the overall mosaic of wetland habitats in the area.

Marsh is located near Ping Hang and at Chau Tau Tsuen, near Horn Hill (Ngau Kok Shan), and at LMC Tsuen, Ma Tso Lung Tsuen and Chau Tau Tsuen. There are two large areas of marsh to the northeast of LMC Loop (M1 and M2 in **Figure 12-2**), both of which contain areas of reed marsh. Two-striped Grass Frog was recorded in Marsh 1, while a Coastal Glider was noted over an adjacent fish pond; no species of conservation significance were noted in Marsh 2. The ecological value of both marshes is limited by the seasonal nature of water supply and a lack of open water areas and microhabitat diversity. However, both marshes could potentially serve as a foraging and nursery/breeding ground for Eurasian Otter.

Two amphibian species of conservation significance were recorded in this habitat. The first, Chinese Bullfrog, which is of Potential Regional Concern ^[12-31], was recorded at Ma Tso Lung; in addition, Ruby Darter was recorded during field surveys for NENT NDA PES. Two-striped Grass Frog, which is listed as Local Concern in Fellowes *et al.* (2002) ^[12-31], was recorded in marsh near Horn Hill. The small marsh near Ping Hang also provides suitable habitat for Paradise Fish. Chinese Bull Frog has previously been recorded in the marsh at LMC Tsuen. The record of Small Three-ring, a species of Local Concern in Fellowes *et al.* (2002) ^[12-31], in grassy hillside above Ma Tso Lung indicates that the marsh edge may support its host plant *Ischaemum barbatum*.

The marsh area at Ma Tso Lung is linked with an area of seasonally wet grassland, and is part of the stream network of the valley (**Appendix 12-12**, plate 15). Faunal diversity is limited in all these areas by a lack of microhabitat diversity. The ecological evaluation of marsh at different locations potentially impacted by development is summarized in **Table 12.11**.

Table 12.11 Ecological evaluation of marsh

Criteria	Marsh in LMC Loop	Marsh at Chau Tau Tsuen	Marsh at HHW	Marsh at Ma Tso Lung	Marsh at LMC Tsuen
Naturalness	Semi-natural	Semi-natural.	Semi-natural.	Semi-natural.	Semi-natural
Size	Small (0.50ha)	Small (3.50ha)	Large (28.52 ha).	Small (2.56 ha)	Small (1.54ha)

Criteria	Marsh in LMC Loop	Marsh at Chau Tau Tsuen	Marsh at HHW	Marsh at Ma Tso Lung	Marsh at LMC Tsuen
Diversity	Low in faunal and floral diversity	Low in faunal and floral diversity.	Low to moderate faunal diversity and low vegetation diversity.	Low to moderate faunal diversity and low vegetation diversity.	Low in faunal and floral diversity
Rarity	Lowland freshwater marsh is a relatively scarce and declining habitat in HK.	Lowland freshwater marsh is a relatively scarce and declining habitat in HK.	Lowland freshwater marsh is a relatively scarce and declining habitat in HK; Two-striped Grass Frog (found near Horn Hill) is uncommon and of Local Concern.	Lowland freshwater marsh is a relatively scarce and declining habitat in HK; Chinese Bullfrog is of Potential Regional Concern.	Lowland freshwater marsh is a relatively scarce and declining habitat in HK. Chinese Bullfrog is of Potential Regional Concern.
Re-creatability	Can be re-created under suitable hydrological conditions.				
Fragmentation	Significantly fragmented into 2 discrete areas.	Largely fragmented by urbanized areas.	Some fragmentation by fish ponds and boundary fence road.	Fragmented by roads and Border Fence.	Fragmented by roads and Border Fence.
Ecological Linkage	Some linkage with adjacent reed marsh and grassland habitats.	Some linkage with nearby wet agricultural habitats.	Ecological and hydrological linkage to ponds, streams, shrubland and seasonally wet grassland nearby.	Ecological and hydrological linkage to ponds, streams, shrubland and seasonally wet grassland nearby.	Linkage with nearby wet agricultural habitats.
Potential Value	Potential for increase under appropriate management.	Low potential as it is surrounded by village area and is somewhat separate from nearby wetland habitats.	Potential for increase under appropriate management regime.	Potential for increase under appropriate management regime.	Potential for increase under appropriate management regime.

Criteria	Marsh in LMC Loop	Marsh at Chau Tau Tsuen	Marsh at HHW	Marsh at Ma Tso Lung	Marsh at LMC Tsuen
Nursery/ Breeding Ground	Provides suitable habitat for odonates and amphibians.	Chau Tau: provides suitable habitat for odonates and amphibians.	Provides suitable habitat for odonates and amphibians. Ping Hang provides suitable habitat for Paradise Fish. Potentially suitable for Eurasian Otter.	Provides suitable habitat for odonates and amphibians.	Provides suitable habitat for odonates and amphibians.
Age	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Abundance/ Richness of Wildlife	Low.	Low.	Low to moderate.	Low to moderate.	Low to moderate.
Ecological Value	Low to Moderate due to potential for enhancement and connectivity with reed marsh.	Low.	Moderate for marsh due to potential for enhancement and connectivity with nearby wetland, and potential occurrence of Eurasian Otter. Part of a habitat mosaic at HHW that is of high ecological value overall.	Low to Moderate for marsh due to potential for enhancement and connectivity with nearby wetland.	Low to Moderate for marsh due to potential for enhancement and connectivity with nearby wetland.

12.5.1.3 Mitigation Wetland

There are two areas of mitigation wetland in the Ecological Assessment Area. The first and largest is that for MTR LMC Spur Line and Station (LMC WMA). Eight globally-threatened bird species of conservation significance have been recorded, including Black-faced Spoonbill, which occurs in substantial numbers. Large numbers of several other bird species of conservation importance also occur, some of which also breed on site. White-shouldered Starling is relatively common in summer, and breeds in high numbers due to the provision of nest boxes. Non-bird fauna of conservation significance comprise Eurasian Otter, Danaid Egg-fly, nine

herpetofauna species and three dragonfly species (see **Appendix 12-16** for complete list of fauna).

At the San Tin Eastern Main Drainage Channel (STEMDC) and associated mitigation wetland, low numbers of a suite of freshwater wetland bird species have been recorded, including Greater Painted-snipe, which is of Local Concern^[12-31]. This mitigation area includes a small pond of 0.71 ha between the channel and San Sham Road, alongside the New Boundary Patrol Road. This pond has the character of an inactive fish pond, with extensive areas of emergent vegetation around the edges. The small size and enclosed aspect (with trees nearby) mean that it is not of significance to large waterbirds. Only Chinese Pond Heron was recorded there, with no more than one individual each visit.

Species lists of fauna recorded at both sites are provided in **Appendix 12-17**. The ecological evaluation is summarized in **Table 12.12**.

Table 12.12 Ecological evaluation of mitigation wetland

Criteria	San Tin Eastern Main Drainage Channel mitigation wetland	LMC WMA
Naturalness	Anthropogenic	Anthropogenic
Size	Small at 3.7ha.	Large at 36ha.
Diversity	Low floral diversity and moderate faunal diversity.	Low floral diversity but moderate to high faunal diversity.
Rarity	Uncommon habitat in Deep Bay area.	Uncommon habitat in Deep Bay area, and no other fish pond area is managed as intensively for wildlife.
Re-creatability	Readily recreated via suitable hydrological and vegetation management.	Readily recreated via suitable hydrological and vegetation management.
Fragmentation	Not fragmented.	Not fragmented.
Ecological Linkage	Linked ecologically to drainage channel, Shenzhen River and adjacent fish ponds.	Close linkages with the pond and reed marsh areas nearby. Also linked to Mai Po NR, Ramsar Site and Inner Deep Bay by movement of waterbirds.
Potential Value	Limited scope for enhancement.	Limited scope for further enhancement.
Nursery/ Breeding Ground	None of significance known.	Breeding site for a number of amphibian and bird species. Eurasian Otter has possibly bred previously.
Age	Less than ten years.	Approximately ten years.
Abundance/ Richness of Wildlife	Low.	High abundance and richness.
Ecological Value	Low to Moderate.	High due to abundance of rare fauna and linkages with Ramsar Site.

12.5.1.4 Pond

Ponds are a major habitat type in the Ecological Assessment Area, including HHW, Ta Sha Lok and the area between LMC Loop and the boundary fence (**Appendix 12-12**, plate 5). These ponds show strong ecological linkages to the extensive fish pond area elsewhere in the Deep Bay area, especially for wetland birds, and large waterbird species in particular. The ponds between LMC Loop and the boundary fence are within the WCA and constitute a crucial element of the ecological and flight-line corridor linking wetlands at Mai Po and LMC with those at HHW.

The Deep Bay fish pond wetland ecosystem is generally considered to be of high ecological importance, as it is an important foraging area for a wide range and large number of waterbirds, in particular egrets and herons. Some of these species are present in Deep Bay in internationally-important numbers. In addition, Eurasian Otter, which is listed as Regional Concern by Fellowes *et al.* (2002)^[12-31] and “Near Threatened” under IUCN Red List^[12-38], occurs in the area. Reptile species of conservation significance present include Chinese Soft-shelled Turtle, Common Rat Snake, Indo-Chinese Rat Snake, Chinese Cobra and Burmese Python. Four dragonfly species present, Coastal Glider, Ruby Darter, Sapphire Flutterer (albeit this species is uncommon) and Scarlet Basker, are of Local Concern in Fellowes *et al.* (2002)^[12-31]. Two amphibian species of conservation importance present are Chinese Bull Frog and Two-striped Grass Frog, which were recorded in ponds to the south of the Loop. Finally, Rose Bitterling was recorded in a pond (and natural stream) to the south of Lung Hau Road.

Given that pond habitat throughout the Ecological Assessment Area is an integral element of the Deep Bay fish pond wetland ecosystem and inextricably linked, the total area is assessed in **Table 12.13**. Inevitably some ponds are of lower ecological value than others. In particular, disturbance arising from proximity to roads or houses, long-term lack of management, unfavourable pond profile or small size may reduce ecological value. However, as a whole, the pond area is of high ecological value.

Table 12.13 Ecological evaluation of pond

Criteria	Pond
Naturalness	Man-made.
Size	Large, an integral part of the Deep Bay wetland ecosystem. Total area between LMC and Ng Tung River approximately 166.45ha.
Diversity	Low floristic diversity restricted to common species, and moderate to high faunal diversity.
Rarity	Common habitat in the northern NT, part of a larger area that supports a number of rare faunal species.
Re-creatability	Readily recreated if suitable hydrological conditions present.
Fragmentation	Some fragmentation by roads.

Criteria	Pond
Ecological Linkage	Ecological and hydrological linkages with adjacent wetland habitat, especially ponds at HHW. Form part of the flight-line corridor for birds between HHW and the rest of Deep Bay.
Potential Value	Value could be improved with dedicated management regime for wildlife.
Nursery/ Breeding Ground	Pond south of Lung Hau Road may provide nursery and breeding habitats for Rose Bitterling, while other ponds support breeding dragonfly and herpetofauna species of conservation concern. Breeding ardeids, especially from Ho Sheung Heung egrety, forage in these ponds.
Age	Unknown.
Abundance/ Richness of Wildlife	Moderate abundance and richness of wetland-dependent birds, herpetofauna and dragonflies.
Ecological Value	High overall due to importance to fauna of conservation significance, although smaller and more disturbed ponds, in particular at Ma Tso Lung, are of lower ecological value.

12.5.1.5 Secondary Woodland

Scattered patches of secondary woodland are present on the hillsides behind Chau Tau, on both sides of LMC Road close to Pun Uk Tsuen, close to Ha Wan Tsuen and near LMC Tsuen. A small secondary woodland patch is also present at Ma Tso Lung (**Appendix 12-12**, plate 14). These woodland patches are somewhat fragmented and disturbed at their fringe by adjacent villages. A sapling of a protected tree species *Aquilaria sinensis* (protected under Cap. 586) was identified at the fringe of secondary woodland adjacent to the access road to LMC Tsuen. A few seedlings and a mature tree specimen of *A. sinensis* were also recorded in the secondary woodland close to Pun Uk Tsuen. The ecological evaluation of secondary woodland in different areas is summarized in **Table 12.14**.

Table 12.14 Ecological evaluation of secondary woodland

Criteria	Secondary Woodland from Chau Tau to area close to Pun Uk Tsuen	Secondary Woodland close to Ha Wan Tsuen	Secondary Woodland close to LMC Tsuen	Secondary Woodland at Ma Tso Lung
Naturalness	Semi-natural to natural through natural succession.			
Size	Area is 14.68 ha.	Area is 1.78 ha.	Area is 4.24 ha.	Area is 6.29 ha.
Diversity	Moderate floral diversity and structural diversity.	Low floral diversity and structural complexity.	Moderate floral diversity and structural complexity.	Moderate flora diversity and structural complexity.

Criteria	Secondary Woodland from Chau Tau to area close to Pun Uk Tsuen	Secondary Woodland close to Ha Wan Tsuen	Secondary Woodland close to LMC Tsuen	Secondary Woodland at Ma Tso Lung
Rarity	Not uncommon in HK, though <i>Aquilaria sinensis</i> is not common in a global context.	Not uncommon in HK.	Not uncommon in HK. <i>Aquilaria sinensis</i> not common in global context.	Not uncommon in HK.
Re-creatability	Can be recreated, but considerable time required to reach current state.			
Fragmentation	Somewhat fragmented by village areas nearby.	Somewhat fragmented by grassland/shrubland and ponds nearby.	Somewhat fragmented by roads, villages and shrubland nearby.	Somewhat fragmented by roads.
Ecological Linkage	Linkage with adjacent hillside shrubland and grassland.	Linkage with grassland/shrubland nearby.	Linkage with adjacent shrubland and grassland.	Linkage with hillside grassland nearby.
Potential Value	Limited scope as near climax stage.			
Nursery/ Breeding Ground	None of significance known.			
Age	Unknown.			
Abundance/ Richness of Wildlife	Low to Moderate.			
Ecological Value	Moderate as relatively extensive woodland areas could provide suitable habitat for birds and mammals.	Low due to its small size, isolation from habitats of significant ecological value, and disturbance from the adjacent villages.	Low to Moderate due to linkage with nearby woodland, and potential use by breeding and wintering bird species.	Low to Moderate due to small size and isolation.

12.5.1.6 Plantation

Small stands of plantation trees (including *Leucaena leucocephala*, *Macaranga tanarius*, *Acacia confusa* and *Melia azederach*) are scattered across LMC Loop (**Appendix 12-12**, plate 12), with those that are close to LMC Meander possibly used by Eurasian Otter as resting sites. Small areas of plantation are present to the west of STEMDC and close to LMC Station Public Transport Interchange. Other hillside or lowland plantation areas lie close to village areas at in Ma Tso Lung area and are scattered across the rest of the Ecological Assessment Area.

Plantation to the south of Ma Tso Lung is of higher ecological value as it forms part of the riparian corridor adjacent to a location of a record of Three-banded Box Terrapin. It also provides foraging and roosting sites for fauna. The ecological evaluation of plantation in different areas is summarized in **Table 12.15**.

Table 12.15 Ecological evaluation of plantation

Criteria	Plantation in LMC Loop	Plantation to the east of STEMDC	Plantation south of Ma Tso Lung	Remaining plantation areas
Naturalness	Man-made plantation, with some self-sown species established by natural succession.	Man-made plantation.	Man-made plantation dominated with planted fruit trees, some self-sown species established by natural succession.	Man-made plantation mainly for screening along roads, with some self-sown species established by natural succession on the hillside at Pak Shek Au.
Size	Very small (1.70ha).	Very small (0.74ha).	Small (1.74ha).	Large (115.69 ha).
Diversity	Very low in faunal and floristic diversity, and structural complexity.	Very low in faunal and floristic diversity, and structural complexity.	Very low in faunal and floristic diversity, and structural complexity.	Very low in faunal and floristic diversity, and structural complexity in general. Low floristic diversity at Pak Shek Au.
Rarity	Common habitat in HK.	Common habitat in HK.	Common habitat in HK. Three-banded Box Terrapin is very rare.	Common habitat in HK.
Re-creation potential	Possible, but considerable time required to reach current state.			
Fragmentation	Rather fragmented patches.	Minor fragmentation by channel.	Fragmented by village areas nearby.	Fragmented by developed area and road infrastructure.

Criteria	Plantation in LMC Loop	Plantation to the east of STEMDC	Plantation south of Ma Tso Lung	Remaining plantation areas
Ecological Linkage	Limited linkage to grassland and grassland/shrubland nearby. Linkage with LMC Meander if Eurasian Otter uses these areas for resting.	Limited linkage to surrounding habitats.	Linkages with adjacent stream and hillside grassland.	No significant linkages to habitat of ecological importance; small plantation stands close to LMC Public Transport Interchange and in Pak Shek Au have linkages with surrounding hillside grassland
Potential Value	Limited scope as seed source from other tree and shrub species are limited in Loop.	Limited scope due to small size, frequent disturbance and limited seed source from other tree and shrub species.	Potential to develop to woodland through natural succession if undisturbed.	Plantations close to the surrounding hillside grassland have potential to develop to woodland through natural succession and enrichment planting. Limited potential for plantations along roads due to frequent disturbance.
Nursery/Breeding Ground	None of significance known.	None of significance known.	Possibly a breeding area for the terrapin.	None of significance known.
Age	Exact age unknown, but approximately ten years.	Exact age unknown, but the plantation approximately ten years.	Unknown.	Exact age unknown, but roadside plantation approximately twenty years.
Abundance/Richness of Wildlife	Low.	Low.	Low.	Low.
Ecological Value	Low due to small size. Stands close to LMC Meander possibly of Low to Moderate value if used by otters.	Low due to small size.	Low to Moderate due to possible presence of Three-banded Box Terrapin.	Low due to existing low floristic diversity and high fragmentation by village areas.

12.5.1.7 Shrubland

Shrubland is primarily located in the area from LMC Tsuen to the Ma Tso Lung area, along the boundary fence (**Appendix 12-12**, plate 13), and on hillside close to Shun Yee San Tsuen. Hillside shrubland usually supports a more diverse flora than grassland, while Chinese Cobra and Burmese Python, both of Potential Regional Concern^[12-31] are present in this area. Pale Palm Dart and Blackvein Sergeant have been recorded in this habitat and both are of Local Concern^[12-31]. An *Aquilaria sinensis* sapling is present at the shrubland fringe next to the vehicular road to LMC Lookout near the proposed Western Connection Road. The ecological evaluation of shrubland in different areas is summarized in **Table 12.16**.

Table 12.16 Ecological evaluation of shrubland

Criteria	Shrubland from LMC Tsuen to Ma Tso Lung Area	Shrubland close to Shun Yee San Tsuen	Shrubland south of Kwu Tung Road
Naturalness	Semi-natural to natural through natural succession.	Semi-natural to natural through natural succession.	A semi-natural habitat derived from succession on grassland habitats.
Size	Small to Moderate (36.51 ha).	Small (6.90 ha).	A relatively small area (7.30ha).
Diversity	Moderate floristic diversity	Moderate floristic diversity.	Moderate floristic diversity.
Rarity	Common habitat in HK. One specimen of the locally common (though globally uncommon) <i>Aquilaria sinensis</i> present at the fringe of a hillside shrubland close to Fisherman San Tsuen.	Common habitat in HK.	A common habitat type in Hong Kong.
Re-creatability	Readily re-created but considerable time required to reach current state.		
Fragmentation	Some fragmentation in eastern section close to Ma Tso Lung.	Limited fragmentation by hillside grassland.	Limited fragmentation
Ecological Linkage	Linkages with hillside grassland shrubland and woodland nearby.	Linkages with hillside grassland and woodland nearby.	Linkages with adjacent grassland and plantation.
Potential Value	Potential to develop to woodland through natural succession if undisturbed.	Potential to develop to woodland through natural succession if undisturbed.	Potential to develop to woodland through natural succession if undisturbed.
Nursery/ Breeding Ground	None of significance known.	None of significance known.	None of significance known.
Age	Unknown.	Unknown.	Unknown.
Abundance/ Richness of Wildlife	Low.	Low.	Low.

Criteria	Shrubland from LMC Tsuen to Ma Tso Lung Area	Shrubland close to Shun Yee San Tsuen	Shrubland south of Kwu Tung Road
Ecological Value	Low to Moderate as part of larger shrubland area supporting certain uncommon species. Fragmented areas elsewhere of Low value.	Low.	Low.

12.5.1.8 Seasonally Wet Grassland

Two areas of seasonally wet grassland are present to the southwest of Chau Tau and in the Ma Tso Lung valley area (**Appendix 12-12**, plate 15). These seasonally wet grassland areas are lower-lying and have the capacity to retain water during the wet season, and so could support wetland plant species able to tolerate periodic drought. Chinese Bullfrog, which is of Potential Regional Concern^[12-31], was recorded at Ma Tso Lung, the maximum count being 14 individuals. The ecological evaluation of seasonally wet grassland in these areas is summarized in **Table 12.17**.

Table 12.17 Ecological evaluation of seasonally wet grassland

Criteria	Seasonally Wet Grassland near Chau Tau Tsuen	Seasonally Wet Grassland in Ma Tso Lung area
Naturalness	Semi-natural and developed through natural succession.	Semi-natural and developed through natural succession. Water quality poor.
Size	Very small (1.68ha).	Small (13.08ha).
Diversity	Low in floristic diversity, lacking structural complexity.	
Rarity	Not uncommon in HK.	Habitat not uncommon in HK; Chinese Bullfrog is uncommon.
Re-creatability	Readily re-created under suitable hydrological conditions.	
Fragmentation	Somewhat fragmented by village area.	Not fragmented.
Ecological Linkage	Linkage with marsh nearby.	Linkage with ponds, marsh and stream nearby.
Potential Value	Enhancement as marsh habitat possible.	
Nursery/ Breeding Ground	None of significance known.	None of significance known.
Age	Unknown.	Unknown.
Abundance/ Richness of Wildlife	Low.	Low.
Ecological Value	Low due to small size.	Low to Moderate as, although bullfrog numbers low (max. 14), area of habitat is large and has closely linkages with marsh.

12.5.1.9 Grassland/Shrubland

Grassland/shrubland patches are scattered across the LMC Loop (**Appendix 12-12**, plate 3), while very small areas are present close to Ha Wan Tsuen, and on the hillside at Ma Tso Lung. No species of conservation interest was recorded in this habitat. The ecological evaluation of grassland/shrubland in different areas is summarized in **Table 12.18**.

Table 12.18. Ecological evaluation of grassland/shrubland

Criteria	Grassland/Shrubland in LMC Loop	Grassland/Shrubland in Ha Wan Tsuen	Grassland/Shrubland near Ma Tso Lung
Naturalness	Originally man-made, has become semi-natural through succession.	Semi-natural through natural succession.	Semi-natural through natural succession.
Size	Small (14.62 ha).	Very small (1.20 ha).	Very small (0.85 ha).
Diversity	Moderate floristic diversity and simple structural complexity.	Low floristic diversity and simple structural complexity.	Low floristic diversity and simple structural complexity.
Rarity	Common habitat in HK.		
Re-creatability	Readily re-created.		
Fragmentation	Some fragmentation by grassland and reed marsh.	Some fragmentation by roads.	Some fragmentation by plantation.
Ecological Linkage	Some linkage with grassland and reed marsh.	Some linkage with secondary woodland.	Some linkage with plantation nearby.
Potential Value	Succession to shrubland and woodland in the absence of disturbance.	Succession to shrubland and woodland in the absence of disturbance.	Succession to shrubland and woodland in the absence of disturbance.
Nursery/Breeding Ground	None of significance known.	None of significance known.	None of significance known.
Age	Exact age unknown, but approximately ten years.	Unknown.	Unknown.
Abundance/Richness of Wildlife	Low.	Low.	Low.
Ecological Value	Low	Low	Low

12.5.1.10 Grassland

Grassland is the dominant habitat in LMC Loop (**Appendix 12-12**, plate 3), while hillside grassland is present between LMC Tsuen and Ma Tso Lung Tsuen, and

near Shun Yee San Tsuen and lowland grassland is present in the Ma Tso Lung area. Grassland in LMC Loop has developed on the mud dredged from the Shenzhen River. Most of the grassland area outside the Loop is located on hillside, and this is maintained by hill fires that prevent natural succession.

A breeding population of Zitting Cisticola, listed as of Local Concern by Fellowes *et al.* (2002)^[12-31], was recorded in LMC Loop, while Golden-headed Cisticolas occurred in this area in the non-breeding season. Eurasian Eagle Owl, which is listed by Fellowes *et al.* (2002)^[12-31] as of Regional Concern, was in past years recorded in hillside grassland between LMC Tsuen and Ma Tso Lung Tsuen. This same area supports a suite of grassland species that, while individually not rare, forms a distinctive community. Small Three-ring and Spotted Angle, both butterfly species of Local Concern (Fellowes *et al.* 2002)^[12-31], were recorded, and Danaid Egg-fly (also of Local Concern) was recorded hill-topping in this area. The ecological evaluation of grassland in different areas is summarized in **Tables 12.19** and **12.20**.

Table 12.19 Ecological evaluation of grassland

Criteria	Grassland in LMC Loop	Grassland between LMC Tsuen and Ma Tso Lung Tsuen
Naturalness	Originally man-made, semi-natural through natural succession from bare ground. Very low levels of human disturbance.	Semi-natural, hillside grassland maintained by hill fire.
Size	Large (55.59 ha).	Large (107.33 ha).
Diversity	Low floristic diversity and limited structural complexity.	Low floristic diversity and limited structural complexity.
Rarity	Common habitat type in HK supporting uncommon bird species.	Common habitat type in HK supporting uncommon owl and distinctive grassland bird community.
Re-creatability	Readily recreated.	
Fragmentation	Limited fragmentation by reed marsh and grassland-shrubland habitats.	Minor fragmentation by shrubland, and some fragmentation by road close to LMC Tsuen area.
Ecological Linkage	Linkages with other habitats in LMC Loop, in particular reed marsh and grassland/ shrubland.	Linkage with adjoining grassland and shrubland areas.
Potential Value	Potential to develop to shrubland and woodland through natural succession if undisturbed.	Potential to develop to shrubland and woodland through natural succession if undisturbed.
Nursery/ Breeding Ground	A breeding population of Zitting Cisticola present.	Eurasian Eagle Owl regularly, though not frequently recorded.
Age	Exact age unknown, but approximately ten years.	Unknown.
Abundance/ Richness of Wildlife	Low to Moderate.	Low.
Ecological Value	Low as it is a widespread habitat in HK.	Low to Moderate in view of possible presence of Eurasian Eagle Owl.

Table 12.20 Ecological evaluation of grassland

Criteria	Grassland in Shun Yee San Tsuen	Grassland in Ma Tso Lung area
Naturalness	Semi-natural, hillside grassland maintained by hill fire.	Largely man-made area, with some grassland patches developed through natural succession from bare ground or abandoned agricultural field.
Size	Small.	Very small.
Diversity	Low floristic diversity and limited structural complexity.	Very low floristic diversity and little structural complexity.
Rarity	Common habitat type in HK supporting no fauna of conservation interest.	Common habitat type in HK and supports no fauna of conversation interest.
Re-creatability	Readily recreated.	Readily recreated.
Fragmentation	Minor fragmentation by shrubland.	Major fragmentation by roads, plantation and urban/residential area.
Ecological Linkage	Linkage with adjoining grassland and shrubland areas.	Linkage with adjoining plantation area; limited linkage with the hillside grassland.
Potential Value	Potential to develop to shrubland and woodland through natural succession if undisturbed.	Limited potential to develop into shrubland or wooded area due to frequent human disturbance.
Nursery/ Breeding Ground	None known.	None known.
Age	Unknown.	Unknown.
Abundance/ Richness of Wildlife	Low.	Very Low.
Ecological Value	Low.	Low.

12.5.1.11 Orchard

An orchard area is present in the southern part of LMC Loop and scattered orchards were identified at Ma Tso Lung. This habitat type is usually dominated by fruit trees (such as *Dimocarpus longan*, *Litchi chinensis* and *Musa x paradisiaca*). No species of conservation significance are generally present in such habitats.

The ecological evaluation of orchard in different areas is summarized in **Table 12.21**.

Table 12.21 Ecological evaluation of orchard

Criteria	Orchard in LMC Loop	Orchard in adjacent areas in HK outside LMC Loop
Naturalness	Man-made.	Man-made.
Size	Small (0.96 ha).	Small (4.14 ha).
Diversity	Very low floral and faunal diversity.	Very low floral and faunal diversity.

Criteria	Orchard in LMC Loop	Orchard in adjacent areas in HK outside LMC Loop
Rarity	Not uncommon in HK.	Not uncommon in HK.
Re-creatability	Readily re-created.	Readily re-created.
Fragmentation	Limited fragmentation.	Some fragmentation.
Ecological Linkage	Limited linkages with surrounding habitats.	Limited linkages with nearby plantation areas.
Potential Value	Limited scope for enhancement.	Scope for enhancement via increasing species diversity and improving linkages with other wooded habitats.
Nursery/ Breeding Ground	None of significance known.	None of significance known.
Age	Exact age unknown, but approximately ten years.	Unknown.
Abundance/ Richness of Wildlife	Low.	Low.
Ecological Value	Low.	Low.

12.5.1.12 Wet Agricultural Land

Two small areas of wet agricultural land are present at LMC Tsuen (**Appendix 12-12**, plate 12) and Chau Tau Tsuen. These areas are flooded to a lesser or greater degree for most of the year as a result of seasonal rainfall patterns and management practices. The area at LMC Tsuen is of greater ecological significance as it is larger, has greater microhabitat diversity and is closer to the wetland area at HHW. As a result, it has greater diversity and abundance of fauna, including several wetland-dependent bird species (including records of Greater Painted-snipe), Chinese Bullfrog and Ruby Darter. The ecological evaluation of wet agricultural land at different locations is summarized in **Table 12.22**.

Table 12.22 Ecological evaluation of wet agricultural land

Criteria	Wet Agricultural Land at LMC Tsuen	Wet Agricultural Land at Chau Tau Tsuen
Naturalness	Man-made.	Man-made.
Size	Small (3.26 ha).	Small (2.77 ha).
Diversity	Low floristic and low to moderate faunal diversity.	Low floristic and low to moderate faunal diversity.
Rarity	Common habitat in northern New Territories, but declining due to development; supports uncommon wetland-dependent bird and amphibian species.	Common habitat in northern New Territories, but declining due to development; supports uncommon wetland-dependent birds.
Re-creatability	Readily re-created with appropriate hydrological conditions.	Readily re-created with appropriate hydrological conditions.
Fragmentation	Very little.	Some fragmentation by road.

Criteria	Wet Agricultural Land at LMC Tsuen	Wet Agricultural Land at Chau Tau Tsuen
Ecological Linkage	Linkages with wetland area at HHW.	Few linkages with wetland area at HHW.
Potential Value	Potential for enhancement through management, but this limited by small size.	Potential for enhancement through management, but highly limited by small size.
Nursery/ Breeding Ground	Chinese Bullfrog present and probably breeds.	None of significance known.
Age	Unknown.	Unknown.
Abundance/ Richness of Wildlife	Low to Moderate.	Low abundance and low to moderate richness.
Ecological Value	Low to Moderate due to presence of wetland-dependent species.	Low due to very small size and low abundance of fauna.

12.5.1.13 Dry Agricultural Land

Very small areas of this habitat are scattered around Ma Tso Lung area. Faunal use is much less than that in wet agricultural land, but it can still provide suitable habitats for amphibians such as Chinese Bull Frog, which was recorded in this habitat. The ecological evaluation of dry agricultural land in different areas is summarized in **Table 12.23**.

Table 12.23 Ecological evaluation of dry agricultural land in all areas

Criteria	Assessment
Naturalness	Man-made.
Size	Very small (0.30 ha).
Diversity	Low floristic and faunal diversity.
Rarity	Common habitat in northern NT, but declining due to the lowland development. Chinese Bull Frog recorded at Ma Tso Lung, Tse Koo Hang and Chau Tau.
Re-creatability	Readily recreated if hydrological conditions suitable.
Fragmentation	High.
Ecological Linkage	Some linkages with nearby habitats.
Potential Value	Limited scope under current intensive management regime.
Nursery/ Breeding Ground	Small numbers of Chinese Bull Frog breed in water storage ponds.
Age	Unknown.
Abundance/ Richness of Wildlife	Low.
Ecological Value	Low due to current intensive management regime.

12.5.1.14 Natural Watercourse

Several natural watercourses lie within the Ecological Assessment Area, including LMC Meander (**Appendix 12-12**, plate 9), which is one of the largest semi-

natural river channels remaining in HK, a number of small streams draining the hills between LMC Tsuen and Ma Tso Lung Tsuen (including Ping Hang and Tse Koo Hang) and a two streams in the fish pond area at HHW (see **Figure 12.5**). In addition, there is a stream network in the Ma Tso Lung valley.

For the purposes of evaluation, streams have been grouped into discrete areas and each stream is assessed separately to reflect the differences in faunal use (see **Tables 12.24 to 12.26**).

In the semi-natural stream and nearby ponds south of Lung Hau Road a population of Rose Bitterling was recorded. This species only occurs at three sites in HK (including the subject site) and is considered to be of Local Concern (Fellowes *et al.* 2002)^[12-31] and rare locally^[12-47].

Table 12.24 Ecological evaluation of natural watercourses

Criteria	Ping Hang Stream	Stream south of Lung Hau Road
Naturalness	Largely natural.	Semi-natural.
Size	Small (length 1,180m, area 0.28 ha).	Small (length 800m, area 0.23 ha).
Diversity	Low floral and faunal diversity.	Low to moderate fish diversity, but mainly exotic species. Low floral diversity.
Rarity	Lowland streams uncommon in HK.	Lowland streams uncommon in HK. Rose Bitterling is rare.
Re-creatability	Difficult to re-create.	Can be re-created in its semi-natural form.
Fragmentation	Not fragmented.	Some fragmentation.
Ecological Linkage	Linkage with riparian vegetation and LMC Meander (one of the clean water sources for latter).	Linkage with adjacent fish ponds.
Potential Value	Value could be increased if protected and managed for wildlife.	Value could be increased if pollution sources can be removed and managed for wildlife.
Nursery/ Breeding Ground	Nursery/ breeding grounds for Paradise Fish and other native species.	Nursery/ breeding habitat for Rose Bitterling.
Age	Unknown.	Unknown.
Abundance/ Richness of Wildlife	Low faunal diversity.	Low to moderate faunal diversity, though many exotic species.
Ecological Value	Low to Moderate	Moderate

Natural streams between LMC Tsuen and Ma Tso Lung Tsuen that drain into LMC Meander are in general in good condition and potentially provide habitats for species of conservation concern, including the endangered crab *Somanniathelphusa zanklon*, which was recorded in one of these streams.

In terms of the streams in the Ma Tso Lung area, the stream at Tse Koo Hang contains a small population of the minnow *Nicholsicypris normalis*, which is considered to be of some local ecological interest as this species does not

normally appear in western HK (although it is common in eastern HK). The streams in this area support a number of species of conservation concern, including Ruby Darter, *Somanniathelphusa zanklon*, Small Snakehead, Chinese Bull Frog and Common Rat Snake. In addition, the upper sections of the stream network around Ma Tso Lung also provides habitat suitable for Three-banded Box Terrapin, based on a record during surveys for NENT NDA PES; it is possible this species occurs occasionally in the lower sections, though this area is unlikely to be important to the species given its known habitat preferences.

Although the stream east of Chau Tau contains *Somanniathelphusa zanklon*, it is highly polluted and thus its value is limited.

The ecological evaluation of these natural watercourses is summarized in **Table 12.25**.

Table 12.25 Ecological evaluation of natural watercourses

Criteria	Streams draining into LMC Meander	Streams draining into Ma Tso Lung area	Stream east of Chau Tau Tsuen
Naturalness	Largely natural.	Although partially channelised, the stream bed is largely natural.	Semi-natural.
Size	Medium (length 4,810m).	Ma Tso Lung: medium (length 5,330m)	Small (length 1,315m).
Diversity	Low to moderate.	Ma Tso Lung: low to moderate. Tse Koo Hang: low.	Low.
Rarity	Lowland streams not common in HK. <i>Somanniathelphusa zanklon</i> is rare, and may provide habitats for Paradise Fish.	Lowland streams not common in HK, especially in largely natural condition. A number of rare fauna present, and one record of the extremely rare Three-banded Box Terrapin in upper reaches of Ma Tso Lung Stream.	Lowland streams not common in HK. <i>Somanniathelphusa zanklon</i> is rare.
Re-creatability	Not readily re-created.	Not readily re-created.	Could be re-created in current form.
Fragmentation	Individual streams not fragmented.	Not fragmented.	Somewhat fragmented by developed area.
Ecological Linkage	Linkage with riparian vegetation and LMC Meander.	Linkage with riparian zone, marsh, HHW and, ultimately, LMC Meander.	None of significance.
Potential Value	Value could be increased if protected and managed for wildlife.	Value could be increased if pollution sources removed, and protected and managed for wildlife.	Limited scope for enhancement.
Nursery/ Breeding Ground	Nursery/ breeding grounds for <i>Somanniathelphusa zanklon</i> and other native fauna.	Potential nursery/ breeding grounds of native aquatic and odonate species.	Nursery/ breeding grounds for <i>Somanniathelphusa zanklon</i> .

Criteria	Streams draining into LMC Meander	Streams draining into Ma Tso Lung area	Stream east of Chau Tau Tsuen
Age	Unknown.	Unknown.	Unknown.
Abundance/Richness of Wildlife	Low to moderate faunal diversity.	Low to moderate faunal diversity.	Low faunal diversity.
Ecological Value	Moderate as crab is endangered and is a freshwater source for LMC Meander.	Ma Tso Lung Stream: Moderate to High due to diverse stream fauna and presence of Three-banded Box Terrapin. Tse Koo Hang Stream: Low to Moderate due to natural condition and presence of the minnow.	Low.

Constituting mitigation for training of the Shenzhen River, LMC Meander is one of the largest semi-natural river sections remaining in HK. Lying adjacent to LMC Loop and fish ponds for much of its length, it remains relatively undisturbed. Its banks are natural and heavily vegetated, providing roosting sites for large waterbirds. Its primary ecological interest is as a foraging area and presumed movement corridor for Eurasian Otter, and as the key focal point of the flight line corridor for large waterbirds that links wetlands to the southwest of LMC BCP as far away as MPNR with those at HHW.

A short permanent stream is present alongside ponds 96 and 58; largely overgrown with the herb *Brachiara mutica*, the shrub *Sesbania cannabina*, the floating herb *Eichhornia crassipes* and the herb *Commelina diffusa* are also present. Only very low numbers of common and widespread aquatic fauna, dragonflies and herpetofauna were recorded; however, given its natural condition and that it is hydrologically and ecologically linked to adjacent wetlands, it is rated of low to moderate ecological value. In addition, a narrow stream drains M1 between ponds 45 and 47, though it is polluted and of low ecological value.

The ecological evaluation of LMC Meander areas is summarized in **Table 12.26**.

Table 12.26 Ecological evaluation of LMC Meander

Criteria	LMC Meander	Stream adjacent to ponds 96 and 58	Stream between ponds 45 & 47
Naturalness	Semi-natural.	Semi-natural	Semi-natural, rather polluted.
Size	Large (length 2,670m, area 15.77 ha).	Small (length 200m)	Small (length 150m)
Diversity	Low to moderate faunal and floral diversity.	Low faunal and floral diversity	Low faunal and floral diversity.
Rarity	Large, undisturbed, natural lowland rivers are very rare in HK. Eurasian Otter is rare.	Common habitat in HK	Common habitat in HK

Criteria	LMC Meander	Stream adjacent to ponds 96 and 58	Stream between ponds 45 & 47
Re-creatability	Not readily re-created.	Readily re-created	Readily re-created
Fragmentation	None.	None	None
Ecological Linkage	Linkage to fish ponds and other wetland habitats at HHW, to Shenzhen River and riparian vegetation.	Linkage to adjacent marsh habitat	Linkage to adjacent marsh habitat
Potential Value	Value could be increased if managed for wildlife.	Value could be increased if managed, but not greatly	Value could be increased if managed, but not greatly
Value could be increased if managed, but not greatly	Nursery/ breeding grounds for some native aquatic and odonate species.	Nursery/breeding ground for native but common and widespread herpetofauna and odonata	Possibly nursery/breeding ground for common and widespread species.
Age	Unknown.	Unknown	Unknown
Abundance/Richness of Wildlife	Low to moderate faunal diversity and richness.	Low	Low
Ecological Value	High , in view of use by Eurasian Otter and its forming a important element of flight line corridor.	Low to Moderate	Low

12.5.1.15 Channelised Watercourse

There is one narrow channelised watercourse in LMC Loop, which forms the spine of the main reed marsh area. This channel is now largely occupied by reeds, and it is only in a short section closer to the Shenzhen River that it is obvious as a watercourse.

The three main channelised watercourses are the Shenzhen River (**Appendix 12-12**, plate 10), the STEMDC (**Appendix 12-12**, plate 8) and Ma Tso Lung Nullah. Tidal influence stretches along the entire length of Shenzhen River, and also affects the downstream section of STEMDC. Ma Tso Lung Nullah was a natural stream before 2008 and was trained as a drainage nullah under Project 4156CD - Drainage improvement in Ki Lun Tsuen, Ma Tso Lung, Ying Pun, Shek Tsai Leng and Sha Ling in New Territories. Downstream of Ma Tso Lung Nullah lie the HHW wetlands, and thus there is relatively little influence from tidal surges.

In addition to these channels, there is an interconnected set of drainage channels in the vicinity of Chau Tau Tsuen (**Appendix 12-12**, plate 11). **Figure 12.5** illustrates the locations of these channels.

Channelised watercourses undergo varying, occasionally high, levels of human disturbance and those with concrete-lining have limited scope for the establishment of natural riparian vegetation. The southern bank of the Shenzhen

River supports reed marsh. Disturbance levels are not high in the three main channels, but are more significant for the channels in the vicinity of Chau Tau Tsuen. In addition, the water of the Shenzhen River is highly polluted, which severely limits its capacity to support flora and fauna. However, given that it can tolerate such waters in the short-term, it is possible that the globally-threatened Eurasian Otter may utilise the river as a movement corridor between wetland areas at LMC/San Tin and those at HHW. Large numbers of waterbirds, mostly ducks, also use the river downstream from LMC WMA, especially at low tide. The ecological evaluation of channelised watercourse in different areas is summarized in **Table 12.27**.

Table 12.27 Ecological evaluation of channelised watercourse

Criteria	LMC Loop	Shenzhen River	Ma Tso Lung Nullah	STEMDC and Chau Tau Tsuen
Naturalness	Man-made and somewhat influenced by tidal action.	Man-made banks with a semi-natural base and influenced by tidal action.	Man-made banks with less influence by tidal action. Bottom remains semi-natural.	Man-made. STEMDC partly influenced by tidal action and supports semi-natural vegetation inside channel.
Size	Small (length 462m, area 0.29 ha).	Large (length in Ecological Assessment Area 4,020m, area 28.23 ha).	Small (length 512m, 0.78 ha)	STEMDC: moderate (length 2,160m, area 6.80 ha). Total length of all 11,200m.
Diversity	Low.	Low.	Low	STEMDC: low to moderate. Chau Tau: low.
Rarity	Common habitat in HK.	Common habitat in HK. Likely to be a corridor for the rare Eurasian Otter.	Common habitat in HK.	Common habitat in HK.
Re-creatability	Readily re-created.	Readily re-created in suitable hydrological conditions.	Readily re-created.	Readily re-created.
Fragmentation	Not fragmented.	Not fragmented.	Not fragmented.	Not fragmented.

Criteria	LMC Loop	Shenzhen River	Ma Tso Lung Nullah	STEMDC and Chau Tau Tsuen
Ecological Linkage	Ecologically and hydrologically linked to Shenzhen River.	Strong linkage with many wetland habitats in the Deep Bay wetland system. May provide linkage between other habitats.	Linkage with HHW in downstream	STEMDC: Linkage with Shenzhen River and adjacent ponds and mitigation wetlands. Chau Tau: Little linkage to other habitats.
Potential Value	Highly limited due to small size.	Value could increase if pollution load decreases.	Limited scope for enhancement.	Limited scope for enhancement.
Nursery/Breeding Ground	Not known to support significant breeding grounds.	Not known to support significant breeding grounds.	Not known to support significant breeding grounds.	Not known to support significant breeding grounds.
Age	Presumed to have been completed at same time as channelisation of Shenzhen River.	Constructed in 1997.	Commence Construction in 2008 and completed in 2012	Less than 10 years.
Abundance/Richness of Wildlife	Low.	Low abundance of birds in vicinity of LMC Loop.	Low	Moderate for avifauna in STEMDC. Low for Chau Tau.
Ecological Value	Low.	Moderate in view of possible corridor function and potential for water quality improvement.	Low to Moderate.	STEMDC: Moderate. Chau Tau: Low.

12.5.1.16 Village Area

Scattered village areas are located mainly in the western part of the Ecological Assessment Area; there are none in LMC Loop. Village land is present at Ha Wan Tsuen, Ha Wan Fisherman San Tsuen, Pun Uk Tsuen, Chau Tau Tsuen, Shun Yee San Tsuen, Ma Tso Lung San Tsuen and Wing Ping Tsuen. Villages typically have low ecological value due to the non-natural habitats and high levels of disturbance, although some species of conservation value from surrounding habitats may sometimes be recorded within the village. Three reptile species of conservation importance have been recorded in village areas: Many-banded Krait at Ma Tso Lung, and Common Rat Snake and Copperhead Racer at Ha Wan

Tsuen. The ecological evaluation of different village areas is summarized in **Table 12.28**.

Table 12.28 Ecological evaluation of village area

Criteria	Assessment
Naturalness	Man-made.
Size	Moderate (41.76 ha in total).
Diversity	Low in both floristic and faunal diversity.
Rarity	Common habitat in HK.
Re-creatability	Readily re-created.
Fragmentation	Some fragmentation.
Ecological Linkage	Some linkage with surrounding natural habitats.
Potential Value	Limited scope for enhancement due to high levels of disturbance.
Nursery/ Breeding Ground	White-shouldered Starlings breed in most villages in this area.
Age	Unknown.
Abundance/ Richness of Wildlife	Low.
Ecological Value	Low due to high level of human disturbance.

12.5.1.17 Waste Ground

A very small area of waste ground is present near Ha Wan Fisherman San Tsuen. Other small areas are located near Pak Shek Au and Lo Wu Firing Range within the Ecological Assessment Area. This habitat does not support significant floristic or faunal diversity. The ecological evaluation of waste ground in different areas is summarized in **Table 12.29**.

Table 12.29 Ecological evaluation of waste ground

Criteria	Assessment
Naturalness	Man-made.
Size	Very small (2.88 ha).
Diversity	Very low floristic and faunal diversity
Rarity	Not uncommon habitat in HK.
Re-creatability	Readily re-created.
Fragmentation	Not fragmented.
Ecological Linkage	Limited linkages with surrounding habitats.
Potential Value	Potential to develop to grassland depending on substrate and level of human disturbance.
Nursery/ Breeding Ground	None of significance.
Age	Unknown.
Abundance/ Richness of Wildlife	Very low.

Criteria	Assessment
Ecological Value	Very Low

12.5.1.18 Urban/Residential Area

Urban/Residential Area includes an unmade access track along the western boundary of LMC Loop and the urbanised area and road infrastructure located in the assessment area outside the LMC Loop. These areas have little natural habitat, suffer high levels of human disturbance and are intensively managed to maintain these conditions. Generally speaking, any fauna occur opportunistically, and the habitat is of significance to very few species.

The ecological evaluation of urban/residential areas is summarized in **Table 12.30**.

Table 12.30 Ecological evaluation of Urban/Residential Area

Criteria	Assessment
Naturalness	Man-made.
Size	Moderate (173.75ha in total).
Diversity	Moderate floristic diversity but majority of plants are planted for ornamental purpose and actively managed; Low fauna diversity.
Rarity	Common habitat in HK.
Re-creatability	Readily re-created.
Fragmentation	Not fragmented.
Ecological Linkage	No significant linkage with habitats of ecological importance.
Potential Value	Limited scope due to the high disturbance level.
Nursery/ Breeding Ground	None of significance known.
Age	Variable.
Abundance/ Richness of Wildlife	Low.
Ecological Value	Very Low

12.5.1.19 Summary of Habitat Evaluation

The habitat evaluations discussed above are summarized in **Table 12.31**.

Table 12.31 Summary of habitat evaluations

Habitat	LMC Loop	Areas outside LMC Loop
Reed Marsh	High	High at HHW. Low to Moderate at LMC Station.
Marsh	Low to Moderate	Moderate at HHW. Low to Moderate at Ma Tso Lung. Low to Moderate at LMC Tsuen. Low to Moderate at Chau Tau.
Mitigation Wetland	-	Low to Moderate for STEMDC and constructed wetland. High for LMC WMA.

Habitat	LMC Loop	Areas outside LMC Loop
Pond		High
Secondary Woodland	-	Low to Moderate depending on site.
Plantation	Low	Low to Moderate (south of Ma Tso Lung) Low (remaining plantation areas)
Shrubland	-	Low to Moderate
Seasonally Wet Grassland	-	Low at Chau Tau Low to Moderate at Ma Tso Lung
Grassland/Shrubland	Low	Low
Grassland	Low	Low to Moderate in area from LMC Tsuen to Ma Tso Lung Tsuen. Elsewhere Low.
Orchard	Low	Low
Wet Agricultural Land	-	Low to Moderate (LMC Tsuen) Low (Chau Tau Tsuen)
Dry Agricultural Land		Low
Natural Watercourse	High (LMC Meander)	Low to Moderate (Ping Hang Stream) Moderate (stream south of Lung Hau Road) Moderate (streams draining into LMC Meander) Moderate to High (streams draining into Ma Tso Lung area) Low (stream east of Chau Tau Tsuen) Low to Moderate (adjacent to ponds 96 & 58) Low (stream between ponds 45 & 47)
Channelised Watercourse	Low	Moderate (STEMDC) Low (at Chau Tau) Moderate (Shenzhen River) Low to Moderate (Ma Tso Lung Nullah)
Village Area	-	Low
Waste Ground	-	Very Low
Urban/Residential Area	Very Low	Very Low

12.5.2 Species Evaluations

12.5.2.1 Avifauna

A total of 78 species of conservation concern have been recorded in the Ecological Assessment Area, a figure that includes 64 wetland-dependent or wetland-associated species. A full list is provided in **Appendix 12-2**, which includes their distribution and abundance in Hong Kong and their conservation status based on assessments by BirdLife International and Fellowes *et al.* (2002) [12-31].

Due to their wetland-dependence and the threats to wetlands regionally, a large number of waterbirds are assessed as of conservation significance. These include large waterbird species such as cormorants, egrets, herons and spoonbills, for all of which the HHW area in particular is of significance in maintaining Deep Bay area populations.

Among those occurring regularly in the Ecological Assessment Area, of most significance from a conservation perspective (in that the area is likely to be of importance to their HK populations) are the following:

Black-faced Spoonbill: Listed as Endangered by BirdLife International, this species occurs in fish pond areas adjacent to the LMC Loop and utilises the airspace above the LMC Loop to commute to and from foraging areas.

Greater Spotted and Imperial Eagles: Listed as Vulnerable by BirdLife International, both these species occur in small numbers throughout the Deep Bay area, and both have been recorded utilising habitats within the LMC Loop, as well as adjacent fish pond areas. Both, however, appear to be somewhat rarer in the Ecological Assessment Area than was previously the case.

Yellow-breasted Bunting: Listed as Vulnerable by BirdLife International, this species was both trapped and seen in the LMC Loop during fieldwork for this Study.

Collared Crow: Listed as Near Threatened by BirdLife International, this species is present all year in the Ecological Assessment Area, and utilises habitats in the LMC Loop, though probably not as frequently as the adjacent fish pond areas.

In terms of overall conservation value, this group of birds must in general be rated as High.

Red-billed Starling occurs frequently in the area in the winter period from October to April, and in very low numbers during the breeding season, although it is not considered to breed in the area. While LMC Loop itself does not appear to be of significance to local populations, the fish pond areas at HHW probably are due to the presence of significant foraging opportunities in terms of grain used to feed fish and fruiting trees. Conversely, the fish pond areas are not of significance to Japanese Quail, while the lowland grassland in LMC Loop is more attractive. However, that only two birds were recorded in one month (November) does not suggest the area is an important area for local populations, especially given the availability of similar grassland and grassland/shrubland habitat in the general area.

In addition, Falcated Duck, Styan's Grasshopper Warbler and Japanese Yellow Bunting have occurred, but the area is not considered important to their HK populations.

12.5.2.2 Mammals

Table 12.32 lists mammals of conservation significance known to occur in the Ecological Assessment Area.

Table 12.32 Mammals of conservation significance occurring in the Ecological Assessment Area.

Species	Protection Status	Distribution	Rarity	Conservation Value
Eurasian Otter	Cap. 170, Class II in China ¹ , Appendix II CITES ² .	Highly restricted in HK, only in northwest NT.	Regional Concern ³ , Near-threatened ⁴ and Endangered in China ⁵ .	High.
Small Indian Civet*	Cap. 170 protected, Class II in China ¹ .	Widely distributed in HK.	Vulnerable in China ⁵ .	Medium.
Leopard Cat	Cap. 170 protected, Appendix II CITES ² .	Widely distributed in HK.	Vulnerable in China ⁵ .	Medium.
Small Asian Mongoose	Cap. 170	Fairly wide distribution in HK.	Uncommon in Hong Kong	Medium
East Asian Porcupine	Cap. 170	Widely distributed in HK except Lantau Island.	Very Common in Hong Kong. Potential Global Concern ³	Low
Red Muntjac	Nil.	Widely distributed in HK.	Potential Regional Concern ³ , Vulnerable in China ⁵ .	Medium.
Japanese Pipistrelle	Cap. 170	Widely distributed in HK.	Very common in Hong Kong	Low
Brown Noctule	Cap. 170	Fairly widespread in Hong Kong	Local Concern ³	Medium

Notes

- [1] <http://www.sepa.gov.cn>
- [2] UNEP-WCMC (2009)
- [3] Fellowes et al. (2002)
- [4] IUCN (2010)
- [5] CSIS (2010); *Not recorded in field surveys but observed during surveys for other projects.

12.5.2.3 Herpetofauna

Table 12.33 lists herpetofauna of conservation significance known to occur in the Ecological Assessment Area.

Table 12.33 Herpetofauna of conservation significance occurring in the Ecological Assessment Area

Species	Protection Status	Distribution	Rarity	Conservation Value
Three-banded Box Terrapin*	Cap. 170, Class II in China ¹ , Appendix II of CITES ² .	HK has largest population in world. Widely distributed but rare in HK.	Global Concern ³ , Critically Endangered ⁴ and Endangered in China ⁵ .	Very High.
Chinese Soft-shelled Turtle*	Cap. 170.	Highly restricted in HK, only in northwest NT.	Global Concern ³ , Vulnerable ^{4, 5} .	Medium.
Burmese Python*	Cap. 170, Class I in China ¹ , Appendix II CITES ² .	Widely distributed in HK.	Potential Regional Concern ³ , Lower Risk/Near Threatened ⁴ , Critically Endangered ⁵ .	Medium to High.

Species	Protection Status	Distribution	Rarity	Conservation Value
Chinese Cobra	Appendix II CITES ² .	Widely distributed in HK.	Potential Regional Concern ³ , Vulnerable ⁵ .	Medium.
Indo-Chinese Rat Snake	Nil.	Widely distributed in HK.	Potential Regional Concern ² , Vulnerable ⁵ .	Medium.
Common Rat Snake	Appendix II CITES ⁵ .	Widely distributed in HK.	Potential Regional Concern ² , Vulnerable ⁵ .	Medium.
Two-striped Grass Frog	Nil.	Restricted in HK.	Local Concern ² .	Medium.
Many-banded krait	Nil.	Widely distributed in HK.	Potential Regional Concern ³ , Vulnerable in China ⁵ ,	Medium
Chinese Bull Frog	Class II in China ¹ .	Quite widely distributed in HK.	Potential Regional Concern ³ .	Medium.

Notes

- [1] <http://www.sepa.gov.cn>
- [2] UNEP-WCMC (2009)
- [3] Fellowes *et al.* (2002)
- [4] IUCN (2010)
- [5] CSIS (2010); *Not recorded in present field surveys but observed during surveys for other projects.

12.5.2.4 Odonata

Table 12.34 lists odonata of conservation significance known to occur in the Ecological Assessment Area.

Table 12.34 Odonata of conservation significance occurring in the Ecological Assessment Area

Species	Protection Status	Distribution	Rarity	Conservation Value
Coastal Glider	Nil	Uncommon in HK, but globally widespread	Local Concern ¹ .	Low to Medium.
Sapphire Flutterer	Nil	Common.	Local Concern ¹ .	Low to Medium.
Ruby Darter	Nil	Common.	Local Concern ¹ .	Low to Medium.
Scarlet Basker	Nil	Common.	Local Concern ¹ .	Low to Medium.

Notes

- [1] Fellowes *et al.* (2002).

12.5.2.5 Butterflies

Table 12.35 lists butterflies of conservation significance known to occur in the Ecological Assessment Area.

Table 12.35 Butterflies of conservation significance occurring in the Ecological Assessment Area

Species	Protection Status	Distribution	Rarity	Conservation Value
Spotted Angle	Nil	Rare	Local Concern ¹	Medium
Pale Palm Dart	Nil	Common	Local Concern ¹	Low to Medium
Small Three-ring	Nil	Rare	Local Concern ¹	Medium
Danaid Egg-fly	Nil	Common	Local Concern ¹	Low to Medium
Blackvein Sergeant	Nil	Uncommon	Local Concern ¹	Low to Medium
Baron	Nil	Uncommon	Local Concern ¹	Low to Medium

Notes

[1] Fellowes et al. (2002)

12.5.2.6 Aquatic Fauna

Table 12.36 lists aquatic fauna of conservation significance known to occur in the Ecological Assessment Area.

Table 12.36 Aquatic fauna of conservation significance occurring in the Ecological Assessment Area

Species	Protection Status	Distribution	Rarity	Conservation Value
Rose Bitterling	Nil.	Only occurs at three sites in HK.	Local Concern ¹ .	High.
Small Snakehead	Nil.	Uncommon in the wild.	Local Concern ¹ .	Medium.
<i>Somanniathelphusa zanklon</i>	Nil.	HK endemic, but quite widely distributed.	Global Concern ¹ , Endangered ² .	Medium.

Notes

[1] Fellowes et al. (2002)

[2] IUCN (2009)

12.5.2.7 Flora

A few individuals of the protected tree species *Aquilaria sinensis* were recorded in the secondary woodland and shrubland close to Pun Uk Tsuen. A sapling of this species was recorded at the fringe of the secondary woodland adjacent to the access road to LMC Tsuen, while another sapling was identified at the shrubland fringe next to the vehicular road to LMC Lookout (see Figure 12.4). **Table 12.37** lists the conservation significance of this species.

Table 12.37. Flora of conservation significance occurring in the Ecological Assessment Area.

Species	Protection Status	Distribution	Rarity	Conservation Value
<i>Aquilaria sinensis</i>	Cap. 586	Commonly found in lowland forest and <i>fung shui</i> wood in Hong Kong	Vulnerable ¹ ; Category II ² ; Vulnerable in <i>China Plant Red Data Book and Illustration of Rare & Endangered plant in Guangdong Province</i> ²	Medium

Notes

- [1] Sun, W. 1998. *Aquilaria sinensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 19 January 2011.
- [2] South China Institute of Botany & Agriculture, Fisheries and Conservation Department 2003. *Rare and Precious Plants of Hong Kong*. AFCD, Hong Kong.

12.6 Prediction and Evaluation of Ecological Impacts

In addition to infrastructure and development within LMC Loop, the following Designated Projects (DPs) have been included in the ecological impact assessment:

- Ecological Area (DP1);
- Western Connection Road (DP2);
- Direct Linkage to LMC Station (DP3);
- Drainage System under Internal Transport Networks (DP4);
- Sewage Treatment Works (DP5);
- Eastern Connection Road (DP6); and
- Flushing Water Service Reservoir (DP7).

12.6.1 Introduction

12.6.1.1 Approach

This section assesses the direct and indirect impacts likely to be caused by development of LMC Loop during the construction and operational phases. It also addresses the cumulative impacts together with those of other projects in the area.

The approach adopted is to assess impacts on habitats, species, those arising from fragmentation, those from disturbance and, finally, the potential cumulative impacts. These impacts are approached from the standpoint of the main constituents of the whole Project, as these are largely independent of each other in terms of construction. Impacts are assessed arising from the following: infrastructure and development of LMC Loop, the Western Connection Road, the Eastern Connection Road, the Direct Link to LMC Station, the flushing water service reservoir and development of the adjacent area in Shenzhen (i.e. Area C in Figure 1.1). Within each of these sections, impacts have been predicted and evaluated according to direct or indirect impacts where appropriate, and further defined according to construction phase and operational phase.

The significance of ecological impacts has been evaluated based primarily on the criteria set out in Table 1 of Annex 8 of the TM-EIAO, using the following criteria: habitat quality, species impacted, size/abundance, duration, reversibility, magnitude and severity.

The current conditions of habitats in and around the proposed developments are used as the baseline against which impacts of the development are assessed. This is based on the expectation that ecological conditions in this area would remain largely unchanged in future in the absence of the development. Future conditions are difficult to predict, being dependent upon changes to habitat conditions, human activity in and around the area and the population dynamics of species present. The potential ecological value of each habitat has been evaluated in **Section 12.5** to determine whether the ecological value may be expected to change in the absence of the Project. In most habitats conditions are expected to remain unchanged, albeit with the potential for ecological enhancement if active management measures were implemented. Some habitats may be expected to increase in ecological value in future as a result of ecological succession (for example the maturation of shrubland into woodland). Where the change in ecological conditions can be predicted (from vegetation succession or other changes) the potential value of the predicted conditions is taken into account in the impact assessment for the relevant habitats.

In many cases, changes arising from human development are more predictable, especially where these relate to developments that have been proposed and/or approved under planning legislation. The cumulative ecological impacts of the LMC Loop development after implementation of other planned developments are discussed in **Section 12.6.5**.

In terms of existing land uses zoned for the area, neither LMC Loop nor the fish pond wetland area at HHW has an Outline Zoning Plan (OZP). As part of the Approved San Tin OZP (No. S/YL-ST/8), the pond area to the south and southeast of LMC Loop is zoned as Conservation Area, for which the planning intention is to conserve the ecological value of wetland and fish ponds that form an integral part of the Deep Bay Area by adoption of a no-net-loss in wetland principle. The primary intention is to discourage new development unless it is required to support the conservation of the ecological integrity of the wetland ecosystem, or the development is an essential infrastructure project with overriding public interest. Under these circumstances, the likelihood of complete loss of wetland ecological function is highly limited, though it could be significantly compromised by certain conforming changes to activities on site. The LMC WCA will remain of high ecological value for as long as the MTR LMC Spur Line and Station are operational, as the implementation of a managed area of mitigation wetland is a requirement of the Environmental Permit (EP) for the development.

Much of the hilly area between Chau Tau Tsuen and Ma Tso Lung is zoned as Green Belt, in which there is a general presumption against development. It is therefore likely that changes to the baseline condition will be limited and very gradual, possibly involving succession from grassland to shrubland.

The areas zoned as Village-type development could, in the case of Lok Ma Chau Tsuen and Chau Tau Tsuen, see the conversion of wet agricultural habitat to village-type development, which involves a loss of ecological value.

Both Hoo Hok Wai and Ma Tso Lung are currently subject to the Approved Ma Tso Lung and Hoo Hok Wai Development Permission Area Plan (No. DPA/NETL/2), with the former zoned as Unspecified Use and the latter as Agriculture. The planning intention of the Unspecified Use zoning is to conserve and enhance the ecological value and functions of the existing fish ponds or wetland in the interim, pending a detailed study of development content. Limited low-density private residential or passive recreational development may be allowed. It is, thus, likely that the current baseline condition will remain unchanged for as long as the DPA plan is in force and current pond culture practices remain largely unchanged.

With regard to the Agriculture zoning that occupies most of Ma Tso Lung area, this is primarily to retain good quality agricultural land/farm/fish ponds, and to retain fallow arable land with good potential for rehabilitation for cultivation or other agricultural purposes. Given that agriculture currently remains a relatively uneconomic activity, it is likely that the fallow state of much of the land in this area will remain in the foreseeable future.

Located in the hills to the south of HHW, between Horn Hill (Ngau Kok Shan) and Shun Yee San Tsuen, is an area of land zoned as Other Specified Use, the planning intention for which is to provide for sustainable tourism in the form of an eco-lodge development of low-rise, low-density resort-type accommodation. This will result in a change to the ecological character of this area. The grassland habitat impacted is of relatively low ecological value.

12.6.1.2 Nature of Impacts

The aim of this section is to describe in general terms the possible impacts that might arise from development. Although reference is made to potential impacts of the Project, it is not intended to be comprehensive in this respect. Detail regarding impacts is contained in **Sections 12.6.2 - 12.6.6**.

1) Direct Impacts

Habitat Loss

Direct impacts comprise habitat loss caused by the developments and their associated infrastructure, including temporary construction impacts and long-term operational impacts. These are readily recognised as they take the form of habitat disappearance, are easy to define, and their magnitude is more easily appreciated. In terms of this Project, the obvious area of habitat loss concerns LMC Loop, which will be entirely recreated; in addition, limited areas of habitat loss will occur underneath road alignments and in association with construction access and works sites, and supporting infrastructure such as the Flushing Water Service Reservoir.

A particular form of habitat loss that may occur as a secondary effect of the provision of access to formerly inaccessible areas concerns illegal fly-tipping or pond/land filling activities. With regard to the Project, the most likely source of such impact are the Eastern and Western Connection Roads, although existing land uses and topography mean the potential impacts arising in the latter area are likely to be of significantly lower magnitude. Further, given that a road currently exists, the potential impact arises more from the removal of any requirement for a closed road permit, rather than the upgrading of the WCR per se, although the

latter will make access slightly easier for large vehicles. In both areas, the severity of potential impact depends much on the extent of filling or fly-tipping.

Wildlife Mortality

Animals may be hit and killed or injured by rapidly-moving vehicles or by collision with stationary objects such as buildings or noise barriers. Birds and mammals appear to be most susceptible (Van der Grift and Kuijsters 1998), though herpetofauna are also prone. Should roads pass through areas of high animal population density or cut across regular lines of movement, such mortality is likely to be greater. The risk of animal mortality arising from road kill and collision with buildings, windows or transparent noise barriers is likely to be greater in rural areas than in already developed, urban areas, as wildlife populations are higher in the former.

Numerous studies have documented avian mortality associated with buildings, usually the result of collision with tall buildings or windows. Long-term studies have documented the chronic nature of collision mortality associated with some buildings. Over a three-year period in Toronto, Ontario, Ogden (1996) [12-56] counted 5,454 dead birds at 54 tall glass buildings. Inclement weather during the migration seasons is known to exacerbate nocturnal collision mortality, as birds become disorientated in such weather conditions. The combination of strong night-time lighting emitted from a tall building or structure is a particular source of mortality.

Collisions also occur in daytime, though the causes are generally related to the nature of the building exterior (glass being the prime culprit), and the key risk factors are transparency and reflectivity. Building façades that constitute transparent glass appear not to present an obstacle to flight and birds may strike windows as they attempt to access potential perches, plants, food and water sources or other lures seen through the glass. Design features such as glass skywalks joining buildings, glass walls around planted atria and windows installed perpendicularly at building corners are dangerous as birds perceive these an unobstructed route.

In addition, materials that reflect surrounding natural vegetation impart the appearance of being suitable for foraging or perching. Where nearby vegetation is limited in extent, even extensive glass surfaces may produce only a few collisions per year; but where this factor is prominent and “mirrored glass exteriors” face ‘forested patches’ (O’Connell 2001) [12-55], high collision rates may occur. Glass windows in the lower stories of building are, typically, a much greater threat as they are more likely to reflect trees and other landscape features that attract birds. Windowed courtyards and open-topped atria, especially if heavily planted, are also hazardous. Birds fly down into such areas, but may try to leave by flying directly towards reflections on walls. Gelb and Delacretaz (2009) [12-33] found that in New York the combination of open space, vegetation and large windows greater than 1m x 2m are more predictive of bird mortality than building height. The angling of glass toward the sky appears to confuse birds [12-43] and constitute an exacerbating factor.

In the same manner, noise barriers are problematic if they are transparent, and thus appear to allow clear passage to suitable habitat on the far side, or are

reflective of surrounding habitats. A particular complicating factor is that if a surface is not obviously impenetrable from some distance, it may be difficult for birds to take evasive action at a closer range. Birds, whether by instinct or morphology, often cannot rapidly reduce flight speed as it results in stalling, and a fall from the air; thus, if there is insufficient distance to avoid a barrier by flying over or around, collision is inevitable^[12-49]. Consequently, surfaces that appear to be solid only at close range (for example, where a pattern such as hatching is not visible at longer range) may still cause significant mortality.

Birds have evolved to fly through tree canopies at speed. As a result, such measures as the placing of falcon silhouettes, owl decals and large eye patterns do not reduce strike rates by a statistically significant level^[12-43]. Such objects have to be distributed sufficiently densely across the problem surface so as to break the glass swaths to less than either 4" vertically or 2" horizontally^[12-64] in order to be effective. Such a density is unlikely to be considered aesthetically pleasing on buildings, though may be acceptable for roadside noise barriers.

Flora

Direct impacts on species of flora arise from vegetation clearance and felling of trees required as part of development works. While transplanting or replanting of species affected can be carried out, the feasibility of such measures depends on the specimens affected, their age/size, the tolerance of any time lag required for growth to maturity and the availability of suitable relocation sites.

Dust deposition is usually a temporary phenomenon, and while it may inhibit growth, the effects are not usually lasting.

2) Indirect Impacts

Indirect impacts comprise the secondary effects of development on habitats or wildlife away from the development footprint. While direct impacts in the form of habitat loss are easily recognised and their significance readily understood as they often result in the total loss of all natural habitat, the mechanism and effects of indirect impacts are less straightforward. These impacts include such secondary impacts as run-off from construction sites that affects water quality of nearby watercourses (of relevance in this case to Eurasian Otter), as well as indirect disturbance impacts in both construction and operation phases that do not prevent a species from using an area (as habitat loss does), but may reduce the area's suitability for that species.

Disturbance impacts

These impacts include active disturbance arising from noise or other human activities, and passive disturbance resulting from avoidance by animals of building structures. For animals there are two main reactions to disturbance. The earliest reaction is to become alert, which usually involves cessation of foraging or roosting; this in itself is energy-intensive and reduces foraging efficiency. The second reaction is to move away or take flight (in the case of birds), or 'flush', when it is felt security is threatened.

Disturbance effects may comprise the complete avoidance of an area because a sense of security is compromised all the time (which is comparable to habitat loss),

reduced densities (where only less-sensitive individuals utilise an area) or reduced habitat quality (where feeding efficiency is reduced as a result of increased vigilance). Thus, although a species may be observed close to a disturbance source, this is not necessarily evidence that there is no disturbance effect. Ultimately, an organism will only approach a potential disturbance source up to the point at which the negative effects prevent achieving sufficient benefits of being there.

Of particular relevance to the current Project is the impedance of or disturbance to flight lines, which could occur in both construction and operation phases. Responding to and avoiding either of these phenomena may require birds to fly a longer distance to foraging or roosting areas, increasing energy expenditure and thus foraging requirements. Increasing foraging time to make up for such an impact will only be possible to a certain extent, as there are a limited number of daylight hours available in which to forage, and birds require to carry out other activities such as digestion, preening and resting in order to ensure they are fit for survival. For those birds at or near the margins of foraging effectiveness, this may make the journey to or from a site uneconomic, and it may thus no longer be used. Alternatively, the extra energy expenditure required may reduce the physical fitness of a bird. Consequently, disturbance impacts may cause a reduction in carrying capacity of an area or affect the survival or reproductive success of individuals.

In terms of mammals such as Eurasian Otter, the principles are the same. Responding to disturbing phenomena may require increased energy expenditure to maintain foraging effectiveness, and the possibility of such action being taken may be limited by the limited number of suitable hours in day to forage.

Disturbance from roads tends to be fairly low compared to that from buildings where people are highly visible or where disturbance events are unpredictable. As with buildings, construction is usually more disturbing than operation. In terms of the area of fish pond wetlands in the Deep Bay area, the Town Planning Board Guidelines for Application for Developments within the Deep Bay Area (TPB PG-No. 12B) acknowledges that, on the basis of scientific studies undertaken during the Fish Pond Study (Aspinwall 1997), reduced bird usage occurs on fish ponds that are adjacent to or in the vicinity of open storage, industrial uses, dispersed village developments and roads. It is reasonable to assume the same applies to Eurasian Otter and other mammals. Mitigation for such disturbance impacts in the form of visual and noise barriers is, thus, recommended.

Night-foraging or night-roosting birds may be subject to impacts from glare or direct lighting from buildings, which might make certain areas unattractive as foraging or roosting sites. The main species groups affected by disturbance are sensitive species such as large waterbirds (cormorants, egrets and herons) and birds of prey such as owls, as well as mammals, including Eurasian Otter. In general, the larger the species, the greater the distance from a disturbance source at which a disturbance impact occurs.

Dust Deposition

Unmitigated construction operations create significant levels of dust under certain weather conditions due to the use of haul roads and the phenomenon of wind-blown dust from works areas. This dust is deposited on nearby habitats, which can cause vegetation damage and, as a secondary effect, have an impact on fauna such

as insects and birds. Impacts from dust deposition of these types will, however, be temporary and reversible, and standard construction best practices as mitigation measures can be implemented to negate harmful impacts.

Increased Sediment and Nutrient Load

Dust and exposed earth from construction operations may also enter watercourses via run-off, particularly during periods of heavy rain. This can lead to high turbidity from soil particles (which can block the gills of aquatic organisms) and eutrophication as a result of nutrient enrichment. Aquatic macrophytes may be reduced as a result of reduced light penetration or increased free-floating algae populations following eutrophication. Severe eutrophication can lead to oxygen depletion and the impoverishment of aquatic communities, as well as animals that prey on them (e.g. waterbirds, Eurasian Otter). Such effects are usually greatest in the construction phase of a project, though can also occur in the operation phase.

Organisms at a higher trophic level (e.g. Eurasian Otter) are unlikely to be directly impacted by run-off before their prey (i.e. fish), the availability of which will reduce. In extreme cases, this may lead to abandonment of habitat. Such impacts are most likely to occur during the construction phase, but are also possible in the operational phase.

Additional sediment inputs to Shenzhen River, while not significant in terms of the river channel itself, may be of significance further downstream in the intertidal areas of Deep Bay. Increased sedimentation of the inner Deep Bay area in particular could increase the spread of mangrove into the mudflat area, which in turn would reduce the available foraging area for waterbirds. Mitigation measures are required and can be implemented to prevent such adverse impacts.

Pollution

Pollution of air or water may arise from a large number of different sources and could occur during construction, operation or both. The severity of a pollution event would depend upon the type of pollutant being released, the nature and ecological value of the habitat affected, the size of the habitat affected, the amount of pollutant released, duration of the event and the sensitivity of species potentially affected. Given the number of factors involved, the potential impacts of pollution are difficult to evaluate with a high degree of accuracy. Impacts of water pollution are of particular importance due to the sensitivity of the species involved and the high ecological value of wetland habitats in HK. In contrast, air pollution generally disperses over a larger area and the impacts are evident regionally but mostly do not affect local ecology.

There is the potential for toxic pollutants from contaminated mud or storage activities to be disturbed and enter surrounding watercourses. Furthermore, spills and run-off from construction sites can contain high levels of toxic pollutants such as oil, which can cause direct mortality of flora and fauna or sub-lethal impacts (e.g. reduced breeding success, reduced foraging efficiency). Bio-accumulation may also occur should toxic substances be passed up the food chain in increasing concentrations. Such a process would impact top-level predators such as large waterbirds and, in particular, Eurasian Otter. Although likely to be of lower magnitude, toxic pollutants such as oil or petrol could enter water bodies during

the operation phase as a result of run-off from road surfaces. At this stage, however, potential sedimentation issues are likely to be of lower magnitude.

Water quality in the Shenzhen River is poor and its ecological value is low. Ecological degradation of this habitat may not occur if pollutant levels in site run-off are not significantly above those in the river channel; however, toxic pollutants could enter the mudflat and mangal ecosystem of Inner Deep Bay, with potential impacts on a large number of species and individuals.

Water quality of LMC Meander is not poor, as it is separate from Shenzhen River and is fed by natural watercourses from adjacent hill streams. Consequently, ecological degradation of this habitat is a possibility if run-off impacts are not mitigated, which could impact Eurasian Otter in particular. It is, thus, essential that standard construction best practice mitigation measures are taken to minimise the potential impacts of such activities and to avoid contaminated material from entering watercourses, and an effective road drainage system is installed that prevents potentially toxic run-off from entering the Meander.

Hydrological disruption

Hydrological disruption as a result of changes to water flow or impacts on the underground water table could impact surrounding water bodies such as Shenzhen River and LMC Meander, as well as adjacent fish pond habitats and downstream intertidal areas in Deep Bay.

3) Impacts of Fragmentation

Fragmentation is the appearance of discontinuities in habitat that render it less attractive to flora or fauna or isolate populations of a species, potentially leading to reduced viability of a population. This is most easily seen in infrastructural links, where roads and rail lines break up habitat into smaller units, but also arises from disturbance impacts, where organisms avoid certain areas due to secondary impacts from nearby development. Where the infrastructural link prevents mobility of organisms, fragmentation has occurred. In the current study, the development comprises a potential fragmentation effect at both a micro level, whereby the fish pond area is potentially fragmented into smaller areas, but also at a macro level, in terms of the whole Deep Bay fish pond area. The latter may occur as the construction of buildings in LMC Loop may impede certain birds from flying over LMC Loop and others from flying close to the Loop; this has particular implications in respect of the flight line corridor through the area.

4) Cumulative Impacts

Cumulative impacts are those arising from this development in combination with other developments in the area. In terms of the Project, developments include operation of the infrastructural links with the boundary crossing point at Lok Ma Chau, comprising the MTR LMC Spur Line and Station, the vehicle BCP and associated San Sham Road. Major developments in the area currently under consideration in two planning studies: LUP CAFS and NENT NDA PES. The relevance of the former lies in land use zonings proposed for the HHW area, while that of the latter constitutes proposals in relation to the Kwu Tung North NDA, concerning the Ma Tso Lung and Long Valley areas.

It is important to note that the existence of other developments in the relevant area means that further developments may impose proportionately greater impacts, as

the initial impact already imposes existing stresses on the ecosystem. In the current case, impacts on the flight line corridor from infrastructure associated with the LMC BCP could mean that further development in the area may cause significant impact synergies to materialise and a tipping point to be reached. As an example, a further road in the vicinity of the BCP, particularly one at a height taller than LMC BCP or in an undisturbed fish pond area may cause the effective width of the road and rail development corridor through the area to be increased to such a point whereby a disproportionate number of birds to stop using the flight line.

12.6.2 Impacts on Habitats

This section deals with direct and indirect impacts on habitats arising from development within LMC Loop itself. Impacts of haul roads to service this are dealt with in **Section 12.6.2.2** (as the haul road alignment is the same as that for the Western Connection Road) and **Section 12.6.2.5** (which deals with the one-way ingress via Sai Kwo Road).

12.6.2.1 Development of LMC Loop

Direct Impacts

Table 12.38 details the areas of habitats in LMC Loop, all of which will be lost due to development.

Table 12.38 Area of Habitats in LMC Loop

Habitat	Area (ha)	Percentage
Grassland	55.59	65.70%
Grassland/ Shrubland	14.62	17.27%
Reed Marsh	10.96	12.95%
Plantation	1.70	2.01%
Orchard	0.96	1.13%
Marsh	0.50	0.59%
Channelised Watercourse	0.29	0.34%
Total	84.61	100%

Impacts on the very small area of channelised watercourse are considered to be of negligible significance due to the very small area of habitat involved and its low ecological value (see **Section 12.5.1**), and are not explicitly dealt with below.

Grassland and grassland/shrubland

The largest area of habitat comprises grassland, which is closely linked to areas of grassland/shrubland. In terms of non-bird fauna, there appears to be nothing of known conservation significance. With regard to birds, this habitat supports a number of migrant and winter visitors; although this suite of species includes some of conservation significance, the numbers involved, the availability of large areas of similar habitat in areas nearby and/or the opportunistic nature of the use of the habitat in LMC Loop renders it of low significance to the species involved.

This includes both Golden-headed and Zitting Cisticola which are both grassland specialists in the breeding season, while the latter also frequents reed marsh in the non-breeding season (see **Table 12.39**).

However, the suite of species recorded in non-wetland habitats in LMC Loop is representative of the non-waterbird species present in the Deep Bay area as a whole, and the loss of such an area of habitat will have an impact on this bird community, though it remains of low severity.

Table 12.39 Potential direct ecological impacts of LMC Loop development on grassland and grassland-shrubland in the absence of mitigation.

Criteria	Assessment
Habitat Quality	Undisturbed but lacking floristic diversity. Low ecological value.
Species	Zitting Cisticola breeds, while a number of bird species utilise these habitats in non-breeding season. Overall, highly representative of the Deep Bay non-waterbird avian community. Non-bird fauna poorly represented.
Size/Abundance	70.24ha in total. Numbers of organisms low.
Duration	Permanent.
Reversibility	Irreversible.
Magnitude	The area of this habitat is relatively large in a local context, but the number of organisms is low.
Impact Severity	In view of abundance of this habitat in the northern NT and the low number of organisms, impact severity is Low .

Reed Marsh

The ecologically most important habitat in LMC Loop is reed marsh (**Appendix 12-12**, plate 1), of which there is 10.96ha. This reedbed, although somewhat fragmented, is undisturbed, relatively large in size and supports wetland fauna of conservation significance (see **Section 12.5.1**), including wetland-dependent birds and Eurasian Otter. Other non-bird fauna of known conservation significance are not known to be present.

Linkages exist with the reed marsh at MPNR, as shown in the bird trapping survey, and with other areas of Deep Bay, as indicated by the roosts of harriers and wagtails recorded. Compared with the reed marsh at MPNR, however, it supports fewer of the larger, reed-specialist species such as Great Bittern, Purple Heron and Yellow Bittern. For this reason it is not as ecologically rich, but is nevertheless of high ecological value (see **Table 12.40**).

Table 12.40 Potential Direct Ecological Impacts of LMC Loop development on Reed Marsh in the absence of mitigation

Criteria	Assessment
Habitat Quality	Undisturbed, but of uniform age; somewhat fragmented, lacks structural diversity and areas of open water. High ecological value due to faunal components and size.
Species	Supports a suite of reedbed-associated and wetland-dependent birds, though with rather few large waterbirds. Eurasian Otter utilises habitat.
Size/Abundance	10.96ha, comprising 8.7% of Deep Bay reed marsh.

Criteria	Assessment
Duration	Permanent.
Reversibility	Irreversible.
Magnitude	Comprises a significant reedbed in a Deep Bay context supporting a range of fauna of conservation significance. Loss of this habitat would constitute an impact of moderately large magnitude.
Impact Severity	Undisturbed large reedbeds such as this are rare in HK; this habitat supports uncommon or rare species, and its loss would have an ecological impact of High severity.

Marsh in LMC Loop

Three undisturbed, water-retaining shallow depressions totalling 0.50ha are present, and these now constitute freshwater marsh. Their ecological value, however, is limited by poor water quality and floating vegetation covering the entire water surface (**Appendix 12-12**, plate 2). However, they support low numbers of certain wetland-dependent species (see **Table 12.41**).

Table 12.41 Potential Direct Ecological Impacts of LMC Loop development on Marsh in the absence of mitigation

Criteria	Assessment
Habitat Quality	Undisturbed, but small and lack open water or microhabitat diversity. Low to Moderate ecological value.
Species	Common flora and fauna, though Eurasian Otter reported to have occurred.
Size/Abundance	0.50ha, marsh of this type not uncommon in Deep Bay area.
Duration	Permanent.
Reversibility	Irreversible.
Magnitude	Given their size and lack of conservation significance, the magnitude is not great.
Impact Severity	Loss of these marshes would have a Low to Moderate ecological impact given their small size, fragmentation and current condition.

LMC Meander (Natural Watercourse)

Development of LMC Loop requires that approximately 3.5km of bank (1.5km along the southeast edge, 1km along the northeast edge and 1km along the southwest edge) is stabilised prior to construction. However, the stabilisation measures will be carried out only at the top of the slope as part of work to raise the level of LMC Loop from the existing 3-4mPD to 6mPD, and the fill material will largely be used to build the level of the bank higher, and not displace large parts of the slope. Much of the slope, including that along the water surface of LMC Meander, will remain intact. The loss of vegetation itself, despite the large area, is considered of low ecological significance, just as loss of vegetation in the Loop is regarded as such. There is scope for topping the stabilised section with soil to facilitate re-growth of vegetation, and this will be carried out as far as possible.

In view of this, the direct loss of vegetation will be relatively limited, and the impacts on fauna using this habitat (e.g. Eurasian Otter) will be correspondingly restricted.

Table 12.41a Potential Direct Ecological Impacts of LMC Loop development on LMC Meander in the absence of mitigation

Criteria	Assessment
Habitat Quality	Undisturbed, large, well-vegetated natural watercourse providing foraging and resting area and movement corridor for Eurasian Otter and waterbirds. High ecological value.
Species	Eurasian Otter, which is of high conservation concern, utilises LMC Meander as a feeding ground and an ecological corridor to access habitat in Hoo Hok Wai. Low numbers of waterbirds of conservation significance forage and roost.
Size/Abundance	LMC Meander is a large lowland river in semi-natural condition, of which there are very few in HK. Faunal abundance not high.
Duration	Construction impacts will be short-term, but operational phase impacts will be permanent.
Reversibility	Impacts reversible to some extent.
Magnitude	Impacts of large magnitude.
Impact Severity	Low to Moderate in construction and operation phase, given potential impacts on habitat of Eurasian Otter. Loss of vegetation at top of Meander slope: Low .

Plantation and Orchard

Development of LMC Loop will result in the loss of 1.70ha of plantation and 0.96ha of orchard. These habitats are small in area, fragmented from other areas of similar habitat and, although undisturbed, both are comprised of, or support, common and widespread species of flora and fauna.

Table 12.41b Potential Direct Ecological Impacts of LMC Loop development on Plantation and Orchard in the absence of mitigation

Criteria	Assessment
Habitat Quality	Small, fragmented from similar habitat in the area.
Species	Common and widespread species of flora and fauna.
Size/Abundance	1.70ha of plantation, 0.96ha of orchard. Small numbers of animals.
Duration	Permanent loss.
Reversibility	Impacts irreversible, though compensation possible.
Magnitude	Low for both habitats.
Impact Severity	Low .

Indirect Impacts

Development in LMC Loop will have disturbance impacts on habitats outside LMC Loop. Two habitats of ecological value will be affected: LMC Meander and

Ponds, the latter comprising the fish pond wetland area of high ecological value extending from Lung Hau Road to HHW.

A third habitat affected is Channelised Watercourse in the form of Shenzhen River; however, its highly polluted state renders its value as a wildlife foraging and roosting area low, and any impacts are considered negligible. The Shenzhen River possibly forms a corridor for movement of Eurasian Otter between the LMC and San Tin area and HHW, and it flows into the intertidal areas of Deep Bay, which is an extremely important site for fauna and flora. Potential impacts on this area are also considered.

Indirect impacts on marsh and reed marsh at HHW and grassland between LMC Tsuen and Ma Tso Lung are not predicted due to distance from LMC Loop and the relative insensitivity of marsh and reed marsh to disturbance.

Pond

The total area of fish ponds from the MTR LMC Spur Line to Ng Tung River is approximately 184ha, of which 127.83ha lies within the area for assessment of ecological impact. Indirect impacts from development of LMC Loop potentially comprise visual, light and noise disturbance from construction and operation of development in the Loop. However, as the 40-50m wide LMC Meander lies between LMC Loop and the fish pond area, the magnitude of disturbance impacts is diluted to a substantial extent as a result. Due to this separation, it is likely that impacts from noise disturbance, given existing levels of background noise in the area, are very limited in the operational phase, though greater in the construction phase (see **Table 12.42**).

Disturbance impacts to waterbirds arising from construction and operation of the development inside LMC Loop are of relevance only to the most sensitive species (large waterbirds such as Great Cormorant, Grey Heron, Great and Little Egrets), based on the principles adopted for the EIA for the LMC Station and Spur Line development. The latter report assumed that disturbance occurs up to 200m distant from the edge of the works site or edge of development, varying from complete exclusion to occurrence at reduced densities, depending on distance from the source of impact. This aspect is further developed in **Section 12.7.10** in respect of this Project.

The ponds impacted in this way comprise those alongside the northeast section of LMC Meander (see **Figure 12-6**), as these ponds are undisturbed by other land uses. Ponds along the southwest portion are already disturbed by habitations and the MTR LMC Spur Line viaduct, and thus no marginal disturbance impacts are predicted.

The cluster of records of Eurasian Otter associated with pond habitats concerns pond numbers 39-42 (see **Figure 12-2**); however, based on **Figure 12-3**, it appears that much of the HHW wetland area is of significance to this species. Most of this area lies outside the 200m disturbance zone, with only a relatively small area within. Buffer zones recommended for otters are highest in respect of natal dens, and these are 150m (NIEA undated); however, it would appear unlikely that a breeding site is present in the area given the habitat configuration and fish pond management activities taking place. For holts or foraging areas buffer zone requirements are much lower (max 30m). For this reason, disturbance impacts on otters in this area are predicted to be of low significance.

Smaller species have much-reduced disturbance zones, as do species that prefer vegetated wetlands. The Spur Line EIA (Executive Summary, Table 4.28) predicted the maximum distance of disturbance for Chinese Pond Heron to be 30m. Even though in retrospect this may appear a little low, given the existing 40-50m width of LMC Meander, potential disturbance impacts to Chinese Pond Herons breeding at Ho Sheung Heung Egrettry or other egrets in the Deep Bay area such as that at Mai Po villages and foraging near LMC Loop are predicted to be negligible.

With regard to ponds to the southeast of LMC Loop that lie between the Meander and the boundary fence, these could potentially be impacted by development in LMC Loop, as they lie approximately 50m from the Loop, depending on the width of the Meander. These ponds are more disturbed than those elsewhere in the HHW area, and have historically supported fewer waterbirds (see **Section 12.4.4.1**), and disturbance impacts are rated as low to moderate in the construction phase and low in operation phase. Impacts on these ponds of actual land use proposals are dealt with in more detail in **Section 12.7.9.1**.

In addition, as ponds to the south of LMC Loop between MTR LMC Spur Line and LMC Meander and alongside Ha Wan Tsuen Road are already considerably disturbed by the Spur Line, traffic and human activity, and are also screened by trees along the edge of the Meander, it is considered that there would be insignificant marginal disturbance impact in this area.

Table 12.42 Potential indirect ecological impacts of LMC Loop development on pond in the absence of mitigation

Criteria	Assessment
Habitat Quality	Large area of habitat of high ecological value supporting large numbers of species of conservation value, including an important element of the HK population of Eurasian Otter.
Species	Wetland-dependent fauna of conservation significance, though floristic interest limited.
Size/Abundance	184ha, has supported up to 48.7% of all waterbirds recorded in fish pond areas during Deep Bay area monitoring, and 16.4% of the wintering population of Great Cormorant in winter 2009-10.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.

Criteria	Assessment
Magnitude	<p>Disturbance impacts in operation phase limited in magnitude, relating to large waterbird species only and focused on ponds along northeastern section of LMC Meander. These ponds, however, include some of the most utilised by waterbirds. Magnitude of construction phase disturbance to these ponds same as operation phase.</p> <p>Construction and operation phase impacts on ponds along southeast section smaller due to lower numbers of waterbirds and higher existing levels of disturbance. Magnitude of construction and operation phase disturbance impacts on these ponds Low to Moderate and Low, respectively.</p> <p>Disturbance impacts on Eurasian Otter using pond habitat of relatively low magnitude both in construction and operation phases, given distance from operations.</p>
Impact Severity	<p>In respect of ponds along northeast section of LMC Meander, operational and construction phase impact Moderate.</p> <p>For ponds along southeast section of LMC Meander, construction phase impact Low to Moderate, operation phase impact Low.</p>

LMC Meander

Construction works in LMC Loop will include site clearance, and during heavy rain storms soil from the site will wash away and enter LMC Meander, which will increase levels of suspended solids. Surface runoff during the operational phase may contain oil and petrol from road surfaces, which could also enter the Meander. Existing contaminated soil identified as part of Site Investigation works will be treated on site and rendered inert, which will remove the potential for this run-off. During the process of soil treatment there is the potential for contaminated run-off to occur.

Most of the natural watercourses around LMC Loop (i.e. those to the south of the boundary fence road) are unlikely to be significantly impacted by the construction and operation of LMC Loop, as toxins and sediment largely flow downstream. Impacts of noise and light disturbance are dealt with in respect of impacts on Eurasian Otter, the primary sensitive receiver for these (see **Table 12.43**).

Disturbance impacts from noise and human activity may also impact the Meander, which is of relevance in respect of Eurasian Otter in particular. Only very small numbers of waterbirds use the Meander for foraging.

Table 12.43 Potential indirect ecological impacts of LMC Loop development on LMC Meander in the absence of mitigation

Criteria	Assessment
Habitat Quality	Undisturbed, large, well-vegetated natural watercourse providing foraging for Eurasian Otter and foraging and roosting for waterbirds. High ecological value.
Species	Eurasian Otter, which is of high conservation concern, utilises LMC Meander as a feeding ground and an ecological corridor to access habitat in Hoo Hok Wai. Waterbirds of conservation significance forage and roost.

Criteria	Assessment
Size/Abundance	LMC Meander is a large lowland river in semi-natural condition, of which there are very few in HK. Faunal abundance not high.
Duration	Construction impacts will be short-term, but operational phase impacts will be permanent.
Reversibility	Impacts reversible to some extent.
Magnitude	The development is large-scale and the volume of run-off and sewage generated will be great. If not controlled properly, the magnitude of ecological impact due to degradation of water quality would be large. Disturbance impacts potentially of moderate magnitude
Impact Severity	Moderate to High in construction phase, in respect of run-off on Eurasian Otter and its prey. Operation phase run-off impacts of Moderate significance. Disturbance impacts of Moderate significance in both phases.

Intertidal areas of Inner Deep Bay

The site is located within the Deep Bay wetland system, which supports a high diversity of species and is recognised to be of international importance by the designation of the Mai Po Inner Deep Bay Ramsar site. Water draining from the LMC Loop enters watercourses directly leading into Deep Bay, which supports intertidal mudflats and mangroves.

In terms of potential hydrological disruption, whilst there may be slight changes to the local water table resulting from construction of the site, these impacts would be temporary and of small magnitude, and are unlikely to be of sufficient magnitude to cause significant ecological impacts.

Storm run-off would increase as a result of the increased paved area compared to existing natural habitats. The potential impacts of increased surface run-off arise from erosion and siltation downstream. However, LMC Loop is very small in size relative to the entire Deep Bay area, and changes to the site would therefore have little potential for downstream impacts. It is not predicted that there would be any significant change in water level of the Shenzhen River (See **Chapter 5**). There may be minor changes to local sedimentation patterns in Shenzhen River, but, given the size of LMC Loop compared to the catchment area of the river, these are unlikely to be of sufficient magnitude to affect sedimentation within the river and would not be of ecological significance.

Impacts of sedimentation in Deep Bay would be greatest during the construction period, when exposed soil could be washed directly into Shenzhen River and thus into the bay. The severity of these impacts would depend upon the area and location of exposed soil (with greater impacts when a large area of soil is exposed close to an existing water course). Sedimentation impacts would mostly be temporary, occurring during the construction phase only.

A greater potential impact to intertidal areas would result from pollution events, if pollutants from within the site were to enter the run-off. Such pollutants could result from waste or accidental spillage during both construction and operation phases; possible contaminants include metals, organics (such as oil, gasoline or solvents), and litter. In addition, the presence of contaminated soils on site means

that there is the potential for release of pollutants within the Loop, which may be washed downstream. The significance of any such impact would depend upon the nature of the pollutant and the scale of the pollution event. The distance from LMC Loop to the main intertidal area of Inner Deep Bay would ameliorate the effects somewhat (see **Table 12.44**).

Table 12.44 Potential indirect ecological impacts of LMC Loop development in intertidal areas in Inner Deep Bay in the absence of mitigation.

Criteria	Impacts from Sedimentation	Impacts from Pollutant Run-off
Habitat Quality	Deep Bay intertidal mudflats and mangroves are of High ecological value and are of international importance.	
Species	A high abundance and diversity of species in intertidal areas, many of which are threatened regionally or globally.	
Size/Abundance	A large area of mudflat and mangrove, supporting a high abundance of species, is located downstream from the site.	
Duration	Risk of impacts would be greatest during construction and temporary.	Risk of impacts would be greatest during construction but some impacts could remain into operational phase. Duration may vary according to nature of pollution event.
Reversibility	Siltation would be largely incorporated into natural processes.	Small-scale pollution may be possible to clean. Clean-up of larger-scale pollution events would be more difficult to achieve.
Magnitude	Sedimentation is a natural process and impacts would be of low magnitude.	Magnitude depends upon nature of pollutant, size of pollution event and duration. More significant pollution events are likely to be detected sooner, so of shorter duration. Magnitude, however, likely to be small due to small size of LMC Loop relative to total Deep Bay area.
Impact Severity	<u>Construction Phase</u> Severity of impacts Low to Moderate . <u>Operation Phase</u> Severity of impacts Low .	Construction Phase Certain pollution events (e.g. oil spills, contaminated soil run-off) have potential for High impact, depending upon the nature and scale. Most pollution events likely to have a Low to Moderate impact as magnitude likely to be small. Operation Phase Although dependent on nature and scale, most likely to be Low .

12.6.2.2 Western Connection Road

The alignment of the Western Connection Road is along Ha Wan Tsuen Road and LMC Road, and this will also form a one-way exit for construction traffic from LMC Loop. In terms of timing, upgrading of the Western Connection Road is planned to occur in two stages. Currently, Ha Wan Tsuen Road is 3.5m wide.

Initially, as part of the advance road works, limited upgrading of Ha Wan Tsuen Road will be carried out to create passing places only; as this work comprises no more than road maintenance, no significant ecological impact is predicted. Creation of the final Western Connection Road will involve upgrading of both LMC Road and Ha Wan Tsuen Road, and will result in a road, footpath, and space for road amenity and cycle track with a completed total width of 17.3m. Impacts of this section of the construction access road and the Western Connection Road are considered together, as the same alignment is utilised. The current condition of Ha Wan Tsuen Road is illustrated in **Appendix 12-12** (plate 16). The one-way ingress to LMC Loop for construction traffic follows Sai Kwo Road and the alignment of the Direct Link to LMC Station; the impacts of this are addressed in **Section 12.6.2.5**.

The section along Ha Wan Tsuen Road runs through an area of mostly rather small and disturbed fish ponds, all of which are abandoned or inactive. Some ponds, however, will be wholly drained to facilitate construction, and the road will pass over LMC Meander on a bridge; these constitute the most significant sources of ecological impact. Near the entry point to LMC Loop, a small area of village edge habitat is impacted; however, impact on this habitat of low ecological value is considered to be negligible.

In terms of the section along LMC Road, the habitats are anthropogenic and disturbed, highly so in some areas. For this reason, potential direct ecological impact is limited to very minor habitat loss; however, in respect of the natural stream and associated fish pond in which Rose Bitterling is present, secondary effects arising from run-off are possible.

Natural Watercourse (including LMC Meander)

Direct Impacts

The Western Connection Road will pass over LMC Meander as a bridge with one or more intermediate supports; the total area of the Meander river bed lost will, based on provisional estimates, be approximately 80-160m². Construction will cause permanent loss of a small area (approximately 0.15ha) of riparian shrubs and trees on the bank of the Meander at the point where the road traverses the water channel, and limited loss of watercourse. Prior to construction of the permanent bridge, a temporary bridge will be used. This will be of a smaller scale than the permanent crossing and will be dismantled once the latter is in place. The temporary habitat loss impacts of the crossing comprise approximately 0.1ha of riparian vegetation, and approximately 100m² of water column and watercourse bottom. In light of the presence of substantial areas of each habitat in the immediate area, such losses are considered to be of low severity. The remaining section will be built on existing roads and will not directly impact other natural watercourses.

Indirect Impacts

Construction stage disturbance may occur, which could impact Eurasian Otter and waterbirds. However, it is predicted that disturbance impacts at this time are less than would occur should a single-span bridge be built, which would require a temporary support to be built. Construction phase disturbance to LMC Meander is

not predicted to result from work along Ha Wan Tsuen Road due to the relatively small-scale nature of the work and the distance from the watercourse.

The disturbance impact on roosting/foraging large waterbirds is likely to be limited, as relatively few use the Meander. The densely-vegetated and steep-sided banks are not favourable to waterbird access for foraging, and only very small numbers of large waterbirds were recorded roosting in trees in this area. With regard to Eurasian Otter, it appears that the existing barrier between LMC Meander and Shenzhen River does not allow passage of mammals, and thus it appears unlikely that this route is used by otters as a means of moving from the LMC area to the wetlands at HHW. For this reason, the significance of temporary disturbance arising from construction of a bridge with intermediate support is reduced.

Operation phase disturbance to both Eurasian Otter and roosting/foraging waterbirds will be lower than in the construction phase.

Construction, however, will generate run-off with high levels of suspended solids, which could affect not only the Meander but also the stream to the south of Lung Hau Road in which is present a population of Rose Bitterling. During the operational phase, surface run-off may have an impact, though as the road will have an effective drainage system, the magnitude is likely to be very low (see **Table 12.45**). Furthermore, the upper section of the stream is separated from the connection road by secondary woodland and village; thus, the volume of run-off impacting this part is likely to be limited.

Table 12.45 Potential ecological impacts of Western Connection Road on natural watercourses in the absence of mitigation

Criteria	LMC Meander	Stream to south of Lung Hau Road
Habitat Quality	Undisturbed, well-vegetated and large natural watercourse providing riparian corridor habitats for Eurasian Otter and low numbers of roosting/foraging large waterbirds. High ecological value.	Semi-natural, small and moderately polluted. Of moderate ecological value, however, due to Rose Bitterling population.
Species	Eurasian Otter utilises LMC Meander as foraging area and probably as a corridor to access fish ponds at HHW. Very small numbers of large waterbirds utilise the Meander as a roosting area in riparian vegetation.	Isolated population of Rose Bitterling present, the third such site in HK.
Size/Abundance	LMC Meander is a large lowland river, though the number of conservation-significant fauna is not high.	Small stream with self-sustaining population of Rose Bitterling.
Duration	Construction phase impacts of both construction road and final connection will be short-term. Operational phase impact will be permanent.	Construction run-off, if entering the stream, will be a short-term impact. However, operational road run-off will be permanent.

Criteria	LMC Meander	Stream to south of Lung Hau Road
Reversibility	Construction phase impacts are reversible. It may be possible to mitigate operational phase impacts.	
Magnitude	<p>Direct Impacts Small scale (max. 0.15ha) permanent loss of riparian vegetation of equal magnitude in construction and operational phase. Some permanent loss of watercourse (max. 80-160m² approx.) due to intermediate support(s).</p> <p>Indirect Impacts Run-off from upgrading of Ha Wan Tsuen Road of low magnitude. Operation phase run-off of low magnitude. Disturbance impacts during construction phase potentially of low to moderate magnitude in respect of Eurasian Otter. Operation phase of low magnitude. Construction and operational disturbance impacts on waterbirds of low magnitude given relatively low number of individuals affected.</p>	<p>Indirect Impacts Although run-off not of large volume, magnitude of impacts could be significant as capacity of stream to dilute the effect is very limited, and Rose Bitterling is sensitive to water quality changes. Construction phase magnitude greater than operation phase magnitude.</p>
Impact Severity	<p>Direct Impacts Loss of riparian vegetation Low. Loss of watercourse Low, given small area impacted.</p> <p>Indirect Impacts Run-off in construction phase of Low significance, as volume generated relatively small. Although capacity of LMC Meander is relatively large, the cumulative impact from this and run-off from LMC Loop is of Moderate to High significance. Surface run-off in operational phase of Low significance. Disturbance impacts on large waterbirds of Low severity in both construction and operation phases. Disturbance impacts on Eurasian Otter habitat potentially of Low to Moderate severity in construction phase and Low severity in operation phase.</p>	Potential indirect run-off impacts on stream Moderate in construction phase, Low in operation phase.

Pond

The ponds potentially impacted by the Western Connection Road comprise those along Ha Wan Tsuen Road; their location is shown in **Figures 12-6** and **12-7**, while their current condition is illustrated in **Appendix 12-12**. Although ponds in the Deep Bay area as a whole are of high ecological value, there is variation in the significance of individual ponds to wildlife. In respect of the ponds potentially impacted by the Western Connection Road, due to their generally small size, proximity to roads and consequent disturbed nature, unfavourable pond profile and lack of management, relatively few waterbirds and other fauna were recorded in most of these ponds. The exception is Pond 12, which regularly supported 20-40 roosting Great Cormorants in the winter period, and which, in early 2012, supported a foraging flock of up to 15 Black-faced Spoonbills. The current condition of this pond is illustrated in **Appendix 12-12** (plate 17). The adjacent Pond 11 was the second most important to waterbirds in this area (**Figure A12-24** and **Figure A12-25** in **Appendix 12-3**).

The presence of these ponds at this location strengthens the connectivity between ponds in the LMC Loop/HHW area and those on the west side of the LMC BCP for both aerial and ground-based fauna. The flight line corridor for many birds enters the LMC Loop area over these ponds, and for this reason keeping their basic habitat characteristics intact is considered necessary. Further, given their location, there are likely to be some ecological linkages with LMC Meander (see **Table 12.46**).

Direct Impacts

Impacts on ponds along this road comprise minor permanent habitat loss (0.92ha), relating primarily to Pond 10 (0.89ha). In addition, a significantly larger area (3.51ha) of temporary loss will occur during the construction phase, when ponds 5, 11 and 13 will be wholly drained.

Indirect Impacts

Potential disturbance impacts in both construction and operation phases are not considered of high significance, as these ponds are already disturbed to some extent as a result of existing traffic along the road and nearby habitation. The traffic flow prediction without project is 26 veh/hr in Year 2016 and will naturally increase to 35veh/hr in Year 2042. Under the with-project scenario, this is predicted to increase to 697 veh/hr in Year 2042.

Although this is a substantial increase, the nature of the disturbance (regular and predictable vehicle passage) is similar, and vehicles are in general less disturbing than visible human activity. Consequently, this is a phenomenon to which wildlife, in particular birds, can adapt, and the anticipated impact is not predicted to be large, especially as these ponds are of lower ecological value than elsewhere in the area and are already disturbed by adjacent land uses. The exception relates to pond 12, which as noted above, has supported higher numbers of both roosting and foraging large waterbirds over the years. Pond 11 will be temporarily drained, and thus disturbance impacts are not relevant at that time.

In addition to minor disturbance in the construction phase, run-off may be an issue that affects some fauna, in particular Chinese Bull Frog in pond 12 (**Figure 12.2**). However, given the relatively short stretch of road alongside this pond, run-off impacts are likely to be restricted in scope.

Table 12.46 Potential ecological impacts of Western Connection Road on Pond in the absence of mitigation

Criteria	Assessment
Habitat Quality	Mostly relatively low quality, though pond 12 provides regular daytime roost site for small numbers of Great Cormorants and a few large waterbirds, including foraging Black-faced Spoonbills in early 2012. Appear to lie at important location in respect of flight line corridor. Despite fish ponds generally being of high ecological value, these are rated as Moderate due to their disturbed nature and unfavourable pond profile.
Species	Wetland-dependent birds; Ruby Darter, Scarlet Basker and Chinese Bull Frog in ponds 11 and 12.
Size/Abundance	Low abundance of fauna in all ponds except 11 and 12, where waterbird numbers low to moderate.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.
Magnitude	<p>Direct Impacts Permanent habitat loss is minor at 0.92ha, mainly pond 10. Construction phase habitat loss impacts low to moderate at 3.51ha.</p> <p>Indirect Impacts Disturbance impacts during construction likely to be moderate for fauna utilising these ponds. Disturbance impacts during operation less significant than during construction phase, and limited by regular nature of vehicle passage. Construction run-off could adversely impact water quality in managed ponds, which currently only comprises one very small pond. Surface runoff in operational phase will be collected effectively by the drainage system.</p>
Impact Severity	<p>Direct Impacts Given that the pond area lost permanently is both small and largely confined to a single pond on the south side of Ha Wan Tsuen Road, near Ha Wan Tsuen, the impact of operational phase habitat loss Low. Construction phase habitat loss Low to Moderate.</p> <p>Indirect Impacts Construction disturbance impacts Low to Moderate, as the numbers of fauna impacted are low. Operational disturbance impacts Low. Run-off impacts of Low severity in both construction and operation phases.</p>

Marsh

A very small area of marsh (0.07ha) will be permanently lost under the footprint of the Western Connection Road.

Table 12.47 Potential ecological impacts of Western Connection Road on marsh in the absence of mitigation

Criteria	Assessment
Habitat Quality	Small size and fragmentation means habitat not of high quality.
Species	Common and widespread flora and fauna.
Size/Abundance	Small in size, number of organisms low.
Duration	Permanent
Reversibility	Irreversible.
Magnitude	Small.
Impact Severity	In view of small area, Low .

Woodland

Upgrading of Ha Wan Tsuen Road/LMC Road will result in the loss of two small areas of woodland along the north edge of the road (**Figure 12-6**). The first area is part of the woodland adjacent to LMC Tsuen village area, which is rated as Low to Moderate ecological value. The second is further south, and is part of the woodland adjacent to Pun Uk Tsuen, which is rated as Moderate ecological value. These woodland areas are somewhat fragmented, with San Sham Road and the MTR LMC Spur Line providing a significant ecological barrier to the south. Given this and the small total area (0.40ha) of habitat, the impact of the loss is considered to be low to moderate (see **Table 12.47**). No direct impact on the saplings of *Aquilaria sinensis* is anticipated.

Table 12.47a Potential ecological impacts of Western Connection Road on woodland adjacent to Lok Ma Chau Road in the absence of mitigation

Criteria	Assessment
Habitat Quality	Small size (0.40 ha) and fragmentation means habitat not of high quality. Low to Moderate near LMC Tsuen, Moderate near Pun Uk Tsuen.
Species	Common and widespread flora and fauna.
Size/Abundance	Small in size, number of organisms low.
Duration	Permanent
Reversibility	Irreversible.
Magnitude	Small.
Impact Severity	In view of small area, fragmentation and impact on common and widespread species, both direct and indirect impacts are Low to Moderate .

12.6.2.3 Eastern Connection Road

The Eastern Connection Road comprises a road and, for part of the length, a cycle track with a completed width lying in the range of approximately 18m – 30m depending on location. The cycle track proposed as part of this Project is present

in the Ma Tso Lung area only. The road passes through the Ma Tso Lung area, where it impacts marsh, seasonally wet grassland of limited ecological value, and natural watercourse. It then follows the course of the existing boundary fence road toward LMC Loop. Just past Ngau Kok Shan, it turns northwest to traverse three large, inactive fish ponds and LMC Meander, before it emerges in LMC Loop. Potentially impacted habitats in this area include ponds of high ecological value, freshwater marsh, secondary woodland, natural watercourse, seasonally wet grassland, grassland, and shrubland. A cofferdam will be used for works on marsh and fish ponds.

The cut-and-cover construction method will be used through the pond area at Ngau Kok Shan and for the underpass below LMC Meander. This requires that excavation works be carried out in the Meander, but for only 50% of its width at any one time. Consequently, water flow will be temporarily impacted along approximately 100m of the length of the Meander through the use of a cofferdam. Due to Drainage Services Department requirements to prevent flooding, the works at the Meander will occur in the dry season.

Construction will occur some years after the commencement of development activities in LMC Loop. The RODP includes an Ecological Area (EA) along the southeastern edge of the Loop, which it is proposed will comprise reed marsh (see **Section 12.7.9** and **Section 12.7.10**). The cut-and-cover construction method for the ECR will result in the temporary loss of the reed marsh in this area. The design of the EA will incorporate a number of separate cells in order that management work can conveniently be carried out. To facilitate construction of the ECR, a single 1.1ha cell will be drained and the reed marsh lost. Draining of the cell will be carried so as to avoid hydrological disruption to other cells in order to maintain their functional integrity. In view of undisturbed condition of the EA and its predicted high ecological value, construction will also impose disturbance impacts on adjacent reed marsh habitat.

Construction access will mainly occur via the Western Connection Road and the LMC Loop internal road network where possible. In addition, construction vehicles will also utilise the section of the boundary fence road between the junction with Ha Wan Tsuen Road and Ngau Kok Shan. The peak transportation requirement during construction of the ECR is estimated at 40 vehicles/hour, though not all of these vehicles will use the boundary fence road (some may use Ma Tso Lung Road). For those vehicles that use the WCR and Loop internal road network, the marginal disturbance impact is predicted to be negligible. For construction vehicles that use the existing Ma Tso Lung Road, given existing vehicle use and the presence of disturbed or disturbance-insensitive habitats, the marginal disturbance impact is predicted to be minor.

A particular form of direct impact that in theory might have impacts for all habitats occurs as an effect of the provision of access to formerly inaccessible areas. This concerns illegal fly-tipping or pond/land filling activities. Currently, the HHW area is zoned as Unspecified Use under the Approved Ma Tso Lung and Hoo Hok Wai Development Permission Area Plan (No. DPA/NE-MTL/2), in which the planning intention is to conserve and enhance the ecological value and function of existing fish ponds, pending detailed study. No filling of land/pond or excavation of land is permitted. By the time that the ECR becomes operational, however, it is highly likely that an OZP will have been gazetted; existing prohibition on filling of land or pond will presumably remain in Ma Tso Lung areas zoned as AGR, but whether such statutory control would apply to the HHW

areas is subject to the OZP to be gazetted. Moreover, the current closed area requirement for a permit to enter the area will have been removed, making access easier. However, it is difficult to estimate the potential extent of such activities, and so the impacts are predicted to range from low to high.

Pond

Direct Impacts

That part of the Eastern Connection Road that passes through the Horn Hill (Ngau Kok Shan) area could potentially cause loss of and disturbance to pond habitat. In the area of Tse Koo Hang, one pond is impacted (number 93 in **Figure 12-2**); two other ponds indicated on maps that lie adjacent to the current boundary fence road are no longer extant. Pond 93 is unmanaged, relatively small and is unfavourable to birds both in terms of its profile and vegetation characteristics.

In the area of Horn Hill (Ngau Kok Shan) and LMC Meander, however, the ponds directly affected (numbers 36, 37 and 38) and indirectly disturbed are, in general, much more attractive to waterbirds. Ponds 36-38 (illustrated in **Appendix 12-12**, plate 18) are abandoned and function primarily as freshwater marsh as they contain much emergent aquatic vegetation.

Indirect Impacts

The ponds adjacent to the ECR alignment near Ngau Kok Shan and potentially subject to disturbance are largely managed and have a pond profile that favours access by birds to the pond edge. As a result, the magnitude of disturbance impacts is potentially substantial (see **Table 12.48**). Disturbance impacts on the fish ponds along the boundary fence road between Ngau Kok Shan and Ha Wan Tsuen Road will arise as a result of use by construction traffic. However, the peak number of vehicles is relatively low (maximum 40 vehicles/hour), and the regular passing of vehicles is in general less disturbing than human activity. Given that vehicles already use this road and that fish pond management operations take place in the fish pond area currently, the marginal disturbance impacts are predicted to be relatively minor.

Surface run-off and hydrological disruption of ponds during both construction and operation phases could occur. However, the scope for this appears limited given that only a small area of pond lies adjacent to the alignment, and Ponds 36-38 will be drained for the duration of the construction period.

Table 12.48 Potential ecological impacts of Eastern Connection Road on Pond in the absence of mitigation

Criteria	Direct Impacts	Indirect Impacts
Habitat Quality	Part of large area of habitat of high ecological value supporting substantial numbers of species of conservation value.	
Species	Wetland-dependent fauna of conservation significance, though floristic interest limited.	

Criteria	Direct Impacts	Indirect Impacts
Size/Abundance	Total area of pond permanently lost is 1.99ha, of which ponds 36-38 constitute 1.36ha and pond 93 constitutes 0.63ha. Area of construction phase habitat loss is 3.32ha.	Disturbance impacts extend up to 100m from alignment, depending on design.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.	
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.	
Magnitude	Impacts of loss of ponds of low to moderate magnitude.	Impacts of disturbance to ponds of low to moderate magnitude. Impacts of run-off and hydrological disruption of low magnitude.
Impact Severity	Habitat loss of Moderate severity during both construction and operation.	Construction disturbance impacts of High severity. Operational disturbance impacts of Moderate to High severity. Construction vehicle disturbance along boundary fence road Low . Run-off and hydrological disruption Low .

Reed Marsh

Direct Impacts

The Eastern Connection Road will cause temporary loss of 1.1ha of reed marsh in the proposed EA due to the required draining of one of the management cells. The duration of this loss is 18 months. The habitat will be re-instated after completion.

Indirect Impacts

Indirect impacts arising from disturbance to adjacent reed marsh habitat may also arise at the same time. However, given the comparatively disturbance-insensitive nature of reed marsh habitat, these are predicted to be of lower significance than on fish ponds. In addition, in this case the location of the impacted area at the northern tip of the EA reduces the extent of disturbance.

Table 12.49a Potential ecological impacts of Eastern Connection Road on Reed Marsh in the Ecological Area in the absence of mitigation

Criteria	Direct Impacts	Indirect Impacts
Habitat Quality	Given habitat will be managed to enhance ecological value, likely to be High.	
Species	Reed-dependent and reed-associated wetland fauna of conservation significance; floristic interest low.	

Criteria	Direct Impacts	Indirect Impacts
Size/Abundance	Total area temporarily lost is 1.1ha.	Area of indirect impact relatively small given linear nature of impact source and closed nature of habitat.
Duration	Temporary in respect of construction impacts. No permanent impact as habitat will be re-instated after construction.	
Reversibility	Reversible as habitat will be re-instated after construction.	
Magnitude	Magnitude of loss and disturbance impacts both low.	
Impact Severity	Habitat loss of Moderate severity due to small area and temporary nature.	Construction disturbance impacts of Low to Moderate severity. Operational disturbance impacts zero as road is underground.

Marsh

Direct Impacts

The Eastern Connection Road will cause permanent loss of 1.76ha of freshwater marsh in the Horn Hill (Ngau Kok Shan) and Ma Tso Lung areas, as well as along the boundary fence road (**Figure 12-6**). There will also be disturbance impacts on adjacent areas of these habitats, though given the character of the habitat and the lack of disturbance-sensitive fauna, these are of low severity. The diversity and number of wetland birds recorded was low due to the closed nature of the habitats and the large seasonal element of the wetland. Further, freshwater marsh in these areas lacks structural and floral diversity, and the only species of conservation significance recorded were Chinese Bullfrog and Two-striped Grass Frog; consequently ecological value is limited (see **Table 12.49b**).

Indirect Impacts

Run-off and hydrological disruption could also occur, especially in the construction phase. However, the impacts in the rather large area of habitat present are predicted to be limited as a cofferdam will be used for works; should any run-off occur, the dilution effect is likely to be significant given the size of the area.

Table 12.49b Potential ecological impacts of Eastern Connection Road on Marsh in the absence of mitigation

Criteria	Horn Hill area	Ma Tso Lung
Habitat Quality	Due to a lack of microhabitat diversity, ecological value rated as Low to Moderate	
Species	Wetland-dependent fauna of conservation significance in small numbers, though floristic interest limited.	
Size/Abundance	Total area permanently lost is 1.18ha.	Area permanently lost is 0.58ha
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.	

Criteria	Horn Hill area	Ma Tso Lung
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.	
Magnitude	Magnitude of loss and disturbance impacts both low.	
Impact Severity	<u>Direct Impacts</u> Habitat loss of Low to Moderate severity. <u>Indirect Impacts</u> Construction disturbance impacts of Low severity. Operational disturbance impacts of Low severity Run-off and hydrological disruption of Low severity.	<u>Direct Impacts</u> Habitat loss of Low to Moderate severity. <u>Indirect Impacts</u> Construction disturbance impacts of Low severity. Operational disturbance impacts of Low severity. Run-off and hydrological disruption of Low severity.

Secondary Woodland

The Eastern Connection Road will pass through secondary woodland in some parts of its length, causing both habitat loss and indirect disturbance impacts. Most of the impacted woodland lies along the boundary fence road near Ma Tso Lung (**Figure 12-6**) (**Appendix 12-12**, plate 14); however, the scope of these impacts is not anticipated to be major (see **Table 12.50**).

Table 12.50 Potential ecological impacts of Eastern Connection Road on secondary woodland in the absence of mitigation

Criteria	Assessment
Habitat Quality	Fragmentation and relatively small area limits ecological value, though floral diversity and structural complexity moderate. Ecological value low to moderate due to fragmentation and somewhat disturbed condition.
Species	Common and widespread floral and faunal species.
Size/Abundance	Area of woodland lost comprises 0.70ha.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.
Magnitude	Habitat loss relatively small; disturbance impacts limited in scope, and fragmentation marginally increased.
Impact Severity	Low to Moderate in terms of both habitat loss and disturbance impacts, as despite ecological value of mature woodland, this area is small and fragmented.

Natural Watercourse

The Eastern Connection Road will traverse or run close to LMC Meander, a stream at Ping Hang and certain sections of Ma Tso Lung Stream. Potential impacts are assessed in **Table 12.51**.

Direct Impacts

Some lower sections of Ma Tso Lung Stream, in the upper sections of which there is a record of Three-banded Box Terrapin, could be directly affected by habitat loss. No direct impact in the upper section of the stream is predicted. It is possible that the turtle occurs in the lower sections of this stream, as it is known to wander. However, given the species' preference for wooded riparian habitats, it is unlikely the lower sections, which largely comprise marsh and seasonally wet grassland, are of high importance to the local population. The stream at Ping Hang, which supports fauna of conservation significance, could be impacted by habitat loss.

Permanent loss of a 60m length of bank and riparian vegetation of LMC Meander will occur. In addition, cut-and-cover construction will cause temporary loss of 50% of width of the water channel and associated riparian vegetation for 100m of its length (approximately 3,000m²), the greatest implications of which relate to Eurasian Otter and the flight line corridor. Permanent loss of bank and riparian vegetation may impact very small numbers of roosting/foraging large waterbirds. See **Section 12.6.3.2** for potential impacts on Eurasian Otter and **Section 12.6.4.2** for potential impacts on the flight line corridor.

Indirect Impacts

During the operational phase, surface run-off from the road will not be of large volume, but would constitute a long-term impact on the watercourses if not properly managed. This impact could be of particular concern at Ping Hang and Ma Tso Lung, given the small sizes of these streams. Run-off impacts during the construction phase are potentially of more significance at all three water bodies. The upper section of Ma Tso Lung stream, where the Three-banded Box Terrapin was recorded, is not predicted to be impacted indirectly during either construction or operation phases of this Project, as it is upstream and outside the site area.

Given that the road crosses the streams at both Ma Tso Lung and Ping Hang, there is the potential for hydrological disruption, which given their small sizes could impose an impact of some magnitude. Hydrological disruption of LMC Meander, mainly in the form of increased velocity of water flow in the area affected, may occur as a result of the need to temporarily block along approximately 100m of its length 50% of the width of watercourse for construction of the depressed road below. However, the section impacted is relatively short in length compared with the total length of the Meander, and water velocity is currently very slow, and is unlikely to speed up sufficiently to deter otters, which utilise fairly fast-flowing streams elsewhere in the range. No such impact is predicted in the operational phase. A greater potential impact would result from pollution events, if pollutants from works sites were to enter natural watercourses. Such pollutants could result from waste or accidental spillage during both construction and operation phases; possible contaminants include metals, organics (such as oil, gasoline or solvents), and litter. The significance of any such impact would depend upon the nature of the pollutant and the scale of the pollution event.

Table 12.51 Potential ecological impacts of Eastern Connection Road on natural watercourse in the absence of mitigation

Criteria	LMC Meander	Ping Hang Stream	Ma Tso Lung Streams
Habitat Quality	LMC Meander is of	Largely natural, though	Although the riparian

Criteria	LMC Meander	Ping Hang Stream	Ma Tso Lung Streams
	high ecological value as it provides habitats for Eurasian Otter and is the core area of the flight line corridor.	with low floral and faunal diversity.	zone is partially modified and somewhat polluted, it still provides habitats for species of conservation concern. Habitat quality of lower reaches lower than upper sections. Ecological value Moderate.
Species	Eurasian Otter, which is of conservation significance, utilises LMC Meander as a foraging area and an ecological corridor to access fish ponds at HHW. Only small numbers of waterbirds use it for foraging or roosting.	Paradise Fish, Two-striped Grass Frog, odonates. Very few waterbirds.	Three-banded Box Terrapin recorded in upper section. Other species of concern observed included Chinese Bull Frog, Small Snakehead and <i>Somanniathelphusa zanklon</i> . Few waterbirds.
Size/Abundance	LMC Meander is a large lowland river of which there are very few in HK. Numbers of fauna directly utilising habitats not large.	Small and narrow. Not uncommon in HK.	Medium length stream of a type not uncommon in HK.
Duration	Construction phase impact will be short-term. Operational phase impact will be permanent.		
Reversibility	Construction phase impacts are reversible. Operational phase impacts will be long-term and irreversible.		
Magnitude	<u>Direct Impacts</u> Habitat loss of low magnitude in respect of riparian vegetation along 60m length of the bank. Construction phase loss of 50% of Meander width for 100m (approx. 3,000m ²) is of low magnitude compared to total length of watercourse.	<u>Direct Impacts</u> Habitat loss of low magnitude.	<u>Direct Impacts</u> Construction requires clearance of riparian vegetation of moderate magnitude in potential habitats for Three-banded Box Terrapin.
	<u>Indirect Impacts</u> Run-off magnitude not	<u>Indirect Impacts</u> Run-off magnitude	<u>Indirect Impacts</u> Run-off magnitude

Criteria	LMC Meander	Ping Hang Stream	Ma Tso Lung Streams
	large in relation to volume of watercourse. Hydrological disruption low in magnitude due to short length of affected section.	potentially large in relation to volume of watercourse. Hydrological disruption potentially of large magnitude compared to size of stream. Disturbance impacts of low magnitude	not large, but may be significant in relation to volume of watercourse. Hydrological disruption potentially of large magnitude compared to size of stream. Disturbance impacts of low magnitude.
Impact Severity	<p>Direct Impacts Potential riparian habitat loss of Low severity, as magnitude small and only very low numbers of waterbirds. Loss of 50% of channel width during construction phase Low given small area (2000m²) and temporary nature.</p> <p>Indirect Impacts Potential construction phase disturbance impacts on habitat of Eurasian Otter of Moderate to High severity, and on foraging/roosting waterbirds of Low severity. All operational phase disturbance impacts Low. Construction and operation phase run-off will be of Low significance as amount generated small relative to LMC Meander volume. Hydrological disruption Low.</p>	<p>Direct Impacts Habitat loss of Low to Moderate severity given aquatic fauna in stream.</p> <p>Indirect Impacts Potential run-off impacts during construction phase of Moderate severity, and in operational phase of Low to Moderate severity. Hydrological disruption potentially Moderate depending on construction methods.</p>	<p>Direct Impacts Moderate should loss of stream bed or riparian vegetation occur.</p> <p>Direct Impacts Moderate, should <u>loss of the stream bed or riparian vegetation occur.</u></p> <p>Indirect Impacts Construction phase run-off severity in lower section Moderate. Operational phase Run-off Low to Moderate severity in lower sections Hydrological disruption potentially Moderate depending on construction methods.</p>

Seasonally Wet Grassland

Water quality is poor and very few fauna were recorded in this habitat, which lacks structural and floral diversity, and consequently ecological value is limited (see **Table 12.52**). However, it is a comparatively large area and is ecologically linked to adjacent marsh habitat.

Direct Impacts

The Eastern Connection Road will cause loss of seasonally wet grassland in the Ma Tso Lung area; the total area of this habitat lost is very small at 0.19ha.

Indirect Impacts

These relate to run-off, hydrological disruption and disturbance impacts, all of which are likely to be greater in the construction phase. Given the relatively large area of habitat of which this is a part and the consequent dilution effect, the former is likely to be limited in scope as a cofferdam will be used for works, while the closed nature of the habitat and the lack of moderately or highly disturbance-sensitive fauna mean that disturbance impacts are likely to be limited.

Table 12.52 Potential ecological impacts of Eastern Connection Road on seasonally wet grassland in the absence of mitigation.

Criteria	Assessment
Habitat Quality	Lack of microhabitat diversity is a significant limiting factor, and surveys recorded few fauna. Ecological value Low to Moderate.
Species	Wetland-dependent fauna of conservation significance, though floristic interest limited.
Size/Abundance	Area of habitat directly impacted is very small at 0.19ha. No species of conservation significance.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.
Magnitude	Magnitude of loss and disturbance impacts both Low, as impacts largely at edge of area.
Impact Severity	Direct Impacts Habitat loss of Low to Moderate severity. Indirect Impacts Construction and operational disturbance impacts of Low severity. Construction and operational run-off impacts of Low severity. Construction and operational hydrological disruption of Low severity.

Shrubland

The Eastern Connection Road will cause very minor loss of roadside shrubland near Horn Hill (**Figure 12-6**). However, this area of habitat is very small and disturbed; consequently, ecological value is low (see **Table 12-53**).

Table 12-53 Potential ecological impacts of Eastern Connection Road on grassland in the absence of mitigation

Criteria	Assessment
Habitat Quality	Relatively low quality. Ecological value Low.
Species	No species of conservation significance recorded.
Size/Abundance	Area of habitat lost is 0.16ha.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.
Magnitude	Magnitude of loss and disturbance impacts both Low, as habitat small and disturbed.
Impact Severity	<p><u>Direct Impacts</u> Habitat loss of Low severity.</p> <p><u>Indirect Impacts</u> Construction and operational disturbance impacts of Low severity.</p>

Grassland

Eurasian Eagle Owl is presumed to breed in the more extensive areas of grassland in the hills between Chau Tau and Ma Tso Lung villages, and utilise adjacent lowland, non-grassland habitats for foraging. Recent records of this species in the HHW fish pond area have occurred on 31st July 2012 (Study Team pers. obs.), and 29th April and 14th May 2013 (AFCD *in litt.*); in addition, one was recorded in the hillside area next to the boundary fence road on 23rd March 2013 (per AFCD). However, although the Eastern Connection Road will cause loss of grassland in the Horn Hill (Ngau Kok Shan) area, as well as disturbance impacts on adjacent areas of the same habitat, the area impacted is very small and lies at the edge of the main grassland area next to the current boundary fence road; thus, it is predicted that impacts on the owl from grassland loss will be minor. In addition to this, the grassland in this area is fire-maintained and lacks faunal and floral diversity, and suffers some disturbance from the boundary fence road and adjacent LMC Police Operational Base at Horn Hill (Ngau Kok Shan). In view of the these factors, impact severity of the habitat loss is rated as low (see **Table 12-54**).

Table 12-54 Potential ecological impacts of Eastern Connection Road on grassland in the absence of mitigation

Criteria	Assessment
Habitat Quality	Relatively low quality. Ecological value Low.
Species	Grassland birds from hills occur in this area. No species of conservation significance were recorded.
Size/Abundance	Area of habitat lost is 0.62ha.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.

Criteria	Assessment
Magnitude	Magnitude of loss and disturbance impacts both Low, as impacts largely at edge of area.
Impact Severity	<p>Direct Impacts Habitat loss of Low severity.</p> <p>Indirect Impacts Construction disturbance impacts of Low severity. Operational disturbance impacts of Low severity.</p>

12.6.2.4 Direct Link to LMC Station

The Direct Link to LMC Station comprises an elevated viaduct that runs from MTR LMC Spur Line Boundary Crossing to Ha Wan Tsuen Road, where it reaches at-grade level. Having designed the road on viaduct means that there is relatively little direct habitat loss along the alignment during the operational phase. Although disturbance impacts to pond and reed marsh habitats are predicted, the area is already very disturbed. Disturbance impacts on STEMDC, the associated mitigation wetland and at LMC WCA may also arise. Other habitats impacted comprise disturbed wasteground, village and urban/residential habitats that are of low ecological value. Disturbance impacts of construction access along Sai Kwo Road and Lung Hau Road are dealt with in **Section 12.6.2.5**.

Pond

Direct Impacts

The location of permanently lost ponds is shown in **Figure 12-6**, while their current condition is illustrated in **Appendix 12-12**. The ponds to the east of San Sham Road are significantly disturbed by adjacent land uses and the presence of the Spur Line viaduct, and only very small numbers of waterbirds were recorded during field surveys. The waterbird species and their total numbers recorded in these ponds during the year were: Little Grebe (3), Great Cormorant (2), Little Egret (3), Chinese Pond Heron (5), Common Moorhen (1), Eurasian Coot (1), White-breasted Waterhen (1), Common Sandpiper (2) and Red-billed Starling (45). A lack of the large waterbirds Grey Heron and Great Egret, a bias toward small species and the low numbers are apparent. These three permanently lost ponds have a total area of 1.53ha.

The area of permanently lost pond underneath the alignment to the west of STEMDC is very small (0.49ha) and not managed for fish culture; this, in addition to its being significantly disturbed by adjacent land uses, means it is of low ecological value. The same holds true for ponds between STEMDC and LMC Meander, which comprise a combined area of 1.79ha. The total area of ponds permanently lost is 2.28ha. There is no extra pond loss in the construction phase (see **Table 12.55**).

Indirect Impacts

Disturbance impacts to pond habitat west of STEMDC and east of San Sham Road are considered negligible given that these areas lie in the disturbance shadow of MTR LMC Spur Line and are disturbed by human activity and roads.

In terms of surface run-off impacts, these will be negligible in the operational phase; although larger in the construction phase, the ponds potentially impacted are not of high ecological value, however. The same applies to potential hydrological disruption and pollution events.

Table 12.55 Potential ecological impacts of Direct Link to LMC Station on ponds in the absence of mitigation

Criteria	Assessment
Habitat Quality	Lies at edge of large area of habitat of high ecological value supporting substantial numbers of species of conservation value. However, these ponds are disturbed by surrounding land uses and MTR LMC Spur Line viaduct, and are of low or low to moderate ecological value.
Species	Very small numbers of wetland-dependent fauna of conservation significance.
Size/Abundance	Total area of pond permanently lost is 2.28ha; disturbance impacts are negligible due to existing human activity in area.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.
Magnitude	Impacts of loss of ponds low to moderate magnitude. Impact of disturbance of Low magnitude.
Impact Severity	<p>Direct Impacts Habitat loss of Low to Moderate severity, as area permanently lost small, involving ponds of relatively low ecological value.</p> <p>Indirect Impacts Construction disturbance impacts of Low severity. Operational disturbance impacts of Low severity. Surface run-off, hydrological disruption and pollution all of Low severity.</p>

Reed marsh

Three small, man-made, clean-up reedbeds between LMC Station and STEMDC are in place as a requirement of the Environmental Permit for that project. As the primary aim of these ponds is wastewater treatment rather than ecological enhancement, and as they lie underneath the Spur Line viaduct, their ecological value is limited, and largely confined to reed-associated passerine birds.

Direct Impacts

Temporary, construction phase habitat loss of one of the waste-water treatment ponds will occur, and the impact is assessed as of low to moderate significance. The area of the affected pond is 0.032ha in terms of the habitat (i.e. water surface and banks).

Indirect Impacts

Given the location of the viaduct immediately adjacent to the Spur Line viaduct, the marginal shade effect is limited in scope. Furthermore, the closed nature of the habitat limits the impact of disturbance in both construction and operation phases (see **Table 12.56**).

Table 12.56 Potential ecological impacts of Direct Link to LMC Station on reed marsh in the absence of mitigation

Criteria	Assessment
Habitat Quality	Disturbance from the station and associated viaduct, and enclosed nature of area limit ecological value.
Species	Small numbers of reedbed-associated passerines.
Size/Abundance	Total temporary loss is 0.032ha.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance might be possible in operational phase.
Magnitude	Impacts of low magnitude due to small area of habitat and low number of individuals.
Impact Severity	<p><u>Direct Impacts</u> Temporary (3 years) habitat loss impacts of Low to Moderate severity.</p> <p><u>Indirect Impacts</u> Construction and operational phase disturbance impacts of Low severity. Construction and operational shade effect impacts of Low severity.</p>

Mitigation Wetland

Mitigation for the STEMDC takes the form of a 3.7ha wetland, comprising a narrow wetland strip alongside the drainage channel and a small 0.71ha pond (**Appendix 12-12**, plate 19) next to the New Boundary Patrol Road. No habitat loss impacts are predicted to occur.

Disturbance impacts in the construction phase are predicted to be of limited significance given the location adjacent to the existing Spur Line viaduct, while those in the operational phase are not, given the location of the viaduct immediately adjacent to the existing Spur Line viaduct.

Potential disturbance impacts on the LMC WMA are predicted to be low significance given that LMC Station and the Spur Line viaduct lie between the Direct Link viaduct and the main wetland area. Furthermore, the closer parts of the latter area lie in the disturbance shadow of the Spur Line viaduct, and existing disturbance impacts of greater magnitude are already present.

Table 12.57 Potential Ecological Impacts of Direct Link to LMC Station on mitigation wetland in the absence of mitigation

Criteria	STEMDC	LMC WMA
Habitat Quality	Small, pond and narrow strip of riverine wetland along drainage channel.	Area of wetland managed to meet EP targets via enhancement, of high ecological value.
Species	Small numbers of wetland-dependent waterbirds.	Moderate to large numbers of wetland-dependent species.
Size/Abundance	Small area of disturbance, due to largely linear configuration of habitat.	Substantial total area (37ha), but only small part potentially impacted.
Duration	Permanent in respect of operational impacts, temporary in respect of construction impacts.	
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.	
Magnitude	Impacts of low magnitude due to small area of habitat and low number of individuals.	Impacts of low magnitude due to intervening barriers to disturbance.
Impact Severity	Construction disturbance impacts of Low severity. Operational disturbance impacts of Low severity.	Construction and operational phase disturbance impacts of Low severity.

12.6.2.5 Sai Kwo Road Construction Haul Road

Sai Kwo Road, which lies immediately to the northeast of the STEMDC, will be used for one-way ingress of construction vehicles into LMC Loop and to support construction of the Direct Link to LMC Station (see **Figure 10.3**). Given the current nature of the road (illustrated in **Appendix 12-12**, plate 20), there will be a sharp increase in the number of vehicles, as very few currently use it. However, due to existing tree screening and the level of the road being below the embankment of the channel, it is invisible to the STEMDC, its mitigation wetland and the fish ponds beyond. In terms of noise disturbance, the regular and predictable nature of this vehicle movement is not anticipated to cause significant marginal impacts as it lies immediately adjacent to the LMC BCP approach road along which a substantial amount of vehicular traffic, including heavy lorries, passes almost continuously.

The access route passes to the north of the single V-shaped pond that is located adjacent to the Shenzhen River, which is part of the mitigation wetland for the STEMDC (**Appendix 12-12**, plate 19). Screening by existing trees, however, will buffer visual disturbance. The road then crosses below San Sham Road to the east side, where vehicles will use the existing Lung Hau Road for a short distance, before turning north to traverse the area of disturbed fish ponds immediately beside the alignment of the Direct Link to LMC Station. As with the latter, construction and operational disturbance in this area is not considered of significance given the existing disturbance shadow of MTR LMC Spur Line and the relatively low ecological value of the ponds. No habitat loss additional to that which will occur as a result of the construction of the Direct Link will occur.

Finally, until a permanent crossing is constructed as part of the Western Connection Road, the haul road crosses LMC Meander on a 6m wide temporary bridge with intermediate support. This bridge is of a smaller scale than the permanent crossing and will be dismantled once the latter is in place. The temporary habitat loss impacts of the crossing comprise approximately 0.1ha of riparian vegetation, and approximately 100m² of water column and watercourse bottom. These temporary impacts are assessed as of low significance (see **Table 12.45**).

12.6.2.6 Flushing Water Service Reservoir

A flushing water service reservoir and associated access road is proposed for construction in the grassy hill area a short distance to the east of the Ngau Kok Shan (Horn Hill) (**Figure 2.1a**). As the pipework required will be laid at the same time as the Eastern Connection Road is constructed, there will be no added impact to the wetland area.

Direct Impacts

Habitats lost permanently comprise marsh and grassland. The marsh area lost is also impacted directly by construction of the ECR. The area is very small, at 60m², of which only 20m² is not already included in the mitigation provision for construction of the ECR. Given this, and given the fact that the mitigation provision for marsh loss arising from the ECR constitutes ecologically enhanced habitat established at the earliest stage of the Project, this is thus regarded as a negligible loss. In respect of the grassland habitat through which the road runs (illustrated in **Appendix 12-12**, plate 32), this is of poor quality supporting widespread and common species of birds such as bulbuls and prinias; the area is 0.32ha. Consequently, given the very small magnitude of habitat loss, direct impact is predicted to be of low significance. With regard to Eurasian Eagle Owl, which is presumed to breed in the hills between LMC Tsuen and Ma Tso Lung Tsuen, given that typical home ranges for the species range from 270ha to 25km², this is considered to be an insignificant loss in terms of its roosting or foraging areas. Ping Hang Stream will not be directly impacted.

Indirect Impacts

Disturbance impacts on the eagle owl are possible. However, it is unlikely that the particular area impacted is frequently used by the owl, given its proximity to the Police Operational Base at Horn Hill (Ngau Kok Shan). Small rocks clearance from the hillside above the site will take place; however, the disturbance impacts of this activity are predicted to be negligible, given that heavy machinery will not be used. As construction will take place at the same time as that of the ECR, the overall marginal disturbance impacts are predicted to be minor, and not impact wetland habitats. In the operational phase, disturbance impacts will be minor given that only intermittent access is required.

Table 12-57a Potential Ecological Impacts on grassland of Flushing Water Service Reservoir

Criteria	Assessment
Habitat Quality	Rather poor, as grass neither dense nor tall.

Criteria	Assessment
Species	Small numbers of common and widespread species, though possibly part of range of Eurasian Eagle Owl.
Size/Abundance	Small area of habitat loss (0.32ha), a common habitat in HK.
Duration	Permanent in respect of operational impacts, 48 months in respect of construction impacts.
Reversibility	Mostly irreversible, though remedial measures to reduce disturbance possible in operational phase.
Magnitude	Impacts of low magnitude due to small area of habitat and low number of individuals.
Impact Severity	<p><u>Direct Impacts</u> Habitat loss of Low severity.</p> <p><u>Indirect Impacts</u> Construction disturbance impacts of Low severity. Operational disturbance impacts negligible.</p>

12.6.2.7 Bio-remediation of Shenzhen River

As mitigation for odour issues of the Shenzhen River will be required under the air quality impact assessment, in-situ bio-remediation will be carried out to improve sediment quality via nitrate injection (no dredging work required). The major water quality impact of this treatment concerns the potential release of nitrate-nitrogen, ammonia and heavy metals from sediments into the water. An in-situ trial test on bio-remediation using calcium nitrate indicated that downstream nutrient levels of TKN, ammonia nitrogen, nitrate, nitrite and total nitrogen will increase slightly under low-flow conditions, but will be highly diluted by natural tidal surge. This slight low-flow increase in nutrient levels in what is already a eutrophic system is predicted to have an insignificant impact in downstream areas, including Mai Po Inner Deep Bay Ramsar Site.

The elutriate test and pore water test results on heavy metal was further compared with Surface Water Standard (GB 3838-2002) or Urban STW Pollution Standard (GB 18918-2002); most of the elutriate and pore water test results complied with the standards. Thus, bio-remediation by injection of calcium nitrate will not induce adverse environmental impact regarding heavy metals.

Given the existing poor water quality downstream of Shenzhen River, adverse water quality impact is not anticipated from these slight elevations in heavy metal loadings (see **Chapter 5 Water Quality Impact, Section 5.6.1.7**). Indeed, it is likely that the long term improvement of water quality will promote recolonisation by aquatic fauna and their predator species, including waterbirds. In order to ensure the acceptance of water quality impact, monitoring of heavy metals and nutrient levels will be conducted during bio-remediation.

The boat to be used is of the type currently in use for bio-remediation of Shing Mun River, is small in size and not predicted to impose significant disturbance impacts on waterbirds or otters using the river, given existing river traffic. No night-time operation is required for this work, and total duration is 36 months.

12.6.3 Impacts on Species

Impacts on waterbirds via impacts on their foraging and roosting habitats are covered in **Section 12.6.2**. Impacts on birds using the flight line corridor are dealt with in **Section 12.6.4**. This section deals with impacts on birds of wildlife mortality and impacts on non-bird species.

12.6.3.1 Collision Mortality of Birds

The height of some buildings in LMC Loop will be substantial, and as modern buildings tend to have large areas of glass, avian mortality is possible. Much depends on the nature of the glass, however, with highly reflective surfaces causing greater mortality, especially if adjacent to dense areas of shrubs or trees. The LMC Loop lies under a flight line corridor for birds to and from foraging areas; in addition, given the presence of a heavily urbanised area and the Shenzhen River to the north, it is likely that it forms a migratory flight path for birds flying to or from areas east of HK to the Deep Bay area. These two factors mean that existing local airspace populations of birds are relatively large, and thus the possibility of collision is potentially higher.

In any location, species involved in collisions will reflect the habitats in the immediate vicinity. The developed area of LMC Loop will be planted with trees and shrubs that will attract the typical common and widespread species that have adapted to this habitat in HK. Some species using adjacent areas of shrubland and secondary woodland will opportunistically use semi-natural habitats inside the developed Loop. However, this phenomenon is common in HK. Consequently, any mortality is not anticipated to be different in nature to that which occurs in other areas of HK. The separation of the main developed area in LMC Loop from surrounding woodland or plantation will go some way to reducing the risk posed by reflective glass, though landscape planting adjacent to some buildings may pose some risk (see **Table 12.58**).

Data from the only study of mortality of birds caused by noise barriers in HK, which was not systematic, are presented on the website of the Hong Kong Bird Watching Society³. Though informal, the data suggest that mortality from transparent noise barriers alongside roads can be significant. Most of the species suffering collision at the site in study were small in size due to the nature of habitats in the surrounding area. The issue at this and similar sites concerned birds flying between separate patches of wooded or shrubland habitat, where the transparent glass imparted the impression of unobstructed passage.

The larger species present in HK are less prone to such impacts as they tend to fly more slowly and at greater heights in more open areas, away from roads and buildings. Consequently, it is not anticipated that cormorants, eagles, larger ardeids or Black-faced Spoonbill will be significantly impacted in this way, given appropriate selection of building materials and design. The main issue for these larger species, including the largely nocturnally-foraging Grey Heron and Night Heron, as well as Eurasian Eagle Owl and migratory birds in general is probably lighting. Certain types of lighting, especially in tandem with poor weather, may

³ <http://www.hkbws.org.hk/BBS/viewthread.php?tid=405&extra=page%3D1>

impose an impact (see **Section 12.6.1.2**). The risk for Eurasian Eagle Owl is possibly slightly higher, given that its prey includes small animals that could cross the road at night. However, it is not a carrion feeder, and does not come down to forage on carcasses hit by vehicles.

In terms of Greater Painted-snipe, as this species is very uncommon in the area, significant mortality is not expected. Red-billed Starling, while common in fish pond areas of Deep Bay, does not appear to be prone to collision in HK, and the same design principles in respect of other small birds (see **Section 12.7.6.1**) will benefit this species.

Table 12.58 Potential collision mortality impacts on bird species in the absence of mitigation

Criteria	Assessment
Habitat Quality	Wetlands of high ecological value and mixed rural habitats support an abundance of both waterbirds and landbirds.
Species	Species of conservation value, wetland-dependent species and a diverse variety of land birds are present in the area.
Size/Abundance	Abundance of birds is high, while the area of buildings and roads that could potentially cause mortality is large at nearly 100ha.
Duration	Construction phase impact will be short-term but operational phase impacts are long-term.
Reversibility	To some extent reversible via installation of measures to minimise impacts.
Magnitude	Impacts probably of low magnitude in terms of larger waterbirds, but potentially of moderate magnitude in terms of smaller birds.
Impact Severity	In the absence of mitigation, potentially Moderate , mainly in relation to small to medium-sized birds, including waterbirds and wetland-dependent species, though Eurasian Eagle Owl and small numbers of larger waterbirds may be impacted.

Disturbance impacts arising from increases in lighting and associated glare could have night-time impacts on birds. However, experience elsewhere in HK suggests that egrets and herons do not shy away from roosting in well-lit, urban areas, as can be seen by the examples of year-round roosts at Wong Chuk Hang, Victoria Park, Penfold Park and Tai Po Market. Furthermore, the Shenzhen side of the river is densely urbanised and levels of existing night-time lighting in the area are relatively high already. For these reasons, it is not considered that lighting or associated glare would impose a significant impact on roosting birds.

Foraging birds may be more sensitive, though there has been no research on this topic in HK due to the difficulties of collecting data. Eurasian Eagle Owl is known to occur in the hills between Lok Ma Chau and Ma Tso Lung villages, and is presumed to roam fairly widely to forage, including at HHW. The continued availability of suitable foraging habitat in the area is likely to reduce potential impacts from the, by comparison, relatively restricted impacts of a marginal increase in lighting levels in the area.

Table 12.58a Potential impacts from increased lighting or glare on bird species in the absence of mitigation

Criteria	Waterbirds	Eurasian Eagle Owl
Habitat Quality	Wetlands of high ecological value support an abundance of waterbirds.	LMC Loop and HHW wetlands probably form an element of the foraging range, although the importance is unknown.
Species	Wetland-dependent species of high conservation value,	Large owl of local conservation significance.
Size/Abundance	Abundance high.	Widespread species, though at low densities. Probably only 1-2 pairs in area.
Duration	Construction phase impact will be short-term but operational phase impacts are long-term.	
Reversibility	To some extent reversible via installation of measures to minimise impacts.	
Magnitude	Impacts probably of low magnitude in terms of larger waterbirds.	Impacts probably of low magnitude given availability of other habitat and relatively restricted nature area of impacts in area of existing, relatively high light levels.
Impact Severity	Low.	Low.

12.6.3.2 Eurasian Otter

The occurrence of Eurasian Otter in LMC Meander and the reed marsh in LMC Loop indicates that these habitats are used by the species for foraging and resting, and possibly breeding in the case of the reed marshes. Based on habitat preferences and habits described in the literature, and on **Figure 12.3**, which illustrates the locations of Eurasian Otter records, it would also appear that LMC Meander or some part of it may act as a movement corridor for the species to access the fish ponds at HHW from areas to the west of LMC BCP (where there have occurred records of this species). Such movements are likely to occur during post-breeding juvenile dispersal or when looking for a mate; it is possible, however, given the large home range of otters overseas, that regular (daily) commutes to and from foraging areas occur.

How otters traverse the area containing LMC BCP, San Sham Road and the Spur Line is unclear. It could be that animals use the Shenzhen River to travel beyond LMC Loop and access the HHW area at some point further on, though it is unknown where this might be. There is a wildlife underpass underneath Lung Hau Road that was created at the time of construction of the Passenger Transport Interchange and associated road upgrading required for MTR LMC Station. However, although possible, there is no evidence that this is used by otters. In addition, it is difficult to see how animals access the Meander from Shenzhen River, given that the connection between the two watercourses comprises a one-way flap valve that allows water to flow from the Meander to the river, but not vice-versa. Should such connectivity exist, however, then construction of the Western Connection Road crossing could potentially have an impact.

In contrast, the location of the Eastern Connection Road crossing of LMC Meander is near an area where many otter sightings have occurred (near Ngau Kok Shan), including one during field work for this Study, and disturbance impacts may occur.

The following main sources of potential impact on Eurasian Otter can be identified (see also **Table 12.59**):

- habitat loss of the larger trees, dense bushes and grass along the tops of the banks of LMC Meander, as this habitat may provide refuge and rest areas;
- habitat loss of the reed marsh and marsh inside the Loop, especially given the potential importance of reedbed to the species (Kruuk 1995, 2006);
- wetland habitat loss in the wetland complex surrounding LMC Loop, including reed marsh, watercourses, fish ponds and marshy areas, arising in particular from Eastern Connection Road;
- disturbance impacts on its use of LMC Meander, which is a foraging area and possibly a movement corridor, arising from human activity and increased lighting;
- disturbance to wetland habitats arising from construction activity, lighting and increased human activity;
- deterioration in water quality causing direct impact or secondary impacts via effects on prey species;
- loss of 50% of width of LMC Meander for 100m during construction of road underneath, and resultant increase in water velocity;
- impedance of access to the main fish pond area at HHW, via habitat loss or disturbance;
- impedance of, or disturbance preventing use of, LMC Meander as a movement corridor;
- fragmentation of populations as a result of road construction;
- road mortality;
- disturbance by dogs, especially during the construction phase as feral dogs are often closely-associated with construction sites;
- Temporary loss of upper part of natural bank of LMC Meander during stabilization works that will reverse itself in time through re-growth of vegetation (see **Section 12.6.2.1**, LMC Meander).

Table 12.59 Potential ecological impacts on Eurasian Otter in the absence of mitigation

Criteria	Assessment
Habitat Quality	Wetland habitats (reed marsh, LMC Meander and fish ponds) are undisturbed, rich in piscine prey items and suitable for Eurasian Otter.
Species	Eurasian Otter is near-threatened globally and endangered in China, and is of high conservation significance in HK.

Criteria	Assessment
Size/Abundance	The area of habitat is large and constitutes a significant proportion of suitable habitat in Hong Kong.
Duration	Construction phase impact will be short-term but operational disturbance effects and habitat loss are long-term.
Reversibility	Habitat loss and disturbance effect during operational phase will be irreversible. Construction impacts are to some extent reversible.
Magnitude	Habitat loss large in magnitude, especially in respect of reed marsh in LMC Loop and riparian vegetation along LMC Meander. Disturbance impacts of high magnitude in construction phase, as Eurasian Otter is a disturbance-sensitive species and is of conservation concern. Of greatest potential significance are those arising during construction of the Eastern Connection Road, the slope stabilisation required for the developed area of LMC Loop and, possibly, the bridge over LMC Meander required for the Western Connection Road. Operation phase impacts significantly less.
Impact Severity	In the absence of mitigation, potentially High in the construction phase and Moderate to High in the operation phase.

12.6.3.3 Other Mammals

The other mammals of conservation concern present in the Ecological Assessment Area are Red Muntjac, Leopard Cat and Small Indian Civet. The single sighting of Red Muntjac faeces on the grassy hillside at Ma Tso Lung is far from the proposed development, and given its preference for grassland-shrubland and shrubland (Shek 2006), impacts are not anticipated.

Small Indian Civet and Leopard Cat utilise a wide range of habitats and in the Ecological Assessment Area they mainly appear in grassland, shrubland and fish ponds. Unlike Eurasian Otter, these mammals are widespread in Hong Kong due to their catholic habitat preferences. Their movements could be impacted by disturbance from lighting or by fragmentation caused by roads or road construction. Although during the construction phase there would be more disturbance in view of their largely nocturnal activity period, they are not likely to be highly disturbed. Other mammals present are common and widespread in HK.

In respect of the Eastern Connection Road, the potential fragmentation and road kill mortality effects are greater, as this new road is being placed in a relatively undisturbed area of natural habitats. Peak morning vehicle flow in 2042 is predicted to be 1085 vehicles/hour. These impacts will be greater in the construction phase, as noise and activity will be significantly greater. The Western Connection Road passes through already disturbed habitats and along existing roads, and is unlikely to have such significant effects. However, it may cause fragmentation of populations east and west of the LMC BCP (see **Table 12.60**).

The bat species recorded are common in Hong Kong, use a variety of habitats and are tolerant of human activity (often roosting in buildings). Numbers recorded within the LMC Loop were moderately low in comparison to nearby wetland habitats, and the LMC Loop probably does not provide an important foraging resource for these species. It is unlikely that significant roosts of any bat species

are present within the Loop due to the lack of suitable habitat (none were noted during evening visits). It is not considered that development within LMC Loop would result in significant impacts to bats, either through loss of roost sites or through loss of foraging habitats.

Wetlands outside the Loop support a greater abundance of foraging bats, and loss of wetlands caused by construction of the Eastern Connection Road may impact upon these populations. The species involved are, however, common in Hong Kong and the area of wetland loss is relatively small in comparison to the total area of wetlands at HHW or in Deep Bay. Bat populations are not therefore considered to be significantly impacted by habitat loss from the connection roads.

Table 12.60 Potential ecological impacts on other mammals in the absence of mitigation

Criteria	Assessment
Habitat Quality	The habitats present in the Ecological Assessment Area vary in quality, but they are sufficient to support populations of these species.
Species	Although species of conservation concern occur, they are widespread in HK.
Size/Abundance	Given the difficulty of survey, records during surveys suggest populations may be higher than other areas. The relative lack of disturbance in the area would support this.
Duration	Construction phase impact is short-term, but operational phase will be permanent.
Reversibility	Mostly irreversible, though limited remedial measures to reduce disturbance possible in operational phase.
Magnitude	The magnitude of impacts fairly limited, as the area does not appear to support significant populations of mammals of conservation significance (apart from Eurasian Otter).
Impact Severity	Construction phase: Moderate due to potential for disturbance and greater magnitude of fragmentation impacts. Operational phase: Low to Moderate in view of potential fragmentation issues associated with Eastern Connection Road through HHW area.

12.6.3.4 Herpetofauna

Amphibians of conservation concern recorded included Chinese Bull Frog and Two-striped Grass Frog. The former was recorded in areas that are not directly impacted, mainly in the agricultural land at LMC San Tsuen, Ma Tso Lung and Tse Koo Hang, and along the upper sections of Ma Tso Lung Stream. It was, however, present in the abandoned ponds near LMC San Tsuen (ponds 11 and 12 in **Figure 12-02**).

Two-striped Grass Frog was mainly found in the abandoned ponds near LMC San Tsuen, as well as in a marsh near Ngau Kok Shan (Horn Hill). In addition, however, many individuals were heard in May 2010 from a temporary rainwater pool created the previous dry season by site investigation work in grassland in LMC Loop. Such a record appears to be a short-term opportunistic response to habitat availability at a time of species abundance, and was a phenomenon noted elsewhere in the Deep Bay area at the same time. A repeat survey in May 2011 did not record any individuals of this species, although it is presumed to be still

present. In addition, construction of the Eastern Connection Road will result in the loss of abandoned fish pond habitat particularly suitable for this species.

Snake diversity was not high in the Ecological Assessment Area but certain species of conservation concern were found, including Common Rat Snake, Indo-Chinese Rat Snake and Chinese Cobra. In addition, Burmese Python, although not recorded in the present study, has been recorded previously in the Ecological Assessment Area and is likely to still occur, particularly in fish pond or marsh areas. Snakes are highly mobile and these species are versatile in habitat utilisation.

Impacts associated with the construction phase are unlikely to have a long-term impact on the local populations of these species. However, removal of the reedbed inside LMC Loop may have an impact on Burmese Python (which was reported by villagers to occur in the reed marsh).

Both the Western and Eastern Connection Roads potentially could impose a fragmentation effect on herpetofauna (primarily as a result of increased road kill), while the potential for the Direct Link to LMC Station to do this is very much reduced, as much of it is on viaduct.

Chinese Soft-shelled Turtle, although not recorded in the present study, is known to inhabit the fish ponds at HHW. Although this Project will not cause a large magnitude loss of fish ponds, the Eastern Connection Road could be a physical barrier to this species. Potential impacts on herpetofauna other than Three-banded Box Terrapin are summarised in **Table 12.61**.

Table 12.61 Potential ecological impacts on herpetofauna (excluding Three-banded Box Terrapin) in the absence of mitigation

Criteria	Assessment
Habitat Quality	The mixture of wet and dry habitats provides good quality habitats for herpetofauna.
Species	Burmese Python and Chinese Soft-shelled Turtle are of high conservation concern, while Two-striped Grass Frog is of local concern and Chinese Bullfrog is of potential regional concern.
Size/Abundance	Chinese Bull Frog and Two-striped Grass Frog appear to be of moderate abundance in parts of the Ecological Assessment Area. Chinese Soft-shelled Turtle presumed also to occur in low to moderate abundance. Burmese Python of low abundance. The species mentioned are all fairly common and widespread in HK.
Duration	Construction phase impact is short-term, but operational phase will be permanent.
Reversibility	Largely irreversible, limited mitigation may be possible during construction.
Magnitude	Magnitude of development of LMC Loop large, while that of the road connections restricted. However, habitats of Two-striped Grass Frog will be directly impacted, and the Eastern Connection Road in particular will result in habitat loss that will affect this and the other herpetofauna species.

Criteria	Assessment
Impact Severity	<p>Construction phase Two-striped Grass Frog: Moderate due to combination of habitat loss and fragmentation. Burmese Python, Chinese Bull Frog and Chinese Soft-shelled Turtle: Low to Moderate.</p> <p>Operation phase All species: Low to Moderate.</p>

Three-banded Box Terrapin has previously been recorded in the upper section of Ma Tso Lung Stream. Given that the upper stream course lies outside the site area and upstream of the proposed ECR through Ma Tso Lung, impacts are not anticipated. However, should the terrapin use the lower sections of this stream, there might be some impact due to loss of riparian vegetation. However, it is uncertain if the terrapin does use the lower sections of the stream given its habitat preferences are known to be riparian woodland. It is likely that this area is of less significance than upstream areas (see **Table 12.61a**).

Indirect impacts on the terrapin population due to water quality deterioration, road-kill and habitat fragmentation could also occur.

Table 12.61a Potential ecological impacts on Three-banded Box Terrapin in the absence of mitigation

Criteria	Assessment
Habitat Quality	The marsh and seasonally wet grassland present not of high ecological value due to lack of microhabitat diversity. Lower section of Ma Tso Lung stream not of high quality for same reason and previous modification of riparian zone.
Species	Three-banded Box Terrapin is of high conservation concern.
Size/Abundance	Only one record in higher section of stream means that accurate assessment of these not possible. However, almost certainly very few individuals.
Duration	Construction phase impact is short-term, but operational phase will be permanent.
Reversibility	Largely irreversible, limited mitigation may be possible during construction.
Magnitude	Given that lower streams sections do not contain preferred habitat, magnitude low to moderate.
Impact Severity	Given rarity, impacts from all sources combined potentially of Moderate severity.

12.6.3.5 Odonata

In the present study, five odonate species of conservation concern were recorded. However, three of these (Sapphire Flutterer, Ruby Darter and Scarlet Basker) are now considered to be common in Hong Kong; Coastal Glider is considered to be locally uncommon, but is globally abundant and widespread^[12-76]. These four species were mainly observed in abandoned ponds. The construction of the Eastern Connection Road could potentially have some impacts on their habitats

(see **Table 12.62**). A maximum count of five Common Evening Hawkers, which is uncommon in Hong Kong^[12-76], was made in the reed marsh inside LMC Loop. Given the difficulty of censusing this species accurately, it appears likely that the reed marsh supports a reasonable population, and site clearance could have a significant direct impact on this species.

Other odonates recorded in the present study are lowland species inhabiting pond-like areas and lowland streams. Most are common and widespread in HK and the Project is unlikely to significantly affect their local populations.

Table 12.62 Potential ecological impacts on odonata in the absence of mitigation

Criteria	Assessment
Habitat Quality	Suitable abandoned ponds and reed marsh are not uncommon in the Ecological Assessment Area.
Species	Although of local conservation concern, three are common in Hong Kong and one is widespread globally. Common Evening Hawker, which was found in LMC Loop, is uncommon locally.
Size/Abundance	Generally odonata not abundant, but an abandoned pond at LMC Tsuen supports a population of Sapphire Flutterer, while there is likely to be a reasonable population of Common Evening Hawker in the LMC Loop reedbed.
Duration	Construction phase impacts will be short-term. Operational phase impacts will be permanent.
Reversibility	Reversible short-term construction phase impacts, but operational phase impacts irreversible.
Magnitude	Direct impacts of significant magnitude affect Common Evening Hawker in LMC Loop, though construction run-off may affect some ponds and thus impact breeding grounds.
Impact Severity	Low for Sapphire Flutterer, Ruby Darter, Scarlet Basker and Coastal Glider as the first three are common in Hong Kong and, while the last is locally uncommon, it is abundant on a global scale, and their habitats (including suitable habitats nearby) will not be severely impacted. Low to Moderate for Common Evening Hawker: although suitable habitat will be directly impacted, some individuals will be able to find other areas in view of their high mobility.

12.6.3.6 Butterflies

Only three butterfly species of conservation concern were found in the present study. All were observed on the grassy hillside to the west of Ma Tso Lung, which will not be impacted by the proposed development. In respect to Small Three-ring, its host plant *Ischaemum barbatum* is found at the edge of marsh where it interfaces with shrubland; although the Eastern Connection Road will result in the loss of marsh, this is in an area where it interfaces with seasonally wet grassland. Spotted Angle was also observed in a small patch of bare ground near Ma Tso Lung village, but this is not suitable breeding habitat, and the individual may have strayed from the nearby hillside.

Although certain uncommon butterflies were observed by ENSR (2009)^[12-30a] within LMC Loop and fish pond areas at HHW, data from ENSR (2009)^[12-30a]

and the current study both indicate that LMC Loop and most surrounding lowland areas (fish ponds) support a relatively low abundance and diversity of butterfly species (i.e. with a low diversity of plant species providing few opportunities for foraging adults or larvae). A greater diversity of butterflies is present in shrubland at Ma Tso Lung and around Lok Ma Chau Lookout, but impacts to these habitats from the proposed development and connecting road will not be significant. As a result, impacts on the butterfly community arising from the Project are anticipated to be low (see **Table 12.63**).

Table 12.63 Potential ecological impacts on butterflies in the absence of mitigation

Criteria	Assessment
Habitat Quality	Most habitats have low diversity of plant species, and can only support relatively few species.
Species	Most species common and widespread, apart from three of conservation concern on hills above Ma Tso Lung, while the host plant of one (Small Three-ring) occurs at the interface of marsh and shrubland.
Size/Abundance	No species recorded in unusually high abundance.
Duration	Construction phase impact is short-term, but operational phase will be permanent.
Reversibility	Largely irreversible, limited mitigation may be possible during construction.
Magnitude	Habitats impacted are of low value for butterflies, so magnitude of impacts fairly low.
Impact Severity	Impacts of Low severity because, in general, small numbers of common species are affected.

12.6.3.7 Aquatic Fauna

Rose Bitterling, which is rare in Hong Kong [12-47], is present in a semi-natural stream and nearby ponds to the south of Lung Hau Road. This site is the third in HK in which a population of this species has been found, the others being a reservoir in Sha Tin and a stream at Kam Tin. Although this area would not be directly impacted by the Western Connection Road, construction run-off entering the stream could have some effect on this species as it is sensitive to water quality change. Potential effects to the upper part of the stream are limited, however, given intervening village and secondary woodland habitats. During the operational phase, road run-off would be of substantially lower magnitude (see **Table 12.64**).

A small population of Paradise Fish occurs in Ping Hang Stream (illustrated in **Appendix 12-12**, plate 33). The Eastern Connection Road passes through the fish pond area close to this stream, and there exists the potential for indirect impacts arising from run-off and increased sedimentation. In addition, the construction site is nearby and there is the potential for other, unanticipated impacts from site staff.

Small Snakehead is of local conservation concern^[12-31]. A pair was observed in a tributary of Ma Tso Lung Stream, to the south of Ma Tso Lung San Tsuen. This tributary would not be directly affected by the Project but road upgrading work will generate construction run-off that could affect this stream and thus impact aquatic organisms.

Somanniathelphusa zanklon, considered endangered by IUCN (2010) [12-38], was also found in the same tributary of Ma Tso Lung stream, as well as in a stream to the south of LMC Loop alongside the Border Road and a polluted stream at Chau Tau. The latter two habitats would not be impacted by the Project (see **Table 12.65**).

Table 12.64 Potential ecological impacts on aquatic fauna in the absence of mitigation

Criteria	Rose Bitterling	Paradise Fish
Habitat Quality	Polluted and fragmented.	Ping Hang stream is clean and largely natural.
Species	Rose Bitterling is very rare in HK. The present stream is one of only three with this species in HK.	Paradise Fish is widespread in HK.
Size/Abundance	Self-sustaining population present.	Self-sustaining population present.
Duration	Construction phase impact will be short-term but operational phase impacts will be long-term.	Direct and indirect short-term construction impacts, and long-term, though minor, operational phase impacts.
Reversibility	Irreversible.	Irreversible.
Magnitude	Localised construction run-off could have an effect of moderate magnitude, while surface run-off could have a low impact.	Potentially of large magnitude due to construction run-off or other impacts by site staff.
Impact Severity	Construction phase: Moderate . Operational phase: Low to Moderate .	Construction phase: Moderate . Operational phase: Low to Moderate .

Table 12.65 Potential ecological impacts on aquatic fauna in the absence of mitigation

Criteria	Small Snakehead	<i>Somanniathelphusa zanklon</i>
Habitat Quality	Small but relatively clean stream. Other sections in Ma Tso Lung area may also contain this species.	Small but relatively clean stream at Ma Tso Lung; other habitats unaffected. Other sections in Ma Tso Lung area may also contain this species.
Species	Of local conservation concern.	Considered as endangered, but present in other areas in HK.
Size/Abundance	One two individuals were observed, but a larger population likely present in Ma Tso Lung Stream and Marsh.	Abundance: low; but a larger population in Ma Tso Lung Stream and Marsh likely.
Duration	Construction phase impact short-term, operational phase impact long-term.	
Reversibility	Largely irreversible.	
Magnitude	Project unlikely to have significant impact. The construction and operation of Eastern Connection Road may impact Ma Tso Lung Stream.	
Impact Severity	Construction phase: Moderate due to potential run-off impacts. Operational phase: Low to Moderate .	

12.6.3.8 Flora

The obvious impact is the entire clearance of all herbaceous vegetation and woody plants (mainly isolated patches of shrubs and trees, and the exotic weed *Leucaena leucocephala*) resulting from site formation and development of LMC Loop. Species of flora identified in surveys of LMC Loop are common and widespread throughout Hong Kong.

Development outside LMC Loop will mainly occur along existing paved roads and urban areas, which are covered by common to very common herbaceous vegetation, and common street trees and shrubs. The development will avoid direct impacts and disturbance to major connected secondary woodland and shrubland areas with higher diversity of flora, and no impact is predicted on the protected tree species *Aquilaria sinensis*. However, development of the Eastern Connection Road will cause obvious impact on vegetation as it will pass through secondary woodland in some parts of its length. Again, however, the species involved are common and widespread in HK. In respect of the single sapling of *Aquilaria sinensis* recorded at MTL during NENT NDA PES, this lies approximately 53m to the west of the proposed ECR alignment, and no impacts are predicted.

12.6.4 Impacts of Fragmentation

The fragmentation impacts of primary concern relate to those on the flight line corridor through the area. Assessment of these is divided into two aspects, those arising from development of LMC Loop itself, and those arising from the provision of Western and Eastern Connection Roads and the Direct Link. Provision of the Flushing Water Service Reservoir is not predicted to impose fragmentation impacts as the works are limited in scope and occur in the hilly areas over which no birds using the flight line corridor were recorded.

The potential fragmentation impacts on Eurasian Otter, other mammals and herpetofauna are best considered as part of an assessment of the impacts on the species from the whole development (see **Section 12.6.3**).

12.6.4.1 Impacts from LMC Loop development

Development of LMC Loop has the potential for impacts on large waterbirds (in particular Great Cormorant, Grey Heron, Great and Little Egrets) utilising the flight line corridor linking wetlands southwest of LMC BCP (as far as Mai Po NR and Inner Deep Bay) with the fish pond area at HHW (see **Table 12.66**). Surveys of the flight line have revealed that most birds utilise a corridor that begins at Ha Wan Tsuen, travels northeast to include the southeastern part of LMC Loop and LMC Meander, before entering the main HHW fish pond area near Ngau Kok Shan (**Appendix 12-3** and associated figures). The focus of this corridor is LMC Meander, but it extends to cover the adjacent fish ponds between the Meander and the boundary fence and adjacent areas of LMC Loop up to a maximum of approximately 170m from the Meander at the widest point (though generally about 150m). A critical area is located at the entry point to this area, which lies in the vicinity of Ha Wan Tsuen.

The nature of these impacts constitutes direct airspace loss impacts and indirect disturbance effects arising from the placement of buildings in an otherwise largely

rural area. A proportion of birds that currently fly over the Loop are expected to be forced to adopt a higher altitude or a different route during construction and operation of the development. These responses will be dictated either by the physical barrier posed by taller buildings or by the requirement of birds to fly a certain distance away from buildings or human activity to maintain a sense of security. If this sense of security cannot be maintained or acquired via other, energetically feasible routes, birds will stop using the flight line. It is reasonable to suppose that taller buildings provide more of a disturbance impact than those of a lower height, and that bird flights currently over the central parts of LMC Loop will be more impacted than those closer to Shenzhen River or LMC Meander (see **Section 2** for an illustration of the height profile of buildings in the Loop).

In terms of the Shenzhen River, 8.8% of bird-flights occurred along the river channel. It is predicted that birds will continue to use this route, even after LMC Loop reaches the operational stage, though numbers may be fewer. Furthermore, after the intensification of development on the Shenzhen side of the river, when building height is likely to increase, this may impose a further, cumulative impact. The river channel, however, is 160m wide alongside LMC Loop, which will maintain a fairly broad, unimpeded corridor, and it is predicted that many birds will continue to use this. Elsewhere in HK at such sites as Tai Po, Aberdeen and Causeway Bay, egrets regularly carry out flights between roosting and foraging areas that include sections close to buildings.

Should foraging opportunities increase in the future as a result of the expected improvement in water quality in the river, this will attract more birds to fly through this area. However, it should be noted that a possible pedestrian walkway across the river may have an adverse impact, the potential for which should be assessed in detail prior to design and construction.

If the extra flight distance involved in adopting a different route results in significantly increased energy expenditure, this may outweigh the benefit of using the flight line to access foraging or roosting areas at HHW. The net result would be a decline in the number of birds using the flight line. Fewer birds using the flight line would reduce the number of birds foraging at HHW, which would in turn reduce the overall carrying capacity of the Deep Bay area for waterbirds.

The Deep Bay area wetland ecosystem is recognized as of international significance through the designation of the approximately 1,500ha Mai Po Inner Deep Bay Ramsar Site. Although the Ramsar Site boundary does not extend near to the Ecological Assessment Area, there are significant linkages between the two, as noted above. As a result of these linkages, the fish ponds at HHW and the flight line linkage between this area and wetlands to the southwest of LMC BCP must be regarded as important ecologically, as the presence of foraging and roosting areas outside the Ramsar Site constitutes a significant resource for wildlife inside, either contemporaneously or with a temporal gap (i.e. birds may forage in both areas at broadly the same season, or they may utilize one area in the breeding season and the other area in the winter period).

Further, some linkage appears to exist with the freshwater wetland area of Long Valley, where Black-faced Spoonbills have been recorded foraging (up to nine birds in the winter 2009-10). To reach Long Valley, these birds probably overfly the LMC Loop, a phenomenon that was observed during field surveys for this Study. However, neither the number of birds, the frequency of their occurrence

nor the availability of suitable habitat at Long Valley is sufficiently great as to make this linkage important to the species in HK.

The relatively low intensity of birds flying over the main part of LMC Loop is noteworthy, as is the lack of birds over or adjacent to the hills between Chau Tau Tsuen and Ma Tso Lung Tsuen. Given this concentration of flight lines and the nature of nearby habitats and topography, it would appear that birds are highly unlikely to use what would be the remaining narrow strip of open land between the hills and the edge of LMC Loop, should development of the whole area of LMC Loop occur.

In terms of non-waterbird species, no discernibly consistent use of any flight route was found during surveys of flight lines. As noted in **Appendix 12-3**, the number of bird flights of species of conservation significance other than large waterbirds was low. In terms of Imperial and Greater Spotted Eagles, the fact these birds now appear not to use the HHW area frequently, as in former years^[12-22], was reflected in the scarcity of records from this Study, including only two recorded during flight line surveys. It thus appears that the HHW area is not of significance to the local populations of the two *Aquila* eagles, and thus any impacts of buildings in LMC Loop on their use of the area is unlikely to be significant in terms of the Deep Bay area population.

There are no data to suggest that the hills between Chau Tau and Ma Tso Lung villages constitutes a significant migration or other flight route for birds, though it is likely that Bonelli's Eagle and Black Kite occur over this area more than most species as a result of foraging activity.

Table 12.66 Potential fragmentation impacts on waterbirds using the flight line corridor in the absence of mitigation

Criteria	Assessment
Habitat Quality	Flight lines through the area link fish ponds habitats of high quality and are important for wetland birds.
Species	Large waterbirds (Great Cormorant, Grey Heron, Great and Little Egrets, Night Heron, Chinese Pond Heron) are a critical component of the Deep Bay area wetland ecosystem, and some occur in regionally important numbers.
Size/Abundance	Substantial numbers of waterbirds utilise the flight line corridor, especially in the non-breeding season, including up to 16.4% of Great Cormorants and significant percentages of Great and Little Egrets.
Duration	Permanent.
Reversibility	Mostly irreversible, though limited remedial measures to reduce disturbance possible in operational phase.
Magnitude	In absence of mitigation, a very large magnitude impact could occur, in particular on Great Cormorant.
Impact Severity	Very High for large waterbirds due to potential impacts of building in LMC Loop and ECR, in particular, and the WCR and Direct Link to a lesser extent.

12.6.4.2 Impacts from External Road Connections

Flight Line Corridor

The provision of Western and Eastern Connection Roads and the Direct Link to LMC Station has the potential to impose fragmentation impacts on the flight line corridor through the area (see **Table 12.67**). The Western Connection Road passes through the area near Ha Wan Tsuen, which is important in this respect as it is the entry point to the LMC Loop and HHW area for large numbers of waterbirds. The Direct Link joins the WCR near this point.

However, the existing road and adjacent village area already provides some level of disturbance, which reduces the marginal impact of the upgraded and new roads, while existing landscape characteristics in the form of trees and a hill act as a visual barrier that buffers significantly the impact of any road through the area. Of greater potential significance, however, is the more open and less disturbed area nearest LMC Loop, which may result in a greater ecological impact.

As the Eastern Connection Road involves the construction of a major road in a relatively undisturbed area of wetland habitat, and as the alignment passes near to a critical area of the corridor where birds leave LMC Meander to enter the HHW fish pond area, this connection has the potential to impose major ecological impacts as a result of fragmentation of the flight line corridor.

Table 12.67 Potential fragmentation impacts of connection roads on the flight line corridor in the absence of mitigation

Criteria	Western Connection Road and Direct Link to LMC Station	Eastern Connection Road
Habitat Quality	Flight lines through the area link fish ponds habitats of high quality and are important for wetland birds.	
Species	Large waterbirds, which are a critical component of the Deep Bay area wetland ecosystem.	
Size/Abundance	Substantial numbers of waterbirds utilise the flight line corridor, especially in the non-breeding season, many of these entering the Loop/HHW area near Ha Wan Tsuen.	Substantial numbers of waterbirds utilise the flight line corridor, especially in the non-breeding season, many of these entering the HHW area over fish ponds near Ngau Kok Shan.
Duration	Permanent.	
Reversibility	Mostly irreversible, though limited remedial measures to reduce disturbance possible in operational phase.	
Magnitude	Existing road and landscape in area means marginal impact limited, though magnitude potentially large, as the more open areas alongside LMC Meander appear to lie at an important location in respect of the flight line corridor as many birds enter the HHW/LMC Loop area at this point.	Construction of road in hitherto natural and relatively undisturbed area that constitutes a critical area of the flight line corridor potentially has impact of large magnitude. Potential impact on Meander greater than for Western Connection Road.

Criteria	Western Connection Road and Direct Link to LMC Station	Eastern Connection Road
Impact Severity	Impact of roads potentially High , especially in the more open area alongside LMC Meander. Operation phase may be slightly lower.	Potentially Very High , in view of magnitude of impact and importance of corridor to Deep Bay wetland ecosystem. Operation phase may be slightly lower.

12.6.5 Cumulative Impacts

12.6.5.1 Geographical Scope

In terms of geographical scope, the LMC Loop and adjacent areas are part of the Deep Bay area wetland ecosystem. This comprises intertidal areas of Deep Bay and fishpond and wetland areas in the immediate hinterland, with the boundary to the latter defined largely by the ecological barrier formed by the disappearance of fish ponds as the level of land rises toward Castle Peak Road and Fanling Highway and, in the area of the LMC Loop, the hills between LMC Tsuen and Ma Tso Lung Tsuen. The ecological linkages between these hills and lowland wetland areas appear to be limited to a small number of streams connecting to the LMC Meander.

12.6.5.2 Significance of Cumulative Impacts

Reed Marsh

Loss of reed marsh in the LMC Loop also needs to be related to the potential effects of other activities on the same habitat elsewhere in the Deep Bay area. The two largest areas of reed marsh habitat in the Deep Bay area lie at MPNR and Nam Sang Wai. It is considered that the long term future of reed marsh at MPNR is secure, subject to the management plan for the reserve.

In terms of Nam Sang Wai, this area is owned privately and is earmarked for development. The site is zoned as “OU (CDWEA)” on the relevant OZP, which allows limited low-density private development. Previous planning permission for development was revoked in 2010 due to non-compliance of the relevant planning approval conditions before the end of the expiry period. A revised scheme of development is under preparation by the developer; however, the implementation details and schedule remain uncertain as it is subject to approval from the TPB and falls under the EIAO.

Of particular significance in respect of reed marsh is Chinese Penduline Tit, which is largely reedbed-dependent in the winter and was recorded on surveys in reasonably high numbers of up to 27 birds. It would thus appear that this area of habitat in LMC Loop is of significance to this species locally, and the loss from LMC Loop of what is 8.7% of Deep Bay reed marsh habitat in the absence of mitigation would have a significant adverse impact on the local population of Chinese Penduline Tit in the Deep Bay area.

No other projects under implementation or planned appear to have significant implications in respect of reed marsh habitat in HK. In terms of areas outside HK, the reed marsh inside LMC Loop was shown in field work for this study to

support migratory species of conservation significance, providing opportunities for these birds to rest and refuel on migration. The existence of such sites is an important element of the migratory journey for many bird species, and the relative lack of reed marsh in the Pearl River Delta area (as a result of development) probably means that Deep Bay reed marsh habitat may be of significance to Pearl River Delta populations of certain migratory species.

Fish Ponds

In terms of the important fish pond wetland area at HHW, this is currently zoned as 'Unspecified' under the Ma Tso Lung and HHW DPA Plan No. DPA/NE-MTL/2. The planning intention is to 'conserve and enhance the ecological values and functions of the existing fish ponds or wetland in the interim pending a detailed feasibility study'.

A potential cumulative impact of development of LMC Loop arises from the potential disturbance impact on adjacent wetland habitats. Should these areas also be subject to adverse impacts from development in the HHW area, the combination of impacts might be synergistic. For example, a loss in wetland area or increase in disturbance at HHW, combined with the loss of flight-lines connecting this area to the rest of Deep Bay, may reduce the viability of HHW for supporting populations of waterbirds. Predicting the significance of such an impact is very difficult, as much depends on the location and nature of any development that may occur at HHW. It should be noted that in January 2012 a study commenced of the ecological value of HHW, which information would be used to inform the formulation of a draft OZP for the area.

A cycle track proposed under LUP CAFS is aligned along the boundary fence road, and could result in cumulative impacts on pond 12 (the only pond along this stretch of road impacted by disturbance during the construction phase of the Western Connection Road). Operational phase impacts are not predicted due to screening of the road from the pond. Cycling is generally regarded as a less intensive outdoor activity that poses limited disturbance impacts. Birds using this pond do so despite the passage of minibuses and other vehicles along two sides of the pond. Further, existing vegetation along the side of the pond will reduce any disturbance impact. In respect of ponds 36-38, these will be drained during construction of the Eastern Connection Road, and so cumulative disturbance impacts are not of relevance.

The wetland loss arising from cycle track development is likely to be highly limited, as the existing boundary fence road will be used as the basis; however, detailed design is not yet available. Furthermore, no wetland loss immediately alongside the relevant part of the boundary fence road is predicted.

Natural Watercourses

Lowland natural watercourses are one of the most threatened habitats in Hong Kong, as indirect impacts from agricultural and residential development in nearby areas can seriously impact water quality and riparian vegetation. That some of the natural streams in the Ecological Assessment Area retain good water quality and a high degree of naturalness is related both to topographical factors and location within the Closed Area. Adverse impacts on these streams would impose a

cumulative impact in the form of loss of biodiversity of an already threatened and declining habitat.

A particular example is the natural watercourse and associated riparian corridor at Ma Tso Lung, in the upper section of which there is a recent record of Three-banded Terrapin; this indicates the area may be of significance to a species for which Hong Kong supports the largest known wild population^[12-42]. That this remains the sole record, despite dedicated fieldwork during this Study, means that the exact status of the species in the area is unclear. Assessment of the potential cumulative impacts on natural watercourse are incorporated within the NENT NDA section in ‘Other Projects’ below.

Eurasian Otter

The Hong Kong population of the globally-threatened Eurasian Otter is likely to be of regional significance, and the LMC Loop area appears to be of particular importance for this species. Any loss of habitat or fragmentation of this area, as might, for example, occur from disturbance impacts to LMC Meander, could potentially result in serious adverse impacts on a disturbance-sensitive animal. This, in turn, could reduce the Hong Kong population of this species, which would, in turn, have impacts on the regional population. Other projects, however, do not appear to be of significance, though the eventual OZP for HHW may have implications for this species.

Other Projects

The NENT NDA PES potentially has implications for Long Valley, which is part of the Priority Area for Enhancement as defined in the New Nature Conservation Policy. Long Valley may potentially be directly impacted by development of the Kwu Tung North NDA, although the current proposal is for 37ha of the area to be turned into a Nature Park, which would protect and enhance a major portion of the wet agricultural habitats. As noted above, there is some linkage with the Deep Bay area, possibly via the flight line over the LMC Loop area, which means that development of the latter may contribute to cumulative impacts on Long Valley. However, given the differences in typical habitats (disturbed agricultural fields and channelized watercourse at Long Valley, intertidal, pond and marsh wetlands in the Deep Bay area), it is unlikely that the former is of significance to local populations of species that have been recorded at both sites. This includes Black-faced Spoonbill, which occurs in small numbers and only rarely in the Long Valley area. Other large waterbirds such as Great Egret and Grey Heron, which occur commonly in the Deep Bay area, are relatively scarce at Long Valley.

A further element of overlap concerns the stream network of Ma Tso Lung valley. The connection road from LMC Loop to Kwu Tung North NDA runs through the study areas for both projects, and thus there is the potential for cumulative impacts as a result. The EIA for NENT NDA PES currently proposes for relevant sections of the stream outside the area of potential impact for this Project, a riparian buffer zone of 15 to 30m width on both sides of the stream, Green Belt zoning for the middle and upstream sections of the stream and no development within the buffer zone in the downstream section as far as the point where it meets the ECR. Where diversion of the stream is required, the diverted section of stream will be reinstated using natural materials and the buffer zone will be planted with

appropriate riparian vegetation. In addition, the section of the road at grade will have a permanent barrier to prevent terrestrial fauna from straying onto the road.

Potential fragmentation impacts from the road and barrier in the NENT NDA Project Area will be minimised by the stream restoration measures, together with the retention of the riparian corridor where the road will cross the stream (on viaduct) and a fauna underpass to keep the maximum distance between crossing structures (including those proposed under this Project) to within the recommended distance of less than 325m in core conservation areas and habitat corridors^[12-83].

Thus, assuming sufficient mitigation is implemented for any impacts arising from construction and operation of the ECR, the cumulative impacts are predicted to be of low severity.

The study regarding construction of a secondary boundary fence and new sections of a primary boundary fence and boundary patrol road^[12-52] indicates that ecological impacts within the Ecological Assessment Area of the current Project are restricted to areas in a narrow corridor immediately adjacent to sections of the fence and road being amended. The new boundary fence will be located along the existing man-made track that runs along the Shenzhen River for the whole length of the Ecological Assessment Area. Impacts cumulative to those incurred during development of LMC Loop are not anticipated as the fence is of relatively low height and the habitats impacted in LMC Loop are of low ecological value.

LUP CAFS proposed a cycle track along the boundary fence road along the whole length of the HHW fish pond area. For the section from Shun Yee San Tsuen to Liu Pok, this is considered sufficiently far from LMC Loop and the ECR so as not to impose additional impacts. The section of cycle track proposed for the road between Horn Hill and Ha Wan Tsuen Road could have disturbance impacts on bird-flights along the corridor, though these are predicted to be minor given the location of the track away from the main fish pond area and the early morning timing of most flights, and are likely to be outweighed by the impacts of the road itself.

Agreement No. CE 46/2007 (DS) Review of Drainage Master Plans in Yuen Long and North Districts – Feasibility Study is ongoing. In the Draft Final Report village polder flood control works are recommended for Ha Wan Tsuen and LMC Tsuen. This would prevent village areas from flooding and pump water directly to LMC Meander at times of high water levels, following which it would drain into the Shenzhen River. Although flooding of the Meander may occur at times of heavy rainfall, the fauna that use it are adapted to high water levels in the short-term, and it is not considered that any significant cumulative impact would result in relation to the LMC Loop Project. Design of flood control works in this area is at an early stage, and it is not possible to predict the extent of cumulative impacts, if any, in relation to this Project. Should these become apparent at a later stage, they should be resolved by further study under these drainage projects.

Other concurrent projects listed in **Section 2.7** are considered to lie outside of the potential scope of cumulative impacts in respect of development of LMC Loop.

12.6.6 Impacts from Development of Area in Shenzhen

In the short and medium term, the adjacent area in Shenzhen (Area C in **Figure 1.1**) will mainly retain the present urban land uses and facilities, but will reserve space and facilities for integral development with the LMC Loop in the future. The current development proposal envisages Integrated Cross-Boundary Port Zone, R&D and Information Exchange Zone, Public Open Space Zone and Residential Zone that would be complementary to those in LMC Loop, with a total GFA of 1.5 million m². To facilitate future cross-boundary movements, a possible pedestrian linkage and associated boundary crossing facility is reserved in the northeastern part of LMC Loop. As noted in **Table 2.6**, as this is no more than a possibility, no assessment of its impact cannot be carried out; however, should this proposal crystallise, an assessment of the ecological impact of the walkway across the river should be carried out, especially with regard to the impact on waterbirds using the river for foraging or as a flight line route.

Since the adjacent area in Shenzhen is already a developed area of low ecological value lacking in natural vegetation, no significant functional linkage with present or future habitats in LMC Loop exist, and no ecological impacts are predicted on the HK side if its urban character is intensified. The additional acoustic disturbance of construction will be largely masked within an already high level background noise in this area.

There is the potential for greater disturbance impacts to Shenzhen River, which may affect the number of waterbirds using the river channel. However, the anticipated improvement of water quality to be undertaken by this Project via bioremediation and the Shenzhen Government is likely to see a net increase in waterbird numbers ultimately. The use of the river channel as a movement corridor by waterbirds may be impacted slightly, though as development in LMC Loop may create a dual disturbance impact from both sides of the river.

12.6.7 Impacts on Sites of Conservation Importance

Sites of Conservation Importance in the vicinity of LMC Loop are listed in **Section 12.3.3**. Section 3.2.2(iii) of the Study Brief requires that potential impacts on ecologically sensitive areas are identified and assessed. For the following sites listed in **Section 12.3.3**, the ecological value and potential impacts have been identified in relevant habitat or species sections above: reed marsh inside LMC Loop, Hoo Hok Wai, LMC Meander, Wetland Conservation and Wetland Buffer Areas, MTR LMC Spur Line Mitigation Area, riparian corridor at Ma Tso Lung, STEMDC and associated constructed wetland, Ho Sheung Heung Egrettry, Mai Po Inner Deep Bay Ramsar Site including Mai Po Nature Reserve.

With regard to Mai Po Village egrettry, the minimum 2km distance from development associated with LMC Loop, much of which passes over fish ponds, means that impacts are likely to be negligible. Issues of disturbance to flight lines and impacts on foraging areas are dealt with in relevant sections above. Furthermore, observations by the Study Team indicate that the majority of flight lines from this egrettry are to the north or northwest, and not toward LMC Loop.

12.7 Mitigation Measures

12.7.1 Summary of Ecological Impacts

The analysis in **Section 12.6** presented impacts separately according to the various elements: development of LMC Loop, provision of transport linkages in the form of the Western and Eastern Connection Roads and the Direct Link to LMC Station, Sai Kwo Construction Haul Road, the Flushing Water Service Reservoir and Bio-remediation of Shenzhen River. Impacts on species and on connectivities (via fragmentation) were, broadly speaking, presented across all elements of the Project. The aim of this section is to assess the total impacts of all elements of the Project (quantitatively where possible), which are presented in **Tables 12.67a and 12.67b**.

Table 12.67a Potential total direct and indirect ecological impacts of the Project on habitats and their severity in the absence of mitigation.

Habitat	Direct Impacts	Indirect Impacts
All habitats	<ul style="list-style-type: none"> Loss arising from illegal filling or fly-tipping due to easier access to the HHW area in particular. Combined impact Low to High, depending on extent. 	
Reed Marsh	<ul style="list-style-type: none"> Permanent loss of 10.96ha in LMC Loop (8.7% of reed marsh in Deep Bay Area) (High). Direct Link temporary loss of 0.032ha of clean-up reedbed (Low to Moderate). ECR construction phase loss of 1.1ha (part of EA in LMC Loop) Moderate. Combined impact High in view of permanent area lost (11.33ha) and importance of habitat. 	<ul style="list-style-type: none"> Disturbance to reed marsh adjacent to ECR in LMC Loop (Low to Moderate). Combined construction and operational phase disturbance and shade impacts on clean-up reedbeds for LMC Station of Low severity.
Marsh	<ul style="list-style-type: none"> Permanent loss of 0.50ha in LMC Loop (Low to Moderate). ECR: permanent loss of 1.18ha at Horn Hill (Low to Moderate). ECR: permanent loss of 0.58ha at Ma Tso Lung (Low to Moderate). WCR: permanent loss of 0.07ha (Low). Combined permanent loss of 2.33ha of Moderate severity. 	<ul style="list-style-type: none"> Combined construction and operational disturbance impacts Low at all sites. Combined Run-off and hydrological disruption Low at both sites.

Habitat	Direct Impacts	Indirect Impacts
Grassland and grassland / shrubland	<ul style="list-style-type: none"> Permanent loss of 70.21ha in LMC Loop (Low). ECR: Permanent loss of 0.62ha at Ma Tso Lung. (Low). Flushing Water Service Reservoir: Permanent loss of 0.32ha (Low). Combined permanent loss of 71.15ha (Low). 	<ul style="list-style-type: none"> Construction and operation phase disturbance from ECR (Low). Construction and operation phase disturbance from Flushing Water Service Res (Low). Combined disturbance impact severity Low during construction/operation.
Stream south of Lung Hau Road	<ul style="list-style-type: none"> No direct impact. 	<ul style="list-style-type: none"> Run-off from WCR during construction (Moderate) and operation (Low).
Ping Hang Stream	<ul style="list-style-type: none"> Permanent habitat loss of Low to Moderate severity. 	<ul style="list-style-type: none"> Potential run-off impacts during ECR construction phase Moderate, and in operational phase Low to Moderate. Hydrological disruption potentially Moderate.
Ma Tso Lung Stream	<ul style="list-style-type: none"> Habitat loss in lower section Moderate. 	<ul style="list-style-type: none"> ECR construction phase run-off Moderate in lower sections. ECR operational phase run-off Low to Moderate in lower sections. Hydrological disruption potentially Moderate depending on construction methods.

Habitat	Direct Impacts	Indirect Impacts
Pond	<ul style="list-style-type: none"> WCR: permanent habitat loss of 0.92ha (Low). WCR: construction phase habitat loss 3.51ha (Low to Moderate). ECR: permanent habitat loss 1.99ha (Moderate). ECR: construction habitat loss 3.32ha, duration 36 months (Moderate). Direct Link: permanent loss 2.28ha (Low to Moderate). <p>Total permanent direct or indirect loss of 9.70ha. Additional indirect loss of 3.51ha during construction of WCR and 3.32ha during construction of ECR. Combined severity potentially High.</p>	<ul style="list-style-type: none"> Permanent disturbance to ponds adjacent to northeast section of LMC Meander: effective wetland loss of 4.51ha (Moderate during both construction and operation). Disturbance to ponds along southeast section of LMC Meander Low to Moderate in construction (duration 12 months) and Low in operation phase. WCR construction disturbance (duration 30 months) Low to Moderate. Operational phase Low. ECR construction disturbance impacts (duration 36 months) High. Permanent ECR Operational disturbance impacts Moderate to High. Direct Link construction and operation disturbance Low. Combined disturbance impacts of whole project Moderate during Loop/WCR/Direct Link construction/operation, but High during ECR construction/operation/full operation of Project. Combined run-off, hydrological disruption and pollution impacts across all projects Low.

Habitat	Direct Impacts	Indirect Impacts
LMC Meander	<ul style="list-style-type: none"> Permanent loss of 60m of natural bank arising from underpass construction for ECR. Temporary loss of uppermost section of approx. 3,500m of existing natural bank along three sides of LMC Loop (Low to Moderate). Small-scale permanent loss of riparian vegetation due to ECR (Low) and WCR (max. 0.15ha) (Low). Small-scale (max 80-160m²) permanent loss of river bed and water column due to intermediate bridge support(s) required for WCR (Low). Construction phase (2-3 dry seasons) loss of 50% width of water channel for 100m length (approx. 3000m²) for ECR construction (Low). Combined severity of habitat loss High 	<ul style="list-style-type: none"> Run-off from LMC Loop during construction (Moderate to High) and operational phase (Moderate). Run-off from WCR during construction and operation Low. Disturbance impacts during LMC Loop construction and operational phases (Moderate). Disturbance impacts from WCR construction and operation to habitat of large waterbirds (Low). Disturbance impacts from WCR to habitat of Eurasian Otter during construction of bridges (duration 24 months) (Low to Moderate) and operation (Low). ECR construction phase (max. 36 months) disturbance Moderate to High. ECR operation phase disturbance Low. ECR construction and operation run-off Low. Hydrological disruption Low. Combined disturbance impacts during construction of LMC Loop, WCR and Direct Link Moderate, but Moderate to High during construction of ECR. In operation phase of entire Project Moderate. Combined run-off and hydrological disruption impacts Moderate to High during construction of LMC Loop and WCR, Low subsequently.
STEMDC Mitigation Wetland	<ul style="list-style-type: none"> No direct impact. 	<ul style="list-style-type: none"> Construction disturbance of Low. Operational disturbance Low.
LMC WMA	<ul style="list-style-type: none"> No direct impact (excluding clean-up reedbed; see Reed Marsh above). 	<ul style="list-style-type: none"> Combined construction and operational phase disturbance impacts of Low severity.
Seasonally Wet Grassland	<ul style="list-style-type: none"> ECR: permanent habitat loss 0.19ha (Low to Moderate). 	<ul style="list-style-type: none"> Construction and operational disturbance, run-off and hydrological disruption Low.

Habitat	Direct Impacts	Indirect Impacts
Woodland and shrubland	<ul style="list-style-type: none"> Permanent loss of 0.40ha woodland due to WCR (Low to Moderate). Permanent loss of 0.70ha woodland (Low to Moderate) and 0.16ha shrubland due to ECR (Low). Combined permanent loss of 1.26ha Low to Moderate. 	<ul style="list-style-type: none"> Indirect impact Low to Moderate for WCR and ECR. Combined impact Low to Moderate.
Intertidal areas of Deep Bay	<ul style="list-style-type: none"> No direct impact 	<ul style="list-style-type: none"> Combined effect of Sedimentation (Low to Moderate) and pollutant run-off (Low to High, depending on nature of event).
Orchard and Plantation	<ul style="list-style-type: none"> Habitat loss in LMC Loop Low for Plantation (1.70ha) and Low for Orchard (0.96ha). No other loss of these habitats. Combined permanent loss for each habitat Low. 	<ul style="list-style-type: none"> No disturbance impacts to these habitats.

Table 12.67b Potential total direct and indirect ecological impacts of the Project on species and their severity in the absence of mitigation.

Sensitive Receiver	Severity of Impact
Large waterbirds	<ul style="list-style-type: none"> Direct or indirect loss of pond due to LMC Loop development, ECR, WCR and Direct Link Moderate to High. Small numbers may suffer collision mortality with buildings: Low. Fragmentation impact of buildings in LMC Loop: Very High. Fragmentation impact of ECR: Very High Fragmentation impact of WCR and Direct Link to LMC Station: High. Minor cumulative impact on Long Valley arising from fragmentation impacts on flight line corridor: Low. Impacts of increased lighting and glare: Low. Combined impact Very High.
Other Birds	<ul style="list-style-type: none"> Direct loss of wetland habitats Moderate. Direct loss of non-wetland habitats Low. Mortality impacts arising from collision Moderate, mainly affecting small to medium-sized birds. Increase in lighting and glare on waterbirds and Eurasian Eagle Owl Low, due to existing levels of night-time light in the area. Combined impact Moderate.

Sensitive Receiver	Severity of Impact
Eurasian Otter	<ul style="list-style-type: none"> Loss of reed marsh and marsh in LMC Loop. Loss of natural bank and riparian vegetation along topmost part LMC Meander channel for approximately 3,500m in length. Loss of watercourse channel during construction phase of ECR and permanently for WCR. Loss of wetland habitat associated with ECR and WCR. Disturbance impacts on use of LMC Meander and nearby wetland habitats at HHW arising in both construction and operation phases. Disturbance impacts from dogs associated with construction site. Secondary impacts on prey species via deterioration in water quality arising from construction or operational phase run-off to LMC Meander. Fragmentation and road kill impacts as a result of road or bridge construction. Temporary loss of topmost section of bank of 3,500m length of Meander during stabilisation works. Overall, construction phase impacts of High severity, while operation phase impacts of Moderate to High severity.
Other Mammals	<ul style="list-style-type: none"> Construction phase: Moderate due to potential for disturbance and greater magnitude of fragmentation impacts. Operational phase: Low to Moderate in view of potential fragmentation issues associated with Eastern Connection Road through HHW area.
Herpetofauna	<ul style="list-style-type: none"> Construction phase Two-striped Grass Frog: Moderate due to habitat loss and fragmentation. Burmese Python, Chinese Bull Frog and Chinese Soft-shelled Turtle: Low to Moderate. Operation phase All species: Low to Moderate.
Three-banded Box Terrapin	<ul style="list-style-type: none"> Given rarity, impacts from all sources combined potentially of Moderate severity.
Odonata	<ul style="list-style-type: none"> Impacts largely Low. Common Evening Hawker: Low to Moderate.
Butterflies	<ul style="list-style-type: none"> Impacts of Low severity because small numbers of common species are affected.
Rose Bitterling	<ul style="list-style-type: none"> Construction phase: Moderate. Operational phase: Low.
Paradise Fish	<ul style="list-style-type: none"> Construction phase: Moderate. Operational phase: Low to Moderate.
Small Snakehead and <i>Somanniathelphusa zanklon</i> .	<ul style="list-style-type: none"> Construction phase: Moderate. Operational phase: Low to Moderate.

12.7.2 Mitigation for Impacts arising from LMC Loop Development

As recommended in the TM-EIAO, proposed mitigation should give priority to avoidance and then minimisation of impacts. In terms of the RODP, the following design elements were incorporated to avoid or minimise impact.

1. Minimum 23m setback from edge of LMC Loop to minimise disturbance impacts on adjacent wetland habitats (Open Space Zoning along southwest and northeast sections of LMC Meander);
2. Provision of Ecological Area and associated 50m-wide buffer zone along southeastern portion to minimise impacts on flight lines, including a broader area near Ha Wan Tsuen, a critical area of entry for this corridor;
3. Incorporation of a stepped building height profile whereby above-ground building height increases from 14mPD in the area closest to the EA to 46mPD in the central part (**Figure 2.1b**), to minimise impacts on the flight line corridor.

Where these design elements are insufficient to reduce adverse residual impacts to sufficiently low levels, measures are proposed to minimise the impact or if necessary to compensate for the impact. In the rest of this section, details are given of the proposed mitigation measures, with an explanation of the impacts that will be avoided, minimised or compensated by the adoption of each of these measures.

Section 3.4.13.3 of the Study Brief states that the Applicant shall examine the ecology of the Assessment Area ‘...with an aim to protect, maintain or rehabilitate the natural environment’. The possibility of doing such in-situ environmental improvement in respect of habitats of conservation significance in LMC Loop was given serious consideration. However, in this case such avoidance or minimisation of reed marsh and freshwater marsh loss is not considered the optimal solution to mitigating impacts for a number of reasons. Firstly there are issues of soil contamination that may be affecting water quality and thus ecological value of the reed marsh. It is desirable for these to be resolved prior to establishing any mitigation habitat. Secondly, even if rehabilitation was carried out, the location of the existing reed marsh somewhat toward the centre of LMC Loop means that avoidance of this area, with development in surrounding parts of the Loop, would result in higher levels of disturbance and fragmentation, and a reduction in the strength of linkages with other wetland habitats in the surrounding area. These factors would combine to reduce ecological value below what it might otherwise be. Thirdly, a reed marsh of higher per unit ecological value is possible via establishment of a managed, unfragmented wetland at a location where functional linkages with adjacent wetland habitats can be maximised.

With regard to the infrastructural alignments, in theory there is the possibility of rehabilitating pond habitat that is temporarily drained during construction. However, although the ponds have to be restored, the conditions to which they are returned require to be similar to those extant at the time of draining, and thus there is limited scope for rehabilitation, at least without the agreement of the landowner.

Rehabilitation of the natural environment will occur in respect of the section of Shenzhen River adjacent to the Loop, however, in which bio-remediation works are to be carried out as mitigation for air quality impacts (see **Section 12.6.2.7**). This is likely to result in improvements to the ecological value in the long term provided that pollution sources can be controlled, as the improvement of water quality will promote recolonisation by aquatic fauna and their predator species, in particular waterbirds.

12.7.2.1 Provision of Compensatory Reed Marsh

Development of LMC Loop requires total loss of all existing habitat, of which the most significant is 10.96ha of reed marsh. **Figure 12.1** illustrates areas of reed marsh habitat in LMC Loop that are considered sufficiently large in area and uncompromised by terrestrial plant species to contribute to the overall ecological value of reed marsh habitat in LMC Loop. Small areas or areas significantly compromised by terrestrial plant species have been included as grassland or grassland/shrubland, as appropriate. The figure of 10.96ha of reed marsh habitat is based on **Figure 12.1**, and this is the area for which it is considered mitigation is required.

Based on unsuitability of rehabilitating the existing reed marsh (see above), it is proposed that habitat compensation in the form of a reprovisioned reed marsh sited in a more desirable location in LMC Loop is most appropriate. The provision of a purpose-built area of compensatory reed marsh habitat in an Ecological Area (EA) facilitates more effective ecological enhancement through targeted design and avoidance of the fragmentation and disturbance impacts that might result if it was partially surrounded by development. Such an approach allows not only compensation of the existing reed marsh but also facilitates enhancement of the value of this habitat by combining the total area within LMC Loop (which is currently somewhat fragmented) and integrating this into a single, unfragmented, managed wetland. Further, this enhancement can be achieved in a more cost-effective manner that is less disruptive in terms of management activities to other stakeholders in the LMC Loop, as well as allowing more efficient utilisation for development of the available land area remaining in LMC Loop. Finally, by locating the Ecological Area along the southeastern edge of LMC Loop, it can also perform a crucial additional mitigation function in that it provides an area of undisturbed natural habitat suitable for protection of the flight line corridor (see **Section 12.7.6.1**).

Although currently habitats in LMC Loop are undisturbed as there is no public access, the ecological value of the reedbed is somewhat compromised by its uniform age, some degree of fragmentation and lack of both structural diversity and open water. Redressing these issues in a compensatory reedbed through design and management would increase microhabitat diversity and enhance ecological value in comparison with the current reedbed. Consequently, it is anticipated that appropriate management will enable significant ecological enhancement and form a significant environmental benefit of the Project.

The impact of such management can be seen at Mai Po NR, where the reedbed supports, in addition to the normal suite of reed-associated passerine species present in LMC Loop, significant numbers of larger, more specialist species such

as Yellow Bittern, Purple Heron and Great Bittern (up to 35 of the latter species were recorded in the Mai Po NR reedbed in winter 2009-10 by members of the study team).

The EA also aims to provide suitable habitat for Eurasian Otter, which was recorded in the reed marsh in LMC Loop during survey work, and is known to utilise reed marsh for foraging and breeding elsewhere (Kruuk 1995, 2006). Adequate provision for otters to access the reed marsh in the EA from LMC Meander should be provided.

The reed marsh will be established before total clearance of the reedbed in LMC Loop takes place, in order that adverse ecological impacts, albeit temporary, of moderate to high significance do not occur. In order to maintain the integrity of the reed marsh, to minimise disturbance and, in particular, intrusion by dogs, it is essential that suitable fencing is provided around the reserved original reed marsh area while reed establishment is occurring in the EA. The exception is the section facing the EA, which, in order to maintain connectivity with adjacent wetland habitats, will have a 30-cm gap at the bottom to allow passage of animals.

This approach is also required from the point of view of flight line preservation (see **Section 12.7.6.1**). Clearance of a limited area (2.50ha) of the existing reed marsh will be required in order to carry out site formation work for the proposed Ecological Area, which will result in a temporary habitat loss impact. However, this temporary loss is not considered of more than low significance. Calculation of the total area required for mitigation is considered in tandem with that for freshwater marsh in **Section 12.7.10**.

An important factor contributing to the ecological value of the current reedbed is the fact that it is undisturbed. This needs to be reproduced in any compensatory habitat, which means that public access to the reed marsh has to be restricted, while a suitable buffer zone is required to mitigate the visual and noise disturbance impacts of the operational development.

Determination of the size of that buffer zone requires consideration of the type of habitat, the critical species of birds or other fauna involved and the nature of adjacent disturbance activities. In general, larger avian species tend to flush (fly away from a disturbance event) at greater average distances than smaller species, and the buffer zone for any given habitat should cater for the species most sensitive to disturbance. The EIA for the Lok Ma Chau Spur Line and Station utilised avoidance distances of 100m for Grey Heron and Great Egret, species comparable in size to the only large reedbed-associated species recorded in the reed marsh in LMC Loop, Purple Heron. However, the former two occur in open habitats, while Purple Heron occurs in closed habitats such as reedbeds or vegetated wetland areas, in which, generally speaking, birds are disturbed less easily; thus, a lower avoidance distance is applicable. In view of this, and as no data relating to the disturbance distance of Purple Heron appear to be available in the literature, the buffer distance requirement is recommended to be 50m from tall buildings. This is considered to be adequate for all fauna that utilise reed marsh habitats in LMC Loop, including such species as Chinese Pond Heron, as Purple Heron is the most disturbance-sensitive.

In terms of Eurasian Otter, the most appropriate buffer zone is dependent on the nature of use of any given area and the habitat present. Otters are adaptable and

can live in reasonable proximity to development as long as foraging habitat remains and there is no frequent intrusion into areas of activity by humans or dogs. Breeding sites are the most sensitive to disturbance. Thus, NIEA (undated) recommends that an otter holt (used for resting) requires a 30m protection zone, whereas a natal den requires a 150m protection zone. However, these protection zones relate to construction activities, and it is presumed that in the operation phase, neither of these requires to be so large. The same work recommends a minimum 10m buffer on both sides of any watercourse used by otters. Consequently, in view of the undisturbed nature of the proposed EA, the closed nature of reed marsh vegetation, the proposed provision of reed-free channels within the reedbed and of suitable holt or natal den sites within the EA, it is considered that a 50m buffer zone that allows only passive recreational activities (see below) and is extensively planted with vegetation, especially along the edge facing the EA, should be sufficient to minimise potentially disturbing activities to acceptable levels in the operation phase.

In order to limit levels of disturbance to the reed marsh, the buffer zone should constitute an area of passive recreational activity and highly limited development. In respect of the latter, a plot ratio of 0.1 is considered the maximum possible, together with a height restriction on buildings of no more than 14mPD (except the maximum height of on-site STW is 15mPD) (approx. 8 to 9m above ground level) and a requirement that all buildings are placed in the internal 25m of the buffer zone, closest to the main area of development. Appropriate planting of taller and denser trees will be carried out around individual buildings in this zone in order to further shroud them from both the EA and the air. The use of green roofs, where feasible, should also be considered.

However, despite these conditions, there are opportunities for passive recreational activities in the buffer zone as long as the visual impact is suitably minimised. Passive recreation here refers to less-intensive, non-consumptive and non-disturbing outdoor activities compatible with preserving natural resource functions, such as walking, running and cycling. The interface of the buffer and reedbed, as well as the buffer itself, should largely comprise trees and shrubs that would act as a visual barrier partially shrouding human activity in this zone.

The buffer zone provides an excellent opportunity to increase the wildlife value of LMC Loop post-development, via the provision of native tree species and/or established exotics with existing wildlife value. Albeit not required in terms of statutorily mitigating ecological impact, such provision would also go some way to reproviding shrubland and plantation habitats currently present in LMC Loop.

Most of the fauna using reed marsh habitats, are small in size (and so less disturbance-sensitive), while the closed nature of the habitat reduces significantly the impact of disturbance. Given the conditions of the 50m wide buffer zone and the reduced building height in areas adjacent to it, no significant disturbance impacts from the developed area of LMC Loop on the reed marsh is predicted. The proposed passive recreation activities are considered to be feasible in the buffer zone, assuming some visual screening by trees and shrubs.

Detailed design of the EA and the buffer zone (including the planting proposal) should be submitted and agreed with the relevant authorities prior to commencement of works.

12.7.2.2 Provision of Marsh Habitat

The loss of 0.5ha of Marsh in LMC Loop is considered to be an adverse impact of Low to Moderate severity for which it is necessary to provide mitigation. The provision of a compensatory reedbed in the EA with microhabitat diversity in the form of open water areas would provide suitable habitat for species that regularly occurred in this marsh habitat, viz. Common Moorhen, White-breasted Waterhen and White-throated Kingfisher. In addition, it is proposed that the EA include an area of marsh-type habitat that includes emergent vegetation such as lilies. Such an area would prove attractive to the same species, and provide a visual amenity and point of wildlife interest for users of LMC Loop. In this way, the loss of this marsh habitat would be compensated. There may be a temporary impact during the establishment phase of the reed marsh in the EA, but this is predicted to be minor, as the temporary habitat created is likely to prove attractive to a similar range of species as occur currently in marsh in LMC Loop.

12.7.2.3 Mitigation of LMC Meander habitat loss

Development of LMC Loop requires strengthening of approximately 3,500m of the bank along three sides of LMC Meander. The main impact is the temporary loss of the dense natural vegetation at the top of the slope, which may be used by Eurasian Otter, as well as very small numbers of waterbirds. Rock fill is required to build up the level of LMC Loop and provide stability; the surface, however, will be landscaped to allow re-colonisation of natural vegetation, although the detail of this requires formulation at detailed design stage.

Consideration of other design and ecological aspects, including possible installation of otter holts and the provision of potential feeding area and spraint locations for otters in the stabilised bank, should also be carried out at detailed design stage.

Detailed design (including planting proposals) should be submitted and agreed with the relevant authorities prior to commencement of works.

12.7.2.4 Mitigating Disturbance Impacts on Fish Ponds

The development of LMC Loop will have disturbance impacts on surrounding habitats, primarily fish pond and associated wetlands, and LMC Meander, in both construction and operational phases. The existing separation of fish ponds from LMC Loop by LMC Meander will reduce the magnitude of impacts on pond habitat considerably, however. The existing separation distance along this section of the Meander between the edge of LMC Loop (where vegetation meets water) to the fish ponds opposite lies in the range 60-90m.

In the operation phase these will be further minimised by setting back development a minimum of 23m from the edge of the Meander along the northeastern and southwestern sections. Thus, buildings will lie at minimum 80m from fish ponds, which will serve toward reducing impacts.

In order to minimise impacts during the construction phase, clear definition of the construction area for the duration of construction activity should be provided to minimise and confine disturbance. However, given that slope stabilisation work is

required for the bank of the EA facing LMC Meander, the works required will mean that the erection of a fence is not feasible in this area. Furthermore, it is desirable to have no barrier between the EA and the Meander in order to maintain maximum connectivity (including the area of the EA closest to a cluster of otter records near the alignment of the Eastern Connection Road – see **Figure 12-3**); for these reasons, it is considered preferable not to place any hoarding around the edge of the EA facing LMC Meander. Instead, a fence along the inner edge, adjacent to the existing reed marsh will incorporate a 30cm gap at the bottom to allow passage of otters and other mammals. Once the existing reed marsh is removed, however, this gap will require closing to prevent dogs accessing the EA. **Figure 12-13** illustrates the location of this fence.

Not having a fence, however, means that disturbance impacts of adjacent habitats are potentially greater. However, site formation work generally involves less intensive activity and fewer machines than other construction work, which, together with the 40-60m separation from adjacent fish pond areas provided by the Meander, a restriction of working hours to the period 9-5pm, the phasing of work such that it is not the whole length of the EA that is impacted simultaneously and the use of moveable noise/visual barriers, will reduce disturbance impacts considerably; in addition, adjacent fish ponds along the boundary fence road are already subject to some disturbance (heightened by the linear nature of their alignment). In order to minimise further potential impacts, all major works to raise the level of the site platform to about +6mPD along the edge of LMC Meander and all major works in the EA will be conducted in the wet season. The level raising / slope stabilization works will not involve contact with the water, and can be carried out in the wet season. As a result, no impacts above and beyond those already described for construction work in LMC Loop are predicted, and the marginal impact on these ponds of activities in LMC Loop are predicted to be of low severity.

The fencing used for the site boundary and as a visual barrier during the construction phase will be 3m high and of a dull or olive green colour, in order to minimise visual impact. The aim of this fencing is to shroud the most visible human activity (movement of persons and vehicles) from adjacent wetland areas. In the operational phase, the set-back will largely comprise natural landscaping, to blend in with the immediately adjacent heavily-vegetated banks of the Meander and surrounding natural habitats. This landscaping will be dominated by species attractive to fauna to maximise the ecological value of the site. Noisy and/or mechanised construction activities will be restricted to the period between 9am and 5pm.

The combined width of the proposed Ecological Area, its associated buffer zone and LMC Meander is sufficient to reduce to negligible levels marginal disturbance impacts to the fish ponds along the southeastern section of the Meander. Further, the small area of ponds outside the MTR LMC Spur Line disturbance shadow opposite the southwest corner of LMC Loop is considered to be already disturbed, and no additional disturbance impact from development in the Loop is predicted. As a result, the only disturbance impacts of significance in the fish pond area arising from development of LMC Loop occur to the northeast in respect of the most disturbance-sensitive species, large waterbirds.

Assuming appropriate mitigation areas are provided to compensate for disturbance impact, it is not considered necessary to minimise disturbance impact further by, for example, restricting construction to the wet season. A detailed analysis of the compensation requirements for disturbance impacts of buildings in LMC Loop and the two road connections is provided separately in **Section 12.7.10**. Disturbance impacts on pond habitat arising from the Direct Link to LMC Station are detailed in **Section 12.7.5.1**.

12.7.2.5 Mitigating Impacts of Construction Run-off

Impacts during the construction phase from development of LMC Loop could impact water bodies, that of most concern being LMC Meander. Construction run-off is potentially destructive to aquatic communities, and of particular concern is Eurasian Otter, which could be adversely affected should there be negative impacts on its prey. A particular concern is related to existence of contaminated soils on site. However, these will be rendered inert and solid prior to site formation work occurring in the relevant areas, which will avoid the potential for impact.

Construction work for this Project could generate surface run-off containing lubricants, chemicals and pollutants. In order to prevent these contaminants entering surrounding water bodies, a standard drainage system along with silt traps, oil traps and gullies will be installed at required sites, and collection to proper receivers will occur. This drainage system will be maintained routinely to prevent blockage. Sewage from construction areas will be properly collected to treatment facilities.

The following measures are adopted by most local projects to mitigate the impacts of construction run-off, and will be employed as mitigation for this Project.

- Temporary sewerage and drainage will be designed and installed to collect wastewater and prevent it from entering nearby water bodies (sewage will not be discharged to Shenzhen River or LMC Meander);
- Proper locations well away from nearby water bodies will be used for temporary storage of materials (i.e. equipment, filling materials, chemicals and fuel) and temporary stockpile of construction debris and spoil, and these will be identified before commencement of works;
- To prevent muddy water entering nearby water bodies, work sites close to nearby water bodies will be isolated, using such items as sandbags or silt curtains with lead edge at bottom and properly supported props. Other protective measures will also be taken to ensure that no pollution or siltation occurs to the water gathering grounds of the work site;
- If temporary access along a riverbed is unavoidable, this will be kept to the minimum in width and length. Temporary river crossings will be supported on stilts above the river bed;
- Stockpiling of construction materials, if necessary, will be properly covered and located away from nearby water bodies;

- Construction debris and spoil will be covered and/or properly disposed of as soon as possible to avoid being washed into nearby water bodies;
- Construction effluent, site run-off and sewage will be properly collected and/or treated. Wastewater from any construction site will be minimised via the following in descending order: reuse, recycling and treatment;
- Proper locations for discharge outlets of wastewater treatment facilities well away from sensitive receivers will be identified (i.e. treated wastewater will not be discharged into LMC Meander, natural streams, marsh, reedbed, active or abandoned fish ponds);
- Adequate lateral support will be erected where necessary in order to prevent soil/mud from slipping into the Ecological Area or LMC Meander;
- Site boundary will be clearly marked and any works beyond the boundary strictly prohibited;
- Regular water monitoring and site audit will be carried out at adequate points along LMC Meander, Shenzhen River and at the outfalls of the natural streams around LMC Loop. If the monitoring and audit results show that pollution occurs, adequate measures including temporary cessation of works will be considered.

With regard to the specific issue of preventing run-off impacts arising as a result of soil decontamination works required prior to wider construction occurring, the following mitigation measures listed in **Section 7.6.1** should be implemented.

- Excavation profiles must be properly designed and executed with attention to the relevant requirements for environment, health and safety;
- Where the soil to be excavated is situated beneath the groundwater table, it may be necessary to lower the groundwater table by installing well points or similar means;
- Excavation should be carried out during dry season as far as possible to minimise contaminated runoff from contaminated soils;
- Stockpiling site(s) should be lined with impermeable sheeting and bunded. Stockpiles should be properly covered by impermeable sheeting to reduce dust emission during dry season or contaminated run-off during rainy season. Watering should be avoided on stockpiles of contaminated soil to minimise contaminated runoff;
- Supply of suitable clean backfill material after excavation, if require;
- Vehicles containing any excavated materials should be suitably covered to limit potential dust emissions or contaminated run-off, and truck bodies and tailgates should be sealed to prevent any discharge during transport or during wet season;
- Speed control for the trucks carrying contaminated materials should be enforced; and

- Vehicle wheel washing facilities at the site's exit points should be established and used.

At present, the bank of LMC Meander is a well-vegetated area with a gentle slope on one side, and appears to be of significance to wildlife, including Eurasian Otter. In addition to general measures for mitigating and monitoring potential impacts on the water quality of natural water bodies, a buffer zone will be established within LMC Loop, separating it from LMC Meander. This buffer zone will correspond to the proposed minimum 23m setback from the developed area, and will act as a natural filtration system to physically and biologically trap and degrade certain pollutants accidentally spilled into LMC Meander. In addition, this zone will function as a buffer to minimise disturbance impacts on the Meander. In order to clearly mark the buffer zone, a fencing or hoarding system should be set up to define the site boundary and any unnecessary works of significant disturbance inside the buffer should be prohibited. The colour of the fencing to be used will be a dull or olive green, to minimise visual disturbance to surrounding natural areas.

Operational phase run-off to LMC Meander will be minimised by the use of a modern road drainage system. Should there be any discharge to LMC Meander or other natural watercourses, appropriate use of oil interceptors and silt traps should be made so as to minimise potential impacts on water quality.

12.7.2.6 Mitigation for Large, Accidental Spillage Events

Accidental spillage events, whether in construction or operational phases, could potentially have a large impact on nearby habitats in view of their susceptibility to such pollution. Therefore, an emergency contingency plan should be established and implemented by the Project Proponent or its delegate prior to the construction, and will be in place at all times during the construction and operational phases. The plan will include, but not be limited to, the following:

- Potential emergency situations;
- Chemicals or hazardous materials used on-site (and their location);
- Emergency response team;
- Emergency response procedures;
- List of emergency telephone hotlines;
- Locations and types of emergency response equipment;
- Training plan and testing for effectiveness.

Detailed plans will be prepared and implemented by the Project Proponent or its delegate at later stages during both construction and operational phases.

Surface runoff during the operational phase from the developed area within LMC Loop could also affect nearby habitats. However, a modern drainage system along with silt traps, oil traps and gullies will be installed at required sites, and collection to proper receivers will occur. This drainage system will also be maintained routinely to prevent blockage. Under such a system, surface runoff is unlikely to affect nearby habitats significantly.

12.7.3 Mitigation for Impacts Arising from the Western Connection Road

In terms of design elements incorporated to minimise ecological impact, the alignment chosen utilises existing Lok Ma Chau Road and Ha Wan Tsuen Road in order to minimise habitat loss impacts and marginal disturbance impacts (details in **Section 2.4.1.6**). The former are minimised by virtue of the ponds in this area generally being of somewhat lower ecological value than elsewhere in the area, due to their largely being small, unmanaged, disturbed and possessing an unfavourable profile. Further, habitats along LMC Road are highly anthropogenic (see **Appendix 12-12**, plate 21), and direct and indirect impacts are thus low. In terms of disturbance impacts of Ha Wan Tsuen Road, it is already used by minibuses and taxis, and the impact of passing traffic is less than that of human activity. Options to cross LMC Meander to the east of ponds 11 and 12 were discounted due to the potential considerable impact on the flight line corridor, and the eventual crossing point minimises ecological impacts overall.

Construction of the Western Connection Road comprises two phases: the first upgrades the existing road to a standard suitable for construction traffic, while the second upgrades the road to its final desired condition. Along Ha Wan Tsuen Road the first phase comprises little more than road maintenance work, and ecological impacts are predicted to be negligible. However, it is necessary at this time to construct a temporary bridge across LMC Meander to facilitate access to the Loop. The section along LMC Road is not predicted to impose significant disturbance impacts due to the low ecological value of adjacent habitats, and mitigation is not required for this; however, there will be some very minor habitat loss.

12.7.3.1 Mitigation for Impacts on LMC Meander

Construction of a means to cross LMC Meander will result in minor loss of trees, shrubs and the natural bank of the Meander totalling 0.15ha. The small scale of these impacts, however, is predicted to be of low significance, and mitigation is considered unnecessary. In terms of the temporary bridge provided for construction access prior to completion of the permanent bridge, very minor habitat loss will occur. This temporary impact will resolve itself once the bridge is removed.

Due to the location within the Deep Bay area and the sensitivity to construction activity of surrounding habitats, Eurasian Otter and flight lines through the area, work will be restricted to the hours between 9.00am and 5.00pm, thus avoiding the time of day when flight lines and otters are most active in HK. Night-time lighting of the crossing during construction will be avoided or reduced to the minimum possible, and direct lighting of the Meander itself will be avoided.

12.7.3.2 Mitigation for Impacts on Ponds along Ha Wan Tsuen Road

The second phase upgrading of Ha Wan Tsuen Road will cause minor loss (0.92 ha) of pond, for which enhancement of the ecological value of existing fish ponds elsewhere is appropriate mitigation, given that reprovision of pond habitat is not a

feasible option due to the lack of non-wetland areas nearby suitable for conversion to pond habitat. Calculation of this requirement is included in **Section 12.7.10**.

To minimise impacts, works requiring the operation of mechanical plant along this section will only be carried out in the wet season months of April to October between 9.00am and 5.00pm.

The use of noise/visual barriers is proposed for sections of this road adjacent to fish ponds, in order to minimise impacts on waterbirds, which are regularly present in ponds 11 and 12 in particular. Given the existing disturbance to ponds along Ha Wan Tsuen Road arising from the MTR LMC Spur Line and vehicular traffic, it is considered that placement of noise/visual barriers along the road is sufficient to reduce residual impacts to negligible levels in most sections, the exception being ponds 11 and 12. Although some of these two ponds lie in the disturbance shadow of the Spur Line, a portion does not, and disturbance impacts are thus imposed. As pond 11 requires draining to facilitate construction, however, disturbance impacts are only relevant in respect of pond 12. Disturbance impacts of developments outside LMC Loop on wetlands are to be mitigated by compensatory habitat management elsewhere, and this is discussed in **Section 12.7.8**.

12.7.3.3 Mitigation for Impacts on Secondary Woodland and Shrubland along Lok Ma Chau Road

The Western Connection Road will result in the loss of 0.40ha of secondary woodland. However, while replanting of an area of trees sufficient to compensate this loss is feasible, establishment at an equivalent level of maturity prior to construction or early operation of the development is not. However, this temporary residual impact is not considered to be of significance as the woodland impacted is small in area and highly fragmented from the nearest areas of similar habitat.

Compensatory planting does not, however, appear feasible in the vicinity of the existing woodland, due to surrounding land uses. Consequently, it is proposed that the woodland compensation requirements for both the Eastern and Western Connection Roads (the latter constituting 0.70ha) be provided in one block of woodland in the hills near Ngau Kok Shan (Horn Hill), and thus close to the impacted area for Eastern Connection Road (**Figure 12-12**). The creation of an enlarged single area would, ultimately, enhance ecological value of the woodland. Species proposed for planting are listed in **Table 12.67c**.

12.7.3.4 Mitigation for Impacts of Run-off

Construction of the Western Connection Road and construction access road will also generate run-off, potentially impacting LMC Meander and the stream south of Lung Hau Road, the latter of which supports a population of Rose Bitterling. In general, the relevant measures mentioned in **Sections 12.7.2.5** and **12.7.2.6** are adequate to mitigate this impact. In particular, appropriate use of oil interceptors and silt traps should be made. However, to detect possible impacts on the stream to the south of Lung Hau Road, water quality monitoring and site inspection in

this stream should be carried out, in order to monitor the effectiveness of these measures.

A modern, effective drainage system will be installed to collect surface runoff from the finished road, which will prevent impact on nearby habitats, except at times of short-term temporary overload arising from rain storm events. Should there be any discharge to LMC Meander or other natural watercourses, appropriate use of oil interceptors and silt traps should be made so as to minimise potential impacts on water quality.

12.7.4 Mitigation for Impacts arising from the Eastern Connection Road

In terms of alignment and design, considerable thought went into selecting the most appropriate from an ecological point of view, given existing practicalities. A detailed option review process (see **Section 2.4.1.6** for details) considered nine alternative alignments. The optimum alignment from an ecological perspective was Option E6, which comprised a tunnel from the KTN NDA road network directly to LMC Loop. However, this option may impose planning and engineering constraints since it will take a greater length to rise to the Loop site formation level. In addition, this option does not allow connection to the villages at Ma Tso Lung, thereby not providing improvement to the accessibility of these villages. Thus, this was deemed impractical.

In terms of the critical areas of ecological interest at HHW, two basic alignments were considered. Both utilised the current boundary fence road, the first passing through Marsh 1 while the second passed through ponds 36-38 (see **Figure 12-2**) to access LMC Loop. In order to minimise direct and indirect impacts on the wetlands at HHW, the alignment through ponds 36-38 was selected. Further, a depressed road design was chosen in order to ensure that the severity of operational phase disturbance impacts was reduced to low, with both wildlife underpasses and overpasses to maintain connectivity for animals.

In terms of traversing LMC Meander, an underpass was chosen so as to avoid construction and operation phase impacts on the flight line corridor that would otherwise result from use of a bridge. In order to avoid these impacts, the road emerges in LMC Loop outside the EA.

Construction access will be along the Western Connection Road and then through LMC Loop; these roads will be at the operational stage, and marginal impacts of disturbance in these areas are negligible given that mitigation will already be in place.

Adverse ecological impacts from the Eastern Connection Road in the absence of mitigation comprise loss of and disturbance to pond, marsh, secondary woodland, natural watercourse, seasonally wet grassland and grassland. Impacts on the latter two habitats, however, are assessed to be of low significance. In addition, however, as the underpass section through the EA will be constructed after establishment of the reed marsh, there will be temporary habitat loss and disturbance impacts.

Detailed design of the Eastern Connection Road should be submitted and agreed with the relevant authorities prior to commencement of works.

12.7.4.1 Mitigation for Loss of and Disturbance to Pond, Marsh, Reed Marsh and Seasonally Wet Grassland

A number of alignments of the Eastern Connection Road through the fish pond area are possible. That chosen avoids and minimises impacts on wetland habitats by broadly following the alignment of the existing boundary fence road and by passing through the fish pond area at a point where the area of ponds impacted is smallest, which is immediately to the west of Horn Hill (Ngau Kok Shan). Passing through a narrower section of the fish pond area further west, while it could potentially cause slightly less direct habitat loss, would result in greater disturbance impacts on both adjacent fish ponds and the flight line corridor in the construction phase.

In the Horn Hill (Ngau Kok Shan) area and along the boundary fence road, the Eastern Connection Road will result in the loss of pond habitat, affecting ponds 93 permanently and, in the construction phase, ponds 36, 37 and 38. A portion of these ponds will be lost under the footprint of the road. Other apparent ponds marked on maps are no longer extant; having been abandoned, they have dried out, are completely engulfed by vegetation and have limited value to wildlife.

In terms of pond 93, this is an inactive fish pond with little emergent vegetation, attracting low numbers of waterbirds. Compensation for impacts on this pond will be carried out via ecological enhancement of other fish ponds (see **Section 12.7.10**).

In terms of ponds 36-38, construction phase habitat loss impacts on these ponds are greater than those in the operational phase, as the works area affects a larger area, and thus requires a larger area of compensation.

These ponds are long abandoned and have significant quantities of aquatic vegetation. The range of species recorded (typically Scarlet Basker, Sapphire Flutterer, Two-striped Grass Frog, Little Grebe, Chinese Pond Heron and White-breasted Waterhen) reflects this, and thus reprovision of abandoned pond, marsh-type habitat is considered more appropriate (rather than that of a typical fish pond).

In addition to direct habitat loss, there would also be disturbance impacts on pond habitat resulting in exclusion and reduced-density zones as described in **Section 12.7.10**. Such impacts are unavoidable in the construction phase. However, placement of appropriate barriers and planting of trees and shrubs of ecological value will be carried out prior to commencement of construction along the length of the Eastern Connection Road to minimise disturbance impacts on adjacent habitats. The fencing used for the site boundary will be 3m high and of a dull green colour, in order to minimise visual impact in this natural area. To further minimise impacts in areas outside the current boundary fence (i.e. HHW), construction requiring the operation of mechanical plant will occur only in the wet season months of April to October between 9.00am and 5.00pm. Given that road construction is significantly less disturbing than the construction of high-rise buildings, it is considered that the zone of disturbance for pond habitat should be 50% lower than it is for LMC Loop itself (see **Section 12.7.10**). These measures, plus the provision of compensatory wetland habitat are considered sufficient to reduce the magnitude of impacts to Low significance.

In order to minimise disturbance impacts in the operational phase, the section of road that runs through ponds 36-38 west of Horn Hill (Ngau Kok Shan) will be depressed below ground level. It is predicted that this measure, together with associated placement of noise barriers and planting of trees and shrubs along the edges of the road, will reduce disturbance impacts to insignificant levels. This approach will minimise fragmentation impacts of disturbance on the flight line corridor to insignificant levels (see **Section 12.7.6.3**) and reduce disturbance to Eurasian Otter. Calculation of disturbance zones in terms of large waterbirds is detailed in **Section 12.7.10**.

Also lost would be 1.76ha of marsh, comprising 1.18ha in the area of Horn Hill (Ngau Kok Shan), and 0.58ha at Ma Tso Lung. In addition, 0.19ha of seasonally wet grassland will be lost at Ma Tso Lung. Loss of these habitats can be compensated for as part of re-provisioned freshwater marsh habitat. Two-striped Grass Frog was recorded in the area, and habitat conditions suitable for this species would be appropriate as mitigation.

As construction of the Eastern Connection Road will take place after establishment of the reed marsh in the EA inside LMC Loop, there will be temporary habitat loss impacts of 1.1ha and disturbance to adjacent reed marsh habitat. Compensatory habitat to meet the functional loss will be provided on-site on the alignment of the ECR in ponds 36-38. In view of the below ground level nature of the works, it is considered that a dull green visual/noise barrier of up to 2m in height around the works area will be sufficient to mitigate disturbance impacts (exact height to be determined based on soil stability and other issues); furthermore, work will only take place in the period 9am to 5pm. The habitat will be re-instated after completion of construction, while the mitigation habitat provided will remain until habitat in the EA returns to its original level of functionality.

Calculation of the total area required for mitigation is considered in tandem with that for reed marsh in **Section 12.7.9**. Detailed design should be submitted and agreed with the relevant authorities prior to commencement of works.

12.7.4.2 Mitigation for Impacts on Secondary Woodland and Shrubland

The Eastern Connection Road will result in the loss of 0.70ha of secondary woodland and 0.16ha of shrubland. While replanting of an area of trees sufficient to compensate this loss is feasible, establishment at an equivalent level of maturity prior to construction or even operation of the development is not. However, this temporary residual impact is not considered to be of significance as the woodland impacted is relatively small in area and fragmented from the nearest areas of similar habitat. In addition, 0.40ha of woodland requires to be created to compensate for loss of this habitat under the footprint of the Western Connection Road.

As on-site mitigation is not possible given the narrow footprint of the connection roads, planting of compensation woodland will be carried out on nearby hillside areas in an existing Green Belt zone (see **Figure 12-12**). The area selected has been chosen to lie as near a site of impact as possible, given the constraint of requiring to be on a slope less than 1 in 3, while the configuration restricts the

woodland to the lower slopes of the hills, in order to minimise impacts on Eurasian Eagle Owl, which has been recorded elsewhere in the hills. The area to be provided will be, at minimum, at a ratio of 1:1, though the exact number of trees and implementation programme will be provided at detailed design stage. Combining the woodland mitigation required for both the Western and Eastern Connection Roads in the same expanded area of woodland would bring benefits due to the larger area. In this way, no residual impact is predicted in the longer term. The species proposed for planting (**Table 12.67c**) have been chosen for their tolerance, suitability for the site and ecological value. Details of the woodland and shrubland compensation proposal should be submitted and agreed with the relevant authorities prior to the commencement of construction works for either the WCR or ECR.

Table 12.67c Species proposed for planting as woodland and shrubland compensation.

Trees	Shrubs
<i>Ailanthus fordii</i>	<i>Diospyros vaccinoides</i>
<i>Bischofia javanica</i>	<i>Gardenia jasminoides</i>
<i>Castanopsis fissa</i>	<i>Ixora chinensis</i>
<i>Celtis sinensis</i>	<i>Ligustrum sinense</i>
<i>Cinnamomum burmannii</i>	<i>Litsea rotundifolia</i>
<i>Cinnamomum camphora</i>	<i>Melastoma malabathricum</i>
<i>Hibiscus tiliaceus</i>	<i>Melastoma dodecandrum</i>
<i>Liquidambar formosana</i>	<i>Atalanitia buxifolia</i>
<i>Sapium discolor</i>	<i>Rhodomyrtus tomentosa</i>
<i>Schefflera heptaphylla</i>	<i>Rhaphiolepis indica</i>
<i>Ilex rotunda</i>	<i>Rhododendron simsii</i>

12.7.4.3 Mitigation for Impacts on Natural Watercourse

The Eastern Connection Road will have potential run-off impacts on natural watercourses, mitigation for which is dealt with in **Section 12.7.4.4**. Insignificant permanent habitat loss is anticipated along LMC Meander due to the depressing of the road through the fish pond area and the use of an underpass below the Meander.

Potential direct impacts on Ping Hang Stream will be avoided by the use of a viaduct over the stream. Minor vegetation clearance will be required for this, however. As far as possible, the detailed design should allow vegetation to regrow in the same area.

Potential habitat loss impacts on natural watercourse are potentially of most significance in the lower sections of MTL stream. However, via design, hydrological disruption or loss of natural watercourse will not occur due to use of viaduct over the stream and associated MTL Nullah, and by not employing diversion in construction. The only culvert proposed for the ECR lies in the section of road outside the former boundary fence near Horn Hill to facilitate the passage of a seasonal stream underneath the road (**Figures 2.13-2.19**); this will also serve as a wildlife underpass. In terms of other sections of Ma Tso Ling stream under the remit of this Project, as it is not predicted that significant impact will occur, mitigation is not required. Detailed design of the road and associated

mitigation measures should be submitted and agreed with the relevant authorities prior to commencement of works.

In terms of disturbance impacts, for Ping Hang Stream and Ma Tso Lung stream, given the nature of the habitat and fauna of conservation significance, the use of fencing during construction to mark the site boundary (as described in **Section 12.7.6.4**) is considered sufficient to minimise the severity of impact to low levels. With regard to LMC Meander, disturbance impacts on the habitat will be of relatively low severity given its use by rather few waterbirds and overall length of the Meander. By restricting construction activities to the period from 9am to 5pm, this will avoid the main activity periods of Eurasian Otter in this habitat.

12.7.4.4 Mitigation for Impacts of Fly-tipping/Illegal Land-filling

Construction of the Eastern Connection Road will allow access to areas previously inaccessible to most vehicles and people. A potential effect of this is an increase in fly-tipping or illegal land or pond-filling activities that could cause loss of a wide-range of habitats, especially pond or marsh. To prevent these activities occurring, it is necessary, via appropriate road markings, to ensure that vehicles do not stop (except in emergency) on the road, and that there is no possibility of access to adjacent areas.

12.7.4.5 Mitigation for Impacts of Construction Run-off

Construction of the Eastern Connection Road will also generate run-off. In general, the relevant measures mentioned in **Sections 12.7.2.4** and **12.7.2.5** are adequate to mitigate this impact.

Within the construction site a temporary sewerage and drainage system will be installed. The outfalls of wastewater treatment facilities will not be directed to Ma Tso Lung Stream, its tributaries or other natural streams. The actual discharge location will be further assessed during the discharge license application process by the Contractor under the WPCO. Water quality monitoring and site audit will be carried out at appropriate points along Ma Tso Lung Stream, and if necessary, its tributaries, the Ping Hang Stream and LMC Meander.

12.7.4.6 Mitigation for Impacts of Operational Phase Run-off

A modern, effective drainage system will be installed to collect surface runoff from the finished road, which will prevent impact on nearby habitats, except at times of short-term temporary overload arising from rain storm events. Should there be any discharge to LMC Meander or other natural watercourses, appropriate use of oil interceptors and silt traps will be made so as to minimise potential impacts on water quality. Water collected in the section of road at HHW will not enter wetlands, streams or LMC Meander, and should be diverted to LMC Loop for drainage. All drainage will occur via gravity pipes, except that a storm pump will be installed for underpass sections of ECR.

12.7.4.7 Mitigation for Impacts of Accidental Spillage Event

The Eastern Connection Road is situated in an area of wetland habitat comprising freshwater marsh, reed marsh and fish ponds. Spillage events, whether during construction or operational phases, could potentially have substantial ecological impacts. Consequently, an emergency contingency plan will be prepared and implemented by the Project Proponent or its delegate, as outlined in **Section 12.7.2.6**.

12.7.5 Mitigation for Impacts arising from Direct Link to LMC Station

In terms of alignment and design, a wholly at-grade road option was ruled out in order to minimise pond loss, while the viaduct alignment was adjusted to minimise loss to wetlands associated with the clean-up reedbed for LMC Station and to keep, as far as possible, close to the existing Spur Line viaduct to minimise disturbance impacts. By situating support pillars on the banks of the wastewater treatment cells, reed marsh habitat loss is avoided during the operation phase.

Adverse ecological impacts from the Direct Link to LMC Station comprise loss of fish pond and reed marsh, and disturbance to fish pond, reed marsh, mitigation wetland, wasteground, urban/residential and village area. Impacts on the latter three habitats, however, are assessed to be of low significance, with mitigation unnecessary.

12.7.5.1 Mitigation for Loss of and Disturbance to Pond and Marsh

The use of viaduct for this connection minimises habitat loss impacts compared to an at-grade road. Some pond loss occurs, however. The permanent habitat loss from this development comprises 2.28ha of pond. Operation phase disturbance impacts are negligible given the existing disturbed nature of the area.

The reed marsh habitat loss is temporary and relates to 0.032ha of wastewater treatment reedbed. This is not only disturbed by adjacent land uses, but the ecological value of the reed cell is constrained by its use for wastewater treatment. Thus, although it is proposed that mitigation be provided in the form of enhanced compensatory habitat elsewhere, the location of such areas is not a key concern, and it does not need to lie in an area of generally undisturbed fish ponds. Mitigation for construction phase disturbance impacts on these already disturbed habitats, especially the closed reed marsh habitat, is not considered necessary.

Details regarding the calculation of wetland compensation requirements are provided in **Section 12.7.10**. Detailed design should be submitted and agreed with the relevant authorities prior to commencement of works.

12.7.6 Mitigation for Impacts on Species

Mitigation for impacts on avifauna are described in **Sections 12.7.2.1** and **12.7.2.2** dealing with loss of and disturbance to fish ponds from the Project. The mitigation measures dealing with disturbance impacts on other fauna of conservation importance and fragmentation impacts are described below.

12.7.6.1 Mitigation for Impacts of Mortality on Birds

The siting of noise barriers alongside roads has already been identified as a contributor to avian mortality in HK, and the magnitude of this impact is inevitably greater should these structures be placed in otherwise largely rural areas such as the environs of LMC Loop. In view of evidence to suggest that the placing of predator images on transparent surfaces may not be effective in reducing avian mortality^[12-43] and that barriers that *appear* to be transparent at insufficiently long distances are not effective^[12-49], potential impacts of collision mortality will be minimised by the use of opaque noise barriers, through which it is obvious there is no passage, and in which no reflection of the surrounding environment is created.

Noise or visual barriers designed on these lines also serve to reduce mortality associated with vehicle collision by preventing birds or animals from accessing the road. For this reason, the entire length of the Eastern Road Connection through both the Ma Tso Lung and HHW areas should be lined with barriers at heights of 1m and 3m during the operational phase. During the construction phase standard 3m-high site hoarding will prevent collision.

In terms of building design inside LMC Loop or of structures associated with development of LMC Loop, the following design guidelines for glass and façades should be reflected in the relevant statutory land use plans to minimise avian mortality.

Glass should provide as low a degree of reflectivity as possible, in order that surrounding natural environments are not replicated, thereby enticing birds to fly into the building exterior. Further, careful consideration should be given at the design stage as to whether the appearance of free passage is imparted by any glass feature of a building or other structure. If so, design should be amended.

Appropriate glass and façade treatments should be used to minimise collision mortality, especially in areas where the glass façade faces natural vegetation. These include the following:

- i. Fritting, or the placement of ceramic lines or dots on glass, has little effect on the human-perceived transparency of a window but creates a visual barrier to birds outside. This treatment also has the advantage of reducing air conditioning loads by lowering heat gain, while still allowing light transmission for interior spaces. It is most successful when the frits are applied on the outside surface. Frosted glass has similar effects.
- ii. Angled glass may be used only for smaller panes in buildings with a limited amount of glass.
- iii. The use of glass that reflects UV light (primarily visible to birds, but not to humans) acts to reduce collision.
- iv. Film and art treatment allow glass surfaces to be used a medium of expression, often related to the nature and use of the building, as well indicating to birds their impenetrability.
- v. Lightweight external screens can be added to windows or become a façade element of larger buildings, and are suitable where non-operable windows are prevalent, which is often the case in modern buildings in HK.

In terms of reducing night-time mortality and disturbance impacts, eliminating unnecessary lighting of both roads and buildings is one of the easiest methods, and has the added advantage of saving energy and expense. Potential impacts of nocturnal avian collision with buildings should be minimised by not creating sky glow from the use of night-time lighting at or near the top of buildings or other structures. In addition to avoiding uplighting, light spillage, in particular to adjacent wetland areas including LMC Meander, should be minimised, while green and blue lights should be used where possible, as these impact birds less. As far as possible, lights should be controlled by motion sensors, and building operations should be managed in such a way as reduce or eliminate night-lighting near windows. The potential advantages of removing unnecessary lighting in terms of reducing the carbon footprint of the LMC Loop development are obvious.

12.7.6.2 Mitigation for Impacts on Eurasian Otter

Wetland habitats in LMC Loop, LMC Meander and the HHW area are all important for Eurasian Otter in Hong Kong. Potential adverse impacts on this species will be mitigated in the following manner.

Construction Phase

Although the densely vegetated condition of the banks of LMC Meander will largely be retained due to their likely importance to Eurasian Otter, with regard to the ECR and WCR small areas may be directly impacted during construction. These impacted areas will be confined and kept as small as possible, and after construction, suitable replacement planting of vegetation will be carried out as far as possible to mitigate any adverse impact.

Engineering work required for stabilisation of the slopes of LMC Loop along the three sides of LMC Meander (totalling 3,500m in total length), in addition to around 60m of works within water associated with the ECR) may impose disturbance impacts on the use of the Meander by otters. Restricting working hours to the period 9am to 5pm will minimise the temporary disturbance impacts during the period of construction, while the managed area of mitigation wetland habitat in Area 2 (see **Section 12.7.10.6**) will provide a reduced-disturbance refuge for fauna impacted.

Construction of the underpass under the Meander for the Eastern Connection Road will require the use of a cofferdam that blocks approximately 50% of the width of the channel for approximately 100m during the dry season. The habitat loss of the water channel and riparian vegetation is not considered sufficiently severe to require mitigation, but in terms of potential disturbance impacts, it is important that there are no construction works in or near the Meander outside of the period 9am-5pm, and no night-time lighting. Under these conditions, given the crepuscular and nocturnal nature of most otter activity in HK, it is predicted that there would no residual impact.

Potential disturbance impacts in the form of lighting and noise will be minimised via measures to ensure there is no direct light on the Meander or its banks; these measures include minimising requirements for night-time lighting and directing lighting inward into the centre of LMC Loop. Suitable barriers will be erected to

minimise noise and to screen light impacts outside all construction sites associated with the Project. This fencing should be 3m high dull or olive green to blend in with the natural environment and to make it an effective light barrier.

Pre-construction surveys for otter holts or natal dens should be carried out in LMC Loop before the commencement of construction works. Should either be encountered during these surveys or during construction, work in the area will cease until the site is examined by an experienced Ecologist.

If the holt or natal den is in use for breeding (e.g. dependent young are present), works in the area will cease, following which an access corridor and a buffer area, as required, around the natal den or holt will be designated in which no human activity will be allowed until breeding is completed. In general, no works should be undertaken within 150m of any active natal den or within 30m of any active holt. Appropriate mitigation measures should also be activated to restrict vehicular/public access. Further measures will be taken, as required, in consultation with the Ecologist and AFCD. Data regarding the size and nature of the holt will be recorded for use as reference material in the detailed design and/or management of the Ecological Area.

Given that Eurasian Otter is a largely nocturnal and crepuscular animal in HK, construction activities will be restricted to the hours 9am to 5pm, in order to avoid disturbance impacts during the important early morning and evening times.

Loss of the reed marsh currently in LMC Loop could potentially have a significant impact on Eurasian Otter, given its habitat use and records of the species in the area. Compensation of this habitat is required, and this is dealt with in **Section 12.7.2.1**. This will be constructed prior to the loss of reed marsh within the Loop. During construction of the compensatory wetland habitat, however, there will be a need to maintain connectivity between the existing reed marsh and LMC Meander. This will be achieved by allowing a 30cm gap at the bottom of the fence separating the area to be developed from the mitigation reed marsh during the establishment period for the latter. Once established and once the existing reed marsh has been cleared, this gap will be closed to prevent access by dogs.

Once the reed marsh has been created, during the construction phase of the Loop development area, adequate fencing between it and the reedbed will be required to minimise disturbance impacts. This fencing will be dull green to blend in with the natural environment.

Given the sensitivity of otters to disturbance by dogs, it is important that effective fencing protects reed marsh habitats in LMC Loop at all stages of construction and operation from intrusion by dogs. Indeed, it is recommended that dogs be excluded from the all Project construction sites completely, and any that are found are trapped and removed. This is especially important with regard to the Eastern Connection Road, which passes through the HHW area, part of the core range of Eurasian Otter in HK.

Operational Phase

In order to minimise disturbance impacts on the use of LMC Meander by Eurasian Otter, a buffer between the buildings and the Meander is required to minimise adverse impacts of disturbance caused by the buildings and associated human

activities. During construction work NIEA (undated) recommends buffer zones of 150m for a natal den and 30m for a holt, as well as a general 10m prescription along a natural watercourse at any time. Given of the difference in level between the platform of LMC Loop and the Meander, activities occurring away from the very edge of the Meander will be less visible than would be the case if the level was the same, the required buffer may not be so wide.

The banks of the Meander should remain densely vegetated, which will act as a further buffer of any disturbing activities in the Loop. Furthermore, that Eurasian Otter appears to be largely crepuscular or nocturnal in HK means its activity period will be at a time when human use of the setback will be lower. Where the slope has to be stabilised, design should ensure it remains as close as possible to the existing gradient, and should facilitate reprovision of dense vegetation. Detailed design should be submitted and agreed with the relevant authorities before the commencement of works.

In view of this, an undeveloped strip of land a minimum of 23m wide is included to function as a buffer along the northeastern and southwestern sides of LMC Loop, where development borders the LMC Meander. An outer strip of 5m will be restricted designed to minimise human access via the planting of suitable shrubs and trees and by not providing footpaths. The inner portion can support limited, low-impact human activities (e.g. footpaths, cycle tracks), as long as they are compatible with the preservation of natural resource functions. It is not considered necessary to exclude completely human access to this buffer, as extensive planting of native trees and shrubs or established, ecologically-valuable exotic species throughout the buffer area will be carried out to minimise potential disturbance impacts and enhance ecological value. In addition, where habitat loss occurs along LMC Meander or any other watercourses, replacement planting will, as far as possible, be carried out to maintain a vegetated wildlife corridor.

In respect of the reprovisioned reed marsh inside the EA, the single, unfragmented and managed area of habitat will be of benefit to otters; provision should be made for otter breeding, either in the form of artificial natal dens or in the creation of undisturbed, small islands where dens/holts could be created. Adequate provision for access by otters to the EA from LMC Meander should also be incorporated. Although the 50m buffer area will support low-impact human activities compatible with natural resource functions, substantial planting will be carried out to act as a visual buffer for the EA. Further review and input from experienced ecologists will be required at the detailed design stage to ensure impacts are reduced to acceptable levels. Detailed design should be submitted and agreed with the relevant authorities prior to commencement of works.

Surface runoff associated with the approach roads and developed areas and sewage will be collected by proper facilities, as described in **Sections 12.7.2.5, 12.7.3.3 and 12.7.4.4**.

The Eastern Connection Road will pass through a section of the wetland area near Horn Hill (Ngau Kok Shan), which may impose a significant fragmentation effect on Eurasian Otter and other wildlife, especially as this connection lies at the margin of the area providing most records of Eurasian Otter. The section of road passing through this fishpond area will be depressed below ground level and a 70m-broad vegetated wildlife corridor will be provided above the road, which

should be designed to allow otters and other animals to pass over the road through undisturbed habitat, thus maintaining a strong degree of connectivity. Appropriate vegetation will be planted to allow incorporation into surrounding environments, while adjacent wetland habitat will be reinstated after construction and no barrier to mammal movement will be installed between the overpass and surrounding areas. If required, suitable features to funnel animals to the overpass will be installed. In addition, animal movement along the bank of the Meander during the operational phase will be possible. Based on this provision, it is predicted that connectivity will remain as strong as it is now. Detailed design should be submitted and agreed with the relevant authorities prior to commencement of works.

Typical non-authorised human access to the wildlife overpass will be prevented by fencing, though the fence must allow passage by non-flying mammals. Detailed design will be carried out at a later stage, at which time a further review of the ecological baseline and the requirements in respect of maintaining connectivity is required. The latter will be reflected in the final design of the submerged road, the animal overpass and adjacent areas. In addition, the Eastern Connection Road should be designed so as to discourage cars from stopping along the road in the HHW area, which could thereby increase disturbance impacts on the area.

In terms of the Western Connection Road, the level of the bottom of the bridge above the water surface will be much more than 1m at most times, though the exact difference depends on water levels. Passage of otters should, therefore not be impeded, except perhaps during extreme flooding events, when the gap may be less than 1m.

As in the construction phase, potential impacts of artificial lighting on LMC Meander, the Ecological Area and the fish pond wetland area during the operational phase of the development will be minimised by the minimal use of low levels of lighting.

The provision of reed marsh habitat in the EA to compensate for loss of reedbed in LMC Loop will compensate for adverse impacts on Eurasian Otter arising from the loss of this area. The provision of open channels within the reedbed will increase micro-habitat diversity to the benefit of otters, as well as other species. Such water channels will allow otters easier passage, and also provide refuge and rest areas at the edge. Detailed design of this wetland requires consideration at a later stage.

12.7.6.3 Mitigation for Impacts on Other Mammals

Mitigation measures for Eurasian Otter will in general also apply to other mammals present in the area. The main issue concerns maintaining connectivity such that the Eastern Connection Road does not fragment mammal habitat. Wildlife underpasses based on guidance provided in AFCD Nature Conservation Practice Note No. 04 will be installed at three locations in the Ma Tso Lung section and four locations along the existing boundary fence road (see **Figures 2.12 to 2.23**); in addition, wildlife passage is provided under the viaduct over the stream at Ma Tso Lung and via a box culvert installed for a seasonal stream along the existing boundary fence road. The proposed underpasses should be provided

in tandem with barrier fences along the at-grade road in order to keep wildlife off the road and avoid road kill, as well as guide them to the underpasses.

In addition, a 70m-wide animal overpass will be provided above the depressed road through the fish ponds near Ngau Kok Shan. This overpass will be vegetated to facilitate mammal use, and will allow access to adjacent habitats for onward travel (see above). In addition, the area alongside LMC Meander under which the underpass below the Meander enters the ground will be designed and vegetated in such a way as to allow mammal passage.

Close consultation with an experienced ecologist should be carried out during the detailed design stage of all these animal passages to ensure that they are appropriate and effective. Detailed design of these wildlife passages should be agreed with the relevant authorities before the commencement of works.

In addition, further potential impacts of the construction site for the Eastern Connection Road in the Ma Tso Lung area also require mitigation. The construction site will be fenced around its boundary; however, this fencing system will be designed so as not to completely block the passage of large, non-flying mammals such as Leopard Cat, as during night-time when works cease, animals may still require to pass through the construction site (see below).

In terms of bats, the provision of wetland compensation habitat within LMC Loop will continue to provide foraging opportunities in the area, and the road connections will not provide a significant barrier for bat species.

12.7.6.4 Mitigation for Impacts on Herpetofauna

The use of a viaduct for the Eastern Connection Road will avoid direct impacts on Ping Hang Stream. In general, measures for mitigating impact on mammals, such as wetland compensation and the creation of overpasses or underpasses, will have the same benefits for herpetofauna as well, including Chinese Soft-shelled Turtle. Detailed design of the mitigation wetlands is required at a later stage with the aim of maximising value for wildlife.

In respect of the Ma Tso Lung Stream network, prior to construction of the Eastern Connection Road a survey of relevant areas to be directly impacted will be carried out to identify any herpetofauna species of conservation concern present in the affected area. If any are found, if possible they will be translocated to suitable areas after consultation with AFCD.

The construction area will be separated from the riparian zone of the stream by a fencing system that prevents most or all herpetofauna and snakes from accessing the construction site. Should these gain ingress, there is a significant likelihood that they will not be able to effect egress, which would place them at risk of capture or accidental injury. This is especially important in respect of Three-banded Box Terrapin. However, it is desirable to allow larger animals such as Leopard Cat to pass through the site to maintain connectivity between areas either side of the alignment; as they are nocturnal, there would be little chance of capture.

Consequently, while most of the fence will be solid and olive or dull green to minimise visual impact, the section of the fence from 40cm to 90cm above ground

will comprise a large mesh size of approximately 70cm to allow mammals to pass through. In addition, a lipped design will be used along the top of the lower section to prevent animals such as snakes and frogs from successfully scaling the smooth wall. Close consultation with an experienced ecologist and AFCD will be required. Detailed design of any fencing should be agreed with the relevant authorities before the commencement of works.

With regard to the operation phase, to minimise road kill mortality wildlife underpasses based on guidance provided in AFCD Nature Conservation Practice Note No. 04 will be installed at three locations in the Ma Tso Lung section and four locations along the existing boundary fence road (see **Figures 2.12 to 2.23**). The proposed underpasses should be provided in tandem with barrier fences along the at-grade road in order to keep wildlife off the road and avoid road kill, as well as guide them to the underpasses.

12.7.6.5 Mitigation for Impacts on Rose Bitterling and Aquatic Fauna (including *Aquatica leii*)

Since the habitats for these species will not be directly impacted, general measures for ensuring water quality do not vary significantly from current conditions will be sufficient; these are described in **Sections 12.7.2.4 and 12.7.2.5**.

12.7.6.6 Mitigation for Impacts on Odonata and Butterflies

The impact of the loss of reedbed habitat in LMC Loop on Common Evening Hawker will be mitigated by the creation of compensatory reed marsh habitat in the Ecological Area. Elsewhere, measures for protecting herpetofauna, mammals and water quality of nearby water bodies will generally benefit odonata and butterflies.

12.7.6.7 Mitigation for Impacts on Paradise Fish

Standard practices designed to prevent run-off, increased sedimentation of aquatic bodes and unanticipated spillage events are described in **12.7.2.4** and **12.7.2.5**. To prevent access to the stream by site staff, effective site boundary fencing requires to be set up; other measures to prevent or deter access to the stream should be taken where necessary in consultation with an experienced ecologist.

12.7.7 Mitigation for Impacts of Fragmentation

The primary potential fragmentation impacts concern those in respect of the flight line corridor, mammals and, in particular, Eurasian Otter; the latter are dealt with in **Sections 12.7.6.2 and 12.7.6.3**.

As the flight line corridor is a location-specific phenomenon, it is essential that mitigation occurs at the site of the corridor. There is no evidence that birds might be able to adopt a different route in a situation where the preferred route is impeded, given the surrounding topography and land use. The preference for LMC Meander illustrated in **Figure A12-1 in Appendix 12-3** is marked, and it is reasonable to suppose that adverse impacts deterring their use of this route could have substantial ecological impacts. As off-site compensatory habitat provision is

not feasible, the principles of avoidance and minimisation of impacts need to be adopted.

12.7.7.1 Mitigation for Impacts on Flight Line Corridor of LMC Loop Development

Development of LMC Loop potentially has severe adverse consequences for the flight line corridor. However, the flight line corridor is a location-specific phenomenon for which there is no possibility of habitat compensation as a form of mitigation. Given the surrounding topography and development of Shenzhen, it is not reasonable to assume birds using the flight line corridor can adopt another route outside the LMC Loop area. Thus, the aim must be to ensure adverse residual impacts are not so large as to threaten the integrity of the linkage.

Literature search has produced no comparable example either in HK or internationally on which an assessment of the width required to maintain the flight line corridor largely intact can be based. In any event, the developmental, geographic and topographic characteristics of the area are unique, as are the characteristics of the flight line, and must be analysed based on the data to hand. Consequently, an assessment of the location and extent of the corridor that needs to be set aside has been made based on field surveys carried out to map flight lines. These revealed that the flight line corridor is centred on LMC Meander and extends across LMC Loop to a distance of approximately 170m at the widest point (**Figure A12-1 in Appendix 12-3**), though generally at around 150m in width.

Generally speaking, birds on flight lines to and from foraging areas are less sensitive to disturbance than when foraging or roosting. For example, based on observations in the Deep Bay Area, Great Cormorants are disturbance-sensitive in the following increasing order of magnitude: when roosting, when in flight, when foraging. Urban-roosting Great and Little Egrets such as those at Tai Po Market each day fly above buildings when preparing for nocturnal roost, yet they are more sensitive to the urban environment when foraging. Consequently, it is considered that the 100m and 200m disturbance zones arising from development within LMC Loop and relevant to foraging large waterbirds are not applicable to birds commuting between foraging and roosting areas.

It is considered that preservation of the flight line corridor requires reproducing in the core part the character of current semi-natural habitat conditions (though it is not necessary to duplicate these), as well as retaining the undisturbed, natural condition of LMC Meander. Based on this, the principle of avoidance is embodied in establishing a set-back along the southeastern edge of LMC Loop that lies underneath the core area of the flight line corridor. The undisturbed and ‘green’ element has been retained, while the habitat will be reed marsh, freshwater marsh and trees/shrubs (in the Ecological Area) and plantation (in its associated buffer zone). The location of these areas in relation to the overall distribution of bird flights through the area is illustrated in **Figure 12-11**. The habitat characteristics of these areas are determined by the fact that loss of reed marsh currently in LMC Loop requires compensation on a like-for-like basis, and an area of low-intensity human use will provide a buffer to this. The approximately 150m width is based on the flight line survey data.

As noted in **Section 12.4.4.1**, the main entry point for large waterbirds to the LMC Loop and HHW area lies in the vicinity of Ha Wan Tsuen. In order to reduce disturbance impacts in this sensitive area, the development area in LMC Loop has been set back to provide natural habitat of greater width, resulting in a slightly wider Ecological Area in this area.

In addition, in the buffer zone for the Ecological Area buildings will be placed only in the internal 25m closest to other buildings and their height will be restricted to 14mPD (except the maximum height of on-site STW and electricity substation are 15 and 25mPD respectively), similar to the height of village housing currently present in the general area of LMC Loop, in order to minimise disturbance impacts to the core area of the flight line corridor. The proposed plot ratio is 0.1. As birds are currently able to tolerate such development at Ha Wan Tsuen, it is reasonable to suppose the same will apply in areas bordering the Ecological Area. From **Figure A12-17** in **Appendix 12-3** it can be seen that in the area of the buffer zone 1-135 bird flights at 10m were recorded in the 18 surveys, at a mean of less than 8 bird-flights per survey. It is predicted that any reduction of bird flights in this area as a result of 14mPD-high buildings (except the maximum height of on-site STW and electricity substation are 15 and 25mPD respectively) and associated human activity will be minimal, based on the early morning timing of most flights, the restriction of buildings to the inner 25m of this zone closest to other buildings and the similarity to conditions at Ha Wan Tsuen village, over which a much larger number of birds fly.

Maximum building heights in LMC Loop increase from 14mPD in the buffer zone to 26mPD in the area between the buffer zone and the main roads running parallel with the EA, and 46mPD in much of the remainder (**Figure 2.1b**). With regard to the Sewage Treatment Works along the northeastern section of the Meander, maximum building height is 15mPD, similar to that in the buffer zone. Thus, in areas closest to the EA or the important northeast section of LMC Meander, building height is restricted to 14mPD (except the maximum height of on-site STW and electricity substation are 15 and 25mPD respectively); there is then an intermediate height zone of 26mPD before the core area maximum building height of 46mPD and western corner maximum building height of 54mPD, which will lie at a minimum distance of 200m from the nearest edge of LMC Meander. This stepped profile has been designed to minimise impacts on the core areas of the flight line corridor, as mapped in **Figure A12-1**. A comparison of **Figures A12-15, A12-16 and A12-17** indicates that over the interior areas of LMC Loop, fewest birds fly at 10m above ground, while highest numbers fly at 30m or above, which is broadly in line with this building height layout.

The exception to this is the 25mPD-high electricity substation adjacent to the alignment of the Eastern Connection Road underpass under the EA. Given that the width of natural habitat between there and the existing boundary fence road is wider at this point than elsewhere along this section of LMC Meander, it is considered any impact from a higher building height will be offset by the greater width of undisturbed adjacent habitat available.

Figure A12-1 illustrates the total number of ‘bird-flights’ recorded in the area of LMC Loop. This figure is reproduced in **Figure 12-11** together with the grid used during field surveys, which divided the area into 100m squares, and the boundaries of the proposed EA and its buffer zone. This figure shows that large

waterbirds moving between wetland areas either side of the LMC BCP are not restricted to the area of LMC Meander, as they fly across the whole area from Shenzhen River to the boundary fence road. The EA and its buffer zone have been placed underneath the core part of the corridor, and the quantitative impact of this placement is presented in **Table 12.67d**. For each of the 100m-wide divisions of the flight line corridor over LMC Loop or above the southwest section of LMC Meander in **Figure 12-11**, the total number of large waterbirds counted during the year flying through each 100m square was summed, and separated into those affected by the development (i.e. those over LMC Loop) and those not affected (i.e. those over the EA, its buffer, LMC Meander and the adjacent fish ponds along the boundary fence road). Column S was excluded as only a very small portion lies over the developed part of LMC Loop.

Table 12.67d Number of affected bird-flights of large waterbirds in each 100m-wide column of the corridor (see Figure 12-11).

Column	E	F	G	H	I	J	K
Total no. of bird-flights affected	1390	505	454	424	345	184	148
Total no. of bird-flights unaffected	2644	3553	2970	3032	2612	1713	1982
% of bird-flights affected	34%	12%	13%	12%	12%	10%	7%
% of bird-flights unaffected	66%	88%	87%	88%	88%	90%	93%
Column	L	M	N	O	P	Q	R
Total no. of bird-flights affected	144	304	494	676	943	2153	2986
Total no. of bird-flights unaffected	3652	3708	3800	4359	4009	3158	4227
% of bird-flights affected	4%	8%	12%	13%	19%	41%	41%
% of bird-flights unaffected	96%	92%	88%	87%	81%	59%	59%

From **Table 12.67d** it can be seen that the proportion of birds-flight impacted (i.e. from approximately 4% to 41%) varies according to location. Broadly speaking the overall mean figures are 83% for unaffected portions of flight lines and 17% for affected portions.

This assumes that all birds are willing to fly over the buffer area even though there are buildings nearby. Based on experience elsewhere in HK, some birds will continue to fly over the built area of the development even after building construction, especially in areas adjacent to the buffer zone where building height is lower than elsewhere. For this reason the assumption is considered valid.

The percentage of affected bird-flights is highest in columns E, Q and R (34%, 41% and 41% respectively). With regard to the higher percentages in Q and R, this is due mainly to the presence of bird-flights along the northeastern section of LMC Meander. These mainly concerned birds that had initially flown along the southeast section of LMC Meander with the majority of individuals, but had then re-oriented north following the watercourse. It is predicted that once construction has commenced or the development is under operation in LMC Loop, based on the fact that these birds are flying towards ponds in the area of HHW closer to the Shenzhen River, there is likely to be only a minor impact on the route adopted.

From **Figure 12-11**, it can be seen that with regard to Q and R, these columns contain the broadest area of wetland habitat on the boundary fence road side of the Meander, and it is predicted that this will minimise the impacts in this area. In respect of column E, the character of the area near the southwestern corner of LMC Loop will not change substantially as there will remain a mix of village-type development, trees and roads.

It is predicted that affected birds will re-route to fly over LMC Meander and the approximately 100m wide Ecological Area and its 50m wide buffer, the airspace above the buildings of lower height adjacent to the buffer zone, or fish ponds adjacent to the Meander. Some birds may be permanently deterred from using the flight line, but it is considered that the number affected in this way will be sufficiently small as to render the residual adverse impact of low significance.

In order to minimise the impact of construction activities in LMC Loop on the flight line corridor, it is important that the compensatory reed marsh area is established prior to broader site decontamination works and subsequent construction activities (including those related to the Eastern Connection Road). Thus, creation of the reed marsh will be one of the first activities to take place. Otherwise, the carrying out of site clearance and decontamination works simultaneously in the Ecological Area and associated buffer zone may impose an adverse, though temporary, impact of high ecological significance on the flight line corridor. Further, restriction of site formation and noisy construction works involving the use of mechanical plant to the period from 9am to 5pm each day will minimise the impact on the flight line corridor and mammals by avoiding the main activity periods of both.

12.7.7.2 Mitigation for Impacts on Flight Line Corridor of Western Connection Road

Impacts of the Western Connection Road on the flight line corridor are likely to be less than those of the Eastern Connection Road, though nevertheless potentially significant.

Use of the flight line is greatest in the early morning. In view of this, the timing of road upgrading work along Ha Wan Tsuen Road will be as follows:

- a) no construction activities involving the use of mechanical plant to be carried out before 0900h in order to minimise disturbance to birds using the flight line corridor, or after 1700h during an important activity periods of mammals;
- b) construction work will be restricted to the wet season (April to October);

Given the importance of this area as the entry/exit point for birds to the LMC Loop and HHW area, suitable buffering of the impacts of road widening and increased traffic volume during both construction and operation phases is required. These will take the form of a 3m visual/noise barrier and dense tree and shrub screening in the crucial open areas between ponds 3 and 5 and adjacent to ponds 11 and 12, and retention or reinstatement of the dense natural tree screening between ponds 5 and 9. Such barriers are required in the operation phase, and should be erected in the construction phase as part of normal procedure, as visual and noise disturbance will temporarily reduce bird activity in the area.

No restrictions on the timing of construction is required for the section of the WCR along LMC Road, or for work on the San Tin interchange, in view of the urbanised and highly disturbed habitats impacted.

12.7.7.3 Mitigation for impacts on flight line corridor of Eastern Connection Road

Impacts of the Eastern Connection Road on the flight line corridor are potentially great, in view of the fact this will introduce an entirely new road into a previously, largely undisturbed area. Currently, very low traffic volume uses the boundary fence road, and only the occasional fish pond operator's vehicle crosses the fish pond area. In addition, the area lies under the preferred route for birds using the flight line corridor. Further, the requirement to traverse LMC Meander is of particular significance, as a very large proportion of birds fly directly along this watercourse at relatively low heights above the water surface in this area (10m and 20m – see **Figures A12-16 and 17 in Appendix 12-3**).

In order to minimise the operational impacts of the road, it will be depressed below ground level during its passage through the fish pond area, and will traverse LMC Meander in an underpass, emerging on the far side of the Ecological Area in the developed part of LMC Loop. It is considered that with appropriate 3m-high vegetative screening (landscape planting) and/or visual/noise barriers for the whole length of the road, the ecological impact during the operational phase will be reduced to an insignificant level. Review at the detailed design stage and, if necessary, during construction should be carried out to ensure that road construction activities are not visible from adjacent wetland habitats, in particular the section of road along the boundary fence. The marginal noise impact will be little, as it will simply constitute a slightly higher level of background noise and is not exacerbated by simultaneous visual disturbance.

Construction phase disturbance impacts, however, are unavoidable and will be greater due to the higher levels of both visual and noise disturbance. It is not possible to mitigate these impacts entirely, though certain measures will be adopted to minimise them, as follows:

- a) construction of the section of the ECR along the current boundary fence road will not commence until the Ecological Area reed marsh in LMC Loop is established, in order to provide an area of undisturbed natural habitat over which birds can fly;
- b) during the time when the underpass below the EA is under construction, reed marsh will be reprovisioned in Area 4 (ponds 36-38) in order to provide an undisturbed flight line corridor.
- c) prior to commencement of construction and detailed design of compensatory wetland habitat, the baseline ecological profile should be renewed via a 12-month survey of flora and fauna, as the data collected for this Study will be out of date;
- d) apart from the section under the Meander and the adjacent section of the EA (due to DSD restrictions for flood prevention), construction works will only

occur in the wet season period from April to October, as this is the period when fewest birds use the flight line;

- e) construction works will be phased to avoid working simultaneously in two or more of the sections traversing the EA, LMC Meander and ponds 36-38;
- f) employ to the maximum visual and noise barriers that are olive or dull green in colouration and up to 3m high (lower in the EA) to minimise adverse impacts; and
- g) no construction activities are to be carried out before 0900h or after 1700h in order to minimise disturbance to birds using the flight line corridor and to the main activity periods of mammals, including Eurasian Otter.

12.7.8 Mitigation for Cumulative Impacts

Section 12.6.5.2 describes the potential cumulative impacts associated with the Project. Broadly speaking, mitigation for these is the same as that described above for the stand-alone impacts. In respect of potential cumulative impacts at HHW in connection with the OU(CDWEA) zoning for this area proposed by LUP CAFS, as noted above predicting the nature and significance of such an impact is not possible without knowledge of the location and nature of any development at HHW. The contribution of the LMC Loop Project to this impact from impedance of flight lines and loss of habitat will be mitigated by the measures detailed above.

12.7.9 Impacts of and Mitigation for Mitigation Provision

12.7.9.1 Impacts of Mitigation Provision

Ecological Area

The creation of the Ecological Area will require site formation, including (as with the rest of the site) the raising of the bank between the Meander and the Loop in order that it is higher than the design flood level, which is required for the EA to fulfill a drainage retention function at times of flood. By keeping the two sides balanced, excavation and dredging of the bank will be avoided, and re-growth of vegetation should occur on the natural slopes. The slope gradient of the bank will be similar to that existing, which will maintain a similar degree of connectivity with adjacent wetland habitats in this respect. As a result of work at the top of the bank, there will be temporary loss of riparian vegetation that will re-establish either naturally or via planting.

Temporary disturbance impacts of approximately 12 months' duration on the surrounding airspace, LMC Meander and adjacent fish ponds from work required for bank stabilization and site formation of the EA will result. As noted in **Section 12.7.2.4**, it is proposed that hoarding is not erected around the EA, so as to reduce overall disturbance impacts to adjacent fish ponds and maintain connectivity with LMC Meander. Moreover, there is a conflict between the installation of fencing along the bank between the EA and the Meander, and the requirement for stabilization works.

Impacts in respect of the flight line corridor in both with and without-hoarding scenarios are predicted to be similar in view of the height at which birds fly and the fact that greatest numbers occur early morning and evening, outside construction hours. Disturbance impacts on large waterbirds foraging or roosting in the Meander are considered of low severity given the length of the watercourse, availability of other areas, and the relatively low number of individuals impacted.

Potential impacts on adjacent fish ponds (numbers 5 to 47) are reduced to a varying extent by the distance between the construction activity and the relevant ponds. Usage of these ponds is heaviest in the dry season, and impacts at this time would be greatest. However, Ponds 5 to 10 are highly disturbed, and support few waterbirds.

In terms of slope stabilisation work, the disturbance impacts of this on LMC Meander are potentially greater. With regard to Eurasian Otter, that it is largely crepuscular or nocturnal in HK reduces significantly the potential for disturbance impacts given that noisy or mechanized construction activities are restricted to the period from 9am to 5pm. However, although during site formation of the EA the existing reed marsh will be preserved and fenced off to minimise disturbance, not all of the reed marsh can be protected this way. Areas of reed marsh currently in the area of the proposed EA together with scattered, smaller areas of reed marsh in the area to be developed will be impacted, which will result in the temporary loss of 2.50ha. Further, access to the part of the reed marsh remaining while the EA is under creation might be deterred by site formation activities, though nocturnal crossing of this area could occur (see **Table 12.68**).

Management of water levels in the EA will be carried out in order to provide optimum conditions for the reed marsh, and thus be favourable to appropriate wildlife, including Eurasian Otter. Occasional flood events in the wet season, contributed to by surface run-off from the developed area of LMC Loop, are not predicted to be an issue, given that these naturally occur and the fauna and flora are adapted.

Table 12.68 Potential indirect impacts arising from formation of Ecological Area and its buffer zone in the absence of mitigation

Criteria	Assessment
Habitat Quality	Flight lines through the area link fish ponds habitats of high quality and are important for wetland birds, while the Meander appears to be a focus of Eurasian Otter activity.
Species	Large waterbirds are a critical component of the Deep Bay area wetland ecosystem, and some occur in regionally important numbers. The HK population of Eurasian Otter is regionally important.
Size/Abundance	Substantial numbers of waterbirds utilise the flight line corridor, especially in the non-breeding season, including up to 16.4% of Great Cormorants and significant percentages of Great and Little Egrets. Eurasian Otter records have been located near the Meander, including one in the Meander during field work for this study.
Duration	12 months.
Reversibility	Mostly irreversible, though limited remedial measures to reduce disturbance possible.

Criteria	Assessment
Magnitude	In absence of mitigation, a low to moderate magnitude impact on the flight line is possible, given that it is most active early morning, prior to construction commencing. A similar magnitude of impact is possible on Eurasian Otter. Relatively small magnitude of disturbance on fish ponds along boundary fence road.
Impact Severity	Low impacts on large waterbirds utilising LMC Meander, Low to Moderate on those utilising adjacent fish ponds and Low to Moderate on those using the flight line corridor. Moderate impacts on Eurasian Otter arising from temporary site formation and slope stabilisation works, loss of riparian vegetation, loss of connectivity with reed marsh in Loop and temporary loss of 2.50ha of reed marsh habitat. Low to Moderate impacts on fish pond habitat along boundary fence road.

Woodland and Off-site Wetland Mitigation areas

Woodland Compensation Area

The creation of a woodland compensation area will involve planting of woodland and shrubland species in grassland areas currently of low ecological value along the existing boundary fence road near Horn Hill (Ngau Kok Shan). The impact of tree-planting and routine maintenance activities are predicted to be of low significance.

Off-site Wetland Mitigation Areas

The creation, management and maintenance of wetland compensation in the existing fish pond area in the vicinity of LMC Loop may have disturbance impacts on nearby wetlands, depending on location. In general, though, the activities involved are in nature the same as those associated with commercial fish pond management currently taking place in the area. Initial wetland creation will require the drain-down and re-profiling of ponds, significantly reducing their ecological value, but this will be a temporary impact of a few months duration. Disturbance from vehicles required for the carrying out of management and monitoring work is likely to be greater than is currently the case, though will still be at very low levels. Area 4, should it be used, can be accessed via the existing boundary fence road. The combined ecological impact, relatively short in duration and arising from a moderate intensification of routine fish pond management activities, is predicted to be of low significance. Monitoring activities at the operational wetland, if carefully designed and carried out in respect of timing and methodology, impose little stress on habitats or species. With regard to the stream alongside ponds 96 and 58, it lies outside Area 2, and no significant secondary impact is predicted to occur given the nature of the activities and its separation from the fish ponds.

These areas are located within a Priority Site for Enhanced Conservation, namely "Deep Bay wetlands outside the Ramsar site". Many of these fishponds are currently participating in the Nature Conservation Management Agreement Scheme in the Northwest New Territories, which has the objective of restoring and enhancing the conservation value of commercial fishponds in the area. This

arrangement will involve minor modifications to fish pond management practices that should be of ecological benefit to the area. However, there are no direct implications for the ecological impacts of or mitigation measures required for establishing wetland compensation habitat in the midst of these ponds, above and beyond the considerations already taken into account for the area.

Fragmentation impact of construction site fencing

The use of construction site fencing along the Eastern Connection Road to minimise disturbance to adjacent wetland habitats and reduce wildlife mortality creates the potential for fragmentation impacts in relation to certain mammals and herpetofauna. As described in **Sections 12.7.6.3, 12.7.6.4 and 12.7.7.3**, the design of the fencing will be such as to allow the passage of larger non-flying mammals but prevent access by herpetofauna. The potential for fragmentation impacts is restricted to the construction phase, as underpasses, viaducts and an overpass will be in use during the operational phase.

In terms of the section of road along the boundary fence, the magnitude of the potential impacts on amphibians and Eurasian Otter is somewhat low, as there is little wetland habitat to the south (the opposite side to Hoo Hok Wai), and use of the shrubland, woodland and grassland habitats by the amphibian species present in the area is limited and opportunistic. In regard to the section of road through the Ma Tso Lung area, the fencing is required to prevent wildlife mortality, and given that the strongest ecological linkage is considered to be along the riparian corridor rather than perpendicular to it, the fragmentation impact in this area in relation to herpetofauna is predicted to be of low significance (Eurasian Otter does not occur in the marsh and seasonally wet grassland habitat in this area).

In terms of herpetofauna and Eurasian Otter passage through the fish pond area near Horn Hill (Ngau Kok Shan), construction will be phased to avoid working simultaneously in two or more of the sections traversing the EA, LMC Meander and ponds 36-38; for Eurasian Otter, in particular, this will reduce potential fragmentation impact significantly. Further, Ping Hang Stream will be traversed on viaduct, and connectivity along and across the stream will be maintained for all fauna throughout the construction phase. In view of these measures, the predicted impacts are of Low significance.

12.7.9.2 Mitigation of Impacts

Mitigation for impacts of habitat loss in the form of riparian vegetation and reed marsh is difficult, given that it is the location of the former that is critical, while the provision of compensatory habitat in the case of the latter would only cause further impacts. However, given that these adverse residual impacts are only temporary in nature, they are assessed as of low significance.

The creation of the Ecological Area in LMC Loop as mitigation for wetland habitat loss will cause a moderate temporary disturbance impact on the use of LMC Meander by Eurasian Otter in the absence of mitigation. However, by restricting the timing of construction to the period from 9am to 5pm, this will avoid the main period of activity of otters in HK. In addition, moveable barriers to hide from the Meander areas of more intense site formation activity should be used.

Site formation works are relatively low intensity compared to construction activity, and thus the disturbance impacts on large waterbirds are predicted to be relatively low in severity. By restricting work to the period from 9am to 5pm, impacts on the flight line corridor are much reduced. Moreover, all major works along the edge of LMC Meander and in the EA will be conducted in the wet season. As slope stabilization works will not involve contact with the water, this is possible. Consequently, the combination of wet season construction, timing and the use of moveable barriers will reduce the disturbance impact of works in the EA on adjacent ponds to low severity. Overall, disturbance impacts for both are reduced to low.

A fence is required between the EA and the developed area of LMC Loop, which will initially contain much of the existing reed marsh. In terms of the potential loss of connectivity between LMC Meander and the reed marsh, this should be mitigated for via the provision of a 30cm gap between the bottom of the fence and the ground in order to allow otter passage (**Figure 12-13**).

In terms of the creation and management of ecologically enhanced pond habitat, using the road that runs alongside Shenzhen River to access these areas is preferred. However, given the relatively low numbers of vehicles required for management, disturbance impacts on adjacent pond habitat via use of a track through the fish pond area is also considered to impose impacts of low severity.

12.7.10 Meeting Wetland Habitat Compensation Requirements

12.7.10.1 Approach to Calculation of Compensation Requirements

In determining wetland habitat compensation requirements, the following basic principles have been adopted. Firstly, the functional value of habitat loss must be compensated for entirely. In most situations, this will require the same area of habitat to be reprovisioned, which is the approach that has generally been adopted in the Deep Bay area.

Secondly, permanent loss of wetland habitats (reed marsh and marsh) currently in LMC Loop will be compensated by habitat reprovision inside the Loop (in the Ecological Area), while permanent indirect disturbance impacts, in addition to direct (habitat loss) and indirect (disturbance) impacts resulting from provision of infrastructure connections will be compensated outside the Loop.

Thirdly, direct and indirect impacts caused by development in LMC Loop and operation of infrastructural links will require compensation for as long as the life of this or future development at the site (i.e. permanently).

Calculation of direct impacts for each element of the Project is straightforward, and involves measuring the area of habitat loss; however, the situation with regard to disturbance impacts is significantly more complex. **Figures 12-6, 12-7 and 12-8** illustrate the impacted areas.

Indirect impacts of disturbance to habitats and the fauna utilizing them is mainly restricted to the effects on large waterbirds, on which the impacts of adjacent development are greatest. Their preference for open habitats, their large size and

slow escape speed, mean that they are most sensitive to disturbance. Provision of mitigation for disturbance impacts on these species will also mitigate for disturbance impacts on other species that are less disturbance-sensitive due to their preference for closed, or vegetated, habitats and/or their smaller size.

Very few previous studies appear to have taken place in the field of disturbance impacts in respect of species occurring in HK. Rodgers and Schwikert (2003) calculated a mean flush distance of 113m (n=104) for Great Egret, the only species common to the investigation and to HK. However, no data are available regarding other species, nor the distance at which large waterbirds in HK become alert and their foraging or roosting efficiency reduced.

As part of the EIA for the LMC Spur Line and Station, large waterbird species were predicted not to use wetlands within an exclusion distance of 100m (the so-called 'Exclusion Zone') from substantial development of the kind planned for LMC Loop, and to occur at reduced densities between 100m and 200m away ('Reduced Density Zone' (RDZ)). In the latter zone, numbers of birds are lower than they would be in the absence of disturbance, either because only more disturbance-tolerant individuals are present or because individual birds are present for shorter periods of time (e.g. during periods of reduced human activity). It was assumed that the overall utilization of the RDZ is 50% of that in undisturbed areas (0% at the border with the Exclusion Zone and 100% at the border with the undisturbed area).

The Executive Summary (Table 4.28) of the EIA for the LMC Spur Line and Station lists the large waterbird species Great Cormorant, Grey Heron, Great Egret and Black-faced Spoonbill, for all of which the Exclusion Zone was estimated to be 100m. The maximum distance of reduced density was estimated at 200m for all but Great Cormorant, for which 150m was used.

With regard to Eurasian Otter, this appears not to be as disturbance-sensitive as large waterbirds, except when breeding. During construction work NIEA^[12-54] recommends buffer zones of 150m for a natal den, but only 30m for a holt and a general 10m prescription along a natural watercourse at any time. Thus, for much of the year otters utilising wetlands at Hoo Hok Wai are not predicted to be impacted by development in LMC Loop. There are a number of inactive or abandoned fish ponds along the northeast side of LMC Meander as far as ponds 36-38, which might theoretically provide suitable conditions for a natal den. Ponds 36-38, however, are more than 200m from the developed area of the Loop, and thus otter use of these is not predicted to be impacted by development. With regard to the remaining inactive ponds in this area (ponds 24-27), these are of narrow configuration and are adjacent to actively managed ponds, and as a result are considered to be too disturbed for otter breeding. In summary, due to habitat conditions, proximity to existing disturbance activities and distance from the development, no buffer zone is required in respect of disturbance to otter utilization of wetland habitat at Hoo Hok Wai arising from development in LMC Loop.

Although larger avoidance distances were calculated for Greater Spotted Eagle and Imperial Eagle, these species appear now to use the LMC and HHW area rather infrequently^[12-22], and there was only one record during the study. As a result, it is not considered necessary to provide mitigation for these species.

The exclusion distances were calculated on the basis that there is minimal visual human disturbance. In other words, people in buildings will not be highly visible from outside, and basic mitigation measures such as screening with fences (in the construction phase) and landscaping (in the operational phase) are implemented.

The years since construction of LMC Spur Line and Station have brought no data to contradict these assumptions, and consequently they are considered relevant for this Project. Accordingly, the area required for mitigation of impacts of disturbance arising from construction and operation of the Project is based on these, as the same species occur regularly in the fish pond areas adjacent to LMC Loop.

However, while these disturbance zones are considered appropriate for construction of tall buildings and viaducts, it is considered that for at-grade road construction the zones do not need to be so wide, as the disturbance caused by such works is significantly less with suitable mitigation (use of hoarding, quiet construction methodology, minimum use of percussion piling, restriction on the use of tall plant machinery). Although noise levels may be comparable, animals and birds habituate more readily to noise disturbance as long as it is neither explosive nor percussive, nor accompanied by visual disturbance. The latter is much reduced compared to development in the Loop.

Although no studies appear to have been carried out regarding the comparative disturbance impacts of high building and road construction, it is considered reasonable to assume that disturbance impacts of road construction are 50% less, given the relative lack of high level construction activity which results in lower levels of visible disturbance. Consequently, for the Western and Eastern Connection Roads the Exclusion Zone occurs at a distance of up to 50m, while the RDZ occurs between 50m and 100m.

As the Exclusion Zone is predicted to experience more or less complete avoidance by waterbirds, it requires compensation at a 1:1 basis in terms of land area. As the RDZ is assumed to experience, on average, 50% of the density of waterbirds, it requires compensation on a 1:2 basis.

Calculation of the overall land requirement to compensate for disturbance effects to large waterbirds is based on a sum of the land requirement to compensate for the Exclusion Zone around the developed area and the land requirement to compensate for the area of reduced density around the same area. For development in LMC Loop, no difference between the construction and operational phases is predicted. The boundary of works site and the boundary of developed area will, broadly speaking, be the same, and while noise impacts from heavy plant may be greater during the early stages of construction, visual impacts as buildings rise will be greater in the latter stages.

In calculating the final compensation requirement, the following principles were adopted:

- where an Exclusion Zone overlaps with a Reduced Density Zone, the Exclusion Zone takes precedence.
- only one disturbance effect is assumed in areas where there are two disturbance sources imposing a disturbance effect; although not relevant in

this case, where the two disturbance impacts differ in magnitude, that with greater impact is adopted.

- existing disturbance effects should not be mitigated for by this Project (this is particularly relevant to MTR LMC Spur Line, for which disturbance impacts are already mitigated).

According to the TM-EIAO, the provision of compensatory habitat should be on a like-for-like basis. As the scope for reprovision of fish ponds is highly limited, the solution appears to be enhancement of existing fish ponds to an ecological value higher than their current, pre-development value. This approach was adopted for the mitigation wetland for the LMC Spur Line and Station and has broadly been very successful, with two exceptions: Little Egret and Chinese Pond Heron, for which targets are not consistently met (see **Table 12.68a**).

With regard to the area of wetland mitigation for the LMC Spur Line and Station, as there were no baseline data for the area impacted, a mechanism was chosen whereby the managed wetland was required to achieve densities of target species twice those in comparable control areas nearby. However, the aim should be to compensate for functional value of the ponds impacted. Consequently, the critical data concern those recorded during baseline surveys in the areas impacted, and how these relate to what is achievable in a managed wetland.

With regard to the Eastern Connection Road, the fish ponds impacted are relatively undisturbed and are currently only affected by minor disturbance from the road along the boundary fence. With regard to LMC Loop, fish ponds along the northeastern side are similarly subject to relatively low levels of disturbance.

However, the fish ponds along the Meander to the southeast of LMC Loop currently experience higher levels of disturbance due to their proximity to the boundary fence road and the presence of human activity associated with fish pond operations; the narrow configuration of these ponds means that the impact of this existing disturbance is greater. For this reason, it is considered unnecessary to activate Exclusion and Reduced Density Zones in this area, especially as the nearest area of buildings lies to the other side of both the Meander and the Ecological Area, which is a distance of nearly 200m.

Table 12.68a Ratio of density of target species at wetland mitigation area for MTR LMC Spur Line to those in Control Areas 2008-2011 (LMC = recorded in wetland mitigation area only, CA = recorded in control areas only, nr = not recorded in either).

Density(mean/ha)	2008	2009	2010	2011
Great Cormorant	14.04	7.19	11.79	7.04
Grey Heron	22.11	20.00	23.79	12.23
Great Egret	2.63	1.99	4.22	3.04
Little Egret	1.59	1.02	1.33	1.25
Chinese Pond Heron	1.04	1.52	1.97	1.60
Black-faced Spoonbill	40.41	14.55	69.78	14.79
Common Teal	62.13	55.15	198.30	131.81
Greater Spotted Eagle	LMC	LMC	32.26	LMC
Imperial Eagle	LMC	108.24	LMC	LMC
Eurasian Hobby	nr	nr	LMC	2.45
Japanese Quail	CA	LMC	4.90	nr

Density(mean/ha)	2008	2009	2010	2011
Eurasian Coot	LMC	LMC	252.36	148.23
Pheasant-tailed Jacana	LMC	LMC	10.62	19.60
Greater Painted-snipe	47.23	119.20	52.27	70.44
Black-winged Stilt	6.77	7.38	1.77	4.45
Pintail/Swinhoe's Snipe	12.75	5.62	8.31	2.22
Common Snipe	6.09	3.37	6.60	2.45
Richard's Pipit	1.61	1.26	1.11	1.02
Bluethroat	6.75	22.49	LMC	LMC
Common Stonechat	2.95	2.06	2.07	2.45
Pallas's Grasshopper Warbler	13.49	2.25	7.76	2.1778
Zitting Cisticola	1.51	1.20	1.76	1.6305
Japanese Yellow Bunting	nr	nr	nr	nr
Red-billed Starling	1.10	0.94	3.80	1.6496
Black-naped Oriole	LMC	LMC	CA	CA

For fish ponds along or near Ha Wan Tsuen Road, the alignment of the Western Connection Road, the situation is more complex. Ponds along this road are already impacted by traffic, largely minibuses and police vehicles, as well as by adjacent village development. The proximity of LMC Spur Line also provides a considerable disturbance impact; importantly, these latter impacts have already been mitigated as part of the ecological compensation requirements for the Spur Line. If appropriate noise and visual barriers (3m or 5m) are installed along Ha Wan Tsuen Road, it is predicted that the marginal disturbance impacts of an upgraded road will be minimal during the operational phase, despite the increased traffic volume. Consequently, it is not considered necessary to mitigate for disturbance to ponds arising from this source in the operational phase, although there is a minor loss of fish pond of 0.92ha.

During the construction phase, however, disturbance to ponds that are not drained and are not under the disturbance shadow of the LMC Spurline viaduct will occur. Mitigation for this impact must be carried out in the same way as that for habitat loss, through ecological enhancement of existing fish ponds. However, given that large waterbirds only appear to utilise ponds 11 and 12, and as pond 11 will be drained during the construction phase, these disturbance impacts only relate to pond 12.

Regarding the Direct Link to LMC Station, the alignment runs through an area of disturbed ponds all of which lie in the disturbance shadow of the Spur Line. Consequently, mitigation for disturbance impacts is not required.

The elements of the Project relevant to a wetland compensation requirement are development of LMC Loop and the three infrastructural connections, the western and Eastern Connection Roads and the Direct Link to LMC Station. Construction work in LMC Loop will occur throughout the pre-operational stage, while construction of the two connection roads will occur separately within that period, with that of the Direct Link to LMC Station overlapping with that of the Western Connection Road. In chronological order, five phases can be identified, as shown in **Table 12.69**.

Table 12.69 Project components requiring wetland compensation

Phasing of Project (see Table 2.8)	Project Components	
	under construction	under operation
Advance Works	LMC Loop	-
Phase 1 Infrastructures	LMC Loop, WCR, Direct Link to LMC Station	-
Phase 1 Buildings	LMC Loop	WCR, Direct Link to LMC Station
Phase 2 Infrastructures	LMC Loop, ECR	WCR, Direct Link to LMC Station
Phase 2 Buildings (Full Operation)	-	LMC Loop, ECR, WCR, Direct Link to LMC Station

In terms of devising mitigation requirements, however, as construction and operational phase impacts arising from development of LMC Loop are the same this can be simplified into the following ecological compensation phase:

1. **Phase 1:** Construction and permanent (operational) impacts of development of LMC Loop. Given that construction and operational impacts of LMC Loop development are the same, it is necessary to put in place permanent mitigation areas before construction commences. (Advance Works / Phase 2 Buildings (Full Operation))
2. **Phase 2:** Temporary mitigation requirements arising from construction of the Western Connection Road and the Direct Link to LMC Station. These requirements are additional to those above. (Phase 1 Infrastructures)
3. **Phase 3:** Temporary mitigation requirements arising from construction of the Eastern Connection Road. These are also additional to number 1, above, but additional to number 2 only if they occur simultaneously. (Phase 1 Buildings / Phase 2 Infrastructures)

Figures 12.6 to 12.8 illustrate the impacted areas of habitats of conservation significance for each of these three provisions. It can be seen in **Figure 12.6** that permanent mitigation requirements arise from loss of reed marsh and marsh habitat currently in LMC Loop. In addition, to the northeast of the Loop, disturbance impacts arise from a 100-wide Exclusion Zone that is largely occupied by LMC Meander, and a further 100m-wide RDZ that impacts ponds in the same area that lie adjacent to the Meander. Direct loss impacts concern those habitats of ecological value under the footprint of the two connection roads and the Direct Link to LMC Station, as well as ponds or marsh that will inevitably be lost or seriously compromised as a result of construction.

Figure 12.7 illustrates the additional areas of habitats of conservation concern impacted during construction of the Western Connection Road. Construction of the Western Connection Road is a two-stage process that involves initial upgrading during the first year of construction, followed by more substantial upgrading five years later. As the first part of this process involves only resurfacing of the road and the creation or expansion of existing passing places, this

is regarded as equivalent to routine road maintenance, for which mitigation is not required.

However, the second part of this process involves more substantial work including raising the level, widening and installation of noise barriers. For this work, a number of ponds will be temporarily drained and some mitigation of disturbance impacts is required. Ponds 1-13 (**Figure 12.2**) largely lie in the disturbance shadow of the MTR LMC Spur Line, the impacts of which are already mitigated for as part of the wetland compensation area adjacent to LMC Station; for this reason, there is no requirement for mitigation in respect of these ponds where they lie in the disturbance shadow of the Spur Line viaduct or for disturbance impacts if they do not support large waterbirds; this leaves only Pond 12 subject to these impacts.

With regard to the Direct Link to LMC Station, the situation is complex due to impacts on wetland habitat that currently constitutes an element of the Environmental Permit requirement for that project. Underneath the viaduct is a wastewater treatment facility (which uses reeds to polish grey water) that, while compromised by its dedicated design for water treatment and location directly under the viaduct, does nevertheless have ecological value, impacts on which require mitigation. In addition, although not an ecological issue, the functional value as a wastewater treatment facility will require maintaining during the construction phase. **Figure 2.11** illustrates the areas affected by this connection.

Figure 12-8 illustrates the construction phase impacts of the Eastern Connection Road. As noted above, reduced disturbance impacts are predicted compared to LMC Loop, such that the Exclusion Zone occurs up to 50m distance, while the RDZ occurs from 50-100m. Permanent impacts under the footprint are mitigated as part of the permanent mitigation requirement. Although construction of the Eastern Connection Road is predicted to last for approximately three years, the duration of the required mitigation will be longer, as it needs to be established and functional prior to any construction activities. Impacts on reed marsh habitat in LMC Loop will be of a shorter duration as they are specific to the section of road that traverses the EA via underpass.

12.7.10.2 Calculation of Wetland Compensation Requirements

Impacts on wetland habitats that require compensation are summarised in **Table 12.70** and **Table 12.71**, and are illustrated in **Figure 12-6** and **Figure 12-7**.

Table 12.70 Summary of permanent impacts (ha) on wetland habitats arising from the Project. Compensation requirements are calculated at a 1:1 basis for habitat loss and Exclusion Zone (EZ) impacts, and 1:2 basis for the Reduced Density Zone (RDZ).

	LMC Loop			ECR	WCR	Direct Link	
	Habitat Loss	EZ (100m)	RDZ (200m)	Habitat Loss	Habitat Loss	Habitat Loss	Total
Reed Marsh	10.96						10.96
Pond impacted area		0.25	8.52	1.99	0.92	2.28	
Pond Compensation		0.25	4.26	1.99	0.92	2.28	9.70

	LMC Loop			ECR	WCR	Direct Link	
	Habitat Loss	EZ (100m)	RDZ (200m)	Habitat Loss	Habitat Loss	Habitat Loss	Total
requirement							
Marsh	0.50			1.76	0.07		2.33
Seasonally Wet Grassland				0.19			0.19
Total	11.46	0.25	4.26	3.94	0.99	2.28	23.18

Table 12.71 Summary of construction impacts (ha) on wetland habitats arising from the Project. Compensation requirements are calculated at a 1:1 basis for habitat loss and Exclusion Zone (EZ) impacts, and 1:2 basis for the Reduced Density Zone (RDZ).

	Habitat Loss	EZ (50m)	RDZ (100m)	Total
WCR & Direct Link				
Pond impacted	3.51	0.36	0.49	
Compensation requirement	3.51	0.36	0.24	
Reed Marsh	0.032			4.142
ECR				
Pond impacted	3.32	1.20	3.67	
Compensation requirement	3.32	1.20	1.84	6.36
Reed Marsh	1.10			1.10

LMC Loop

The size of the Ecological Area in LMC Loop is 12.78ha. It is proposed that, with appropriate management and planting of vegetation used by wetland-dependent species, the 12.78ha Ecological Area can be used to compensate for the loss of 10.96ha reed marsh and 0.50ha of freshwater marsh inside the Loop. Freshwater marsh comprises approximately 4.6% of the total area lost, and it would be appropriate to provide a similar proportion of this habitat in the final plan for the Ecological Area. As certain freshwater marsh fauna such as herpetofauna and dragonflies are relatively insensitive to disturbance, and as marsh vegetation has a lower height than reed, marsh would be suitable for placement in areas closest to human activity, and would provide a more diverse visual amenity for people viewing from the development area.

Although the current reed marsh in LMC Loop is almost entirely undisturbed, whereas the proposed Ecological Area will suffer minor disturbance from the need to provide an access track for management purposes along the boundary between the reed marsh and the buffer area, most reedbed dependent fauna are relatively disturbance tolerant. It is not predicted, nor required, that large, disturbance-sensitive waterbirds such as Great Cormorant, Grey Heron and Great and Little Egrets utilize the reed marsh, as they were not recorded utilising the existing reedbed. Furthermore, Great Bittern was not recorded, and only one Purple Heron was noted. For this reason, a 50m buffer zone is considered

sufficient. Notwithstanding this, it is anticipated that both Great Bittern and Purple Heron will use the EA once the reed marsh is established.

In terms of indirect disturbance impacts on adjacent fish pond habitats, these comprise 0.25ha in the EZ and 4.26ha in the RDZ. This 4.51ha requirement is provided for in the area set aside for permanent mitigation.

Western Connection Road

In respect of the WCR, permanent loss of pond 10 plus very minor areas at the edge of other ponds constitutes 0.92ha will occur; this is compensated for as part of the permanent mitigation requirement. In addition, there is also a minor loss of marsh comprising 0.07ha.

The construction phase will involve the draining of ponds 5, 10, 11 and 13. (draining of Ponds 3 and 4 is dealt with under Direct Link to LMC Station). The total area of ponds that require draining in the construction phase of the WCR only is 3.51ha. In addition, the indirect disturbance impacts along Ha Wan Tsuen Road (excluding the area of ponds within the disturbance shadow of the Spur Line viaduct) relate to pond 12 only, and are 0.36ha in the Exclusion Zone and 0.24ha in the RDZ, which equates to a mitigation requirement of 0.60ha. In total, this is 4.11ha.

Direct Link to LMC Station

Permanent loss constitutes 2.28ha, and arises from the loss of part of the pond that lies directly below the direct link, immediately to the west of the STEMDC (0.49ha), Pond 3 (0.26ha), Pond 4 (0.77ha), the pond south of Pond 2 (0.35ha) and the pond south of Pond 1 (0.41ha).

Temporarily lost for a period of three years during the construction phase is a single reed cell (part of the wastewater treatment facility for LMC Station); this has an area of 0.032ha (**Figure 12-7**).

In the operation phase the direct connection viaduct is predicted to have negligible ecological impact, as the area is already shaded and disturbed; in any event, it lies underneath the disturbance shadow of the Spur Line viaduct, disturbance impacts of which have already been mitigated in that project.

In terms of disturbance impacts in both construction and operational phases, these are not relevant in respect of large waterbirds, as this area is too disturbed for significant numbers of these species to occur. Only low numbers of small waterbird species were recorded in this area during surveys. All such impacts arising from the Direct Link to LMC Station are regarded as referring to ‘disturbed pond’, which has implications on the area in which mitigation can be implemented (see below).

Eastern Connection Road

In respect of the ECR, permanent wetland habitat loss will accrue from the loss of ponds 93 (0.63ha), and the parts of ponds 36, 37 and 38 that cannot be reinstated later (1.36ha); the total area is 1.99ha. The latter three ponds will be entirely drained in the construction phase, which means an additional habitat loss at this

time of 3.32ha. In addition, during the construction phase, disturbance impacts of 1.20ha in the Exclusion Zone and 3.67ha in the RDZ will occur, requiring 3.04ha of compensatory wetland (1.20ha plus 1.84ha). In addition, there is a permanent loss of marsh and seasonally wet grassland totalling 1.95ha.

With regard to reed marsh, temporary construction phase habitat loss of 1.1ha will occur.

Current calculations of the land area required for compensation are summarised in **Tables 12.70** and **12.71**. The total permanent wetland compensation requirement for the Project is 23.18ha, of which 11.46ha arises from direct impacts in LMC Loop and 11.72ha arises from impacts outside. The construction phase wetland compensation requirement is 4.11ha for the Western Connection Road, 0.032ha for the Direct Link to LMC and 7.46ha for the Eastern Connection Road.

12.7.10.3 Selection of Wetland Compensation Areas

Not all land is suitable for wetland habitats. Certain conditions are required, and the success of compensatory wetland habitats is dependent upon the condition of the land on which mitigation is provided. Land provided as wetland mitigation should be of sufficient in area to provide equivalent wetland function to the habitat being impacted, should have a low gradient, and preferably be on wetland soils capable of retaining water. A suitable water supply or an ability to store water should be present to ensure the wetland function can be retained during the dry season. It is preferable that any mitigation wetland should be located close to existing wetlands in order to maximise potential ecological links. Fragmentation should also be minimised; thus it is preferable for the wetland compensation to be provided in a single block rather than divided into a number of smaller land parcels.

Much of the land in Hong Kong conforming to these requirements already supports wetlands in some form, either seasonally or permanently. In some cases, these existing wetlands may be enhanced to provide wetland mitigation. The degree of enhancement that can be achieved depends upon the existing condition and value of the wetland habitat; habitats that are currently of high ecological value generally have little potential for enhancement, whereas habitats of low ecological value may have significant potential if suitable conditions and resources are available.

Mitigation measures for the MTRC Lok Ma Chau Spur Line^[12-41] have doubled the wetland value of existing fish ponds close to the Lok Ma Chau Station for many species, and the aim for this Project is to double the ecological value of an existing wetland area (on the basis that non-wetland areas are not available for mitigation purposes under this Project) identified for wetland compensation. On this basis, the search for suitable land has concentrated on finding an area equal to the area of wetland loss that will arise from development of the LMC Loop. However, it should be noted that for two species, Little Egret and Chinese Pond Heron, a doubling of numbers at LMC Station wetland mitigation area is not consistently achieved. Consequently, it is preferable for a slightly larger area of land to be provided for mitigation.

12.7.10.4 Principles of On-site and Off-site Ecological Mitigation

It is explicitly stated in Annex 16 of the TM of the EIAO that on-site mitigation measures are favoured over off-site mitigation. Section 5.4.3 of Annex 16 states that “From an ecological point of view, mitigation measures for ecological impact shall preferably be carried out on-site, and well in advance of the works rather than off-site, and after the completion of works.” According to Section 5.4.5, “(a) all possible design measures and all practicable on-site ecological mitigation measures shall be fully investigated in the EIA study and exhausted to minimise the loss or the damage caused by the Project to the ecological habitats or species” and “(c) if the residual ecological impacts require mitigation and all practicable on-site ecological mitigation measures have been exhausted, off-site ecological mitigation measures shall be provided”. Off-site mitigation is therefore only considered appropriate when all possibilities for on-site mitigation have been exhausted.

On-site mitigation can more effectively mitigate for all ecological functions being impacted by a proposed development than is the case for off-site mitigation. Certain ecological functions may be location-specific; for example, the range of certain species may be location-dependent or the species that are impacted by the proposed development may not be present in the location of any proposed off-site mitigation. This is particularly true for species of low mobility, such as fish, herpetofauna and some invertebrates, which are often not evenly distributed across Hong Kong and may not be able to disperse effectively into the location of off-site mitigation.

The conditions present on site may not be replicated at the location of any off-site mitigation. The ecological function of wetlands impacted by the proposed development could not be mitigated in upland areas or areas with high gradient, or in areas where soils and hydrological conditions are not comparable to those present in the area of impact.

Generally speaking, ecological conditions of any site of proposed mitigation are more similar to those being impacted the closer they are to the site of impact. Mitigation for the impacts of the proposed development would be most successful if provided near to the area of impact; while it may be possible to compensate for some of the ecological impacts by enhancement of an area in another part of Hong Kong, there is no certainty that the habitat to be provided would replicate the range of conditions currently present.

As far as this Project is concerned, on-site mitigation is provided in the form of the Ecological Area and its associated buffer zone, as well various measures to minimise disturbance or other secondary impacts such as run-off. All direct habitat loss impacts in LMC Loop will be mitigated for on-site, as are fragmentation impacts associated with the flight line corridor. With regards to indirect impacts of development of LMC Loop (mainly disturbance to adjacent wetland habitats), however, these are to be mitigated off-site, albeit in immediately adjacent wetlands.

A lower development density could allow a larger area of on-site mitigation; justification for the RODP selected is provided in **Section 2.3**. The Hong Kong and Shenzhen governments have a shared objective to optimize the utilization of the scarce land resources of the Loop. Taking into account public views received

in 2008, land uses involving higher education as the primary land use complemented by high-tech R&D and C&C Industries were proposed for the Loop. Based on the proposed land uses, development options with varying GFA intensities were tested for flexibility and attractiveness of the Loop for development. Of the options assessed, it was considered that the lower end development intensity involving 1,200,000m² GFA was appropriate to achieve a critical mass that would make the Project attractive for development, while having due regard to minimizing ecological and environmental impacts. Based on the principle of sustainable development, the Loop development aims to incorporate nature conservation and development that balances environmental, social and economic concerns.

In regard to sources of impact for which off-site mitigation is required, justification for the choice of alignment of the Western and Eastern Connection Roads is provided in **Sections 2.4.1.2 and 2.4.1.6**.

In terms of direct and indirect impacts arising from road connections, on-site mitigation is not feasible due to the narrow configuration of the footprint of infrastructural connections (WCR, ECR and Direct Link). For this reason, off-site mitigation must be employed. Ideally land immediately adjacent to these connecting roads would be used to mitigate impacts; the reality, however, is that ownership poses a significant constraint on the availability of suitable land for mitigation. Effectively, it is only government-owned land or land that must be resumed for the purpose of implementing the Project that is available. Potential areas in the vicinity of LMC Loop that meet these conditions are illustrated in **Figure 12.9**.

The proximity of Area 2 and Area 5 to LMC Loop means these are the most suitable sites for mitigation of indirect impacts arising from its development. Area 3 is also suitable based on the issue of proximity, though slightly less so. Area 4 appears to be the most suitable area to compensate for impacts arising from the Eastern Connection Road, but the possibility of using this area for permanent compensation needs further investigation at the time of detailed planning for that element of the Project, as it is not currently government-owned land. Area 6 is the most suitable mitigation area for impacts arising from the Direct Link to LMC Station and the Western Connection Road. However, this area is already disturbed, and will be more so once the Direct Link is constructed, which together reduce greatly its suitability.

Section 2.4 describes the pros and cons of the three options considered for the Direct Link to LMC Station. Neither of the two options not selected are financially viable without government support, and both require additional structures above the Meander, which impose greater ecological impact. The alignment was adjusted to minimise impacts on wetlands associated with LMC Station.

The remaining potential areas are somewhat further removed from the sites of impact. Area 1 lies to the northeast of Area 2 with limited connectivity, while Areas 7, 8 and 9 lie to the southeast of MTR LMC Station; the latter are, however, contiguous, forming a single block of wetland.

In determining the suitability for wetland compensation of given off-site areas a range of factors need to be considered; these are dealt with in the next section.

12.7.10.5 Identification of Sites for Wetland Compensation

Based upon the above criteria, nine sites have been identified as having potential for mitigation of the impacts of the Loop development. These are shown in **Figure 12.9**. Details of these sites and the potential opportunities and constraints are summarised in **Table 12.72** below, with more detail provided in **Appendix 12-14**.

Table 12.72 Breakdown of temporary wetland mitigation requirements (ha) arising from the Project.

Area	Size (ha)	Enhancement potential
EA	12.78	Very high. Could provide suitable mitigation for loss of reed marsh.
1.	3.53	High. Could provide suitable mitigation for large waterbirds as, although of linear shape, disturbance levels very low.
2.	7.96	High. Could provide suitable mitigation for large waterbirds (especially in those areas outside of the RDZ). Areas in RDZ could be converted to marsh to attract smaller birds, herpetofauna and dragonflies.
3.	5.40	Moderate. Potential inhibited by a combination of shape, access issues and disturbance from development in LMC Loop.
4.	3.10	High. Could provide suitable mitigation for large waterbirds and is ideally placed to mitigate impacts on the flight line and terrestrial ecological corridor.
5.	3.04	Moderate. Potential inhibited by a combination of shape, access issues and disturbance from the LMC Loop.
6.	5.74	Low in the construction phase due to significant disturbance from construction activities for the Direct Link to LMC Station. Current low value could be enhanced through the creation of new wetland areas and combining smaller ponds into one large water body. However, even in operational phase, would not be suitable as large waterbird habitat.
7.	3.45	Moderate. Could provide suitable habitat for small birds. Existing connectivity with Area 8 could be enhanced.
8.	35.14	Low. Current value very high following implementation of extensive and intensive ecological enhancement measures as mitigation for the impacts of the LMC Spurline.
9.	7.00	High. The area includes one former fishpond which is no-longer wetland habitat (wetland creation rather than enhancement) and is adjacent to areas actively managed for large waterbirds. Latter connectivity could provide synergistic benefits.

12.7.10.6 Approach to Wetland Mitigation

Permanent Mitigation

All wetland loss (11.46ha) arising from the development of LMC Loop itself will be mitigated for within the Loop. This will take the form of a 12.78ha Ecological Area that includes permanent wetland (reed and freshwater marsh), with the remainder being designed such that it provides habitat for the target species and other wetland dependent fauna (through, for example, provision of roost sites for ardeids, the use of appropriate strengthening of slopes that allows growth of

vegetation and integrating any planting with the reedbed area so that the terrestrial areas are also utilised by reedbed associated birds).

Target species proposed for the mitigation wetland habitats are provided in **Section 12.8.2**. Once these are defined, measurement of current baseline levels of each species using existing reed and marsh habitats in LMC Loop needs to be carried out. Whilst these habitats were fully assessed during field work for the current Study (including the use of mist-netting to detect cryptic species), this work did not aim to determine the levels (i.e. density) at which potential target species were occurring, as this is not required as part of the EIA process. Consequently, surveys carried out in the current EIA are insufficient for this purpose, and further systematic surveys (using standardised mist-netting methodology) are required in order to determine baseline targets levels for certain cryptic reed marsh species. These should cover the ten months of August to May (June and July are excluded due to the lack of target species at that time), and be undertaken prior to any works affecting the reed marsh within the LMC Loop. A number of common reedbed passerines went unrecorded during the transect surveys (e.g. Pallas's Grasshopper Warbler), but were trapped during mist-netting surveys. Mist-netting is widely acknowledged as the most effective way to sample to reedbed passerines.

It is proposed that standardised mist-netting surveys be carried out during the establishment period of the compensatory reed marsh within the EA, and that these cease once it is established that the mitigation measures are effective in meeting the required target levels (above). Following the cessation of mist-netting, monitoring of habitat parameters in conjunction with transect surveys is considered sufficient.

As can be seen from the final row of **Table 12.70**, the total land area required outside LMC Loop for permanent wetland mitigation is 11.72ha (23.18 – 11.46). However, this figure includes 2.28ha of disturbed fish pond lost as a result of the Direct Link to LMC Station. For these reasons, it is proposed to compensate for this loss separately (see below). By removing this wetland area, this reduces the wetland requirement to 9.44ha.

In addition, given that the operational phase impacts of the ECR, which require 3.94ha of compensation wetland, do not occur until some years into the Project, it is not necessary to establish mitigation for these impacts until near the beginning of the ECR construction period. This reduces the initial permanent mitigation requirement in areas outside the EA to 5.50ha, comprising 5.43ha of undisturbed pond (4.51ha of indirect impact of development in LMC Loop plus 0.92ha of habitat loss arising from the WCR) and 0.07ha of freshwater marsh (**Table 12.70**). However, provision of only 0.07ha of marsh will provide a habitat of reduced functional value due to the very small size; consequently, it is proposed to provide the full complement of off-site permanent marsh (1.76ha + 0.07ha) and seasonally wet grassland (0.19ha) mitigation (the latter mitigation taking the form of marsh), totalling 2.02ha, right at the outset, so as to guarantee an effective area of this habitat. The total area of initial wetland mitigation is thus 7.45ha.

Area 2 provides 7.96ha of land. However, of this 3.80ha lies within the RDZ of impact for buildings in LMC Loop, of which 3.14ha is currently pond and 0.66ha is marsh. This means that the ecological value of pond habitat (which is the only

habitat subject to disturbance impacts at such a distance) in this area after commencement of construction will reduce to approximately 50% of potential levels. However, the aim of the mitigation areas is to ensure that current baseline levels of fauna utilising impacted areas remain after implementation of the Project. Data collected for this Study indicate that the mean number per survey in the whole of Area 2 was 0.08 for Great Cormorant and 0.17 for Little Egret, which translate into densities of 0.01/ha and 0.02/ha respectively. Given the densities of these species recorded at LMC WMA (**Table 12.68a**) and the shielding effect of the 2.02ha marsh to be provided within the RDZ of Area 2 along LMC Meander, it is considered that these numbers can easily be achieved by doubling the existing ecological function of the remaining 1.78ha (3.80ha – 2.02ha) pond area within the RDZ of Area 2.

It should also be remembered that the reed marsh in the EA is likely to be attractive to such species as Little Egret, as the design will include open water areas for microhabitat diversity, unlike the reed marsh currently present in LMC Loop. Such use would also form an element of the mitigation for this species.

Deducting 1.57ha (the effective wetland value of 50% of the 3.14ha of pond habitat in the RDZ) from the 5.43ha undisturbed pond requirement reduces the requirement to 3.86ha, which is easily achieved in the remaining 4.16ha of (7.96ha minus 3.80ha) of Area 2.

In terms of the 2.28ha of disturbed fish ponds that require compensation as a result of habitat loss occurring due to the Direct Link to LMC Station, it is proposed that the 3.45ha Area 7 is used for this purpose. These ponds lie alongside the boundary fence road and are surrounded by trees; as a result, they are unsuitable for large waterbirds. They can, however, function as mitigation for disturbed fish ponds or disturbed reed marsh habitats. That this area of ponds lies adjacent to an existing wetland mitigation area enhances its potential value as a managed wetland. Area 7 is 1.17ha larger than the required area of wetland; in order to provide a contingency for failure to meet targets elsewhere, the whole area will be utilised as pond, except for a period of three years during the construction phase of the Direct Link, when a minimum of 0.032ha will be utilised for disturbed reed marsh (see below).

With regard to the impacts of the ECR, subtracting the 1.95ha of marsh provided in Area 2 (above) from the total wetland requirement of 3.94ha results in a need for 1.99ha of pond habitat, which can be provided in either the 3.10ha of Area 4, which comprises the remaining part of the three fish ponds (Pond 36-38) through which the ECR passes, or Area 9, which would cease to be required for construction phase mitigation (see below). In terms of efficiency and ease of management (given the proximity to existing AFCD-managed wetland), Area 9 would seem to be preferable. Area 9, which is 7ha in area, is substantially larger than the 1.99ha required; this will ensure adequate provision for Little Egret and provide a contingency in case of unforeseen circumstances. If appropriate, the requirement for this surplus can be reviewed at an appropriate time in the future.

However, the use of Area 4 has other substantial benefits in terms of protecting both the flight line and terrestrial elements of the ecological corridor through the area, as well as bringing into permanent management an area of wetland that appears to be important for Eurasian Otter. It can, thus, also function as mitigation

for potential impacts on that species. However, there are issues as to whether this land, which would need to be resumed for the construction phase, can continue to be used as wetland mitigation in the operational phase (based on the precedent set by the West Rail mitigation areas, this may be possible). Given this uncertainty, it is currently assumed that Area 9 will be used. The possibility of using Area 4 or other areas should be reviewed during the further ecological assessment and design stages for the Eastern Connection Road, including the feasibility of having the required wetland in place before the operational phase. This can be done under the approved EIA Report and EP conditions.

It should be noted that construction of the ECR is not scheduled to commence for many years, and much could happen in the interim. For example, land use in the HHW area may change as a result of the new OZP currently being devised for the area, or the requirements and thus the design of the road may change. For this reason, the ecological impacts of this element of the Project should be re-assessed, which process should include the formulation of an updated ecological baseline and a review of the mitigation strategy. Changes to the HCMP may also be required.

Temporary Mitigation

During the construction phase most of the area within LMC Loop will be occupied by various construction activities, and idle land will be highly fragmented both geographically and temporally. Consequently, it does not appear possible to provide temporary mitigation within LMC Loop, as the disturbance impacts from construction work and fragmentation would prevent the wetland habitats created from supporting the required suite of disturbance-sensitive, large waterbirds.

Construction phase mitigation requirements for the WCR comprise 3.51ha of pond loss and 0.60ha of disturbance impacts, totalling 4.11ha. For the Direct Link to LMC Station wetland loss confined to the construction phase relates to 0.032ha of reed marsh; in view of the location, this is regarded as 'disturbed reed marsh', and can be mitigated accordingly in Area 7. During construction of the ECR, in respect of pond habitat direct loss constitutes 3.32ha, while disturbance impacts require 3.04ha; the total requirement is 6.36ha. In respect of reed marsh habitat, direct loss constitutes 1.1ha.

A maximum of 6.36 ha of temporary pond habitat mitigation is required. Based on this, the use of Area 2 for permanent mitigation and the use of Area 7 for the disturbed pond and reed marsh mitigation requirement arising from the LMC Direct Link, only Area 9 is available and suitable as mitigation for construction phase impacts on fishponds arising from the WCR and ECR. Area 9 has an area of 7.00 ha, which is sufficient to compensate for this loss, as well as providing a 10% contingency during construction of the ECR (more during construction of the WCR) that allows extra provision for Little Egret.

With regard to reed marsh habitat loss and disturbance arising during construction of the underpass below the EA, 1.10ha is required. This is best reprovisioned in Area 4 (ponds 36-38), which is on-site in respect of the ECR as they require to be drained during construction. Given Area 4 comprises 3.10ha, there is sufficient

land available. The use of all this area as reed marsh will compensate for any temporary loss in EA.

Table 12.73 summarises the approach to wetland compensation from the Project. In summary, Areas 2 and 7 would be utilised at the outset for permanent impacts, while Area 9 would initially be required for construction phase impacts; upon full operation of the project, approximately 30% of Area 9 or 70% of the remaining part of Area 4 would be required for permanent impacts of the ECR.

Table 12.73 Summary of preferred approach to wetland mitigation requirements arising from the Project.

Phase	Compensation area required (ha)	Area used for compensation
<u>Phase 1</u> Construction Phase: LMC Loop, WCR and Direct Link.	LMC Loop permanent direct impacts: 11.46 LMC Loop permanent indirect impacts: 4.51 WCR: direct and indirect impacts: 4.11 Direct Link: 2.312 direct impacts	EA Areas 2, 7 and 9
<u>Phase 2</u> Construction Phase: ECR Operation Phase: LMC Loop, WCR and Direct Link.	LMC Loop permanent direct impacts: 11.46 LMC Loop permanent indirect impacts: 4.51 ECR: direct and indirect impacts: 6.36 WCR: permanent direct impacts: 0.99 Direct Link: permanent direct impacts 2.28	EA Areas 2, 4, 7 and 9
<u>Permanent Impacts</u> Operation Phase: all elements.	LMC Loop direct impacts: 11.46 LMC Loop indirect impacts: 4.51 ECR: direct impacts: 3.94 WCR: direct impacts: 0.99 Direct Link: direct impacts: 2.28	EA Areas 2, 7 and 9 (or 4)

12.7.11 Ecological Enhancement Measures

In view of the emphasis on sustainability aspects of the Project, it is appropriate to incorporate features that will, as far as practicable, enhance the ecological value of LMC Loop and areas associated with its infrastructural connections. In this respect, the following measures will be incorporated; design and implementation of these should be carried out in consultation with a qualified and experienced ecologist. The Project Proponent should make these a requirement of tender documents for the relevant elements.

- Use of largely native species in landscaping for LMC Loop and associated connection roads, with an emphasis on species of ecological value that provide foraging and resting opportunities for fauna. This is of particular relevance in terms of avifauna, as currently LMC Loop supports a representative selection of the birds that occur in such habitats in the Deep Bay area
- LMC Loop currently includes small areas of plantation and orchard, both of which habitats are considered to be of low ecological value, for which compensation is not required. However, it is suggested that along the edge of and within the compensatory reedbed, small trees such as willows and fruit-bearing trees are planted, as they provide substantial food resources for insectivorous and frugivorous bird species. In general small trees only should be planted in the reed marsh in order to maintain the open aspect of the reedbed, which is important for larger species such as Purple Heron.

- Provision of bat boxes on utility buildings and in the buffer zone to the EA to provide roost sites. In addition to the fact that a lack of suitable roost sites is probably a constraining factor in terms of numbers of bats in the Deep Bay area, bats can help reduce numbers of pest species such as mosquitoes, with some species of bat eating over 1000 small insects in an hour^[12-34]. Some bat species will readily occupy purpose built roosts^{[12-5] [12-51]}.
- Encouraging the design of villa-style frontages on utility buildings, similar to those of nearby village houses where the roof overhangs the main body of the house, benefits Barn Swallows, which will feed on flying invertebrate prey (Duff & Symes 2009), including mosquitoes. Barn Swallows construct a neat cup-shaped nest made from mud and lined with grasses, feathers or other soft materials, against a suitable vertical projection (i.e. the wall of the house) where there is overhead cover (i.e. the overhang of the roof or ceiling). Similarly, such structures could have specific artificial bats roosts designed and easily integrated without loss of a building's original functionality. The actual bird and bat species to be targeted, along with the details of construction, location and type (nest box or roost) should be further developed in the detailed design stage by an experienced ecologist.
- In recent years, the provision of nest-boxes for White-shouldered Starlings at the MTR LMC Spur Line WMA has resulted in substantial growth in the breeding population of a species regarded as of Local Concern by Fellowes *et al.* (2002)^[12-31]. This indicates that a lack of suitable nest sites is a significant limiting factor on the HK population of this species. Provision of suitable nest boxes as part of the Ecological Area and/or associated buffer zone would provide further suitable nest sites for a species that is only locally distributed in HK.

Section 12.9.1 summarises the mitigation measures to be implemented in respect of the various ecological impacts and assesses the severity of any predicted residual impacts.

12.8 Implementation of Mitigation

This section addresses item 3.4.13.4(x) of the EIA Study Brief for the Project, which requires that the Project Proponent *evaluate the feasibility and effectiveness of the recommended mitigation measures and define the scope, type, location, implementation arrangement and maintenance of such measures*.

A Habitat Creation and Management Plan in respect of the Ecological Area and any other ecological mitigation areas, including determination of target species and monitoring protocol, the objectives, detailed design, implementation, maintenance and management requirements of all the mitigation wetland areas requires drawing up in advance by the Project Proponent or its designate prior to construction works. To facilitate this, measurement of current baseline levels of target species using existing reed and marsh habitats in LMC Loop needs to be carried out in order that target levels can be established (as described in **Section 12.7.10.6**). In addition, baseline faunal data requires collection for the off-site mitigation Areas 7 and 9, which were not surveyed as part of this Study due to

their being functionally separate from impacted areas or lying outside the Ecological Assessment Area.

12.8.1 Guiding Principles

The guiding principles upon which the mitigation proposals have been created are as follows:

- a) Recognition of the value of the Deep Bay wetlands.
- b) Recognition of the potential of mitigation measures to contribute to the maintenance and enhancement of the wildlife value and habitat diversity of the Deep Bay Wetland system.
- c) Recognition that faunal targets for the mitigation areas should be based upon clear conservation objectives arising from the constraints of the Project (including its size and proximity to established developments, wetland areas etc.), the need to mitigate for any potential adverse impacts of any development on habitats, flora or fauna of conservation importance and any broader ecological enhancement opportunities presented.
- d) Recognition that wetland enhancement or rehabilitation has a proven track record in HK (relevant examples here include wetland rehabilitation or enhancement for the Lok Ma Chau Spur Line, West Rail, HK Wetland Park and the Yuen Long Bypass Floodway).
- e) Requirement that hydrological changes as part of the wetland rehabilitation must not increase the flood risk to other basin users.
- f) Requirement that the habitats should be largely self-sustaining: once the recreated wetlands are established, management should largely be limited to maintenance work. This should still allow for adaptive management, whereby management practices change in response to on-site conditions (especially in response to any failures to attract Key Species, or to the use of the habitats by species of conservation importance that are not target species).
- g) Acknowledgement of the importance of an understanding of the habitat requirements of target species, the feasibility of the provision of the required habitats and a realistic assessment of the likelihood that the habitats will be utilized once they are created.
- h) Recognition of the ecological value of any existing habitats on site, whilst acknowledging that wetland restoration may require significant alterations to other habitats which are of little or no ecological value at present.
- i) Recognition that monitoring is essential to assess the success or otherwise of the rehabilitated wetlands and to inform management decisions.

12.8.2 Key Species Requiring Mitigation Measures

Following a review of the baseline data, the Key Species requiring mitigation have been identified; it is these species for which the mitigation areas will be primarily designed and which form the basis of construction and operational phase targets for the Project as a whole.

Key Species are those which fulfil one of the following requirements:

- Any species of Conservation Importance based upon criteria provided by BirdLife International and Fellowes *et al.* (2002), which was recorded in the impacted areas/habitats in numbers considered to be of significance during the baseline ecological surveys; or
- Any species that, although not of conservation concern, was recorded in the impacted areas/habitats in numbers sufficiently high to indicate that their distribution and abundance in Deep Bay or HK as a whole would be significantly impacted by the proposed development.

During the assessment process the baseline ecological survey data were reviewed and the species that meet these requirements are summarised in **Table 12.74**.

Birds

Of the species of conservation concern listed, eight are considered to have occurred in sufficient numbers during at least one of the phases of the Project to qualify as a Key Species. These include Great Cormorant, Little Egret, Chinese Penduline Tit, Pallas's Grasshopper Warbler and Bluethroat.

In addition, although not species of conservation concern, the number of individuals recorded (particularly during mist netting within the LMC Loop) for Dusky Warbler, Oriental Reed Warbler and Black-browed Reed Warbler indicate that LMC Loop is important for these species (in a HK context); accordingly these are also considered to be Key Species.

Mammals

Two species of conservation concern, Eurasian Otter (see also **Appendix 12-7**) and Leopard Cat qualify as Key Species.

Herpetofauna

Three species of conservation concern, Two-striped Grass Frog, Chinese Bullfrog and Common Rat Snake meet the requirements for Key Species.

Odonata

Five species of conservation concern qualify as Key Species, namely Scarlet Basker, Ruby Darter, Common Evening Hawker, Sapphire Flutterer and Coastal Glider.

Butterflies and Aquatic Fauna

None of the butterfly or aquatic fauna species recorded during the ecological surveys meet requirement for Key Species.

In summary, 19 species were identified as Key Species requiring mitigation measures. These are summarised in **Table 12.74**, and a summary of their habitats requirements is detailed in **Appendix 12-13**.

Table 12.74 Key species for mitigation areas

Species	Basis of qualification
Great Cormorant	Potential Regional Concern (Fellowes <i>et al.</i> 2002).
Little Egret	Potential Regional Concern (Fellowes <i>et al.</i> 2002).

Species	Basis of qualification
Chinese Penduline Tit	Regional Concern (Fellowes <i>et al.</i> 2002).
Dusky Warbler	High numbers recorded.
Oriental Reed Warbler	High numbers recorded.
Black-browed Reed Warbler	High numbers recorded.
Pallas's Grasshopper Warbler	Local Concern (Fellowes <i>et al.</i> 2002).
Bluethroat	Local Concern (Fellowes <i>et al.</i> 2002).
Eurasian Otter	Potential Regional Concern (Fellowes <i>et al.</i> 2002).
Leopard Cat	Vulnerable in China (CSIS 2010).
Two-striped Grass Frog	Local Concern (Fellowes <i>et al.</i> 2002).
Chinese Bullfrog	Potential Regional Concern (Fellowes <i>et al.</i> 2002).
Common Rat Snake	Potential Regional Concern (Fellowes <i>et al.</i> 2002).
Scarlet Basker	Local Concern (Fellowes <i>et al.</i> 2002).
Ruby Darter	Local Concern (Fellowes <i>et al.</i> 2002).
Common Evening Hawker	Local Concern (Fellowes <i>et al.</i> 2002).
Sapphire Flutterer	Local Concern (Fellowes <i>et al.</i> 2002).
Coastal Glider	Local Concern (Fellowes <i>et al.</i> 2002).

12.8.3 Summary of Habitats to be Provided as Mitigation

Section 12.7.10 details the habitats and areas required to be provided as mitigation for the duration of the Project. The total mitigation area to be provided exceeds that requirement in order to ensure adequate provision for Little Egret, and to provide a contingency (mainly in Area 9) in case of unforeseen circumstances in the long construction period.

In dealing with this extra provision it is proposed that non-pond habitats are provided for at a 1:1 ratio, while the additional area is provided as pond habitat. There are two main reasons behind this proposal. Firstly, experience elsewhere (LMC WMA) has shown that targets for certain fishpond species may be less easily achieved than for other wetland habitats; secondly, the mitigation areas are largely fishpond habitats currently; as such, it is more cost effective in the first instance to retain them as (enhanced) fishponds rather than convert them to other habitats. If, in the longer term, targets fail to be met for species utilising other habitats, there is scope at that stage to provide additional area of that habitat through the conversion of enhanced fishponds. The area and location of the proposed mitigation areas during the construction and operational phases of the Project are listed in **Table 12.75**.

It is anticipated that the design of the EA will include open water areas to increase habitat and faunal diversity, while at the same time providing extensive areas of closed reed habitat. Thus, the Ecological Area is likely to support wetland species such as Little Egret, Great Egret and Chinese Pond Heron that are not supported by the existing reedbed in the Loop due to the lack of open water areas. Consequently, in addition to providing habitat compensation, the EA should also be able to support target species such as Little Egret for which, as noted above,

achieving targets at the mitigation wetland for the MTR LMC Spur Line and Station has proved problematic.

As noted above, the long time lag between commencement of works and commencement of construction of the Eastern Connection Road requires that the ecological baseline, impact assessment and mitigation strategy be reviewed in a separate, future submission in order to ensure the approach adopted is valid and suitable to the conditions prevailing at the time. Currently the mitigation requirement for the Eastern Connection Road is 1.99ha of pond and 1.95ha of freshwater marsh (including impacts on 0.19ha of seasonally wet grassland).

Table 12.75 Area (ha) and habitats of proposed mitigation areas during Construction Phase (CP) and Operational Phase (OP) of the Project.

Area (ha)	Habitat	OP (ha)	CP (ha)	Actual requirement (ha)
Initial Permanent Mitigation (LMC Loop, WCR and LMC DC)				
Ecological Area (12.78)	Reed Marsh	10.96		10.96
	Marsh	0.50		0.50
Area 2 (7.96)	Marsh	2.02		0.07
	Pond	5.94		5.43
Area 7 (3.45) ¹	Pond	3.418		2.28
WCR, LMC DC and ECR construction phases				
Area 9 (7.00)	Pond		7.00	4.11 to 6.36
Area 7 (3.45) ¹	Reed Marsh		0.032	0.032
Area 4 (3.10)	Reed Marsh		3.10	1.10
Final Permanent Mitigation				
Ecological Area (12.78)	Reed Marsh	10.96		10.96
	Marsh	0.50		0.50
Area 2 (7.96)	Marsh	2.02		2.02
	Pond	5.94		7.42
Area 9 (7.00)	Pond	7.00		
Area 7 (3.45) ¹	Pond	3.45		2.28

Notes

[1] Used for 'disturbed' pond and reed marsh habitat (see Section 12.7.10.6).

12.8.4 Implementation

The Project Proponent will be responsible for the creation, enhancement and management of all mitigation areas during both construction and operation phases of the Project, and undertakes sole responsibility for management in the long term, or until a successor can be found to the satisfaction of EPD or its agents. The mitigation areas will be maintained and managed as a separate entity from the developed areas of the Project, and appropriately qualified ecologists with wetland design and management experience will be responsible for detailed design, supervising implementation of the mitigation areas and for long term monitoring. In addition, a specialist contractor with experience in wetland construction and planting will be appointed to carry out works for the construction, establishment and the subsequent management of the mitigation areas.

A conceptual implementation programme is illustrated in **Table 12.76**. Although there is a gap between operation of the temporary mitigation for the Western Connection Road and Eastern Connection Road, given the time and cost associated with establishing mitigation areas, it is likely to be more cost-effective that it (Area 9) continues to operate as such in this interim. Moreover, this also allows scope for delays in construction of the earlier element or advancement of the later.

Table 12.76 Implementation schedule for wetland mitigation areas

Year	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13
Ecological Area																
Permanent																
WCR construction																
ECR construction																

Note: Paler grey indicates habitat creation and establishment period; darker grey indicates operational mitigation period.

12.8.5 Mitigation of Reed Marsh Loss

12.8.5.1 Location

Development of the LMC Loop will result in the loss of all existing habitat, of which the most significant is 10.96 ha of reed marsh. Mitigation for this will be through the provision of compensatory habitats in a 12.78 ha Ecological Area along the southeast edge of the LMC Loop, adjacent to the LMC Meander.

As detailed in **Section 12.7.2.1** it is proposed that habitat compensation in the form of a reprovisioned reed marsh is most appropriate. The provision of a purpose-built area of compensatory reed marsh habitat facilitates more effective ecological enhancement through targeted design and minimization of fragmentation and disturbance impacts. Such an approach allows not only compensation of the existing reed marsh but also facilitates enhancement of the value of this habitat by integrating it into a single, unfragmented, managed wetland (the existing reed marsh areas suffer from habitat fragmentation). Further, this enhancement can be achieved in a more cost-effective manner that is less disruptive in terms of management activities to other stakeholders in the LMC Loop, as well as allowing more efficient utilisation for development of the available land area in LMC Loop.

The Ecological Area will be located along the southeastern edge of the LMC Loop (see **Figure 12.10**). The location of the Ecological Area along the southeastern edge of LMC Loop has been carefully selected to maximize the effectiveness of the mitigation area and to buffer adjacent areas of existing ecological value from the proposed development. The location maximizes connectivity with existing wetland habitats and, most importantly, provides an important wetland buffer for the flight line corridor (see **Section 12.7.6.1**). This forms part of a strategy to minimize disturbance to ecologically sensitive habitats across the Project Area. The measures below refer to both the EA and the separate

portion of it that requires reprovision in Area 4 during the construction of the Eastern Connection road underpass in the Loop.

12.8.5.2 Ecological Enhancement

In order to optimize the ecological function of the reed marsh within the Ecological Area (EA), it requires to be permanently under water. This is essential to the formation of homogenous stands of Phragmites reeds and will minimize the colonization of other, unwanted plant species within the reed marsh area. Channels within each cell will facilitate the distribution of water and will be important in providing habitat for Eurasian Otters and wetland bird species that utilise open water habitats. The Ecological Area will be divided into approximately five cells with an average size of approximately 2 ha, each separated by internal bunds. This subdivision into cells is required to facilitate water management, to provide access for management and monitoring, and to minimize the risk of potentially harmful events such as pest or plant disease outbreak.

Following site formation and installation of water control structures, the reed marsh areas will be planted with Phragmites already present on-site. This will significantly reduce the risk of unwanted species or pests being imported to the EA^[12-26] and eliminate the need to buy plants. It is anticipated that a reed marsh nursery will be established at an early stage of the construction of the EA to provide a nearby source of reeds, which will save time and cost in transplanting. More detail regarding reed marsh establishment (including alternative establishment options) can be found in **Appendix 12-15**.

Operational water depths will vary, but during the wet season will generally be kept at a maximum of 1 m in reed marsh areas, and up to 2 m in those areas that are required to be open water. During the dry season operational water levels will be approximately 0.5 m lower, with water levels in reed marsh areas maintained at approximately 0.5 m.

In addition to reed marsh habitats, an area of 0.5 ha of marsh will be provided. This will replace a similar sized area of marsh that will be lost as a consequence of the development of the LMC Loop. The existing marsh is characterized by heavily vegetated pond margins and extensive areas of floating aquatic vegetation. The marsh that will be provided as mitigation will provide a comparable vegetation structure.

The height and width of all external and internal bunds will be designed in order to minimize the area they occupy but will take into account requirements relating to hydrology and stability. Such bund areas, in addition to constituting an intrinsic part of the wetland function of the EA, offer opportunities to increase the biodiversity of the area through the provision of other habitats on site. Through planting such areas with a mixture of short grasses and native trees and shrubs, additional habitat can be provided for most of the Key Species. Use of grased cellular concrete, where desirable, will be made to facilitate this.

The EA will be designed to ensure all areas that are required to be permanently wet will be at or below the level of the water table, which will ensure that dry season water levels can easily be maintained. The alternative is to have a perched wetland (i.e. above the water table) with an impermeable liner (either natural or

man-made); however, such a design would be entirely dependent on rainwater as a water supply and, given the size of the EA, this is considered imprudent. Constructing the EA without an impermeable liner will also be more cost-effective and will significantly reduce the time required for site formation.

Artificial holts suitable for Eurasian Otters will be created at suitable locations, if feasible, including on vegetated islands in the reed marsh. Early provision of holts is required, in order to maximise the chances of use and to prevent disturbance to the reed marsh later. The implementation programme for design and creation of wetland mitigation areas is provided in **Chapter 2**.

Establishment of reed marsh habitats can be readily achieved if the following requirements can be met^[12-35]:

- A reliable, adequate water supply.
- Some control of water levels (e.g. ditches, sluices).
- Level or shallow gradient.
- An existing vigorous reed source.
- Access for management.

Experience in Hong Kong has demonstrated that construction of reed marsh habitats can readily be achieved if these requirements are met. Relevant examples include the Lok Ma Chau Spur Line Wetland Mitigation Area (or Ecological Enhancement Area), the Yuen Long Bypass Floodway, and the site of a private residential development at Wo Shang Wai.

Detailed design of mitigation habitat and other measures such as the location and construction of otter holts requires to be done as part of a Habitat Creation and Management Plan, a separate future submission.

12.8.5.3 Management and Maintenance

Hydrological Management

Whilst the EA will be designed so that the permanently wet areas are at or below the water table, it will also receive rain water during the wet season and there will be a need to discharge water once maximum water level is reached. The latter is essential in order to avoid flooding out Phragmites, which will not grow in water deeper than about 1 m. Water will be distributed between cells and discharged into the Shenzhen River through a series of water control structures (for example weirs/slides/flap weirs/overflow pipes) and will circulate within the system through gravity flow in order to avoid the use of pumps during the routine operation of the EA; the same will happen even during storm events when the EA acts as a water retention pond.

Vegetation Management

Vegetation management will be required to achieve two fundamental aims; to maintain a homogenous Phragmites community and to prevent colonization of terrestrial plants and/or unwanted exotics. In general this will be achieved through

careful maintenance of water levels and the removal of unwanted plant species as required. The control of vegetation on the bunds will be required on a routine basis to prevent the colonization of unwanted grasses, pantropical weeds and exotic creepers. Pruning of trees and shrubs will be required to prevent them encroaching into adjacent habitats. This will be required on an annual basis and will be undertaken at the end of the wet season. One aim of the vegetation management will be for all cut vegetation to be recycled on site with none being sent to landfill. This will be achieved through a combination of composting, natural decomposition and, in the case of cut grass, placement in the water to be consumed by herbivorous fish.

Standard Management Actions

A list of standard management actions is provided in **Table 12.77**.

Table 12.77 Regular management actions of the Ecological Area

Management Action	Frequency	Notes
Water Control		
Measure water levels and adjust sluice heights/other water control structures or pump accordingly to meet target levels	Weekly and/or within 24 hours of heavy rainfall events or during addition of water other than from rainfall.	Target water levels to be set and reviewed monthly in accordance with management regime. Water to be added if required.
Measure water quality to cover most critical concerns for short term management (pH, salinity, dissolved oxygen)	Monthly or more frequently if required.	More frequent measurements required when active steps to adjust water quality are being taken.
Inspect condition of water control structures and water courses and repair/maintain as necessary	Monthly or more frequently if required.	Also to be inspected after lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Inspect condition of pumps and/or water supply structures and repair/maintain as necessary	Every six months at start of wet and dry season or more frequently if required.	
Clear sluices and uPVC pipes	Weekly or more frequently if required.	Also after flooding / heavy rainfall and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Structural Maintenance		
Inspect condition of tracks / paths and repair / maintain as necessary	Every 6 months or more frequently if required.	Also after any flood events and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Inspect condition of bunds and repair / maintain as necessary	Monthly or more frequently if required.	Also after any flood events.
Vegetation Management		

Management Action	Frequency	Notes
Supplemental planting	Requirement to be assessed on a routine basis.	Planting to be restricted to the wet season.
Cutting or pruning and removal	Quarterly or more frequently if required, grass-cutting and weeding across bund areas.	
Removal of exotic / undesirable invasive plants (including algae) (weeding)	Monthly checking with removal to be scheduled for subsequent 30 days.	Aggressive exotics such as Typha and Water Hyacinth to be removed immediately.
Pest control	Monthly checking for <i>Dimorphopterus spinolae</i> Red Imported Fire Ants and Apple Snails with necessary treatment to be scheduled for subsequent 30 days. Control of domestic dogs required whenever noted on site.	Additional pests to be monitored and treated if required. Any cases of <i>Dimorphopterus spinolae</i> will require immediate action.
Fish Stocking		
Monitoring of fish numbers and species	Quarterly, with sampling techniques to allow for different behaviour of large fish, small fish and crustaceans.	
Fish transfer, clearance and stocking	Annually or more frequently if required.	

12.8.6 Mitigation of Fish Pond Loss

12.8.6.1 Location

As detailed in Section 12.7.10, mitigation for fish pond loss will occur (assuming Area 4 is not feasible) in Areas 2, 7 and 9 (**Figure 12.10**). Strictly-speaking, none of these areas is on-site, with the exception of Area 4, the availability of which is uncertain. However, Area 2 lies immediately adjacent to LMC Loop, while Area 1 is relatively closer, though still off-site. Areas 7 and 9, although lying relatively far from the site of impact, do have the advantage of being contiguous with existing managed wetland habitat, which is likely to produce synergistic benefits once they are enhanced and managed for wetland fauna.

12.8.6.2 Ecological enhancement

When ponds are operated commercially, food resources are generally only readily available to birds at times of drain-down for fish harvesting during the winter months. Drain-down for commercial harvesting tends to be concentrated in a short period during the winter. Furthermore, since the purpose of drain-down of commercial ponds is to produce human food for market, the drain-down activity

has the following characteristics, which effectively reduce availability of food for large waterbirds:

- drain-down is conducted as quickly as possible (typical ponds being emptied during a period of 4 – 7 days) in order to make harvesting more efficient and to minimise predation by birds
- most fish are of a size suitable for human food and hence too large for many waterbird species (for example smaller ardeids)
- most fish are removed from the system (as food for humans), hence only the residue (often referred to as ‘trash fish’) is available to birds;
- once drain-down and harvesting has been accomplished, a pond is either quickly refilled or, if recontouring and clearance of mud is required, allowed to dry out completely. In either case, the period when it provides feeding opportunities to fish-eating birds is minimised.

In addition, certain physical characteristics of commercial fishponds reduce the availability of fish and other food to waterbirds. Commercial ponds are steep-sided and typically 1.5 – 2.0 m in depth, which mean that when full they provide suitable habitat for few waterbird species (for example, of the Key Species only Great Cormorant can forage in these conditions). Emergent or floating vegetation is lacking, thus reducing potential niches for invertebrates which would provide additional food for some of the Key Species.

Accordingly, the principal fishpond enhancement measures include the following:

- extending the period during which drained ponds are available to birds by draining ponds sequentially throughout the winter period;
- draining ponds more slowly so that fish and other food is available over a longer period;
- maintaining some ponds with shallow water suitable for ardeids to wade for an extended period;
- maximising the usefulness of fish stocks to birds by stocking in a way that most fish are of a suitable size to be eaten by the target bird species;
- recontouring ponds so that the pond base has a shallow slope, thus providing a larger feeding area when ponds are full, as well as a progressive increase in the feeding area when ponds are drained;
- establishment and maintenance of bankside and emergent vegetation on some ponds to provide refuges for fish and appropriate conditions for invertebrates that will themselves provide food for birds;
- repeated stocking of some ponds with trash fish during the winter months to permit the same pond to be drained (or partially drained) more than once per season.
- fish stocking in ponds serving as potential foraging areas of otters.

In addition, the suitability of ponds for use by the Key Species will be enhanced by the following bund management and earth-moving activities:

- clearance of vegetation (including trees, shrubs, herbs and rank grass) from internal bunds to reduce the inhibitory effect that enclosure of ponds has on their use by some waterbirds and to provide suitable loafing and roosting areas;

- linking some smaller ponds, both to increase overall pond size (larger ponds are favoured by some of the target species) and to create island areas from former bund sections that will form roost areas free from ground predators and disturbance and provide undisturbed areas for otters.

This approach is essentially the modification of an existing wetland habitat - commercial fishponds – and requires similar resources. However, the management objectives change from the production of large commercially valuable fish to providing foraging opportunities for large waterbirds. There is extensive experience of this form of wetland management in Hong Kong, notably at the Lok Ma Chau Spurline wetland mitigation area (aka Ecological Enhancement Area) and the Mai Po Nature Reserve. Conversion is a simple reprofiling exercise that utilises plant and experience widely available in HK. Longer term management rests on the maintenance of water quality, water levels, fish stocks, and both aquatic and terrestrial vegetation. All are easily achieved with adequate resources.

12.8.6.3 Management and Maintenance

Hydrological Management

Rainfall during the wet season will be the only regular source of water for the mitigation fishponds. However, as shown in **Table 12.78**, there is likely to be a deficit during the months of October to February. Since the annual rainfall is significantly higher than annual evaporation, seasonal reductions in water levels could be tolerated as the wetland would be replenished during each wet season.

Table 12.78 Predicted approximate water budget for the fish pond mitigation areas (source: HK Observatory data, climatological means 1981-2010).

Month	Rainfall (mm)	Evaporation (mm)	Surplus/deficit (mm)
January	24.7	71.3	-46.6
February	54.4	59.9	-5.5
March	82.2	70.5	11.7
April	174.7	83.8	90.9
May	304.7	110.7	194
June	456.1	117.1	339
July	376.5	146.2	230.3
August	432.2	134.9	297.3
September	327.6	125.9	201.7
October	100.9	123.9	-23
November	37.6	99.5	-61.9
December	26.8	83.7	-56.9
Total	2398.5	1227.3	1171

Ponds will be approximately 2.0-2.5 m deep, and will be drained on a rotational basis to ensure that a minimum number of ponds are drained at any one time to conserve water. Pond water levels will be replenished during the wet season with water levels permitted to reach the maximum operational level before water is discharged from the mitigation fishponds. In order to achieve this, a system of pipes will be installed, with uPVC pipes located within each internal bund to permit rapid distribution of water between the ponds and at discharge points to

permit the discharge of water when the ponds are full or following heavy rainfall events.

Vegetation Management

Vegetation management will be required to achieve two fundamental aims: to maintain a suitable wetland plant community and to prevent colonization of terrestrial plants and/or unwanted exotics. In general this will be achieved through careful maintenance of water levels and the removal of unwanted plant species as required. The control of vegetation on the bunds will be required on a routine basis to prevent the colonization of unwanted grasses, pantropical weeds and exotic creepers. One aim of the vegetation management will be for all cut vegetation to be recycled on site with none being sent to landfills.

Standard Management Actions

A list of standard management actions is provided in **Table 12.79**.

Table 12.79 Regular management actions of the fish pond mitigation area

Management Action	Frequency	Notes
Water Control		
Measure water levels and adjust sluice heights/other water control structures or pump accordingly to meet target levels	Weekly and/or within 24 hours of heavy rainfall events or during addition of water other than from rainfall.	Target water levels to be set and reviewed monthly in accordance with management regime. Water to be added if required.
Measure water quality to cover most critical concerns for short term management (pH, BOD, salinity, dissolved oxygen)	Monthly or more frequently if required.	More frequent measurements required when active steps to adjust water quality are being taken.
Inspect condition of water control structures and water courses and repair/maintain as necessary	Monthly or more frequently if required.	Also to be inspected after lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Inspect condition of pumps and/or water supply structures and repair/maintain as necessary	Every six months at start of wet and dry season or more frequently if required.	
Clear sluices and uPVC pipes	Weekly or more frequently if required.	Also after flooding / heavy rainfall and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Structural maintenance		
Inspect condition of tracks / paths and repair / maintain as necessary	Every 6 months or more frequently if required.	Also after any flood events and lowering of Typhoon Signal No. 3 or Rainstorm Warning.

Management Action	Frequency	Notes
Inspect condition of bunds and repair / maintain as necessary	Monthly or more frequently if required.	Also after any flood events.
Vegetation Management		
Supplemental planting	Requirement to be assessed on a routine basis.	Planting to be restricted to the wet season.
Cutting or pruning and removal	Quarterly, or more frequently if required, grass cutting and weeding across the entire site.	
Removal of exotic / undesirable invasive plants (including algae) (weeding)	Monthly checking with removal to be scheduled for subsequent 30 days.	Aggressive exotics such as Water Hyacinth to be removed immediately.
Pest control	Monthly checking for Red Imported Fire Ants, Apple Snails with necessary treatment to be scheduled for subsequent 30 days. Control of domestic dogs required whenever noted on site.	Additional pests to be monitored and treated if required.
Fish Stocking		
Monitoring of fish numbers and species	Quarterly, with sampling techniques to allow for different behaviour of large fish, small fish and crustaceans.	
Fish transfer, clearance and stocking	Annually or more frequently if required.	

12.8.7 Mitigation of Freshwater Marsh Loss

12.8.7.1 Location

Development of the Project will result in the permanent loss 2.51 ha of Marsh. This comprises 0.50ha of marsh in LMC Loop, 0.07ha of marsh arising from construction of the Western Connection Road and 1.95ha of marsh and seasonally wet grassland arising from construction of the Eastern Connection Road.

The 0.50 ha of marsh lost in LMC Loop is to be reprovisioned within the Ecological Area. The 0.07ha area of marsh is required in the initial permanent mitigation phase, while the 1.95ha is only required at the commencement of construction of the ECR. However, in order to create a viable area of marsh habitat, the two areas (total 2.02ha) will be reprovisioned together at the outset in Area 2. Marsh areas locations are shown in **Figure 12.10**.

12.8.7.2 Ecological Enhancement

Marsh areas will be designed to provide a variety of microhabitats with permanently wet, seasonally wet and seasonally damp conditions, patches of open water, floating and emergent vegetation and bare mud. The areas to be converted to Marsh will need to be reprofiled and it is likely that levels in these areas will need to be raised. Following reprofiling they will need to be planted with suitable species (native species typical of semi-natural freshwater marshes in Hong Kong and which are also commercially available in the quantities required).

Experience gained from freshwater marsh creation at Mai Po, Kam Tin and Hong Kong Wetland Park and the Lok Ma Chau Spurline EEA has demonstrated that construction and establishment of freshwater marsh habitats is highly effective assuming that the profile of the marsh itself corresponds with the habitat requirements of the target species. This important issue will need to be addressed at the detailed design stage of the Project. Longer term management of marsh areas requires more resources per unit area in order to maintain a diverse plant community. Experience in Hong Kong has shown that in the absence of management, plant communities within marsh habitats become less diverse over time and that colonisation of species that without removal quickly dominate (for example Phragmites).

12.8.7.3 Management and Maintenance

Hydrological Management

The Marsh areas will rely primarily on rainwater as the sole source of water. The deepest parts will be approx. 1.5 m and the majority will be less than 1 m deep. This should be sufficiently deep to prevent the entire marsh drying out during the dry season. The need to sub-divide the marsh areas into smaller cells will be addressed at the detailed design stage. It will be important to ensure that during the wet season the marsh areas do not get inundated as this can kill marsh plants. To enable this water will be distributed between cells and discharged into adjacent water bodies through a series of water control structures (for example weirs/slides/flap weirs/overflow pipes) and will circulate within the system through gravity flow. During periods of extreme drought water may be pumped into the marsh areas from adjacent water bodies which are also being managed as part of this Project. This would be avoided as far as possible however given that it brings the risk of importation of fish which are predators of amphibians and dragonflies.

Vegetation Management

Vegetation management will be required to achieve two fundamental aims; to maintain a suitable wetland plant community and to prevent colonization of terrestrial plants and/or unwanted exotics. In general this will be achieved through careful maintenance of water levels and the removal of unwanted plant species as required. As noted above, maintaining a diverse plant community within created freshwater marshes requires careful management, control of more aggressive species and supplemental planting may be required. The control of vegetation on

the bunds will be required on a routine basis to prevent the colonization of unwanted grasses, pantropical weeds and exotic creepers.

Standard Management Actions

A list of standard management actions is provided in **Table 12.80**.

Table 12.80 Regular management actions of the freshwater marsh wetland mitigation area

Management Action	Frequency	Notes
Water Control		
Measure water levels and adjust sluice heights/other water control structures or pump accordingly to meet target levels	Weekly and/or within 24 hours of heavy rainfall events or during addition of water other than from rainfall.	Target water levels to be set and reviewed monthly in accordance with management regime. Water to be added if required.
Measure water quality to cover most critical concerns for short term management (pH, BOD, salinity, dissolved oxygen)	Monthly or more frequently if required.	More frequent measurements required when active steps to adjust water quality are being taken.
Inspect condition of water control structures and water courses and repair/maintain as necessary	Monthly or more frequently if required.	Also to be inspected after lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Inspect condition of pumps and/or water supply structures and repair/maintain as necessary	Every six months at start of wet and dry season or more frequently if required.	
Clear sluices and uPVC pipes	Weekly or more frequently if required.	Also after flooding / heavy rainfall and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Structural Maintenance		
Inspect condition of tracks / paths and repair / maintain as necessary	Every 6 months or more frequently if required.	Also after any flood events and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Inspect condition of bunds and repair / maintain as necessary	Monthly or more frequently if required.	Also after any flood events.
Vegetation Management		
Supplemental planting	Requirement to be assessed on a routine basis.	Planting to be restricted to the wet season.
Cutting or pruning and removal	Quarterly, or more frequently if required, grass cutting and weeding across the entire site.	

Management Action	Frequency	Notes
Removal of exotic / undesirable invasive plants (including algae) (weeding)	Monthly checking with removal to be scheduled for subsequent 30 days.	Aggressive exotics such as Water Hyacinth to be removed immediately.
Pest control	Monthly checking for Red Imported Fire Ants, Apple Snails with necessary treatment to be scheduled for subsequent 30 days. Control of domestic dogs required whenever noted on site.	Additional pests to be monitored and treated if required.
Fish Monitoring		
Monitoring of fish numbers and species	Quarterly, with sampling techniques to allow for different behaviour of large fish, small fish and crustaceans.	
Fish transfer and clearance	Annually or more frequently if required.	

12.8.8 Habitat Utilisation

The detailed design and longer term management must ensure that habitat requirements of the key species are provided for; these are summarised in **Table 12.81** and described in more detail in **Appendix 12-13**.

Table 12.81 Key species utilization of habitats to be provided as mitigation.

Species	Fish Pond	Reed Marsh	Freshwater Marsh
Great Cormorant	✓		
Little Egret	✓	(✓)	(✓)
Chinese Penduline Tit		✓	
Dusky Warbler	(✓)	✓	✓
Oriental Reed Warbler	(✓)	✓	(✓)
Black-browed Reed Warbler	(✓)	✓	✓
Pallas's Grasshopper Warbler	(✓)	✓	✓
Bluethroat	(✓)	✓	✓
Eurasian Otter	✓	✓	✓
Leopard Cat	✓	✓	(✓)
Two-striped Grass Frog			✓
Chinese Bullfrog			✓
Common Rat Snake	✓	✓	✓
Scarlet Basker			✓
Ruby Darter			✓
Common Evening Hawker			✓
Sapphire Flutterer			✓
Coastal Glider			✓

Note: Parentheses indicate that the habitat can support the species indicated, but is not the preferred habitat, and abundances are likely to be lower.

12.8.9 Control of Human Access and Disturbance

Control of access and minimisation of disturbance are important elements of successful habitat mitigation. As noted above, control of feral dogs must be carried out as and when they are noted on site, especially as Eurasian Otters are highly sensitive to their presence. In addition, human access must also be carefully controlled.

12.8.9.1 Ecological Area

The Ecological Area is bordered on one side by LMC Meander, which will provide a natural barrier to access by humans; consequently, no significant fence is proposed for the area of the EA bordering the Meander at any time, which will ensure continued connectivity between these areas. However, to the north will be the developed portion of the LMC Loop, which is a potential source of human disturbance. Accordingly, the EA requires to be secured to prevent unauthorized access, and actual and visual barriers will be required to prevent intrusion and disturbance. These barriers need not have a significant adverse visual impact on users of the LMC Loop, but should be sufficiently robust to deter all but the most determined entry.

12.8.9.2 Area 2

Area 2 is bordered by the new boundary fence and Shenzhen River to the north and LMC meander to the west. The fish pond areas to the east will have unrestricted access, and there is potential for disturbance and damage to the wetlands as a result. It is proposed that the boundary between Area 2 and the fishponds to the east be fenced to prevent unauthorised disturbance.

12.8.9.3 Area 4

Area 4 would be bordered by the ECR to the north, the current boundary fence road to the east, LMC Meander to the west and fish ponds to the south. The fish pond areas and boundary fence road will have unrestricted access, and there is potential for disturbance and damage to the wetlands as a result. It is proposed that the boundary between Area 4 and these areas is fenced to prevent unauthorised disturbance.

12.8.9.4 Area 7

Area 7 is bordered to the northwest by the boundary fence road and on all other sides by the Lok Ma Chau Spurline Ecological Enhancement Area. As access to both is restricted, the potential for unauthorised access is considered low and therefore there is, at present, no perceived need to fence Area 7.

12.8.9.5 Area 9

Area 9 is bordered by the FCA fence to the west and the Lok Ma Chau Spurline

Ecological Enhancement Area to the east. However, to the south are commercial fishponds with unrestricted access. As such those areas where such access is possible will be fenced.

Access will be required to all areas, however, to facilitate monitoring and management. To minimise disturbance to wildlife, monitoring activities not required to be undertaken during the morning (for example monitoring of water quality and fish stocks) will be undertaken during the early afternoon, with only those activities that must be undertaken during the early part of the day (for example bird monitoring) being scheduled for the morning. Likewise, management (including weeding and vegetation management) activities will avoid the early morning period when bird usage is at its peak, and will be scheduled so as to concentrate work in a small part of the area at any one time (to avoid disturbing large areas of the site).

12.9 Residual Ecological Impacts

This section addresses the requirement stated in Section 3.4.13.4(xi) of the EIA Study Brief. As described in the TM-EIAO, in evaluating residual impacts, more weight is given to adverse impacts that occur in areas that are ecologically fragile and/or rare or undisturbed, or which have little resilience to imposed stresses.

12.9.1 Summary of Mitigation and Residual Impacts

Mitigation measures and predicted residual impacts are summarised in **Tables 12.82a** and **12.82b**. In accordance with Section 5.4.5(b) and (c) of Annex 16 of the EIAO TM, residual impacts with on-site mitigation measures are defined, quantified and evaluated. Where relevant, this is followed by an assessment of the severity of adverse residual impact after implementation of off-site mitigation measures.

Table 12.82a Potential total direct and indirect ecological impacts of the Project on habitats, the mitigation proposed and the severity of residual impacts. ECR = Eastern Connection Road; WCR = Western Connection Road.

Habitat	Impact	Mitigation	Residual Impacts
All habitats (direct impact)	Habitat loss arising from fly-tipping or illegal land or pond-filling. Permanent loss, unquantifiable, severity Low to High , depending on extent.	Appropriate road markings to ensure that vehicles cannot stop on ECR (except in emergency) to access adjacent areas.	With provision of on-site mitigation measures, loss of Low severity.
Reed Marsh (direct impacts)	Permanent loss of 10.96ha in LMC Loop (8.7% of reed marsh in Deep Bay Area) (High). Temporary 3-year loss of 0.032ha wastewater treatment reedbed at LMC Station (Low to Moderate). Temporary (18 months) loss of 1.10ha during construction of ECR underpass below EA (Moderate).	Provide unfragmented, managed and undisturbed reed marsh in a 12.78ha 'Ecological Area' (EA) to compensate for the loss of ecological function of the existing reedbed. Creation and establishment prior to total clearance of the reedbed in LMC Loop. Implement a 50m wide buffer zone planted with trees and shrubs of ecological value to screen and minimise	With provision of on-site mitigation measures, loss of 2.50 ha is a temporary adverse residual impact that cannot be entirely resolved for 2-3 years, when the reed marsh in the EA will be fully established. Given temporary nature, of Low severity. With provision of on-site mitigation measures for loss of 1.10ha of reed

Habitat	Impact	Mitigation	Residual Impacts
		<p>disturbance.</p> <p>Any buildings in the buffer zone no more than 14mPD in height (except the maximum height of on-site STW and electricity substation are 15 and 25mPD respectively) and placed in the internal 25m of the 50m wide strip, as part of a plot ratio of 0.1.</p> <p>Appropriate planting of taller and denser trees around individual buildings.</p> <p>Prior to loss, reprovision of 0.032ha of reed marsh in Area 7.</p> <p>Prior to loss arising from construction of ECR, reprovision of minimum of 1.60ha of reed marsh in Area 4.</p>	<p>marsh, adverse residual impact of Low severity</p> <p>With provision of on-site mitigation measures, residual impact of Low to Moderate severity for temporary loss of 0.032ha of wastewater treatment reedbed; with provision of off-site mitigation measures, adverse residual impact of Low severity</p> <p>Overall, managed on-site compensatory reed marsh likely to be of higher ecological value than existing, creating a positive residual impact.</p>
Reed Marsh (indirect impacts)	<p>Disturbance to existing reed marsh in LMC Loop during construction; duration 2 years.</p> <p>ECR: Temporary (18 months) disturbance during construction underpass below EA(Low to Moderate).</p>	<p>LMC Loop: Erection of 3m high, dull green site boundary fence at a minimum distance of 50m from existing reed marsh habitat (excluding small patches of reeds). Section of fence between existing reed marsh and EA to have a 30-cm gap at bottom to maintain connectivity.</p> <p>Establishment of EA prior to reed marsh clearance.</p> <p>ECR: Erection of site hoarding and restriction of working hours to 9am to 5pm.</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity for the 2 year establishment period of EA.</p> <p>With provision of on-site mitigation measures, adverse residual impact of Low severity</p>
Marsh and Seasonally Wet Grassland (direct impacts)	<p><u>Marsh</u></p> <p>Permanent loss of 0.50ha in LMC Loop (Low to Moderate).</p> <p>ECR: permanent loss of 1.18ha at Horn Hill (Low to Moderate).</p> <p>ECR: permanent loss of 0.58ha at Ma Tso Lung (Low to Moderate).</p> <p>WCR: permanent loss of 0.07ha (Low).</p> <p><u>Seasonally Wet Grassland</u></p> <p>Permanent loss of 0.19ha at Ma Tso Lung (Low to Moderate).</p>	<p>EA to include 0.50ha of marsh.</p> <p>Permanent off-site wetland compensation area to include a minimum of 2.02ha of marsh.</p>	<p>With provision of off-site mitigation measures, no adverse residual impact.</p> <p>Overall, a positive residual impact is predicted due to better habitat quality of managed compensation areas.</p>
Pond (direct impacts)	<p>WCR: permanent habitat loss of 0.92ha (Low).</p> <p>WCR: construction phase (12 months) habitat loss of 3.51ha</p>	<p>Provision of managed pond habitat to enhance ecological value to compensate for loss.</p> <p>Creation and establishment</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Moderate severity, as pond habitat not proposed</p>

Habitat	Impact	Mitigation	Residual Impacts
	<p>(Low to Moderate). ECR permanent habitat loss 1.99ha (Moderate). ECR construction phase habitat loss (36 months) 3.32ha (Moderate). Direct Link permanent loss 2.28ha (Low to Moderate).</p>	<p>of compensation areas prior to commencement of substantive works associated with any element of the Project for which pond compensation is required.</p>	<p>for on-site mitigation. With provision of off-site mitigation measures, adverse residual impacts of Low severity. Overall, managed compensatory wetland likely to be of higher ecological value than existing ponds, creating a positive residual impact.</p>
Pond (indirect impacts)	<p>Permanent disturbance to ponds adjacent to northeast section of LMC Meander (Moderate during both construction and operation) due to development of LMC Loop. Effective wetland loss of permanent nature 4.51ha.</p> <p>WCR construction disturbance (12 months), effective wetland loss of 0.60ha, Low to Moderate.</p> <p>ECR construction disturbance (36 months), effective loss 4.87ha, severity High. Operational disturbance impacts Moderate to High.</p>	<p>Erection of 3m high, dull green site boundary fence to all construction areas to minimise disturbance to wetland habitats.</p> <p>Creation of a vegetated setback from Loop edge of minimum 23m width.</p> <p>Provision of managed pond habitat to enhance ecological value to compensate for disturbance impacts.</p> <p>Creation and establishment of wetland compensation areas prior to commencement of substantive works associated with any element of the Project for which pond compensation is required.</p> <p>For all elements, construction between the hours of 9am and 5pm only.</p> <p>Apart from section under LMC Meander, wet season work only.</p> <p>Use of depressed road through fish pond area and underpass below LMC Meander.</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Moderate to High severity.</p> <p>With provision of off-site mitigation measures, adverse residual impacts of Low severity.</p> <p>Overall, managed compensatory wetland likely to be of higher ecological value than existing, creating a positive residual impact.</p>
LMC Meander (direct impacts)	<p>Temporary loss of the top section of approx. 3,500m of existing natural vegetation and bank along three sides of LMC Loop. (Low to Moderate).</p> <p>Permanent loss of existing vegetation along southeast section of bank of LMC Loop along LMC Meander.</p> <p>Permanent loss of 0.15ha of riparian vegetation under footprint of WCR (Low).</p> <p>Permanent loss of 80-160m² of watercourse due to support(s) for WCR (Low).</p> <p>Permanent loss of bank and riparian vegetation for length of 60m.</p> <p>Temporary loss (18-24</p>	<p>Topping of fill material with soil to allow re-colonisation by vegetation.</p> <p>Revision of riparian vegetation in area impacted by construction of ECR underpass.</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity.</p> <p>These comprise loss of 0.15ha of riparian vegetation and 80-160m² of watercourse due to WCR footprint.</p> <p>Temporary loss of riparian vegetation during stabilisation work for banks. Duration of works approx. 2 years, but not all areas impacted concurrently.</p>

Habitat	Impact	Mitigation	Residual Impacts
	<p>months) of riparian vegetation due to construction of ECR underpass (Low).</p> <p>Temporary loss of approx. 3,000m² of LMC Meander riverbed, water column and riparian vegetation for 18 months Low.</p>		
LMC Meander (indirect impacts)	<p>Run-off during LMC Loop construction (Moderate to High) and operational phases (Moderate).</p> <p>Permanent disturbance impacts during LMC Loop construction and operational phases (Moderate).</p> <p>Permanent disturbance impacts from WCR construction and operation to habitat of large waterbirds (Low).</p> <p>Permanent disturbance impacts from WCR to habitat of Eurasian Otter during construction (Low to Medium) and operation (Low).</p> <p>ECR construction phase (36 months) disturbance Moderate to High.</p> <p>Permanent ECR Operation phase disturbance Low.</p> <p>ECR construction and operation run-off Low.</p> <p>Hydrological disruption Low.</p>	<p>Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).</p> <p>Erection of 3m high, dull green site boundary fence to all construction areas to minimise disturbance.</p> <p>No direct lighting on Meander.</p> <p>Working hours restricted to 9am to 5pm.</p> <p>Wet season work only in respect of relevant sections of WCR and ECR (except for underpass below Meander).</p> <p>Stabilisation works in areas immediately alongside Meander to occur in wet season.</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity.</p>
Stream south of Lung Hau Road (indirect impacts)	Run-off from WCR during 12 months of construction (Moderate) and operation (Low).	Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity.</p>
Ping Hang Stream (indirect and direct impacts)	<p>Potential run-off impacts during ECR construction phase (up to 3 years, wet season only) Moderate, and in operational phase Low to Moderate.</p> <p>Hydrological disruption potentially Moderate.</p> <p>Habitat loss Low to Moderate.</p>	<p>Use of viaduct to traverse watercourse.</p> <p>Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).</p> <p>Erection of 3m high, dull green site boundary fence to all construction areas to minimise disturbance.</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity.</p>
Ma Tso Lung Stream (indirect and direct)	<p>Hydrological disruption and/or riparian zone loss of habitat of Moderate severity due to ECR construction.</p> <p>ECR construction phase (up to</p>	ECR designed to avoid hydrological disruption, stream diversion, loss of riparian zone, including stream bed, and use of	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity.</p>

Habitat	Impact	Mitigation	Residual Impacts
impacts)	3 years) run-off Moderate . ECR operational phase run-off Low to Moderate in lower sections.	culvert (except one along boundary fence road functioning as wildlife underpass). Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).	
STEMDC Mitigation Wetland (indirect impacts)	Construction disturbance (24 months) Low . Operational disturbance Low .	Mechanised plant working hours restricted to 9am to 5pm.	With provision of on-site mitigation measures, adverse residual impacts of Low severity.
Woodland and shrubland (direct impacts)	Permanent loss of 0.40ha woodland due to WCR (Low to Moderate). Permanent loss of 0.70ha woodland and 0.16ha shrubland due to ECR (Low to Moderate).	Reprovision of 1.3ha via planting of tree and shrub species in Ecological Assessment Area near Horn Hill (Ngau Kok Shan).	With provision of on-site mitigation measures, temporary adverse residual impact of habitat loss until suitable maturity is reached in approximately 20-30 years: Low severity.
Intertidal areas of Deep Bay (indirect impacts)	Increased run-off, sedimentation, pollution and nutrient levels arising from various elements of Project (Low to High depending on nature of event).	Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).	With implementation of appropriate practices, and assuming no major, unpredicted pollution events, of Low severity.

Table 12.82b Potential total direct and indirect ecological impacts of the Project on species, the mitigation proposed and the severity of residual impacts.

Species	Impact	Mitigation	Residual Impacts
Large waterbirds	<p>Small numbers may suffer collision mortality with buildings: Low.</p> <p>Permanent fragmentation impact of buildings in LMC Loop: Very High.</p> <p>Permanent fragmentation impact of ECR: Very High.</p> <p>Permanent fragmentation impact of WCR and Direct Link to LMC Station: High.</p> <p>Permanent minor cumulative impact on Long Valley arising from fragmentation impacts on flight line corridor: Low.</p>	<p>On-site Mitigation</p> <p>Include in relevant statutory land use plans guidelines on building design in Section 12.7.6.1.</p> <p>Reduce night-time lighting, light spillage, use green or blue lights where possibly, avoid uplighting.</p> <p>Implement approx. 150m-wide EA and buffer zone, reduced building height in areas nearby.</p> <p>Use of depressed road and underpass to traverse fish ponds and LMC Meander.</p> <p>Mechanical plant operation restricted to 9am to 5pm.</p> <p>Construction of WCR along Ha Wan Tsuen Road and ECR at HHW in wet season only, apart from underpass below</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Low to Moderate severity.</p> <p>With provision of off-site mitigation measures, adverse residual impacts of Low severity.</p>

Species	Impact	Mitigation	Residual Impacts
		<p>Meander.</p> <p>Construction of ECR and WCR along Ha Wan Tsuen Rd not to commence before establishment of EA.</p> <p>Phasing of construction works to avoid adjacent work on the following sections: in the EA, under LMC Meander, through ponds 36-38.</p> <p>Erection of 3m high, dull green site boundary fence to all construction areas to minimise disturbance.</p> <p>Off-site Mitigation</p> <p>Creation and establishment of wetland compensation areas prior to commencement of substantive works associated with any element of the Project for which wetland compensation is required.</p>	
Other Birds	<p>Permanent loss of wetland habitat in LMC Loop, mainly affecting small to medium-sized waterbirds and passerines Low.</p> <p>Permanent mortality impacts arising from collision Moderate, mainly affecting small to medium-sized birds.</p> <p>Permanent increase in lighting and glare on waterbirds and Eurasian Eagle Owl Low, due to existing levels of night-time light in the area.</p>	<p>Provide unfragmented, managed and undisturbed reed marsh and marsh in a 12.78ha 'Ecological Area' (EA) to compensate for the loss of ecological function of existing wetland habitats in LMC Loop.</p> <p>Road lighting designed to minimise glare or shine on non-target areas.</p> <p>Barriers to prevent access to road along entire length of ECR at Ma Tso Lung and HHW.</p>	With provision of on-site mitigation measures, adverse residual impacts of Low severity.
Eurasian Otter (habitat impacts)	<p>Permanent loss of reed marsh in LMC Loop.</p> <p>Permanent and temporary loss of wetland habitat associated with ECR and WCR.</p> <p>Permanent loss of natural bank and riparian vegetation along topmost part of bank on 3 sides of LMC Meander for approximately 3,500m in length.</p> <p>Loss of approx. 3,000m² of LMC Meander channel temporarily (18 months) during construction phase of ECR and permanently for WCR (80-160m²).</p>	<p>On-site Mitigation</p> <p>Provide unfragmented, managed and undisturbed reed marsh in a 12.78ha 'Ecological Area' (EA) to compensate for the loss of ecological function of the existing reedbed.</p> <p>Creation and establishment of EA prior to total clearance of the reedbed in LMC Loop.</p> <p>Create foraging areas and sites suitable for use as holts or natal dens in EA and, if feasible, along strengthened banks of LMC Loop.</p>	<p>With provision of on-site mitigation measures, adverse residual impact of Low to Moderate severity.</p> <p>With provision of off-site mitigation measures, adverse residual impacts of Low severity, comprising temporary loss of riparian vegetation along LMC Meander and temporary loss of 2.50ha of reed marsh habitat.</p>

Species	Impact	Mitigation	Residual Impacts
	<p>Overall, construction phase impacts potentially of High severity, while operation phase impacts of Moderate to High severity.</p>	<p>Strengthening of LMC Loop bank that allows colonisation by dense vegetation.</p> <p>Reprofiling of bank between EA and Meander so as to maintain current profile and vegetated condition (after regrowth).</p> <p>Off-site Mitigation</p> <p>Creation and establishment of wetland compensation areas prior to commencement of substantive works associated with any element of the Project for which wetland compensation is required.</p>	
Eurasian Otter (secondary impacts)	<p>Disturbance impacts on use of LMC Meander and nearby wetland habitats at HHW arising in both construction and operation phases.</p> <p>Disturbance impacts from dogs associated with construction site for duration of construction period (approx. 13 years).</p> <p>Secondary impacts on prey species via deterioration in water quality arising from construction or operational phase run-off to LMC Meander.</p> <p>Fragmentation impacts as a result of road or bridge construction.</p> <p>Potential cumulative impacts in relation to any future development in HHW area.</p>	<p>Mechanical plant operation restricted to 9am to 5pm.</p> <p>Erection of 3m high, dull green site boundary fence to all construction areas to minimise disturbance to wetland habitats caused by human activity. This includes a fence around existing reed marsh to minimise disturbance and prevent access by dogs.</p> <p>Provision of 30cm gap at bottom of fence between current reed marsh and EA/LMC Meander to maintain connectivity. This gap to be closed once reed marsh in EA established.</p> <p>No lighting directed at Meander.</p> <p>Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).</p> <p>Pre-construction surveys for otter holts or dens.</p> <p>No works within 150m of any natal den in use, or within 30m of any holt.</p> <p>Restrict access to areas containing holts or dens.</p> <p>Implement a 50m wide buffer zone to EA planted with trees and shrubs of ecological value to screen</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Low severity.</p>

Species	Impact	Mitigation	Residual Impacts
		<p>and minimise disturbance.</p> <p>Measures to prevent dogs from being brought to construction site and use of fence to prevent entry of dogs or humans to EA or existing reed marsh.</p> <p>Minimum 1m clearance between WCR bridge over Meander and water surface, except at times of extreme flooding.</p> <p>Operation phase vegetated setback from Loop edge of minimum 23m width.</p> <p>Operation phase provision of road underpasses and one overpass for ECR to facilitate connectivity.</p> <p>Discourage human access to underpasses and overpass, and adjacent wetland areas of ECR.</p> <p>Use of moveable barriers during creation of the EA to minimise disturbance to Meander.</p>	
Other Mammals	<p>Construction phase: Moderate due to potential for disturbance and greater magnitude of fragmentation impacts.</p> <p>Operational phase: Low to Moderate in view of potential fragmentation issues associated with Eastern Connection Road through HHW area.</p>	<p>Mechanical plant operation restricted to 9am to 5pm.</p> <p>Erection of 3m high, dull green site boundary fence to all construction areas to minimise disturbance to wetland habitats caused by human activity.</p> <p>Provision of 30cm gap at bottom of fence between current reed marsh and EA/LMC Meander to maintain connectivity.</p> <p>Operation phase vegetated setback from Loop edge of minimum 23m width.</p> <p>Use fence that allows escape of mammals from construction sites associated with connection roads.</p> <p>Operation phase provision of road underpasses and one overpass for ECR to facilitate connectivity.</p> <p>Prevent human access to underpasses and overpass.</p> <p>Barriers to prevent access to road along entire length of ECR at Ma Tso Lung and HHW.</p>	With provision of on-site mitigation measures, adverse residual impacts of Low severity.

Species	Impact	Mitigation	Residual Impacts
Herpetofauna	<p><u>Construction phase</u></p> <p>Two-striped Grass Frog: Moderate due to habitat loss and fragmentation.</p> <p>Burmese Python, Chinese Bull Frog and Chinese Soft-shelled Turtle: Low to Moderate.</p> <p><u>Operation phase</u></p> <p>All species: Low to Moderate.</p>	<p>Prior to construction, <u>search and translocation of any herpetofauna species of conservation concern.</u></p> <p>Provide unfragmented, managed and undisturbed reed marsh and marsh in a 12.78ha EA to compensate for the loss of ecological function of existing habitats in Loop.</p> <p>Creation and establishment of EA prior to total clearance of the reedbed in LMC Loop.</p> <p>Creation and establishment of wetland compensation areas prior to commencement of substantive works associated with any element of the Project for which pond compensation is required.</p> <p>Use fence to prevent access to construction sites.</p> <p>Use of viaduct over Ping Hang Stream.</p> <p>Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).</p> <p>Operation phase provision of road underpasses and one overpass for ECR to facilitate connectivity.</p> <p>Prevent human access to underpasses and overpass.</p> <p>Barriers to prevent access to road along entire length of ECR at Ma Tso Lung and HHW.</p>	<p>With provision of on-site mitigation measures, adverse residual impacts of Moderate severity.</p> <p>With provision of off-site mitigation measures, adverse residual impacts of Low severity.</p>
Three-banded Box Terrapin	Given rarity, impacts from all sources combined potentially of Moderate severity.	<p>Use fence to prevent access to construction sites.</p> <p>Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).</p> <p>ECR designed to avoid need for stream diversion or use of culvert in the Ma Tso Lung area.</p> <p>Barriers to prevent access to road along entire length of ECR at Ma Tso Lung</p>	With provision of on-site mitigation measures, adverse residual impacts of Low severity.

Species	Impact	Mitigation	Residual Impacts
	and HHW.		
Odonata	Impacts largely Low . Common Evening Hawker: Low to Moderate .	On-site Mitigation Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6). Provision of mitigation wetland in EA to be established prior to construction commencing.	With provision of on-site mitigation measures, adverse residual impacts of Low severity.
Butterflies	Impacts of Low severity because small numbers of common species are affected.	General habitat compensation for wetland and woodland/shrubland.	With provision of on-site mitigation measures, adverse residual impacts of Low severity.
Rose Bitterling	Construction phase: Moderate . Operational phase: Low .	Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).	With provision of on-site mitigation measures, adverse residual impacts of Low severity.
Paradise Fish	Construction phase: Moderate . Operational phase: Low to Moderate .	Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).	With provision of on-site mitigation measures, adverse residual impacts of Low severity.
Small Snakehead and <i>Somanniathelphusa zanklon</i> .	Construction phase: Moderate . Operational phase: Low to Moderate .	Standard measures to minimise run-off and impacts of spillage events (see Sections 12.7.2.5 and 12.7.2.6).	With provision of on-site mitigation measures, adverse residual impacts of Low severity.

12.9.2 Adverse Residual Impacts

During site formation of the EA, there will be an unavoidable temporary loss of 2.50ha of reed marsh. However, from the time when the mitigation reeds are planted in the EA, this impact will begin to decline quite quickly, as during the establishment phase two reed marshes will be present in the Loop. In terms of marsh habitat, there will be no residual impact as these areas will remain untouched during establishment of the EA, by the end of which period suitable habitat for the suite of species recorded in these marsh areas will be present.

Woodland loss arising as a result of construction of the Western and Eastern Connection Roads is also a temporary adverse residual impact of low significance. This will only resolve itself once the trees reach a maturity comparable to current conditions.

12.10 Ecological Monitoring Programme

Section 3.4.13.4(xiii) of the Study Brief requires that recommendation be made of the need for any ecological monitoring programme. The aim of ecological

monitoring in the construction phase is to monitor impacts of construction activities, alerting, where necessary, the need for further or more effective mitigation of impacts unforeseen in nature or magnitude.

Baseline ecological monitoring was conducted during the preparation of the ecological impact assessment for the Project. However, these data were collected during 2009-2010, and it may not be appropriate to use them as a baseline for monitoring certain construction phase ecological impacts. This is not an issue inside LMC Loop itself, as the loss of all habitats in this area renders monitoring of impacts unnecessary. Further, the establishment of wetland mitigation areas to compensate for disturbance from this construction activity means that monitoring of fauna at this time should focus on ensuring that targets are met in these areas. Such monitoring should be devised as part of preparation of the Habitat Creation and Management Plan (HCMP), a separate, future submission.

Outside LMC Loop, construction of the three infrastructure connections will commence some years into the Project. Prior to construction of the Eastern Connection Road, it will be necessary to update the baseline ecological profile of the area within 500m of the alignment due to the substantial time period between baseline monitoring and the commencement of works. With regard to the Western Connection Road and Direct Link to LMC Station, given the already disturbed nature of much of the impacted area, the lack of non-bird fauna of conservation significance and the significantly shorter time period until commencement, it is not considered necessary to carry out construction phase faunal monitoring, except in respect of pond 12, which supports foraging and roosting large waterbirds, and Chinese Bull Frog.

Ecological monitoring in the wetland and woodland mitigation areas aims to ensure that mitigation measures and targets are being met, especially in relation to requirements directed by the Environmental Permit. However, with regard to the mitigation areas, detailed monitoring requirements must be drawn up as part of the detailed habitat design process (through the preparation of an HCMP) and once target species have been agreed. Consequently, these are not dealt with here.

12.10.1 LMC Loop

12.10.1.1 Avifauna

Given the importance of the flight line corridor and the significance of potential impacts upon it, its usage should be monitored to identify any impacts from construction activities. The main concern is the number and species composition of birds using the flight line, and to this end construction phase monitoring should comprise a census of the numbers of each species using the flight line, carried out from LMC Lookout. These surveys should last for two hours from 30 minutes before sunrise and be carried out once monthly. Should significant impacts on the flight line be recorded, measures to minimise or reduce these will be devised, where possible. It is considered that such monitoring is required from the beginning of work in LMC Loop until 12 months after establishment of the Ecological Area or completion of work on the Western Connection Road, whichever is the later. Given the uncertainty of project implementation, this requirement should be reviewed at the end of Phase 1 buildings works, if appropriate.

12.10.1.2 Mammals

Monitoring of mammals, including Eurasian Otter, is notoriously difficult due to their secretive, often nocturnal habits in HK. However, Eurasian Otter is potentially the most significant sensitive receiver in terms of conservation significance. The most successful monitoring method for otters in HK has been the use of remote-sensing cameras. For otters, the use of infra-red flash cameras is recommended, as traditional incandescent flash cameras are potentially disturbing to wildlife. To monitor connectivity between the existing reed marsh and the EA, it is recommended that cameras are set up at suitable locations along the north side of the fence (to avoid cameras being tampered with) during the site formation and establishment period of the EA. This would allow monitoring of otters, other mammals and dogs. Once establishment is complete, the cameras would be available for other monitoring activities associated with the EA or off-site compensation areas, as defined in the HCMP.

During the operational phase monitoring of the use of the underpasses below the Eastern Connection Road in both Ma Tso Lung and HHW areas should be carried out via the use of remote-sensing cameras at each site. In addition, monitoring of the use of the overpass above the road should be carried out via the same method. The need for monitoring to continue in the long-term should be reviewed by the authority managing these wildlife passages at suitable intervals and in consultation with AFCD.

Construction phase monitoring of bats is not considered necessary, as the species recorded are common in HK and none are considered to be significantly impacted by the Project.

12.10.1.3 Water quality

Weekly *in situ* monitoring of water quality in LMC Meander should be carried out. Measurements to be taken are temperature, pH, salinity, turbidity and dissolved oxygen. The monitoring should refer to the water quality monitoring requirement as established in the EM&A Manual. Wet and dry season action or limit levels should be reviewed after the first monitoring events in each of these seasons.

12.10.1.4 Site inspections

Site inspections are crucial to monitoring the potential for or occurrence of unforeseen impacts during the construction process. These should be carried out weekly and relate to such items as ensuring site fencing remains intact and that activities within the site do not affect habitats outside (e.g. dumping of construction waste or litter). Should issues be detected, appropriate mitigation will be carried out, where feasible.

12.10.2 Western Connection Road

12.10.2.1 Avifauna

As with the LMC Loop construction phase, given the importance of the flight line corridor and the significance of potential impacts, its usage should be monitored

to identify any impacts from construction activities. It is considered that such monitoring is required from the beginning of work in LMC Loop until 12 months after final establishment of the Ecological Area or completion of work on the Western Connection Road, whichever is the later.

With regard to Pond 12, given its use by large waterbirds, numbers of birds using the pond during construction requires monitoring to ensure that no impacts greater than predicted are occurring. Weekly counts of the number and species of birds using the pond should be carried out both before construction work commences each day and 1 hour after it begins. This would enable an assessment to be made of the impact of construction activities on bird use of the pond.

12.10.2.2 Herpetofauna

The requirement for herpetofauna refers to the only species of conservation significance recorded in this area, Chinese Bull Frog, which was recorded at LMC Tsuen and nearby Pond 12. Monitoring needs to be carried out to ensure numbers of this species are not significantly impacted by construction activities. Both LMC Tsuen and Pond 12, as well as any other wetlands within a radius of 100m into which disturbed bull frogs may move, should be monitored once monthly during the wet season (March to October) prior to commencement of construction and during the whole construction period. The methodology should provide for both day and night-time surveys in each month, and rely on identification of vocalisations and active searching for tadpoles, froglets or adults. Should impacts be identified, remedial measures should be devised in consultation with AFCD and, if necessary, consideration given to translocation.

12.10.2.3 Aquatic fauna

Monitoring of water quality should be conducted weekly at the stream and associated ponds south of Lung Hau Road where Rose Bitterling is present (**Figure 12-4**), and whole site audit should be carried out at the construction site to identify potential impacts on the stream. This is necessary as Rose Bitterling is highly susceptible to degradation of water quality.

Weekly *in situ* monitoring of water quality in LMC Meander should be carried out. Measurements to be taken are temperature, pH, salinity, turbidity and dissolved oxygen. The monitoring should refer to the water quality monitoring requirement as established in the EM&A Manual. Wet and dry season action or limit levels should be reviewed after the first monitoring events in each of these seasons. This monitoring should be carried out during the construction phase and the first 12 months of operation.

With regard to Rose Bitterling, surveys of the population are required to identify potential impacts. In order to provide baseline data, monthly survey for one year prior to construction should be carried out. Subsequently, monthly monitoring should be carried out during the construction period. The methodology should involve standardised netting at suitable locations in order to provide quantitative data, supplemented by active searching.

12.10.2.4 Dragonflies and butterflies

In view of the lack of significant ecological value to dragonflies and butterflies of the areas affected by the Western Connection Road, no construction phase monitoring is considered necessary.

12.10.2.5 Site inspections

Site inspections are crucial to monitoring the potential for or occurrence of unforeseen impacts during the construction process. These should be carried out weekly and relate to such items as ensuring site fencing remains intact and that activities within the site do not affect habitats outside (e.g. dumping of construction waste or litter). Should issues be detected, appropriate mitigation will be carried out, where feasible.

12.10.3 Eastern Connection Road

A revised ecological baseline is required ahead of construction monitoring, given that this element of the Project will be constructed some years hence. Standard baseline data surveys appropriate at the time should be conducted, beginning a minimum of 12 months before commencement of construction; findings will inform the detailed design process in respect of mitigation requirements. All relevant faunal groups will require monitoring, including birds, mammals, herpetofauna, dragonflies, butterflies, aquatic fauna, flora and any others considered relevant at the time. The details of the construction phase monitoring programme may need to be revised after the revised baseline data have been collected.

12.10.3.1 Avifauna

As with other elements of the Project, given the importance of the flight line corridor and the significance of potential impacts, its usage should be monitored to identify any impacts from construction activities. This is particularly the case in respect of the Eastern Connection Road given that reduced disturbance zones compared to LMC Loop will be implemented. Monitoring should commence 12 months prior to the beginning of work until the end of 12 months after, in order that potential operational phase impacts can be monitored.

Disturbance impacts on birds should be monitored via weekly survey of the number and species of birds at wetland habitats within 500m of the alignment.

12.10.3.2 Mammals

Use of the wildlife underpasses and the single overpass should be monitored via the use of remote-sensing cameras to identify their suitability. Such monitoring should commence as soon as practicable after construction of each is completed and continue for 12 months after completion of the ECR. Where issues arise (i.e. they are not apparently in use), these should, if possible, be addressed.

12.10.3.3 Herpetofauna

Monitoring of herpetofauna species and numbers is required to commence in the first full wet season prior to construction beginning in order to determine the baseline. Consideration should be given to the need for and feasibility of translocation of adults or juveniles, which should occur in the early wet season, from directly impacted ponds to nearby suitable wetland habitats.

During construction, daytime and night-time surveys (transect counts) will be conducted in appropriate habitats within 500m of the alignment monthly. Monitoring will in general cover March to October, with night-time survey from March to September. For the upper section of Ma Tso Lung Stream, night-time surveys will cover March to October.

12.10.3.4 Dragonflies and Butterflies

Given the prior establishment of a wetland mitigation area to compensate for impacts on odonata, it is not considered necessary to carry out monitoring in the vicinity of the alignment. The mitigation area will, however, require monitoring to ensure targets are being met. In view of the lack of significant ecological value to butterflies of the areas affected by the Eastern Connection Road, no construction phase monitoring is considered necessary.

12.10.3.5 Aquatic Fauna

Weekly *in situ* monitoring of water quality in LMC Meander, Ma Tso Lung Stream and Ping Hang Stream should be carried out. Measurements to be taken are temperature, pH, salinity, turbidity and dissolved oxygen. The monitoring should refer to the water quality monitoring requirement as established in the EM&A Manual. Wet and dry season action or limit levels should be reviewed after the first monitoring events in each of these seasons.

Monitoring of aquatic fauna in watercourses potentially impacted by the development (in particular, Ping Hang Stream, Ma Tso Lung Stream and LMC Meander) should be carried out. The survey period for Ping Hang and Ma Tso Lung Streams should begin 12 months before commencement of construction works for the ECR (to establish a baseline profile) and continue until 12 months after completion. The survey period for LMC Meander should commence 12 months before work on the Project commences, and continue until 12 months after completion. The frequency of monitoring should be monthly. The location of said watercourses is shown in **Figure 12-5**. The exact monitoring points should be determined in consultation with AFCD ahead of construction commencing.

12.10.3.6 Site inspections

Site inspections are crucial to monitoring the potential for or occurrence of unforeseen impacts during the construction process. These should be carried out weekly and relate to such items as ensuring site fencing remains intact and that activities within the site do not affect habitats outside (e.g. dumping of construction waste or litter). Should issues be detected, appropriate mitigation will be carried out, where feasible.

12.11 Conclusion

The ecological baseline study has identified a number of habitats and species of conservation significance potentially impacted by the Project. Foremost among these is reed marsh in LMC Loop, LMC Meander, Eurasian Otter, the flight line corridor in areas over and adjacent to LMC Loop and a stream network at Ma Tso Lung for which there is a record of Three-banded Box Terrapin.

Construction and operation of development associated with the Project will result in a range of ecological impacts some of which, if unmitigated, are predicted to cause ecological impact of high significance. The key habitat losses and disturbance impacts are as follows:

Permanent Impacts

- Permanent loss of 10.96ha of reed marsh and 0.50ha of marsh in LMC Loop.
- Permanent loss of ecological function (arising from habitat loss and disturbance impacts) of 9.70ha of pond.
- Permanent loss of 2.33ha of marsh.
- Permanent loss of 0.19ha of seasonally wet grassland.
- Permanent loss of 1.26ha of woodland and shrubland.
- Permanent loss of 0.15ha of riparian vegetation along LMC Meander.
- Permanent loss of 80-160m² of LMC Meander river bed and water column.

Temporary Impacts on Habitats

- Temporary loss of functional value of 4.11ha to 6.36ha of pond, duration depending on phase of project, but total period approx. 7 years.
- Temporary 3-year loss of 0.032ha of disturbed reed marsh during construction of Direct Link.
- Temporary loss of 1.10ha of reed marsh in EA during construction of Eastern Connection Road, duration 18 months.
- Temporary loss of riparian vegetation along LMC Meander due to stabilisation works, duration up to 4 years though not all concurrently.

Secondary Impacts

- Disturbance to LMC Meander.
- Fragmentation impacts on movements of large waterbirds, herpetofauna and mammals, including Eurasian Otter, arising from infrastructural connections and disturbance from buildings.
- Disturbance impacts to Eurasian Otter, mainly due to construction-related activities.
- Potential run-off impacts on watercourses.

- Increased wildlife mortality due to noise barriers.

Key mitigation measures comprise the following:

- Creation of 12.78ha Ecological Area containing reed marsh and marsh habitat to compensate for habitat loss in LMC Loop, and a buffer area of 50m width.
- Use of underpass below LMC Meander and depressed road through fish ponds at HHW.
- Provision of permanent compensatory off-site wetland areas totalling a minimum of 11.72ha.
- Provision of temporary compensatory off-site wetland areas totalling a minimum of 6.36ha in construction phase.
- Implementation of lower building heights near to EA.
- Banks of LMC Meander to be stabilised and re-vegetated after completion.
- Site formation works in EA and bank stabilisation works alongside LMC Meander to be carried out in wet season.
- Installation of 3m-high olive green fence site hoarding around construction areas to reduce disturbance and allow or deter animal passage as required.
- Implement standard measures to minimise magnitude of construction run-off and spillage events.
- Use of mechanised equipment only during the period 9am to 5pm.
- No use of direct lighting on LMC Meander.
- Provision of wildlife underpasses and one 70m-wide overpass as part of Eastern Connection Road.
- Phasing of work on Eastern Connection Road to avoid concurrent working in sections of critical ecological value.
- Use of viaducts to cross streams.
- Where possible, wet season work only in critical areas of fish ponds.
- Use of opaque noise barriers along roads to minimise wildlife mortality.

Adverse residual impacts after implementation of mitigation measures are all assessed as of Low severity, and comprise the following:

- temporary loss for 2-3 years (depending on establishment period required) of 2.50ha of reed marsh to allow site formation of the Ecological Area.
- temporary loss for 18 months of riparian vegetation of LMC Meander due to construction of the Eastern Connection Road. Through design, the vegetation will be reprovisioned after construction.
- temporary loss of riparian vegetation due to raising of level of LMC Loop and stabilisation of banks of LMC Meander over period of 4 years;

- permanent loss of 0.15ha of riparian vegetation of LMC Meander and river bed under footprint of Western Connection Road.
- permanent loss of 80-160m² of LMC Meander river bed and water column;
- temporary loss of 1.26ha of woodland and shrubland due to construction of ECR. This will resolve itself in 20-30 years once the area of planted trees reaches maturity.