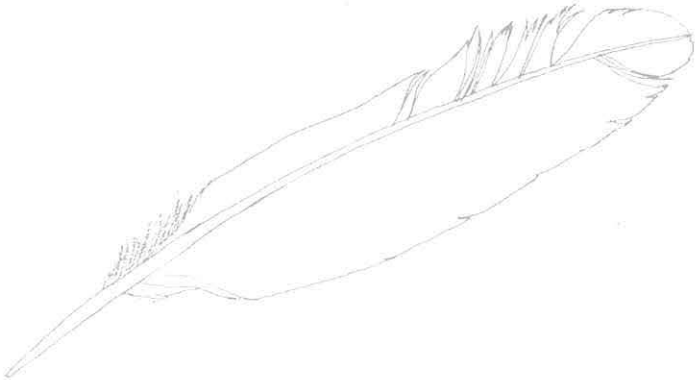
Asia Ecological Consultants Ltd

KCRC EAST RAIL EXTENSIONS
CONTRACT NO. LGSA-017

WETLAND COMPENSATION AREA ECOLOGICAL MONITORING AND ADAPTIVE MANAGEMENT

LOK MA CHAU STATION HABITAT CREATION AND MANAGEMENT PLAN

Issue 11 (Revised)
September 2006



KCRC EAST RAIL EXTENSIONS
Contract No. LGSA-017

WETLAND COMPENSATION AREA ECOLOGICAL MONITORING AND ADAPTIVE MANAGEMENT ADVICE

LOK MA CHAU STATION HABITAT CREATION AND MANAGEMENT PLAN

Issue No. 11
(Revised)

September 2006

Prepared by: Dr Michael Leven

Date: 7th September 2006

Reviewed by: Geoff Carey

Date: 8th Sept 2006

Asia Ecological Consultants Ltd
127 Commercial Centre
Palm Springs
Yuen Long
New Territories
Hong Kong
asiaecol@asiaecol.com.hk

This Document conforms to the findings of the Lok Ma Chau Spur Line EIA Report

Certified by

KCRC Environmental Team Leader

This document conforms to the findings of the EIA Report
Verified by Dr Guiyi Li

Hyder Consulting Limited
Independent Environmental Checker

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1. INTRODUCTION

1.1 Background to Issue 11 of the HCMP for Lok Ma Chau Ecological Enhancement Area

1.1.1 The current Issue (Issue 11) of the HCMP for Lok Ma Chau Ecological Enhancement Areas (LMC EEA HCMP) replaces Issue 10, dated March 2005. That Issue of the HCMP provided the basis for the design and management of the EEA for the period from April – October 2005; the final seven months of the programmed EEA construction period. Issue 11 contains prescriptions for the EEA establishment period (during which some residual construction works will be required), together with prescriptions for the operational period which will commence in 2007, shortly before the LMC Spur Line begins operations. Accordingly, it includes the following main changes and additions to Issue 10:

- Ponds have been renumbered so that pond number is correlated with the management compartments;
- Management compartments have been introduced to better define the relationship between the requirements for target species of wildlife and the management regime;
- Targets and monitoring protocols for all target species have been added. (Previous Issues of the HCMP only included specific targets and monitoring protocols for six large waterbird species, the target species during the construction period.);
- Monitoring protocols for habitat conditions have been reviewed and some modifications have been made;
- Management and monitoring protocols have been extended to cover the full ECA as well as (where appropriate) the Water Polishing Reedbed.

1.2 Statutory and Institutional Background

1.2.1 On 15th January 2004 an amended Environmental Permit No. EP-129/2002/B was issued for the Sheung Shui to Lok Ma Chau Spur Line under the terms of the Environmental Impact Assessment Ordinance, Cap. 499, Section 10(1). Condition 2.4 of the Environmental Permit states that:

> "The Permit Holder shall submit the HCMP for "ecological enhancement areas" as described in Condition 3.23 below no later than two years after the commencement of construction of Lok Ma Chau Station or one and a half years before the operation of the Lok Ma Chau station, whichever comes first. The HCMP shall be prepared and finalized in accordance with the draft HCMP contained in Appendix A4.2 of the EIA Report. The HCMP shall provide the detailed specifications for the habitats and ecological functions to be provided at Lok Ma

> Chau and to define the long-term management and ecological monitoring and audit requirements on these habitats."

1.2.2 Condition 3.23 of the Environmental Permit No. EP-129/2002/B states the following:

> "Prior to the operation of the Lok Ma Chau station, the Permit Holder shall enhance and manage an "ecological compensation area" which shall include not less than 29.65 hectares of fishponds, 0.2 hectares of marshland and 0.7 hectares of reedbed... These measures shall include, but not [be] limited to the following:-
>
> (a) enlarging small fishponds to reduce enclosure effects;
>
> (b) reprofiling of fishpond bunds to provide shallow sloping margins to increase feeding opportunities and the availability of fish and invertebrate prey to birds;
>
> (c) establishing marginal emergent vegetation; and
>
> (d) manipulating fish stocking, feeding/fertilising regime and drain-down to optimise food availability to birds."

1.2.3 In addition, Condition 3.24 of the Environmental Permit states:

> "Prior to the operation of the Lok Ma Chau station, the Permit Holder shall establish not less than 4.9 hectares of marshland ..... as conforming to the criteria set out in the HCMP".

1.2.4 This HCMP (Issue 11) is prepared in order to meet the requirements of the above Conditions of EP-129/2002/B.It is based on the draft HCMP (Issue 5) contained in Appendix A4.2 of the EIA Report and includes, as is required by Condition 4.1 (a) of the Environmental Permit, adaptive modifications to the management and monitoring regime derived from experience gained during the operation of the EEA from August 2002 and incorporated in previous Issues (Issues 6 – 10) of the HCMP.

1.3 Location and area of the Lok Ma Chau Ecological Enhancement Areas (EEA)

1.3.1 The location of the Lok Ma Chau EEA and the Lok Ma Chau Spur Line and Station are shown in Figure 1, together with the boundaries of the Inner Deep Bay Wetland Conservation and Buffer Areas.

1.3.2 Habitats in and around the EEA are shown on Figure 2. This area corresponds to the Lok Ma Chau area surveyed during the preparation of the Sheung Shui to Lok Ma Chau Spur Line Environmental Impact Assessment (the EIA) (BBV 2001a)[1]. The ecological survey of this area undertaken for the EIA study provided the baseline for the determination of the species and habitats of conservation importance, the impacts on which from the Spur Line project will be compensated by the EEA.

1.3.3 Figure 3 shows habitats and water circulation layout for the EEA.

1.4 Purpose of the Habitat Creation and Management Plan

1.4.1 The Habitat Creation and Management Plan (HCMP) details the specifications for the habitats and ecological functions to be provided by the EEA and defines management, monitoring and audit requirements for these habitats. Management, ecological monitoring and audit are subject to the ongoing requirement to review these on a six monthly basis in accordance with the HCMP's internal protocols and on an annual basis in accordance with the requirements of the Environmental Permit. In addition, it is a requirement of the Environmental Permit (Condition 4.1 (b)) that a Five-yearly qualitative and quantitative review of management objectives, together with measures necessary to accomplish any revised objectives and targets is undertaken. The first Five-yearly Review is scheduled to be undertaken five years after the completion of construction of the EEA (i.e. September 2010).

1.4.2 The Environmental Permit requires that the prescriptions and specifications in the HCMP and the accompanying appendices accord with those in the Environmental Monitoring and Audit (EM&A) Manual. Accordingly, the EM&A Manual is updated to correspond with any changes in the HCMP.

1.5 Content of the HCMP

1.5.1 Content of the HCMP includes:

- a summary of the current status of the EEA, including its ecological characteristics and importance and those physico-chemical conditions that may affect habitat restoration and enhancement measures;

- definition of the target species requiring mitigation in the EEA and the target habitats to be created or enhanced for them;

- details of the specific habitat requirements and associated management measures required by target species;

- detailed design drawings and specifications for the habitats (e.g. vegetation composition and structure and water regimes) and associated structures (e.g. topography, water courses for water supply and drainage and water control structures), with underlying design calculations where appropriate;

- management prescriptions and required actions to maintain the long-term ecological value and functions of the mitigation areas;

- a detailed monitoring programme for habitat attributes and target species; and

- an implementation programme for any habitat creation or modification measures or other construction activities which require to be undertaken in the EEA during the period covered by the current Issue of the HCMP.

[1] The full EIA study area is illustrated in BBV (2001a) and BBV (2003).

N

Lok Ma Chau Spur Line Station

Ramsar Site

Wetland Conservation Area

Wetland Buffer Area

Lok Ma Chau Ecological Enhancement Areas (EEA)

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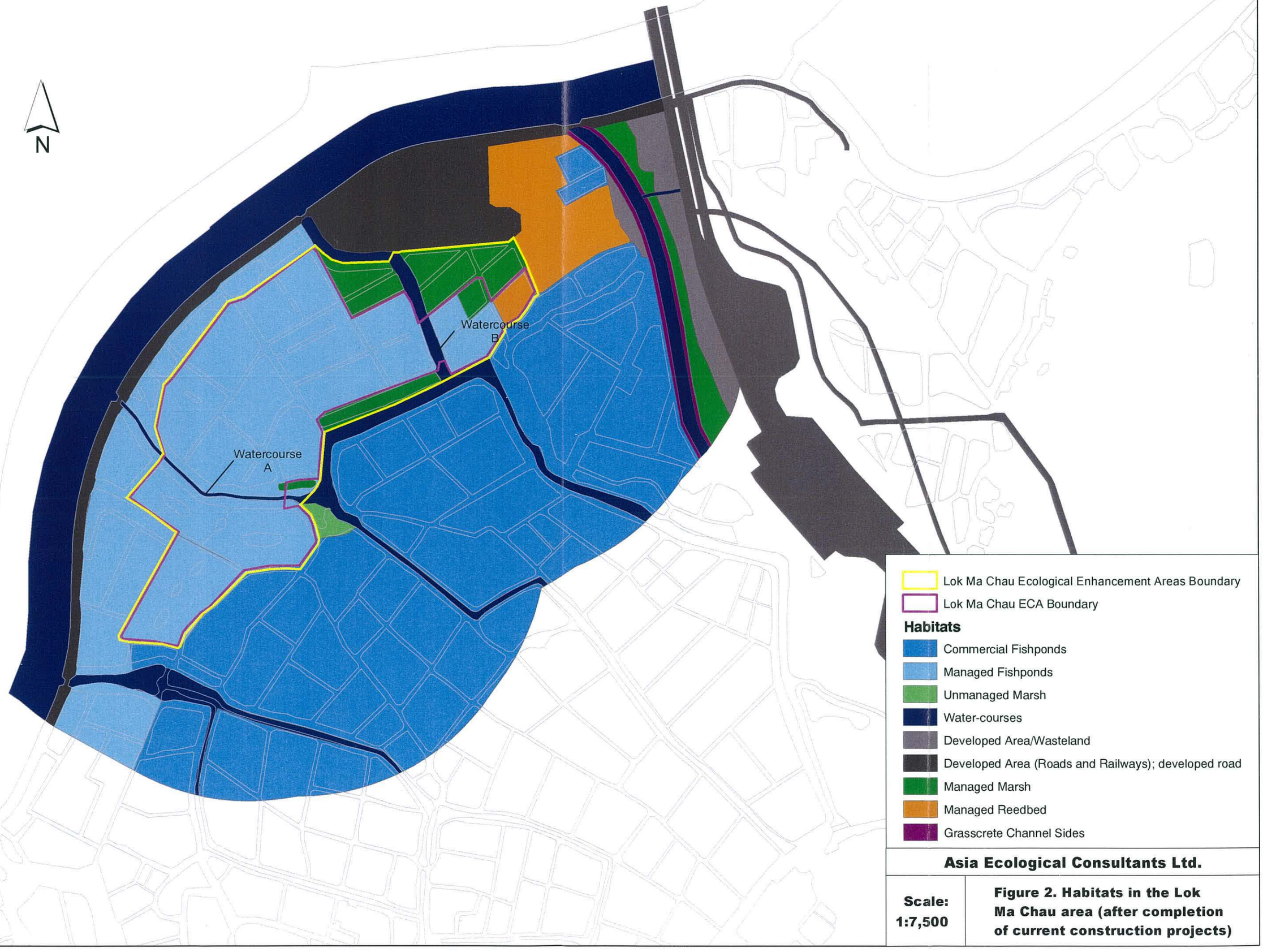
Scale: 1:40,000

Figure 1. Deep Bay Area showing location of Lok Ma Chau Ecological Enhancement Area



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Scale: 1:7,500	**Figure 2. Habitats in the Lok Ma Chau area (after completion of current construction projects)**

2. DESCRIPTION OF THE EEA

2.1 EEA Location and Boundaries

2.1.1 The EEA comprises the area of former fishponds indicated in Figure 3.

2.2 Ownership

2.2.1 The EEA is owned by Government. With exception of Ponds 1A[2] and 1B the EEA is occupied by KCRC under License. Ponds 1A and 1B remain under direct Government ownership but are temporarily occupied by KCRC in order to permit implementation and establishment of ecological enhancement works. These ponds will be handed back to Government in September 2006, prior to commencement of the LMC Spur Line and Station operations. Previously, the entire area was owned by Government and was used for commercial fish farming activities.

2.3 Habitats

2.3.1 The entire area is wetland, largely comprising managed pond and freshwater marsh, together with a small area of reedbed. Secondary habitats are fishpond bunds and drainage channels. Some bunds, notably those around Ponds 1 and 2, to the north of Ponds 3 and 8 and on either side of the drainage channel which passes through the west of the site (Watercourse A in Figure 2) are well wooded, the main tree species present are *Melia azedarach*, *Macaranga tanarius*, *Ficus microcarpa*, *Hibiscus tiliaceus* and *Celtis tetranda*.

2.4 Recent land use changes and habitat management

2.4.1 Commercial fish farming activities ceased at the end of 2000 when the occupiers were required to vacate the land. At this time most fish were removed from the ponds and, in association with fish removal, some ponds were partially drained. Subsequently, during 2001, the partially drained ponds received some recharge from rainwater. In addition, several ponds became more acidic and vegetation (largely grasses) grew up on the pond bunds. Commencing in October 2001 initial management activities were undertaken by KCRC with the objectives of demonstrating how management of ponds could enhance their attractiveness to target species and to enhance experience in practical fishpond management techniques. These management activities were reported in BBV (2002a), and continued until April 2002.

[2] Ponds are numbered according to the revised numbering system described in Section 2.5.

2.4.2 Operation of the EEA commenced in August 2002 when a phased programme of pond reprofiling was begun and ponds were managed in order to attract large waterbirds in accordance with the HCMP prescriptions. This original area, the Initial Enhancement Area (IEA) was 15.5 ha comprising Ponds 2 – 7 inclusive. As enhancement management works progressed, the IEA area was extended to include Ponds 8 – 10 from 1st August 2003, Pond 11 from 1st June 2004 and Pond 1 from 1st November 2005. The area will be further extended from 1st January 2006 to include Pond 12 and the marsh areas at Ponds 13, 14, 17 and 19.

2.4.3 Accordingly, from 1st January 2006, the enhancement management area will include 31.10 ha of open water fishponds and 1.99ha of marsh.

2.4.4 Areas of the EEA where management works have still to be undertaken prior to the operation of LMC Station are as follows:

- Marsh in Ponds 15 (part), 16, 18, 20 and 21;
- Open water area in Pond 15 (part); and
- Reedbed in Pond 22.

2.4.5 Completion of works in these areas will bring the areas of enhanced habitat in the EEA up to 31.61 ha of fishponds, 5.32 ha of marsh and 0.70 ha of reedbed, thus meeting the EP habitat requirements of establishment of at least 29.65 ha of fishponds, 0.2 ha of marsh and 0.7 ha of reedbed in the ECA (EP Paragraph 3.23) and at least an additional 4.65 ha of marsh in the EEA (EP Paragraph 3.29).

2.5 Management Compartments

2.5.1 From 1st January 2006 the EEA will be divided into three compartments, reflecting management practices and the habitat and wildlife targets in these different units (Figure 4). Compartments will be as detailed below; see also habitat requirements for target species (Section 3), management strategy (Section 6) monitoring requirements (Section 7) and Event and Action Plan for Ecological Issues (Appendix 2) :

- *Compartment A* (Ponds 1 – 2): ponds will be managed at a relatively low intensity and water levels will be permitted to fluctuate naturally except when problems of water quality or potential arise. Limited fish stocking will be undertaken in late winter. Bunds and some islands will be wooded. Primary target species in Compartment A are Eurasian Otter, large waterbirds, ducks, raptors and bird species requiring tree cover, notably starlings and Black-naped Oriole;
- *Compartment B* (Ponds 3 - 12): ponds will be managed relatively

N

1A
1B
2A
2B
3A
3B
4A
4B
5
6
7A
7B
8A
8B
9A
9B
10
11A
11B
12
13
14
15
16
17
18
19
20
21
22

HCMP Boundary

Weir

Overflow Pipe

uPVC arterial pipe

Pipe with catchpit incorporating valve pit type I depending on location in the system
See Figure A3

Habitats

- Managed Fishponds
- Marsh
- Reedbed
- Watercourses
- Well Vegetated Bunds and Islands
- Open/Lightly Vegetated Bunds and Islands
- Station, Viaduct and Border Crossing

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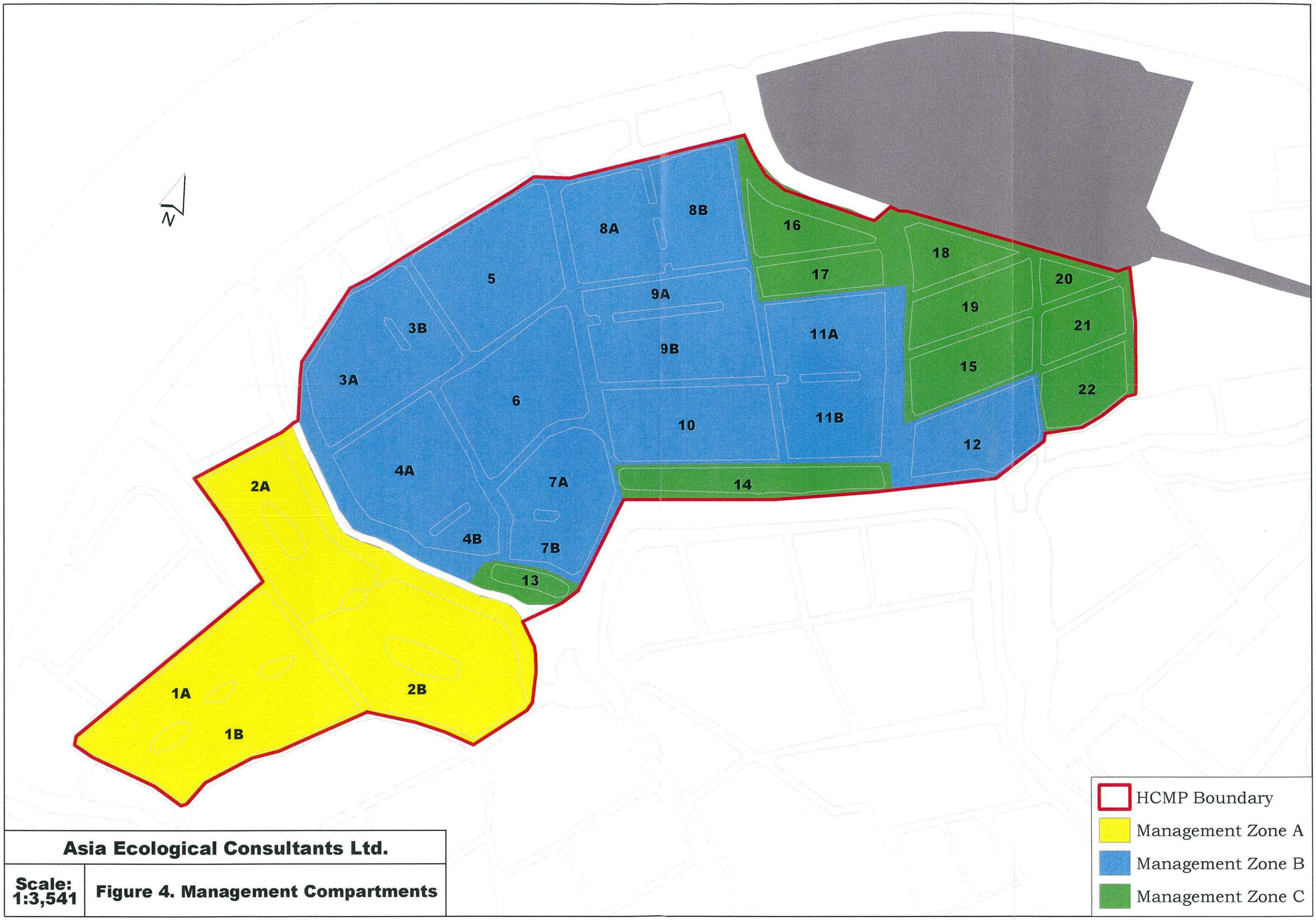
Scale: 1:3,500	Figure 3. Lok Ma Chau Ecological Enhancement Area



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Scale: 1:3,541	Figure 4. Management Compartments

intensively with regular drain-down to attract large waterbirds, notably Great Cormorant, Grey Heron, Great Egret, Little Egret and Black-faced Spoonbill. Fish stocks will be maintained by stocking with trash fish following drain-down and refilling. In addition to large waterbirds, target species will be Black-winged Stilt, passerine birds requiring short grass and open bunds and Chinese Soft-shelled Turtle;

- *Compartment C* (Ponds 13 - 22): marsh and reedbed areas with a variety of shallow water microhabitats managed for amphibians, dragonflies and bird species requiring marsh vegetation (Greater Painted-snipe, *Gallinago* snipe, Pheasant-tailed Jacana and wetland passerines). Ponds will be kept free of fish as far as possible in order to benefit amphibians and invertebrates.

2.6 Adjoining land uses

2.6.1 The EEA is bounded by the Lok Ma Chau Station site to the northeast and by active commercial fishponds to the south and southwest. In the north it adjoins a single row of former fishponds which were reinstated following channelisation works on the Shenzhen River. Vegetation management in these ponds is the responsibility of Agriculture, Fisheries and Conservation Department (AFCD) until 2010.

2.7 Topography and watercourses

2.7.1 A detailed site topographical survey was carried out prior to the preparation of Issue 5 of this HCMP. A further survey was carried out in Ponds 1A and 1B when these were added to the EEA. Spot height measurements and extrapolated contours that were measured indicate that the average base levels of the existing fishponds are typically 0.5 – 1.0 mPD, whilst bund heights vary between 3.0 – 4.0 mPD. Water depths have been measured as a part of the management and monitoring measures undertaken during winter 2001-2002 and, following the establishment of the IEA, from July 2002. The source of all water on the site is rainwater, hence except where ponds are drained-down as a part of the management activities, lowest levels are reached at the end of the dry season in early April. Most ponds, when full, have water depths of approximately 2.0 – 2.5 m; the deepest is 3.3 m (Table 2.1).

Table 2.1 *Maximum water depths of fishponds in the EEA February 2002 – December 2005.*

Pond No.	Max. depth (m)	Date
1A	1.30	27 Oct 2005*
1B	1.30	27 Oct 2005*
2A	2.53	22 Aug 2005
2B	3.33	22 Aug 2005
3	2.35	22 Aug 2005
4	1.99	22 Aug 2005
5	2.28	22 Aug 2005
6	2.17	22 Aug 2005
7A	2.19	16 Sep 2003
7B	2.04	16 Sep 2003
8A	2.72	22 Aug 2005
8B	2.29	22 Aug 2005
9A	2.20	22 Aug 2005
9B	2.40	22 Aug 2005
10	>2.77	22 Aug 2005
11A	2.26	22 Aug 2005
11B	2.83	22 Aug 2005
12	2.49	25 Aug 2005

*Depth marker not in place prior to this date.

2.7.2 A watercourse flows through the site and discharges to the Shenzhen River (Watercourse A in Figure 2). This watercourse is tidal and flows into the Shenzhen River via an open outfall. The watercourse is maintained by Drainage Services Department and has an invert level of about 0.0 – 0.5 mPD. There are no water control structures on this watercourse within the vicinity of the mitigation area.

2.7.3 The watercourse currently has a large catchment in part draining the San Tin area. No data are available on flow rates or water levels in the watercourse. In the wet season/normal flow periods, observations suggest that the watercourse level is of the order of +1 to 1.5 mPD. However, recent observations have shown that the watercourse to the south of the site does run full, and overtopped the bank in June 2001. This situation should ease with the construction of the San Tin Eastern Main Drainage Channel (San Tin EMDC). Meanwhile, bunds along the south side of the EEA have been strengthened and raised to c. 4.0 m APD to reduce the risk of flooding of the site.

2.7.4 Watercourse B, which runs through the EEA between Compartments B and C, is not connected to Watercourse A and thus its catchment area is restricted to part of the EEA. The watercourse previously also flowed into the Shenzhen River but has been blocked temporarily whilst construction of the LMC Station is underway. The watercourse and the outlet to the Shenzhen River will be restored when station construction is complete. It will then provide an outlet for discharge of excess water from the EEA ponds in Compartments B and C.

2.8 Soils

2.8.1 The following account of the soils of the study area is based on Grant (1960, 1986). The soils around the fishponds of Lok Ma Chau are predominantly from the Mai Po Association. These soils are mainly found around the Mai Po, San Tin and Sheung Shui areas. They are similar to the soils of the Chik Nai Ping Association; these are soils derived from Tai Mo Shan porphyry material and imperfectly drained. Soils of the Mai Po Association tend to be sandier than the Chik Ni Ping, particularly at the base of the soil profile. Mai Po Association soils are formed over alluvial and colluvial material from rocks of the Lok Ma Chau formation and metamorphosed Pat Sin rock as well as Tai Mo Shan porphyry.

2.8.2 In the fishpond area the soils are Mai Po Poorly Drained, Mai Po Very Poorly Drained and Mai Po Saline, in addition to a large amount of undifferentiated alluvium. The soils tend to exhibit strong sharp horizon changes likely to be associated with the level of the water table. It has been noted that the pH of the soils decreases with depth to as low as 2.6. The soil tends to be clayey at the surface and become coarser in texture with depth.

2.8.3 The soils are acid sulphates due to the sulphate of the sea water which is broken down to sulphur which combines with iron, which was commonly deposited in sediments in the Deep Bay area, to form iron sulphides. Percentages of sulphur can be up to 3% of the total dry matter.

2.9 Baseline Ecological Interest

Habitat Evaluation

2.9.1 The ecological value of the habitats in the LMC area including the EEA prior to commencement of construction of the LMC Station was detailed in the *EIA Final Report* (BBV 2001a). This Report described baseline studies conducted during May 2000 to May 2001 which reviewed habitat changes and described the status of the following taxa groups: plants, mammals, birds, reptiles, amphibians, dragonflies and butterflies. In addition to general surveys, detailed studies were conducted into the occurrence of Greater Spotted Eagles *Aquila clanga* and Imperial Eagles *Aquila heliaca* and the use of fishponds by Black-faced Spoonbills *Platalea minor*. Subsequent to the completion of the EIA Report a study of the distribution of Eurasian Otter *Lutra lutra* was conducted during October 2001 to April 2002 (BBV 2002b).

2.9.2 At the time of the surveys undertaken by ERM (ERM 1999), the majority of the area consisted of active fishponds. Subsequently, at the time of the baseline studies, they were inactive, whilst, as noted above, during winter 2001-02 they received initial habitat management measures, primarily to enhance their attractiveness to target species of large waterbirds.

2.9.3 As was detailed in BBV (2002a), these recent changes in management status had a significant effect on the number of large waterbirds present in the EEA area. However, these recent changes in status did not alter fundamentally the evaluation of their potential as wildlife habitats. Thus, as is indicated in Table 2.2, both the active and inactive fishponds within the Lok Ma Chau and nearby San Tin areas are considered to be of moderate to high ecological value.

Table 2.2 *Ecological evaluations of fishponds within 500 m of the Spur Line and Station area at San Tin and Lok Ma Chau. (Source: BBV 2001a).*

	Active fishponds		**Inactive fishponds**	
Criteria	**San Tin**	**Lok Ma Chau**	**San Tin**	**Lok Ma Chau**
Naturalness	Man-made habitat, currently subject to limited human disturbance.	Man-made habitat, currently subject to limited human disturbance.	Man-made habitat, currently subject to limited human disturbance.	Man-made habitat, currently subject to limited human disturbance.
Size	Small.	Small.	Small.	Small.
Diversity	Low habitat diversity but high in terms of wildlife recorded.	Low habitat diversity but high in terms of wildlife recorded.	Low habitat diversity but high in terms of wildlife recorded.	Low habitat diversity but high in terms of wildlife recorded.
Rarity	The habitat is not rare but some of the species supported are rare locally or globally, notably some avifauna.	The habitat is not rare but some of the species supported are rare locally or globally, notably some avifauna.	The habitat is not rare but some of the species supported are rare locally or globally, notably some avifauna.	The habitat is not rare but some of the species supported are rare locally or globally, notably some avifauna.
Re-creatability	Readily-re-creatable.	Readily-re-creatable.	Readily-re-creatable.	Readily-re-creatable.
Fragmentat-ion	Heavily fragmented.	Slightly fragmented.	Heavily fragmented.	Slightly fragmented.
Ecological Linkage	Part of the wider fishpond habitat of the Deep Bay area and serves similar function to those located at Mai Po Nature Reserve.	Part of the wider fishpond habitat of the Deep Bay area and serves similar function to those located at Mai Po Nature Reserve.	Part of the wider fishpond habitat of the Deep Bay area and serves similar function to those located at Mai Po Nature Reserve.	Part of the wider fishpond habitat of the Deep Bay area and serves similar function to those located at Mai Po Nature Reserve.
Potential Value	High ecological potential if managed properly to enhance wildlife use.	High ecological potential if managed properly to enhance wildlife use.	High ecological potential if managed properly to enhance wildlife use.	High ecological potential if managed properly to enhance wildlife use.
Nursery/ breeding ground	Part of the wider Deep Bay fishponds habitats that provide an important breeding/nursery ground for the prey of birds and other animals, notably Tilapia and chironomids	Part of the wider Deep Bay fishponds habitats that provide an important breeding/nursery ground for the prey of birds and other animals, notably Tilapia and chironomids.	Part of the wider Deep Bay fishponds habitats that provide an important breeding/nursery ground for the prey of birds and other animals, notably Tilapia and chironomids.	Part of the wider Deep Bay fishponds habitats that provide an important breeding/nursery ground for the prey of bird and other animals, notably Tilapia and chironomids.
Age	No information is available.	No information is available.	No information is available.	No information is available.
Abundance/ Richness of Wildlife	High.	High.	High.	High.
Conclusion	**High Ecological Value**	**High Ecological Value**	**Moderate to High Ecological Value**	**Moderate to High Ecological Value**

2.9.4 The only other habitat present prior to the commencement of enhancement management works is a watercourse with associated riparian vegetation which includes dense grassland and both native and exotic tree species. The value of the watercourse itself is reduced because it is highly polluted. However, evidence from elsewhere in the Lok Ma Chau area suggests that watercourses may form important corridors for the movement of Eurasian Otters (BBV 2002b). In addition, tree species along the watercourse provide roosting and hunting perches for birds (notably ardeids and raptors) whilst fruiting trees provide a winter food source for birds.

2.9.5 Existing vegetation was studied during June 2000 (wet season) and March 2001 (dry season) (BBV 2001a). The vegetation was highly modified as a consequence of commercial fish farming and other agricultural activities and primarily comprised rank grassland along bunds, together with remnant patches of crops and ornamental herbs, especially *Canna indica*. Planted or naturally dispersed trees are found on some bunds; these are largely the widely planted native *Hibiscus tiliaceus* and the naturalised exotic *Melia azedarach*, with smaller numbers of the native (but planted) *Ficus microcarpa* and the native, probably naturally established, *Celtis tetranda*. Some semi-natural vegetation occurred along the edges of ponds, especially where these are adjacent to drainage channels. However, no protected species or species considered to be rare by Corlett *et al.* (2000) were found.

2.9.6 Since the establishment of the EEA, vegetation management has been undertaken to increase the diversity of microhabitats by managing herbaceous vegetation to create a mosaic of largely bare areas, areas covered by vegetation less than c. 20 cm in height and areas of higher and denser vegetation, both along bunds and around the ponds. In addition, extensive areas of the exotic perennial herb, *Canna indica*, have been cleared. Planting of a range of wetland herb species has been undertaken in Ponds 13, 14, 17 and 19 and further wetland planting will be undertaken in Ponds 15 (part), 16, 18, 20 and 21 during the 2006 wet season (see Table 5.1). Tree planting has been undertaken on the island between Ponds 2A and 2B and on the east side of Pond 2A and the west side of Pond 4A. Further tree and bamboo planting will be undertaken during the 2006 wet season (see Table 5.1).

Areas of Important Habitat

2.9.7 The majority of the EEA consists of fishponds, which are already of high ecological value. This ecological value is in the process of being enhanced by means of the management activities detailed in this HCMP (see below).

Species of Conservation Importance and Target Species for the EEA

2.9.8 Target species for the EEA are the list of Species of Conservation Importance that were known to occur within the Lok Ma Chau area prior to the commencement of the Spur Line project (BBV 2001a). This list of

species is provided in Table 2.3 below. Conservation importance has been updated based the review of terrestrial species of conservation importance in Hong Kong (Fellowes *et al.* 2002). Some species previously considered to be of conservation importance did not qualify for inclusion under the criteria followed by Fellowes *et al.* These species remain on the list of target species at the present time pending comprehensive review at a later date.

Table 2.3 *Target Species for the Operational Phase of the Lok Ma Chau Spurline. Species occurring only irregularly are shown in brackets, Level of concern follows Fellowes* et al. *(2002). RC = Regional Concern, PRC = Potential Regional Concern, PGC = Potential Global Concern.*

Species common name	**Status**	**Frequency of Occurrence at Lok Ma Chau**
MAMMALS		
Eurasian Otter *Lutra lutra*	RC	✓
BIRDS		
Great Cormorant *Phalacrocorax carbo*	PRC	✓
Grey Heron *Ardea cinerea*	PRC	✓
Great Egret *Egretta alba*	PRC	✓
Little Egret *Egretta garzetta*	PRC	✓
Chinese Pond Heron *Ardeola bacchus*	PRC	✓
Black-faced Spoonbill *Platalea minor*	PGC	✓
Common Teal *Anas crecca*	RC	✓
Greater Spotted Eagle *Aquila clanga*	GC	✓
Imperial Eagle *Aquila heliaca*	GC	✓
Eurasian Hobby *Falco subbuteo*	LC	(✓)
Japanese Quail *Coturnix japonica*	LC	(✓)
Eurasian Coot *Fulica atra*	RC	✓
Pheasant-tailed Jacana *Hydrophasianus chirurgus*	LC	(✓)
Greater Painted-snipe *Rostratula benghalensis*	LC	✓
Black-winged Stilt *Himantopus himantopus*	RC	✓
Pintail Snipe *Gallinago stenura*	-	(✓)
Swinhoe's Snipe *Gallinago megala*	LC	(✓)
Common Snipe *Gallinago gallinago*	-	✓
Richard's Pipit *Anthus ricardi*	-	✓
Bluethroat *Luscinia svecica*	LC	(✓)
Common Stonechat *Saxicola torquata*	-	✓
Pallas's Grasshopper Warbler *Locustella certhiola*	LC	(✓)
Zitting Cisticola *Cisticola juncidis*	LC	✓
Japanese Yellow Bunting *Emberiza sulphurata*	GC	(✓)
Red-billed Starling *Sturnus sericeus*	GC	✓
Black-naped Oriole *Oriolus chinensis*	LC	✓
REPTILES & AMPHIBIANS		
Burmese Python *Python molurus*	PRC	(✓)
Chinese Soft-shelled Turtle *Pelodiscus sinensis*	GC	✓
Chinese Bullfrog *Rana rugulosa*	PRC	(✓)
Total number of Species of Conservation Importance regularly recorded		**20**

3. MITIGATION OBJECTIVES

3.1 Mitigation targets

3.1.1 The mitigation objective for the EEA is the provision of suitable habitat for the key target species of ecological importance regularly occurring within and adjacent to the Spur Line and Lok Ma Chau station site rather than the restoration of specific habitats of intrinsic ecological value. Accordingly, the habitat target for the mitigation areas is the enhancement, creation and maintenance of at least 29.65 ha of fishponds, 5.1 ha of marshland and 0.7 ha of reedbed in Favourable Condition for these target Species of Conservation Importance.

3.1.2 Numbers of target wildlife species will be a reflection of habitat factors, such as water conditions, food availability, and freedom from disturbance. Accordingly, other targets have been set that reflect the habitat requirements of the target species. Such targets include the increase in shallow feeding areas, benthic composition, water quality, fish stocks and vegetation status and distribution. These habitat-related targets are described in paragraphs 3.5.2 – 3.5.7.

3.1.3 The definition of Favourable Condition of the habitat is dependent on the target species for mitigation and their specific requirements. These are described below.

3.2 Targets for Mammals

Eurasian Otter

3.2.1 Eurasian Otters are restricted to the Deep Bay area in Hong Kong where they are rare (Reels 1996). This species is considered to be "Regionally Threatened" by Fellowes *et al.* (2002). Following the discovery of Eurasian Otters in the Lok Ma Chau area during baseline fieldwork for the EIA during winter 2000-01 (BBV 2001), up two individuals of this species have been recorded on several occasions in the EEA and the surrounding area as well as at the Mai Po San Tsuen Control Area. However, in the absence of data concerning the home ranges of this species in southern China it is not clear how many individuals are present and whether those recorded at Lok Ma Chau are the same as those at Mai Po San Tsuen.

3.2.2 Eurasian Otters feed largely on fish and amphibians. As is shown in BBV (2002b), in Hong Kong otters are known to make use of fishponds, *gei wai* and river channels. The former are probably largely used for feeding, whilst the latter appear to provide important movement corridors. This species will benefit from the appropriate management of river channel fringes by providing cover, prevention of burning of vegetation (the traditional way in which rank grassland along river channels is cleared by fish farmers), together with the provision of appropriate natural and artificial sites for holt formation. Otters will also be able to take advantage of the habitat provision (including food available) in marsh areas.

3.2.3 Within the EEA, management of the river channel will be undertaken with a view to the requirements of this species. Tree and shrub vegetation will be retained on the banks and large expanses of rank grassland will be cleared (by cutting). In addition, following observations during winter 2003-2004 which suggested that the most important area for this species in the EEA is around Ponds 1 and 2, artificial holts have been constructed on the bund on the east side of Pond 2B and on the island between Pond 2A and 2B. This island has also been planted woody vegetation to provide cover for otters.

3.3 Targets for Birds

3.3.1 Appropriate numerical targets in respect of faunal use of the EEA were discussed extensively in the EIA Report (BBV 2001a). With respect to bird species, numerical targets are required to demonstrate that there is no net decrease in the numbers of large waterbird species using the Lok Ma Chau area once the Spur Line and the Station are operational, taking into account both direct habitat loss and disturbance impacts. This requires that the numbers of birds in the EEA must be increased, through habitat management and enhancement, to compensate. As was described in the EIA Report, the size of the mitigation area has been determined by the area required to support the same numbers of the most disturbance and fragmentation sensitive species if the density of these species in the EEA is twice that of commercial fishponds.

3.3.2 Accordingly, in order to demonstrate that targets have been achieved, it is necessary to demonstrate that the EEA supports a density of the most disturbance-sensitive target species twice that of commercial fishponds; i.e. twice the number of birds per hectare. For less disturbance-sensitive species the habitat loss through disturbance impacts is obviously less, accordingly if densities in the EEA are twice those of commercial fishponds then a net increase in numbers of such species will have occurred. However, to avoid unnecessary complexity, and as a measure of the overall success of the EEA, the target of twice the density is retained for all bird species.

3.3.3 In order to demonstrate that numerical targets are achieved, numbers of target species in the EEA are compared with numbers of these species using representative samples of commercial fishponds to be monitored concurrently with management (and monitoring) of the EEA. The groups of fishponds selected as Control Areas are at Mai Po San Tsuen and San Tin and are shown in Figure 5 and Table 3.1. The original intention, as detailed in Issue 7 of the HCMP, was that these Control Areas would be of a similar size to the IEA and that survey methodology would be the same in the EEA and the Control Areas (i.e. counts conducted from an observation tower). Unfortunately, however, it proved impossible to identify a suitable location for the observation tower in the San Tin Control Area; accordingly a walked transect is conducted over (a larger area of) ponds in this location.

Table 3.1 *Control areas of commercial fishponds for monitoring of waterbird numbers.*

Location	Number of fishponds	Pond area (ha)
Mai Po San Tsuen	15	18.18
San Tin	46	49.27
Total	61	67.25

3.3.4 Habitat and habitat management requirements for the target bird species are detailed below. Species are listed as primary target species in a Compartment where specific management measures intended to improve conditions for a species are proposed and as secondary target species in circumstances where a species will derive significant benefit from management measures which are intended primarily to benefit other species.

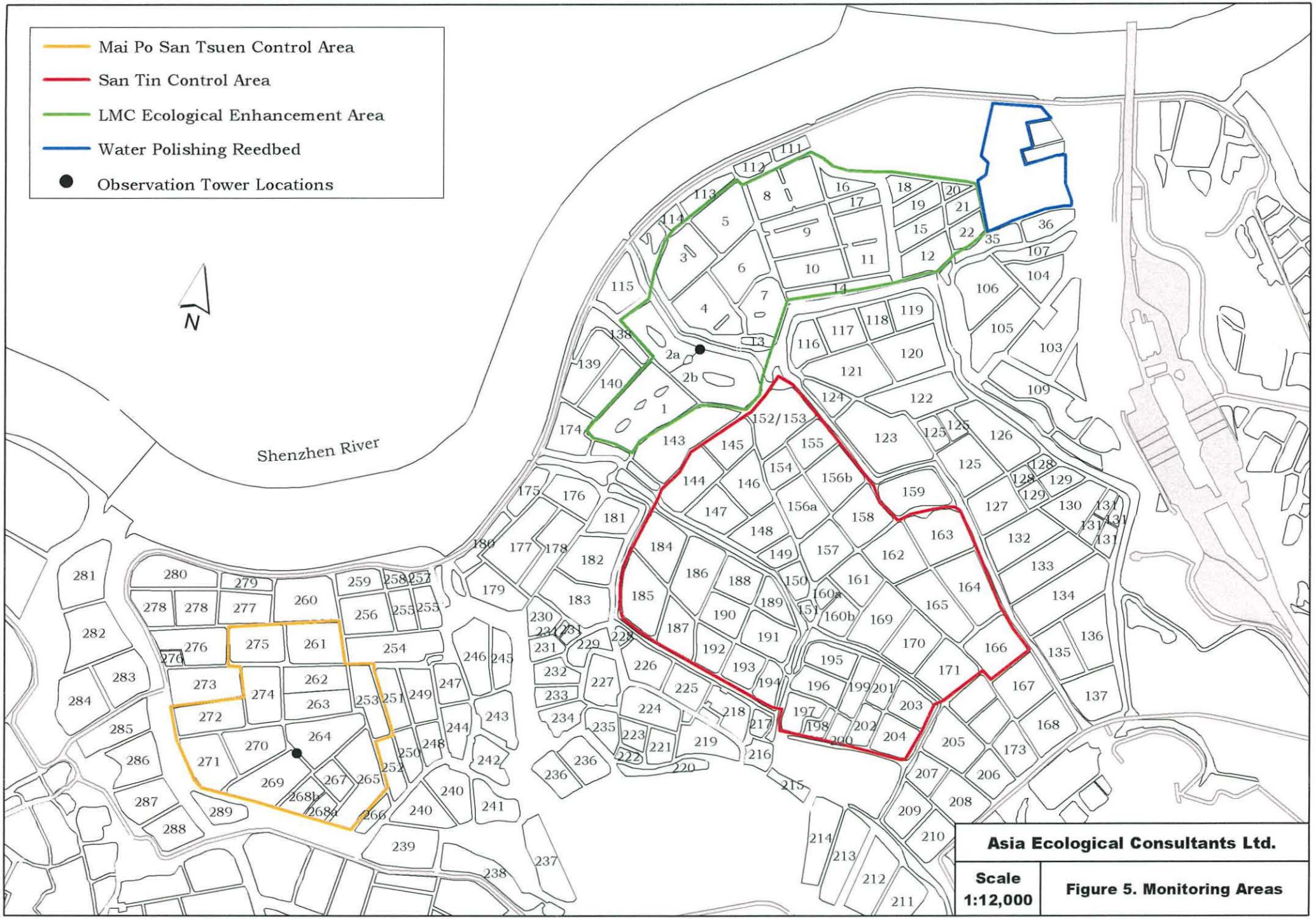
Great Cormorant

3.3.5 Great Cormorants are winter visitors to Hong Kong and are economically important as some of the large numbers of this fish-eating species which occur in Deep Bay feed in commercial fishponds. Studies of the wintering ecology of Great Cormorants and measures to reduce their impact on commercial fisheries including diversionary feeding and wiring ponds to prevent cormorant access have been sponsored by AFCD.

3.3.6 Great Cormorants in Hong Kong roost communally. There are currently two roosts in the Deep Bay area: at Mai Po NR and at Nam Sang Wai. Cormorants disperse to feed; either in Deep Bay itself or on fishponds. They use both active and inactive ponds, but avoid small ponds, especially those surrounded by trees or adjacent to sources of human activity. They readily take advantage of fish concentrations, including the provision of "trash fish" (usually tilapia) to divert feeding pressure from commercial ponds.

3.3.7 Unlike the other target species, Great Cormorants feed by catching fish whilst swimming (usually underwater). Accordingly, they will utilise ponds when they are full or partly full of water. During the day, when not feeding some birds return to the night time roosts whilst others use daytime loafing sites; usually isolated trees or tree lines or bare bunds or banks, especially those which isolated from disturbance and ground predators by being surrounded by water.

3.3.8 Management of ponds in the EEA has demonstrated that Great Cormorants are readily attracted when these are stocked with fish. Stocked ponds attract this species both when they were left at their normal depth (c. 1.5 m) and when they are partially drained to c. 50 cm water depth. In addition, unvegetated islands and bunds are regularly used as daytime loafing areas.


Mai Po San Tsuen Control Area
San Tin Control Area
LMC Ecological Enhancement Area
Water Polishing Reedbed
Observation Tower Locations
N
Shenzhen River
Asia Ecological Consultants Ltd.
Scale 1:12,000
Figure 5. Monitoring Areas

3.3.9 In view of these requirements, Great Cormorant is a primary target species in Compartment A (large stocked ponds providing feeding areas and trees providing loafing and potential roosting sites) and in Compartment B (stocked and periodically drained-down ponds providing feeding areas and bare bunds providing daytime loafing areas).

3.3.10 Numerical targets for Great Cormorants have readily been achieved and no adjustments to the current management regime to meet the needs of this species are required.

Grey Heron

3.3.11 Grey Herons have bred in Hong Kong, but this species is primarily a winter visitor (Young and Cha 1995). Habitat utilisation has been studied in Hong Kong by Young (1994) who noted that this species is predominantly a crepuscular feeder in Hong Kong and primarily uses *gei wai* as a daytime roost; but also utilises fish ponds for feeding. Grey Herons usually feed by wading for fish, preferentially selecting those 10 – 16 cm in length (Cramp and Simmons 1977). As one of the larger target species they can wade in water up to c. 70 cm depth.

3.3.12 Management of ponds in the EEA has demonstrated that Grey Herons are readily attracted to ponds in the EEA. Stocking alone attracts birds; attraction increases when ponds are partially drained or maintained at a low level which permits birds to wade over most of the pond. In addition, birds regularly take advantage of bunds which are largely cleared of vegetation as daytime roosting and loafing sites.

3.3.13 In view of these requirements, Grey Heron is a primary target species in Compartment A (large stocked ponds providing feeding areas) and in Compartment B (stocked and periodically drained-down ponds providing feeding areas and bare bunds providing daytime loafing areas).

3.3.14 Targets for Grey Herons have readily been achieved and no adjustments to the current management regime to meet the needs of this species are required.

Great Egret

3.3.15 Great Egrets are one of the scarcer breeding Ardeids in Hong Kong, but numbers are much greater in winter (Young and Cha 1995). Habitat utilisation has previously been studied in Hong Kong by Young (1994) who showed that whilst this species fed on drained ponds and *gei wai*, intertidal mudflats are typically more important as feeding habitat. However, management of the EEA has shown that Great Egret are strongly attracted to stocked and partially drained-down ponds. However, whilst the pattern of use has been similar to that of Grey Heron, many fewer birds of this species are attracted to stocked but undrained ponds and fewer birds roost or loaf in the EEA.

3.3.16 Thus, whilst targets for Great Egrets have generally been achieved, meeting targets for this species in the EEA is currently dependant upon continuation of the stocking and drain-down regime. However, it has been noted that whilst shortly after stocking (when large numbers of fish are available) Great Egrets feed in open water areas, small numbers persist in feeding in emergent vegetation around ponds once the larger attraction has ceased. It is considered that these remaining birds are seeking fish sheltering in the vegetation. It has also been noted that while both species use both bunds and trees as daytime loafing areas, Great Egrets are proportionally more inclined to utilise trees. Ongoing habitat management measures in the EEA which include the creation of larger areas of shallow water with emergent vegetation and more wooded bunds and islands are, therefore, expected to provide additional feeding habitat for this species and thus reduce the dependence upon stocking and drain-down events.

3.3.17 Great Egret is a primary target species in Compartment A (large stocked ponds with vegetated fringes providing feeding areas and wooded bunds and islands providing loafing areas) and in Compartment B (stocked and periodically drained-down ponds providing feeding areas).

Little Egret

3.3.18 Little Egrets are found in Hong Kong throughout the year. Habitat utilisation has been studied in Hong Kong by Young (1994) and Cornish (1996). These studies showed that Little Egrets in Hong Kong feed primarily in fishpond and intertidal mudflat areas. Little Egrets feed opportunistically on fish remaining when ponds are drained and are often the most abundant Ardeid species in such feeding concentrations. Breeding birds typically forage within 3 km of egretries (Young 1994), which may be situated either in bamboos or a variety of tree species.

3.3.19 Though Little Egrets have been attracted to stocked and partially drained ponds in the EEA, numbers of this species have for the most part not met numerical targets (AEC 2003, 2004, 2005) and tend to be lower than those recorded at nearby commercial fishponds and at Mai Po NR (BBV 2002a).

3.3.20 Possible reasons for the relatively low numbers of Little Egrets are: a relatively low density or diversity of small prey items, exclusion from drained-down ponds by larger Ardeids and distance from established egretries (during summer) or roost sites. Measures which have already been taken to improve numbers include stocking of ponds with Mosquito Fish (which are a suitable size prey), creation of larger areas of islands and associated shallows to increase the area of ponds where water is less than c. 50 cm depth (and hence suitable for feeding Little Egrets), is required to make this prey available. These measures have had some positive effect on the numbers of Little Egrets, especially after the breeding season. Longer term measures to meet the needs of this species are the planting of trees and the bamboo *Bambusa eutuldoides* on the island between Pond 1A and 1B (see schedule and plan in Appendix 1)

This will provide a secure roosting and a potential breeding site. In addition, marshland establishment in Compartment C will increase the area on the site which supports the small prey items which Little Egrets prefer.

3.3.21 Little Egret is a primary target species in Compartments A and B and is a secondary target species in Compartment C.

Chinese Pond Heron

3.3.22 Chinese Pond Herons are found in Hong Kong throughout the year. Habitat utilisation has been studied in Hong Kong by Young (1994) who showed that birds breeding at the Mai Po Village egretry fed mainly around fishponds. Individuals typically forage solitarily along the edges of open water areas or areas within sparse or short vegetation. They utilise open areas such as intertidal mudflats or drained down ponds less than larger Ardeid species in Hong Kong. Chinese Pond Herons breed colonially, either on their own or with other Ardeid species. Nests are often placed in bamboos, especially *Bambusa eutuldoides*. Breeding adults largely forage within 3 km of their colonies (Young and Cha 1995).

3.3.23 Unlike the other target species of ardeids (and Black-faced Spoonbills), Chinese Pond Herons are not attracted in large numbers to drained-down ponds, neither do the make extensive use of *gei wai* (BBV 2002a). Rather, this species is a solitary feeder which typically finds much of its prey in shallow water either in or on the edge of areas of emergent or pondside vegetation. Chinese Pond Herons eat small fish, but also feed extensively on invertebrates and amphibians. Within the EEA therefore, provision for this species must focus on creating suitable shallow water conditions with emergent vegetation where a range of small prey species is available.

3.3.24 Numbers of Chinese Pond Herons in the EEA have for the most part not met numerical targets (AEC 2003, 2004, 2005). As with Little Egret, this species is expected to benefit from the creation of secure roosting and potential nest sites on the island between Ponds 1A and 1B. The available feeding areas for this species will also be considerably increased once the marsh areas become established. An additional measure, specifically aimed at improving feeding conditions for Chinese Pond Herons, is the establishment of mats of *Ipomoea aquatica*, a favoured feeding habitat for this species, around some ponds.

3.3.25 Since numbers of Chinese Pond Herons in Hong Kong are similar throughout the year, the objective of management for this species is to provide suitable conditions in both the breeding as well as the non-breeding season.

3.3.26 Chinese Pond Heron is a primary target species in Compartments A and C and a secondary target species in Compartment B.

Black-faced Spoonbill

3.3.27 Black-faced Spoonbills have been subject of a number of studies in Hong Kong (notably Anon. (1999), Melville *et al.* (1999) and Anon (2001)). In addition, when it was discovered during baseline fieldwork that Black-faced Spoonbills were utilising drained ponds at Lok Ma Chau during winter 2000-01, their use of this area was subject to additional specific survey efforts (BBV 2001a).

3.3.28 Black-faced Spoonbills are tactile feeders. Feeding takes place in turbid water bodies with a flat or gradually sloping fine sediment bottom with water depths from 5 – 23 cm. (Yu and Swennen 2001). In Hong Kong these requirements are met in the intertidal mudflats in Deep Bay, as well as in fishponds and *gei wai*. The relative importance of intertidal areas and fish ponds and *gei wai* is influenced by tidal regime and pond management, with the latter habitats being particularly important during adverse weather and when ponds are drained for harvesting (Anon 2001, Yu and Swennen 2001). Black-faced Spoonbills largely feed on small prey items, especially shrimps *Palaemonetus* spp. and Mosquito Fish *Gambusia affinis*, but larger prey items such as tilapia *Oreochromis mossambicus* are also eaten, especially when these are readily available in partially drained ponds (Leader 1998, Yu and Swennen 2001).

3.3.29 Management of ponds in the EEA has demonstrated that Black-faced Spoonbills are readily attracted to ponds in the EEA. Stocking alone attracted birds; attraction increased when ponds were partially drained or maintained at a low level which permitted birds to wade over most of the pond. In addition, birds regularly took advantage of bunds and islands which were largely cleared of vegetation as daytime roosting and loafing sites.

3.3.30 Targets for Black-faced Spoonbills have readily been achieved and no adjustments to the current management regime to meet the needs of this species are required. Black-faced Spoonbill is a primary target species in Compartment B (stocked and periodically drained-down ponds providing feeding areas and bare islands and bunds providing loafing and roosting areas) and a secondary target species in Compartment A.

Common Teal

3.3.31 The following is based on non-systematic observation in Hong Kong including observations at Lok Ma Chau during winter 2000-01 (BBV 2001) and in the EEA from July 2002 (AEC 2003, 2004, 2005). Common Teal are winter visitors to Hong Kong and are present between September and April. Though there are occasional records from other wetland sites; the majority of Common Teal are found in Deep Bay. Within Deep Bay favoured habitats are intertidal creeks amongst mangroves, *gei wai* and well-vegetated ponds, especially those with abundant growth of the facultative wetland grass *Paspalum distichum*. A common denominator in these preferences is the presence of mud or shallow water feeding areas in

proximity to cover. More open wetland habitats such as active fishponds, intertidal mudflats and Deep Bay itself are less favoured by Common Teal than most other duck species in Hong Kong – it is probably not co-incidence that this species is a frequent prey item for raptors including Greater Spotted and Imperial Eagles.

3.3.32 Diet of Common Teal has not been studied in Hong Kong; however elsewhere in its range it is considered to be omnivorous, filtering invertebrates and seeds from water or soft mud whilst either walking or swimming. Seeds are often particularly important in winter (Cramp and Simmons 1977).

3.3.33 Numbers of Common Teal have considerably increased in the EEA since its establishment. This species has clearly benefited from the management measures which have been implemented, notably the creation of shallow pond areas with emergent vegetation. Further habitat will be provided for this species in the marshland areas. While the primary means of attracting Common Teal will be the provision of suitable habitat with natural food, limited supplementary feeding with suitable duck food (grains etc.) will be carried out. This would not only benefit Common Teal but other duck species, which would in turn be beneficial to Greater Spotted and Imperial Eagles.

3.3.34 Common Teal is a primary target species in Compartment A (provision of winter feeding station) and a secondary target in Compartments B and C as all ponds and marsh areas will provide some feeding and/or leafing habitat for this species.

Greater Spotted Eagle

3.3.35 Habitat utilisation in the Deep Bay area was studied during winter 2000-01 (BBV 2001b). Greater Spotted Eagles are a winter visitor to Hong Kong and are present from late October to early April. Their distribution in Hong Kong is restricted to the Deep Bay area, with the notable exception that they roost at night in hills to the south; with most birds apparently roosting in the Castle Peak area during winter 2000-01 (Carey *et al.* 2001, BBV 2001b). As with Imperial Eagle, observations during winter 2000-01 showed that the most important area for this species was Mai Po, with secondary foci at Tsim Bei Tsui and Nam Sang Wai. Together these areas accounted for 86% of records (BBV 2001b). In contrast to the distribution of Imperial Eagles, during this study there were no records from Lok Ma Chau; indeed there were very few records from east of Mai Po. This species is generally scarcer in Hong Kong than Imperial Eagle (Carey *et al.* 2001); the frequency of sightings during winter 2000-01 was approximately half that of Imperial Eagle (BBV 2001b).

3.3.36 The pattern of occurrence was related to the presence of abundant waterbirds on ponds (especially wild ducks). Despite the presence of large numbers of waterbirds (including ducks) the intertidal zone is not utilised. Trees are required for daytime loafing or hunting perches and the study in

winter 2000-01 suggested that, in comparison with Imperial Eagle, this species is less likely to occur in extensive open active fish pond areas

3.3.37 Greater Spotted Eagles did not, technically, meet the criterion of regular occurrence in the Lok Ma Chau area required for inclusion on the list of Target Species for the EEA as this species was not recorded regularly there during winter 2000-01 (BBV 2001a, BBV 2001b). However this species was included as a Target Species for the reason that it is Globally Threatened (BirdLife International 2000) and has habitat requirements which can be accommodated within the mitigation area without compromising any other mitigation objectives (in fact the mitigation proposals are identical to those required for Imperial Eagle).

3.3.38 Greater Spotted Eagles have regularly been recorded in the EEA since its establishment. Their distribution is closely correlated with that of ducks, notably Common Teal, which provide a source of food. Thus, management measures aimed at improving conditions for Common Teal and other ducks provide an indirect benefit to this species and further adjustments to the management regime to meet the needs of this species are not required. Accordingly, Greater Spotted Eagle is a secondary target species in all three Compartments.

Imperial Eagle

3.3.39 Habitat utilisation in the Deep Bay area was studied during winter 2000-01 (BBV 2001b). Imperial Eagles are a winter visitor to Hong Kong and are present from late October to early April. Their distribution in Hong Kong is restricted to the Deep Bay area, with the notable exception that they roost at night in hills to the south; with most birds apparently roosting in the Castle Peak area during winter 2000-01 (Carey *et al.* 2001, BBV 2001b). Observations during winter 2000-01 showed that the most important area for Imperial Eagles is Mai Po Nature Reserve, with Ma Tso Lung being the second most important area. Together, these two areas accounted for 66% of sightings during the study. Tsim Bei Tsui, Nam Sang Wai and Lok Ma Chau were sites of similar secondary importance, with Lok Ma Chau accounting for 8% of sightings.

3.3.40 The pattern of occurrence was related to the presence of abundant waterbirds on ponds (especially wild ducks), with a secondary factor being an avoidance of developed and disturbed areas. Despite the presence of large numbers of waterbirds (including ducks) the intertidal zone is not utilised. Trees are required for daytime loafing or hunting perches, but ponds surrounded by continuous lines of large trees (as at parts of Nam Sang Wai) are avoided.

3.3.41 Imperial Eagles have regularly been recorded in the EEA since its establishment. As with Greater Spotted Eagle, their distribution is closely correlated with that of ducks, notably Common Teal, which provide a source of food. Thus, management measures aimed at improving conditions for Common Teal and other ducks provide an indirect benefit

to this species and further adjustments to the management regime to meet the needs of this species are not required. Accordingly, Greater Spotted Eagle is a secondary target species in all three Compartments.

Eurasian Hobby

3.3.42 An uncommon passage migrant and scarce summer visitor to Hong Kong (Carey *et al.* 2001) with breeding proven for the first time in 1994, although there is anecdotal evidence to suggest that it has become rarer in recent years.

3.3.43 In summer all records are from the northern, eastern and central part of the New Territories, with the species mainly occurring over marshes, agricultural land and lightly wooded hills; breeding birds are thought to maintain large home ranges. In spring and autumn it is commoner and much more widespread.

3.3.44 Food items recorded in Hong Kong have included dragonflies, bats and birds, but primarily bats.

3.3.45 Northern Hobby has not been recorded on surveys at Lok Ma Chau during the past two years. There have however been several recorded outside of survey times (especially in the evening when Northern Hobby is particularly active) which indicates that the site is suitable for the species. Due to the wide ranging nature of breeding birds and the unpredictability of migrants there is little that can be undertaken in terms of direct management of the site to attract Northern Hobby. As a consequence, Eurasian Hobby has not been identified as a target species in a particular Compartment. However, overall measures to increase habitat diversity through the provision of marshes, reedbeds and other habitats are expected to result in an increase in the preferred prey of this species.

Japanese Quail

3.3.46 A scarce passage migrant and winter visitor to Hong Kong (Carey *et al.* 2001), with anecdotal information suggesting a decline in numbers in recent years. In recent years the majority of records have come from low-lying grassy areas in the northern New Territories where it has favoured areas of dry, short (< 30 cm) vegetation, often broken up by small unvegetated areas, in areas such as abandoned agriculture or filled fishponds. Fishpond bunds covered with short grass are used occasionally, but are not primary habitat for this species. Areas of tall, dense grass are generally avoided.

3.3.47 In the course of the past three years there has been one record of a single bird within the EEA.

3.3.48 Management of vegetation on the bunds will provide suitable habitat for this species within the EEA. If uncontrolled *Panicum maximum* - the dominant grass species on site – becomes too tall and dense for this

species. Regular cutting of *P. maximum* to provide areas of short grass (10 – 30 cm tall) and also to encourage the growth of shorter grasses such as *Paspalum distichum* is required. However, since fishpond areas are not primary habitat for this species it is likely to continue to be of irregular occurrence. In recognition of this, Japanese Quail is a secondary target species in Compartment B.

Eurasian Coot

3.3.49 Although considered a common winter visitor (Carey *et al.* 2001), numbers of this species have declined drastically since a peak in the early 1990s' declining from a peak of 3245 in winter 1992-93 to 260 in winter 2003-04. Of this the vast majority occurred in Deep Bay and it was always rare within fishpond habitats, when they favoured ponds with extensive emergent vegetation.

3.3.50 In the past two winters up to five birds have been present within the EEA. The provision of marshes and reedbed will increase the area of habitat suitable for this species within the EEA. Eurasian Coot is a secondary target species in all Compartments.

Pheasant-tailed Jacana

3.3.51 A scarce passage migrant, mainly in autumn, much decreased but previously bred (Carey *et al.* 2001). Breeding was last recorded in Hong Kong in 1974, and since then the status of this species has changed and it is now a scarce passage migrant, with almost no midsummer records. In the past three autumns up to eleven Pheasant-tailed Jacanas have been recorded on-site (although most outside of the regular bird surveys) and over the past three years the site has become the most important for this species in Hong Kong.

3.3.52 Passage birds tend to favour freshwater or brackish wetlands that have extensive marginal and emergent vegetation. This habitat type is currently provided on-site through the management of marginal vegetation in some of the ponds in Compartment C. In addition the creation of marsh habitats in Ponds 13 and 14 have provided additional suitable habitat. The creation of the main marsh will provide the largest area on-site that is suitable for this species.

3.3.53 Breeding birds appear to be more dependent on areas of Prickly-leaved Lotus *Euryle ferox*, and it an attempt to encourage breeding of this species in Hong Kong once more, an area of Prickly-leaved Lotus will be planted in Ponds 15 and 21 during 2006. Pheasant-tailed Jacana is a primary target species in Compartment C and a secondary target species in Compartment B.

Greater Painted-snipe

3.3.54 A passage migrant and winter visitor, with a small breeding population:

extremely localised and much-declined (Carey *et al.* 2001). Although formerly once widespread this species is largely restricted to freshwater agricultural land and in recent years has breed at just three site (Long Valley, Kam Tin and Mai Po).

3.3.55 Greater Painted-snipe prefers areas with low, dense herbaceous vegetation and shallow water (0-10cm). It is an especially vagile species and is able to make use of suitable ephemeral wetlands, it is also regularly forced to abandon suitable habitat as it dries out during the dry season. However, areas of suitable habitat that contain even small areas that remain wet in the dry season tend to support relatively high numbers and often have birds throughout the year.

3.3.56 Greater Painted-snipe is not a fishpond species, and it was not until ponds were reprofiled to form areas of marsh that this species was recorded in the EEA; this was during summer 2004 when a pair bred on-site. Two pairs bred in 2005, but it is thought that this species does not yet occur in the EEA throughout the year. The provision of areas of marsh, especially the main marsh will provide relatively large areas of habitat suitable for this species, in addition, parts of the marsh will have water levels managed throughout the year that are optimal for this species. Greater Painted-snipe is a primary target species in Compartment C.

Black-winged Stilt

3.3.57 The following is based on non-systematic observation in Hong Kong including observations at Lok Ma Chau during winter 2000-01 (BBV 2001a) and in the EEA since its establishment (AEC 2003, 2004, 2005). In Hong Kong, Black-winged Stilts are restricted to fresh or brackish water habitats, favouring large disused fishponds in the Deep Bay area and bloodworm ponds in Long Valley. Distribution on the Deep Bay area is somewhat erratic with flocks opportunistically utilising ponds which are of a suitable depth for feeding (c. 5 – 15 cm water depth) as this species rarely forages whilst swimming (Cramp and Simmons 1983). There is also some evidence that birds may move several kilometres between feeding and roosting areas in Hong Kong, with birds which roost in the Deep Bay area during the day flying to Long Valley to feed at night (BBV 2001a). Black-winged Stilts are recorded in Hong Kong throughout the year. Until 2003 they had not been known to breed in the territory; the small numbers present in summer were considered to be non-breeding individuals or early returning migrants (Carey *et al.* 2001). However, in 2003, breeding was observed in Hong Kong for the first time, at Pond 2 in the EEA and at Mai Po (AEC 2003). Breeding took place again at Mai Po in 2004 and 2005, but not at Lok Ma Chau (AEC 2004, 2005).

3.3.58 Black-winged Stilts feed predominantly on aquatic invertebrates, especially insects. Food is taken by wading in open water and invertebrates are taken from on and below the water surface and from aquatic vegetation (Cramp and Simmons 1983). In the EEA, Black-winged Stilts have benefited from the creation of shallow open water areas

overlying soft mud with aquatic vegetation sparse or absent. The requirements of this species thus show a synergy with those of Chinese Pond Heron and are complementary to the focus for larger waterbird species (where the focus of management action will be in midwinter).

3.3.59 The breeding birds in 2003 were unsuccessful as their nests were flooded or the eggs were taken by ground predators. The provision of islands in Ponds 1, 2, 3 and 9 should provide breeding sites which are protected from most terrestrial predators, whilst the water management system, as well as the extra elevation provided by the islands, should reduce the chances of nests being flooded. Black-winged Stilt is a primary target species in Compartments A and B and a secondary target species in Compartment C.

Pintail Snipe

3.3.60 A common passage migrant, most common in autumn, and an uncommon winter visitor. It is very similar in appearance to Swinhoe's Snipe and is generally only separable from that species by examination in the hand (Carey *et al.* 2001). The preferred habitat for this species in Hong Kong is wet agricultural areas, especially recently abandoned or inactive areas of wet agriculture.

3.3.61 The provision of marsh areas within the EEA will provide relatively large areas of habitat suitable for this species, and those areas where the water levels are managed for Greater Painted-snipe will also be highly suitable for this species. Pintail Snipe is a primary target species in Compartment C.

Swinhoe's Snipe

3.3.62 A common passage migrant, most common in autumn. It is very similar in appearance to Pintail Snipe and is generally only separable from that species by examination in the hand (Carey *et al.* 2001). The preferred habitat for this species in Hong Kong is wet agricultural areas, especially recently abandoned or inactive areas of wet agriculture.

3.3.63 The provision of marsh areas within the EEA will provide relatively large areas of habitat suitable for this species, and those areas where the water levels are managed for Greater Painted-snipe will also be highly suitable for this species. Swinhoe's Snipe is a primary target species in Compartment C.

Common Snipe

3.3.64 Common Snipe requires marsh vegetation with muddy margins for feeding and, in Hong Kong, is much more abundant in freshwater than brackish water areas. Most feeding occurs at night and dense marshland areas are utilised for roosting during the day. Edges of fishponds are used by Common Snipe, but these are not a major habitat for this species (Carey

et al. 2001).

3.3.65 The marsh areas will provide suitable feeding and roosting locations for Common Snipe; they will also benefit to a limited extent from shallow ponds with emergent vegetation provided primarily to meet the needs of Chinese Pond Heron. Common Snipe is a primary target species in Compartment C and a secondary target species in Compartment B.

Richard's Pipit

3.3.66 The race *A. r. richardi* of Richard's Pipit is a common passage migrant and winter visitor in Hong Kong, whilst the race *A. r. sinensis* is an upland breeding form (Carey *et al.* 2001). *A. r. richardi* occurs in flocks in the Deep Bay area in winter, favouring fish pond bunds or other areas which are bare or covered with sparse or short grass. It does not use areas of rank grassland or full ponds except around the fringes. However, it does make use of drained-down ponds once these are largely dry.

3.3.67 The cleared internal bunds within the EEA provide suitable feeding areas for this species, as do the drier areas around partially drained ponds. As such, Richard's Pipit is a secondary target species in Compartment B.

Bluethroat

3.3.68 Bluethroat is a winter visitor and spring migrant to Hong Kong, with most records occurring between the middle of November and late April. It is a cryptic and relatively mobile species, making it difficult to monitor accurately. Optimum habitats will be provided within the main marsh and EEA Reedbed and it is also likely to utilize the Water Polishing Reedbed. Although it also utilizes well vegetated fishpond edges it tends to be more conspicuous in such habitats and thus it is likely to be comparatively under recorded in the densely vegetated areas within the EEA and within the Water Polishing Reedbed. Special monitoring methods will, therefore, be required for this species. Bluethroat is a primary target species in Compartment C

Common Stonechat

3.3.69 Common Stonechats are common passage migrants and winter visitors in Hong Kong. They are most abundant in areas of open cultivation and shrubland (Carey *et al.* 2001) but also occur in significant numbers along fishpond bunds and the fringes of reedbeds in the Deep Bay area.

3.3.70 Primary provision for this species in the EEA will be in fringe areas, notably the interface between the freshwater marsh and the reedbed and the drier raised shrub and tree-planted area around the station itself. This species will also be able to continue to utilise the areas around the drainage channel and the more vegetated bunds on the fringes of the EEA site. As such, this species is a secondary target species in all three Compartments.

Pallas's Grasshopper Warbler

3.3.71 Pallas's Grasshopper Warbler is an autumn migrant to Hong Kong, with the vast majority of records occurring in September and the first ten days of October. It is a highly cryptic species, making it extremely difficult to monitor accurately. Special monitoring methods will, therefore, be required for this species. Optimum habitats will be provided within the main marsh and EEA Reedbed and it is also likely to utilize the Water Polishing Reedbed. Pallas's Grasshopper Warbler is a primary target species in Compartment C. It is also one of the species which is expected to benefit most from the Water Polishing reedbed (to the east of the EEA).

Zitting Cisticola

3.3.72 Zitting Cisticola is a common winter visitor and passage migrant in Hong Kong and a rare breeding species. It favours areas of grass, especially in lowland wetland areas such as active and disused fishponds. Small numbers breed in Hong Kong, primarily in the Deep Bay area and the northeast New Territories (Carey *et al.* 2001). One or two territorial birds were present in 2004 and breeding was proven for the first time in the EEA (on the island in Pond 9) in 2006.

3.3.73 Primary provision for this species in the EEA will be in fringe areas, notably the interface between the freshwater marsh and the reedbed, together with some bunds and islands where patches of long grass will be retained. Zitting Cisticola is a secondary target species in Compartments B and C.

Japanese Yellow Bunting

3.3.74 A scarce and irregular spring passage migrant (Carey *et al.* 2001), anecdotal evidence suggests that this species has declined since the 1990s. Records in Hong Kong have come from widespread areas but about half are from the Deep Bay area, the species occurs in a wide range of habitats including overgrown landfill sites, well vegetated fish pond bunds, in Horsetail Trees *Casuarina equisifolia* with an extensive understorey of Common Lantana *Lantana camara*, in the edges of mangroves, agricultural land, and shrubland edges. Given the wide variety of habitats and the sporadic nature of it's occurrence in Hong Kong, this species is unlikely to be of regular occurrence within the EEA. However, the provision of a mosaic of habitats in the form of marsh, well vegetated bunds, and reedbeds will provide extensive areas suitable for this species. Japanese Yellow Bunting is thus a secondary target species in both Compartments B and C.

Red-billed Starling

3.3.75 Red-billed Starling is a winter visitor to Hong Kong, occurring in large flocks in the northwest New Territories. The wintering population in Hong Kong is considered probably to be of international importance for this

species (Carey *et al.* 2001). In 2004 a pair of Red-billed Starlings bred in Shenzhen but fed in the EEA, the first instance of breeding of this species in or near to Hong Kong (AEC 2004). Red-billed Starlings are omnivores and feed around fishponds, wet agricultural areas (especially where these are contaminated by effluent from pig farms), edges of reedbeds and both natural and artificial drainage channels. They readily take advantage of spilled food provided for fish or ducks. Much food is obtained on the ground but they also frequently feed in trees where they consume insects and fruit (though their gape size is too small to permit them to take most fruits of *Melia azedarach*, the most frequent fruiting tree around fishponds).

3.3.76 In the EEA, this species will benefit from sparely vegetated fringes to ponds and marsh areas, especially where these are close to tree and shrub areas adjacent to the drainage channels and the station perimeter. It will also benefit from the proposed tree and shrub planting which will provide fruit and invertebrate food and shelter.

3.3.77 Red-billed Starling makes use of the trees along the river channel in the EEA. However, at present most of the larger trees are *Melia azedarach* and hence produce fruit which is too large for this species. In the medium to long term, tree planting undertaken beside the channel which includes *Sapium sebiferum*, *Ficus superba*, *Ficus microcarpa* and *Celtis tetranda*, all species which produce fruit of a suitable size for Red-billed Starlings, will benefit this species. In the short term limited provision of artificial food will be undertaken during the winter months. The provision of artificial food within the EEA in the form of 'waste' biscuits (used by fish farmers as fish food) has been shown to attract very high numbers of Red-billed Starling during winter 2004-05. Whilst this feeding was primarily undertaken to assist in the trapping starlings for monitoring of avian diseases, it resulted in hundreds of Red-billed Starlings (up to 600) being present on the site on most days. This measure also attracted other starling species, including White-shouldered Starling *S. sinensis*; a localised breeding species in Hong Kong. Red-billed Starling is a primary target species in Compartment A and a secondary target species in Compartment B.

Black-naped Oriole

3.3.78 In Hong Kong is now Black-naped Oriole is a scarce autumn passage migrant that breeds irregularly, though it was formerly a relatively widespread breeding species (Carey *et al.* 2001). Passage birds occur widely throughout Hong Kong and favour areas with stands of large trees. Breeding birds favour similar habitat but are much more isolated, and the only known breeding birds in 2002-04 were a single pair that bred close to the Lok Ma Chau EEA. In 2005 two pairs were present, one of which nested successfully in the EEA in a tree beside Watercourse A.

3.3.79 The planting of the island between Ponds 2A and 2B and additional tree-planting on eastern bund of Ponds 2A will create a dense wooded area

ideal for this species as will, in time the maturing trees around Pond 1. Black-naped Oriole is a primary target species in Compartment A.

3.4 Targets for Herpetofauna

Burmese Python

3.4.1 The occurrence of Burmese Python in the Lok Ma Chau area was noted or inferred by ERM (1999). It was not recorded in the baseline survey (BBV 2001a) but two individuals were seen in the EEA in 2005 (AEC in prep.) .

3.4.2 Burmese Python is widely distributed in Hong Kong, but is considered to prefer shrubland, woodland and the edges of mangroves. (Karsen *et al.* 1998). The two records in the EEA were on well-vegetated bunds in the north of Compartment B. Potential habitat for Burmese Python in the EEA are the well-vegetated bunds and islands in Compartment A and around the west and north of Compartment B. The first record of Burmese Python in the EEA involved an individual which was accidentally killed during grass-cutting operations. In response to this incident, the need to retain patches of longer grass and other herbaceous vegetation as refugia for snakes and other less vagile taxa has been identified. Proposed refugia areas are indicated in Figure 6. These areas will be identified on site using marker posts.

3.4.3 Burmese Python is a primary target species in Compartment B (refugia areas) and a secondary target in Compartment A.

Chinese Soft-shelled Turtle

3.4.4 The regionally uncommon Chinese Soft-shelled Turtle was not recorded in the Lok Ma Chau area during the baseline survey but was first found in the EEA area in November 2001 (BBV 2001a) and has been recorded irregularly since then (AEC 2003, 2004, 2005). The highest number of observations was made in 2005, suggesting that numbers in the EEA may be increasing. This species is rare and localised in Hong Kong with a natural population restricted to fishponds around Deep Bay (Karsen *et al.* 1998). Chinese Soft-shelled Turtles are hard to detect as they spend much time buried in the mud but they also wander on land and will bask on mudbanks or floating logs. Eggs are buried in the mud banks of a pond.

3.4.5 The Chinese Soft-shelled Turtle benefits from the management of the fishponds in the EEA as these provide suitable conditions corresponding to those which it favours in commercial fishponds but with a reduced risk of being accidentally killed during fish harvesting or pond management activities. In addition, it benefits from the greater security and lower risk of disturbance to nesting sites. Further adjustments to the management regime of the EEA to meet the needs of this species are not required. Chinese Soft-shelled Turtle is a secondary target species in Compartments A and B.

N

8A
8B
16
18
5
17
20
9A
19
3B
11A
21
9B
15
3A
22
6
11B
10
12
2A
4A
7A
14
4B
7B
13
1A
2B
1B

HCMP Boundary
Long grass / herbs
Shrubs / small trees

Asia Ecological Consultants Ltd.	
Scale: 1:3,500	Figure 6. Refugia Areas

Chinese Bullfrog

3.4.6 This large frog species is thought to be in marked decline locally and drastic decline regionally, and has therefore been rated as of Potential Regional Concern by Fellowes *et al.* (2002). It is commonly sold in food markets in Hong Kong and in southern China. It is a species closely associated with areas of wet agriculture, and breeds in ponds and marshes. The species was listed as present but not common at Lok Ma Chau in the EIA Report (BBV 2001a) and was found in the EEA in 2004 (AEC 2004) but not in 2005 (AEC 2005).

3.4.7 Chinese Bullfrogs feed on insects and small frogs and rodents (Karsen *et al.*, 1998). They will benefit from provision of permanent and, particularly, seasonal marsh habitat (from which predatory fish are absent), with good development of emergent and/or edge vegetation and variable, but generally shallow, depth. Presence of prey items such as odonate larvae and other frog species will also encourage establishment of this species.

3.4.8 As a marsh species, the main habitat provision for Chinese Bullfrog will be in the freshwater marsh area of the EEA, though as the occurrence of this species in 2004 demonstrates, it will also make use of the well-vegetated fringes of freshwater fishponds. The absence of records of this species in the EEA 2005 suggests that there may be elements of this species' requirements which are not yet being met in the EEA. Based on observations in 2005, the problem may be that all permanent ponds in the EEA support fish, albeit only Mosquito Fish in Ponds 13 and 14, and fish are very effective predators on amphibian eggs and tadpoles (AEC 2005). To mitigate for this problem it is proposed to form seasonal pools in one or more of Ponds 16, 18 and 20 in 2006. These seasonal ponds will be designed so that they fill with rainwater in the wet season but dry out in winter, thus preventing fish from becoming established during transfer of water.

3.4.9 Chinese Bullfrog is a primary target species in Compartment C (creation of seasonal pools for breeding, as discussed above).

3.5 Habitat Requirements of Target Species

3.5.1 A summary of the habitat requirements of the target species for the EEA detailed in this section is provided in Table 3.2. All habitats listed will be provided in the EEA prior to the commencement of operations of the railway.

Table 3.2 *Summary of Habitat Requirements of Target Species of Conservation Importance.*

Key: habitat important for F = Foraging; R = Roosting/loafing; B = Breeding. Habitats of secondary importance are shown in lower case; where species is a secondary target in a Compartment, this is shown in brackets.

Species	Compart-ment target	Deep water	Shallow water	Muddy vegetation free margins	Trees on bunds/ channels	Emergent / marsh vegetation	Bare or sparsely vegetated bunds
Eurasian Otter	A	F	F	F	B	F	
Great Cormorant	A, B	F	f		R		R
Grey Heron	A, B		F		R	f	R
Great Egret	A, B		F		R	F	R
Little Egret	A, B, (C)		F	f	R	F	r
Chinese Pond Heron	A, (B), C		f	f	R	F, r	
Black-faced Spoonbill	(A), B		F	F			R
Common Teal	A, (B), (C)	F	F, r	f		F, R	
Greater Spotted Eagle	(A), (B), (C)		F		R	F	F
Imperial Eagle	(A), (B), (C)		F		R	F	F
Eurasian Hobby	-					f	f
Japanese Quail	(B)						F
Eurasian Coot	(A), (B), (C)	f	f		f, r		
Pheasant-tailed Jacana	(B), C					F,R, B	
Greater Painted-snipe	C			F		F,R,B	
Black-winged Stilt	A, B, (C)		F	F		F, b	R, B
Pintail Snipe	C			f		F,R	
Swinhoe's Snipe	C			f		F,R	

Species	Compart-ment target	Deep water	Shallow water	Muddy vegetation free margins	Trees on bunds/ channels	Emergent / marsh vegetation	Bare or sparsely vegetated bunds
Common Snipe	(B), C			F		F,R	
Richard's Pipit	(B)			F			F
Bluethroat	C			f		F, R	
Pallas's Grasshop-per Warbler	C					F, R	
Common Stonechat	(A), (B), (C)				f	F, R	F
Zitting Cisticola	(B), (C)					F, R	f
Japanese Yellow Bunting	(B), (C)				f, R	f, r	F
Red-billed Starling	A, (B)			F	F, R	f	F
Black-naped Oriole	A				F, R, B		
Burmese Python	A, (B)		F,B	F,B	f, r	f, r	
Chinese Soft-shelled Turtle	(A), (B)	r	F	R, B			
Chinese Bullfrog	C		F, R, B			F, R, B	

Habitat Condition Targets

3.5.2 As described in the EIA Report (BBV 2001a) and as is required by the terms of the Environmental Permit, the principal management activities to be conducted in the EEA are the enhancement of fishponds and the creation of marsh and reedbed habitats. Currently, when the target species of large waterbirds use fishponds in the Deep Bay area, they feed on the abundant small non-commercial fish and invertebrates (termed 'trash fish') that thrive as a by-product of the highly productive commercial fish-farming systems. These include *Gambusia affinis* (Mosquito Fish), *Macrobrachium nipponense* (a prawn) and *Oreochromis mossambicus* (a species of tilapia).

3.5.3 However, when ponds are operated commercially, these food resources are generally only readily available to birds when the ponds are drained down for fish harvesting during the winter. Drain-down for commercial harvesting tends to be concentrated in a short period during the winter, in the few weeks before Chinese New Year. 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 do not benefit birds:

- 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 losses to birds;
- most fish are of a size suitable for human food and hence too large for many of the waterbird species (especially Black-faced Spoonbill and the smaller ardeids);
- most fish are removed from the system (as food for humans) hence only the residue 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.

3.5.4 In addition, the following 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. Of the target bird species only Great Cormorants can catch fish in these conditions;
- emergent or floating vegetation is lacking thus reducing potential niches for invertebrates which would provide additional food

especially for Chinese Pond Herons.

3.5.5 Accordingly, the principal fishpond enhancement measures include the following:

- extending the period during which drained ponds are available 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 Black-faced Spoonbills and 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;
- repeating stocking of some ponds in Compartment B with trash fish during the winter months to permit the same pond to be drained (or partially drained) more than once per season.

3.5.6 In addition, the ponds' suitability for use by the target bird species are enhanced by the following bund management and earthmoving 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 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 which will form roost areas free from ground predators and disturbance.
- formation of new islands in the two largest ponds (Ponds 2A and 2B) in order to increase the extent of shallow water areas and to provide secure roosting and nesting sites.

3.5.7 Specific habitat targets for the fishpond area (Compartments A and B) are:

- Enhancement and maintenance of a total of 29.65 ha of fishponds;
- > 20% of the fishpond area (excluding bunds) consists of shallow water (i.e. < 50cm depth);
- vegetation cover >50% of the land area is established on 20-30% of the area of fishpond bunds and islands;
- vegetation cover >10 cm in height is <5% on 70-80% of the area of fishpond bunds and islands;
- Compartment B is maintained under a drain-down regime to maximise fish availability to target species of waterbirds;
- 20-30% of the fishpond area is maintained as shallow ponds (with or without supplementary fish stocking) to suitable long-term feeding conditions for target species of waterbirds;
- emergent and pondside vegetation is maintained over 10-20% of pond areas and 20-30% of pondsides respectively;
- undesirable invasive species and exotic species are < 10% of vegetation cover.

4. CONSTRAINTS ON DESIGN

4.1 Engineering

4.1.1 The engineering design is principally the means to control water levels to close tolerances in this flat area. Construction must not be disruptive to the surrounding habitat. In addition, the ground in which the ponds are located comprises a significant depth of mud, such that moderate surcharge loads could cause significant short and long term settlement. This must be guarded against in the construction and operation of the mitigation area.

4.2 Hydrology/Drainage

4.2.1 The EEA water management scheme has been designed to take into account the highly seasonal rainfall in Hong Kong. Typically there is a period of water deficit (i.e. rainfall is exceeded by evapotranspiration) from September to March, though this varies somewhat from year to year and in some recent years has extended to mid-May. Accordingly, the water management regime in the EEA has been designed to ensure that sufficient rainwater is stored during wet season in order to prevent shortages during the deficit period.

4.2.2 The sole source of water for the EEA is rainwater. During the construction period the only rainwater available has been that falling directly on the EEA. This proved adequate to replenish ponds during wetter years (e.g. 2003 and 2005) but was not sufficient to permit all ponds to be refilled in years when rainfall was significantly below average (e.g. 2004). This potential deficit problem will increase when the full area of marshland (with an extensive extent of shallow water) has been formed.

4.2.3 In order to resolve this potential problem it is proposed that, once LMC Station construction has been completed, some of the rainwater runoff from the station roof will be intercepted. It is calculated that this will provide sufficient additional water to maintain the marsh areas during the wet season (BBV 2001a). During the dry season some top-up from the fishponds will be available; however, partial drying-out of some of the marsh areas in the latter half of the dry season is accommodated in the habitat and wildlife management regime.

4.2.4 There are also potential constraints on the wetland design regarding drainage options as a result of the tidal conditions of the watercourses and local flooding. The top of the bunds in the area are generally at +3.5 mPD and in periods of heavy rain there may be flooding in the area. Such flooding is currently of less than annual frequency (none occurred during the 1993 - 1995 wet seasons) and the risk of flooding will decrease further once the San Tin Eastern Main Drainage Channel, which will protect the locality from upstream events, is operational.

4.2.5 The primary means of redistributing excess water in individual ponds and in the marsh will be the arterial mains system. In addition, the potential for the use of sluices and/or overflow pipes to minimise risk of internal flooding is under review. Routine discharge from the main part of the EEA will be to Watercourse B once this has been restored. The four ponds in Compartment A to the west of Watercourse A will be maintained as a separate system. Because of their large capacity routine discharge from these ponds will not take place; should it be necessary to shed water from these Ponds this will be achieved by pumping to Watercourse A and/or the AFCD ponds to the north.

4.3 Soils

4.3.1 As described in Section 2.5 the soils present at the site consist of poorly drained marine clays. These are sufficiently impermeable to maintain wetland conditions or fishponds over the site as demonstrated by the current presence of such habitats, which are in the main solely maintained by direct rainfall inputs.

4.3.2 The soils are, however, acid sulphate soils which can lead to highly acidic conditions when these are disturbed and dried. As a consequence, when ponds which have been drained are refilled the water in the pond may become excessively acidic. Remedial measures to reduce acidity of the water may then be required (see Section 4.4).

4.4 Water Quality

4.4.1 Detailed information on the water quality in the drainage channels flowing through or adjoining the site is not available. However, visual inspection has shown that these are grossly polluted and carry large volumes of organic animal waste. Both for this reason and because the channel flow regime may change significantly with the construction of the San Tin East Drainage Channel (and the possible construction of a San Tin West Drainage Channel) drainage channel water has not been considered as an appropriate water source for the EEA.

4.4.2 The maintenance of the wetland's conditions and achievement of target water levels will therefore be dependent on the storage of direct rainfall (including rainfall on the roof of the LMC Station) and the maintenance of the quality of water within the system.

4.4.3 Rainwater is, of course, largely free from organic matter. However, it may be acidic and, given the generally acidic condition of ponds and soils, rainwater cannot, therefore, be relied on to neutralise water already in the system.

4.4.4 Monitoring conducted since autumn 2001 has shown that water already within the system (i.e. within ponds) has a tendency to become

increasingly acidic. This tendency is well known to fish farmers (who take routine measures to reduce acidity as a part of their standard fish farming activities). The primary source of acidity is the acid soils of the system; this acidity may also be exacerbated by acid rainfall.

4.4.5 The following methods of reducing acidity may be utilised in the EEA:

- Liming: liming is a traditional method of reducing pond acidity when these have been drained, dried and recontoured. Lime is spread over the pond base prior to refilling. Liming is effective and the effect of liming can be relatively easily quantified in these circumstances. Lime may also be used to reduce acidity in filled ponds, but care is required in these circumstances as the application of too great a quantity will result in the death of fish or other fishpond life.

- Addition of organic matter: a variety of organic matter may be used to reduce acidity. Suitable materials for use in the EEA (avoiding the risk of transfer of pathogens to the site) are addition of peanut residue and use of grass cuttings.

- Transfer of water: transfer of water does not reduce acidity *per se*. However, mixing of water from a pond where water quality is less acidic with one where it is more acidic will reduce acidity in the latter. Mixing of water may be considered as a management option where there is an urgent need to reduce acidity quickly or where less acid water might otherwise be lost to the system through drain-down.

4.4.6 Liming is mainly used to reduce acidity as an initial treatment in refilled ponds, prior to fish stocking. Limited use of lime may also be required as a back up measure if it is necessary to quickly reverse acidification in a filled pond. In such instances lime is applied conservatively in order to prevent deaths of fish or other pond life. .

4.4.7 Acidification is also counteracted by the maintenance of a pond with an active fish and invertebrate community; in other words it is a particular problem where ponds are left inactive without fish stocks. Accordingly, whilst some measures to reduce acidity will always be required, especially after drain-down, acidification is becoming less of a problem over time.

4.5 Access

4.5.1 Access to EEA is from the Lok Ma Cha Border Road to the north. Within the site access is by means of fishpond bund tracks. There is no track over Watercourse A, accordingly Ponds 1 and 2 are reached by separate tracks from the Lok Ma Chau Border Road. A bund area at the northeast of Pond 6 is utilised as an equipment and materials store for the contractor managing the EEA.

4.5.2 The site is within the Frontier Closed Area.

5. DETAILED DESIGN AND CONSTRUCTION METHODS

5.1 Overview

5.1.1 Primary habitats in the EEA are fishponds and fishpond bunds, freshwater marshes and a reedbed; secondary habitats are a natural drainage channel with riparian vegetation including groups of trees and screen planting of trees, shrubs and bamboos around the fringes of the site and in Compartment A (see Figure 3).

5.1.2 At the time when management of the EEA commenced (July 2002) the area (including the area added to the EEA to compensate for impacts of the PTI construction) consisted of 28 existing fishponds. Two of these Ponds (4A and 4B) were already joined at high water levels and an unregulated channel linked Ponds 7A and 7B. Management activities during the first three years of operation of the EEA included recontouring to create larger ponds and islands at Ponds 1A/1B, 2A/2B, 3A/3B, 7A/7B, 8A/8B, 9A/9B and 11A/11B. Ultimately, this will have the effect that (not including marsh and reedbed areas) there will be 15 open water bodies (ponds or pairs of linked ponds) the water levels of which can be manipulated independently. Ponds are joined both because larger ponds are favoured by several of the target species and in order to create islands from bund sections as the ponds are formed.

5.1.3 In addition, the area which formerly comprised Ponds 13, 14, 17 and 19 has been reconfigured to form a shallow freshwater marsh. Creation of further areas of freshwater marsh at Ponds 15 (part) and 21 is in progress, as is formation of a reedbed at Pond 22. Further areas of marsh at Ponds 16, 18 and 20 remain to be formed prior to the commencement of operations of the LMC Station.

5.2 Land Form

Fishponds

5.2.1 As the area already consisted of fishponds, earthmoving works have been restricted to the modification of existing ponds rather than construction of new ponds. Most modifications have involved the joining of ponds to reduce enclosure effects and to provide shallow margins and islands or partial filling to create shallow freshwater marsh areas (Figure 3). At Ponds 2A and 2B additional islands and shallows were created from imported material.

5.2.2 Where ponds are joined, the bund material is lowered and side cast to create shallow sloping margins to islands and / or shoals as well as interconnecting channels. This creates additional areas of muddy shallows that provide suitable feeding areas for herons, egrets, spoonbills and, during low water levels, smaller wading birds.

5.2.3 The purpose of reprofiling the selected pond bunds is to create as shallow a slope as feasible (given the properties of the bund materials) to increase the feeding area for wading birds at different water levels.

5.2.4 To facilitate vehicle access to all parts of the site for water level management and other activities, some works on the remaining bunds to enable them to be used as access ways was undertaken, notably the creation of a separate access track to Ponds 1A and 1B around the north and west side of Pond 2A to permit these ponds to be accessed directly if required once management of these ponds becomes the responsibility of Government. Ongoing maintenance of these access ways including vegetation cutting is required.

5.3 Soils

5.3.1 Groundwater levels may be sufficiently low during the dry season such that all of the EEA will potentially be subject to water losses through seepage. Such seepage was identified between Ponds 2A and 2B during winter 2001-2002 and between Pond 14 and the channel to the south during 2003.

5.3.2 Where seepage is identified, remodelling of the pond bund and reinstatement of the pond bund clay layer should be undertaken. Except where seepage threatens major water loss such that primary management objectives may be compromised, large-scale earthmoving works to prevent seepage should not be undertaken during the October to April period. In general, adjustment of the proposed management regime for a particular pond should provide an appropriate short-term response to such events.

5.4 Water Control System

5.4.1 The primary water management system for the main EEA (to the east of Watercourse A) comprises an arterial pipe system to transfer water between ponds in the dry season when the major draining down take place and to allow fine control of water levels in the wet season. (The large ponds to the west of Watercourse A will be managed as a separate unit and the proposed management regime will not require frequent or extensive movement between these ponds. Where it is necessary to move water between these ponds mobile pumps and portable pipes will be used.)

5.4.2 An uPVC pipe system has been buried in the bunds and connection points for mobile pumps are located adjacent to each pond. When it is necessary to drain or fill a pond a portable pump is brought to site and set up on the bund. A suction hose is placed in the pond, and a delivery hose connected to the arterial system. Water is then directed through the arterial system to the appropriate manhole from which it can be directed into the receiving pond using a delivery pipe. Pumps are electric with diesel pumps available as a back-up. Power for the pumps comes from a supply installed around the ponds, such that no generators are necessary.

5.4.3 Pumps (and other small equipment) will be moved around the site by vehicle.

5.4.4 In the event that water requires to be removed from the site (either for management reasons or because of heavy rainfall), this will be discharged to Watercourse B.

5.4.5 During the middle of the 2005 wet season, for the first time since management of the EEA commenced, a situation arose when minor flooding occurred within the site as ponds which were already full overtopped and spilled into adjacent ponds. It is predicted that this situation may recur in subsequent wet seasons with above average rainfall. Whilst not a serious problem this did result in some remedial work being required where bunds were eroded.

5.4.6 In order to minimise such adverse effects it is proposed to install 100 mm diameter uPVC overflow pipes at the locations shown in Figure 3 to allow water to drain from full ponds towards the permanent outlet weirs feeding into Watercourse B. Overflow pipes will be buried 200 – 300 mm below the lowest point of the respective pond bund. Whilst such pipes will not obviate the need for pumping to undertake large scale transfer of water and may not be sufficient to prevent flooding during extreme rain events, it is considered that they will be beneficial in minimising damage to bunds during more routine heavy rainfall periods during wet summers.

5.4.7 In the dry season water must be conserved, and the operation of the ponds requires that a considerable quantity of water can be transferred from pond to pond in a relatively short time. Commercial practice for fish harvesting is to drain-down as quickly as possible, typically this takes eight to ten days, but is influenced by pond size (Young and Chan 1997). Drain-down for conservation purposes is generally somewhat slower; for example, the drain-down of a *gei wai* at Mai Po takes two weeks (WWFHK undated).

5.4.8 Drain-down in the EEA will follow the latter model, generally ponds will be drained from full (c. 1.5 m water depth) to partially drained (c. 0.5 m water depth in the centre) in around 10 days; i.e. at a rate of c. 10 cm per day. Ponds will be drained at approximately two weekly intervals during the winter period.

5.4.9 In addition to drain-down it is anticipated that periodic topping up of water levels in the marsh areas will be required during the dry season as the extensive well-vegetated shallows will have a high rate of evapotranspiration. The marsh areas have been designed to permit some reduction in water levels in the latter part of the dry season, however complete drying out of the marshes would harm invertebrate communities and allow invasion by dryland vegetation so is not desirable.

5.5 Water Source

5.5.1 All fishpond water will be obtained by direct rainfall (including the rainfall that will be collected from the LMC Station roof) and will be retained and recirculated during drain-down periods as necessary. No surface or groundwater water supplies will be used for fishpond operations.

5.6 Vegetation

Vegetation Management

5.6.1 The original vegetation in the EEA comprised planted and naturally established trees and herbs on bunds and along the river channel and naturally established emergent vegetation on some bunds and in some ponds. No individual plant species or specimens which require special conservation measures have been recorded.

5.6.2 Vegetation is managed in accordance with the habitat targets as follows:

- Internal bunds in Compartments A and B of the EEA are maintained with short herbaceous vegetation (less than 10 cm in height) by regular manual cutting. Shrubs and larger herbaceous vegetation are removed and overhanging trees are pruned to reduce enclosure of the ponds. In some areas grasses and other herbs will not be cut in order to maintain refugia for herpetofauna as well as providing shelter for smaller birds (see Figure 6).

- Only minimal pruning of trees along the drainage channel is undertaken as these provide food and shelter for target fauna species. Similarly, only minimal pruning of trees on bunds along the northern boundary of the EEA is undertaken as these trees form a screen which will reduce disturbance to birds from the station and the Border Road. Where appropriate, for example around the materials store and access tracks, supplementary planting of native tree species is undertaken to improve screening.

- On external bunds on the west, east and south of the EEA herbaceous vegetation and trees and shrubs are retained as this provides a habitat for passerine bird secondary target species, subject to the need to create and maintain access tracks along the south side of Pond 14 and the east side of Pond 2.

- Bankside vegetation (i.e. that extending from the bund sides into the fringes of ponds is retained along 20-30% of pond sides, at Ponds 1, 2, 5, 7, 8 and 12.

- Emergent vegetation will be retained or planted over 10 – 20% of pond areas. Naturally or planted vegetation will be retained or established in up to 30% of Ponds 1, 2, 4, 5, 7, 8 and 15.

- In order to minimise erosion of bunds during heavy rain (which may weaken bund structure and result in silt deposits harming pond fauna) hydroseeding of grass *Cynodon dactylon* may be used to stabilise bare bund areas

5.6.3 This vegetation management regime is adaptive and has been (and will continue to be) reviewed annually in the light of conservation priorities and targets. Previous reviews and their outcome include the following:

- Effectiveness of cutting to maintain short vegetation on bunds. Monitoring has been conducted to assess whether the target of maintaining this vegetation at less than 10 cm height could be maintained by cutting alone. It was determined the target could be achieved so long as cutting was undertaken once per month during the wet season. This also had the benefit that it encouraged lower growing *Paspalum distichum* (which is very palatable to ducks) at the expense of *Panicum maximum*.

- Review of methods of controlling growth of emergent vegetation during the wet season, especially *Panicum maximum*, around the fringes of ponds has determined that use of Grass Carp to eat the vegetation is more efficient than cutting and has the benefit that more bare mud is exposed once pond levels fall (either during planned drain-down or through evaporation). Accordingly, Grass Carp will be used for this purpose except in ponds where extensive growth of emergent vegetation is required.

- Short and long-term merits of permitting/encouraging natural establishment of bankside and emergent vegetation vis-à-vis planting will be evaluated. Trials involving sowing of low growing and palatable (to waterfowl) grass species are underway. Additional trial species may be added in the light of developing experience on target species' habitat requirements. Feedback from monitoring will be incorporated in revisions to the HCMP.

- Following the accidental death of a Burmese Python during routine grass cutting activity, the need to maintain areas of uncut grass and herbs as refugia for herpetofauna was identified (see 5.6.2 above).

5.6.4 The primary objective of planting in Compartments A and B is not to create high botanical diversity or complex microhabitats, but to meet the objectives of providing shelter for fish and feeding areas for target wildlife species (c.f. Section 3).

Marshland

5.6.5 Three marsh areas have been created in Compartment C of the EEA: to the south of Compartment B (Ponds 13 and 14) and to the south of the LMC Station on either side of Watercourse B (Ponds 16 -21) (Figure 2).

Marsh areas are 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. Most planting mixtures are derived from native species known from semi-natural freshwater marshes at Luk Keng and Kam Tin, together with experience gained from recent freshwater marsh creation at Mai Po, Kam Tin and Hong Kong Wetland Park as well as experience gained in the EEA itself as it develops. An exception is the use of the lily *Euryle ferox*. This was formerly grown as a crop species in the Deep Bay area but is no longer grown commercially or found in Hong Kong. Historical records from Hong Kong (Carey *et al.* 2001), together with field observations in Guangdong Province where this species is still grown commercially (P.J. Leader & M.R. Leven pers. obs.) have demonstrated that this species is a key requirement for breeding Pheasant-tailed Jacana, one of the target species for the EEA (c.f. Section 3.3).

5.6.6 Marsh design, including contours, planting layout and plant species lists for Ponds 13, 14, 15 (part), 17, 19 and 21 are detailed in Appendix 1. Design and planting proposals for Ponds 17, 19 and 21 were revised based on experience gained during construction and establishment of the Pond 13 and Pond 14 marsh areas. Final designs of the remaining marsh areas, to be undertaken during the 2006 wet season once the land is no longer required for the LMC Station construction contract (LCC300), will be prepared once detailed interface issues have been resolved and will be included in next Issue (Issue 12) of the HCMP. It is intended, however, that a significant element of the design for these ponds will be the creation of seasonal wetlands. This habitat type, where water bodies form during the wet season but dry out during the dry season is absent from the EEA at present. Absence of this habitat type is considered to be a significant factor in the disappointing rate of colonisation of the EEA by amphibians and their limited breeding success (c.f. paragraphs 3.4.7 – 3.4.9).

Reedbed

5.6.7 A reedbed will be formed in Pond 22. The reedbed will be established in water with a dry season depth 0 – 50 cm (wet season depth 50 – 100 cm). Reeds will be planted as rhimozes with spacing 4 m^{-1}.

5.7 Prevention of unauthorised access

5.7.1 The site is entirely within the Frontier Closed Area access to which requires a permit issued by the Hong Kong Police Force. Access to the EEA is limited to authorised personnel. Lockable gates at vehicular access points prevent vehicular access to the EEA by other than authorised personnel. Warning signs have been erected at these points and at other potential access points to deter pedestrian trespassers.

5.7.2 Other than any barriers or fencing required to permit unauthorised vehicle access, fencing of the EEA is not required at the present time. However, the security of the site and the possible requirement to erect permanent fencing along vulnerable boundaries will be kept under review.

5.8 EEA Establishment and Management Work Programme

5.8.1 The initial EEA establishment and management work programme ran for three years from 1st October 2002 – 30th September 2005. The programme has been reviewed and updated on a six monthly basis and rolled forward six months (hence it now runs until 30th September 2008). The list of the main actions necessary for the enhancement management of the habitats is provided in Table 5.1 below. Since much of the management of the EEA is adaptive, it is inevitable that there will be continuous minor adjustments to the programme. Accordingly, progress is monitored on a weekly basis and updated on a monthly basis (see Section 7). Pond numbers referred to in the table are indicated in Figure 3.

Table 5.1 *EEA establishment, enhancement and management work programme: 1st October 2002 – 30th September 2008.*

	Action	Programmed start date	Programmed completion date	Notes
	Preworks period;			
1	Site handover	(completed)	(completed)	
2	Erection of lockable gates to IEA	August 2002	(completed)	
3	Erect warning signs at potential access points	August 2002	(completed)	
4	Clear vegetation on internal bunds	August 2002	(completed)	Except trees requiring a felling license.
5	Clear redundant structures	July 2002	(completed)	
6	Clear emergent vegetation in Pond 1B	August 2002	(completed)	Now superseded by reconfiguration of pond.
7	Establish site office and compound	August 2002	(completed)	
8	Update tree survey	August 2002	(completed)	
9	Establish status of utilities on site	August 2002	(completed)	Redundant electricity and telephone lines have been removed.
10	Install pond gauge boards	August 2002	(completed)	Renewed/replaced where necessary July 2004.
11	Determine water quality in all ponds	August 2002	(completed)	
	Winter 2002-03			
12	Maintain/restore water quality in all ponds	October 2002	(completed)	
13	Drain down ponds in rotation	November 2002	(completed)	
14	Stock ponds with trash fish	(completed)	(completed)	Partially superseded by fingerling stocking and breeding on site.
15	Commence installation of water pumping system and pipe network	May 2003	Completed September 2006	

	Action	Programmed start date	Programmed completion date	Notes
16	Commence installation of permanent sluices and other water control structures and fixtures	(October 2004)	September 2006	Re-scheduled to accommodate marsh formation schedule and handover from station construction contract.
17	Commence erection of permanent fencing	Not required	-	c.f. Section 4.7.
18	Form permanent bridge link to Ponds 1 and 2	Not required-	-	Deleted: c.f. paragraph 4.4.1.
	Summer 2003			
19	Reprofiling of pond bases and bunds	May 2003	(ongoing)	Completed except for Ponds 16, 18 & 20 to be handed over to EEA August 2006.
20	Manage existing vegetation	May 2003	(completed)	
21	Planting of vegetation on pondsides, islands and in ponds	May 2003	Not required	Natural vegetation establishment adequate to date, but option to plant retained if necessary.
22	Stocking ponds with fingerlings	April/May 2003	(completed)	Replaced by (more effective) early wet season stocking with small trash fish.
	Winter 2003-04			
23	Maintain/restore water quality in all ponds	(ongoing)	(completed)	
24	Drain down ponds in rotation	(ongoing)	(completed)	
25	Stock ponds with trash fish	November 2003	(completed)	
26	Reconfiguration and creation of islands at Ponds 2A and 2B	November 2003	(completed)	
	Summer 2004			
27	Maintain/restore water quality in all ponds	(ongoing)	(completed)	
28	Complete installation of water pumping system and pipe network	May 2004	September 2006	

	Action	Programmed start date	Programmed completion date	Notes
29	Complete installation of permanent sluices and other water control structures and fixtures	(October 2004)	September 2006	Re-scheduled to accommodate marsh formation schedule and handover from station construction contract.
30	Reprofiling of pond bases and bunds at Ponds 3A/3B, 7A/7B and 10	May 2004	(completed)	
31	Reprofile Ponds 13 and 14	May 2004	(completed)	
32	Manage existing vegetation	May 2004	(completed)	
33	Planting of vegetation on pond sides, islands and in ponds	August 2004	(completed)	
34	Stocking ponds with fingerlings and shrimps	April/May 2004	(completed)	
	Winter 2004-05			
35	Maintain/restore water quality in all ponds	(ongoing)	(completed)	
36	Drain down ponds in rotation	(ongoing)	(completed)	
37	Reprofiling of bund between Ponds 2A and 2B to form island	September 2004	(completed)	
38	Island formation in Pond 2A	October 2004	(completed)	
39	Stock ponds with trash fish	October 2004	(completed)	
40	Installation of permanent sluices and other water control structures and fixtures	October 2004	September 2006	Re-scheduled to accommodate marsh formation schedule and handover from station construction contract.
41	Watering and weeding marshland plants in Ponds 13 and 14	October 2004	(completed)	

	Action	Programmed start date	Programmed completion date	Notes
42	Form access track to Ponds 1A and 1B	(Summer 2005)	(completed)	(Brought forward to winter 2004-05.)
	Summer 2005			
43	Maintain/restore water quality in all ponds	(ongoing)	(completed)	
44	Stock ponds with trash fish	April 2005	(completed)	
45	Reprofile sides and bunds at Ponds 12, 15 and 22	May 2005	(completed)	
46	Complete installation of permanent sluices and other water control structures and fixtures	May 2005	September 2006	Re-scheduled to accommodate marsh formation schedule and handover from station construction contract.
47	Reprofiling of main marsh area (to south of station)	May 2005	(completed)	Except Ponds 16, 18 and 20 (still included in station works site).
48	Planting of marsh vegetation in Ponds 17, 19, 21 and Pond 15 (part)	July 2005	(ongoing)	Planting in Ponds 17 and 19 completed, planting in Pond 21 and 15 (part) delayed from August 2005.
49	Planting of reedbed in Pond 22	July 2005	(completed)	
50	Tree and bamboo planting on island between Ponds 2A & 2B and along access track	May 2005	(ongoing)	Tree planting completed, Additional bamboo planting to be undertaken by April 2007.
51	Reprofiling of bunds and sides of Ponds 1A and 1B	May 2005	(completed)	
52	Manage existing vegetation	May 2005	(completed)	
	Winter 2005-06			
53	Maintain/restore water quality in all ponds	(ongoing)		

	Action	Programmed start date	Programmed completion date	Notes
54	Drain down ponds in rotation	(ongoing)		Fortnightly cycle to be determined adaptively.
55	Stock ponds with trash fish	October 2005	(completed)	
56	Watering and weeding marshland plants in marsh areas and hydroseeded areas	October 2005	(as required)	Newly-planted areas only.
57	Complete installation of permanent sluices from Ponds 16 and 18 to Watercourse B.	July 2005	September 2006	Delayed.
	Summer 2006			
58	Maintain/restore water quality in all ponds	(ongoing)		Except those ponds drained down to permit engineering works.
59	Maintain all pipe network, pumps and all water control structures	(ongoing)		
60	Stock ponds with trash fish and Grass Carp	April 2006	(completed)	
61	Complete reprofiling of and planting Compartment C (Ponds 16, 18 and 20)	April 2006	(ongoing)	Programme subject to confirmation of handover of remainder of site from station contract.
62	Manage existing vegetation	April 2006	(ongoing)	
63	Planting of marshland vegetation in Ponds 15 (part), 21 and 22	April 2006	(ongoing)	Ponds 15 and 22 completed, Pond 21 ongoing.
64	Planting of bamboos on island between Ponds 2A & 2B	April 2006	(completed)	Supplementary planting scheduled for April 20007
65	Planting/hydroseed-ing of vegetation on pond sides, islands and in ponds	May 2006	(not required)	If required.

	Action	Programmed start date	Programmed completion date	Notes
66	Install uPVC overflow pipes in Compartment B	September 2006	September 2006	Rescheduled from May 2006 due to high water levels.
	Winter 2006-07			
67	Maintain/restore water quality in all ponds	(ongoing)		
68	Maintain all pipe network, pumps and all water control structures	(ongoing)		
69	Drain down ponds in rotation	(ongoing)		Cycle to be determined.
70	Stock ponds with trash fish	October 2006	March 2007	As conditions and drain-down regime allow.
71	Watering and weeding marshland plants in marsh areas	October 2006		If required.
	Summer 2007			
72	Maintain/restore water quality in all ponds	(ongoing)		
73	Maintain all pipe network, pumps and all water control structures	(ongoing)		
74	Stock ponds with trash fish and Grass Carp	April 2007	May 2007	Commence in March 2007 if suitable fish available; ponds for stocking to be determined following review of winter survey data.
75	Manage existing vegetation	(ongoing)		Exact scope of work to be determined following survey but to include marshland vegetation and reedbed.
76	Planting of vegetation on bunds, islands and in ponds	May 2007	September 2007	If required.
	Winter 2007-08			
77	Maintain/restore water quality in all ponds	(ongoing)		

	Action	Programmed start date	Programmed completion date	Notes
78	Maintain all pipe network, pumps and all water control structures	(ongoing)		
79	Drain down ponds in rotation	(ongoing)		Cycle to be determined.
80	Stock ponds with trash fish	October 2007	March 2008	As conditions and drain-down regime allow.
81	Manage existing vegetation	(ongoing)		Exact scope of work to be determined following survey but to include marshland vegetation and reedbed.
	Summer 2008			
82	Maintain/restore water quality in all ponds	(ongoing)		
83	Maintain all pipe network, pumps and all water control structures	(ongoing)		
84	Stock ponds with trash fish and Grass Carp	April 2008	May 2008	Commence in March 2008 if suitable fish available; ponds for stocking to be determined following review of winter survey data
85	Manage existing vegetation	(ongoing)		Exact scope of work to be determined following survey but to include marshland vegetation and reedbed.
86	Planting of vegetation on pondsides, islands and in ponds	May 2008	September 2008	If required.

5.9 Contingency Measures

5.9.1 Contingency actions should be implemented to deal with any of the following events when they occur:

- failure of the mains pumping system (including pump and timer failure, breakage of supply pipes);
- damage to sluices and drainage structures;
- pollution of water supply;
- direct pollution of EEA by toxic substances (e.g. from spillages / dumping);
- invasion by exotic or other undesirable plant or animal species;
- disease;
- flooding of the site and other potential effects from storm events; and
- fire damage.

5.9.2 KCRC's contractor will be responsible for undertaking contingency actions in consultation with KCRC's Adaptive Ecological Management Specialist (AEMS) will be responsible for monitoring the implementation of the HCMP, reporting to KCRC and issuing appropriate advice as required (see Section 6.1 below).

Failure of the mains supply system

5.9.3 In the event that the mains pumping system is inoperative water will be pumped between ponds using portable diesel-powered pumps (the method used to pump water prior to the mains pumping system becoming operative). Accordingly, at least two mobile pumps each capable of lowering a typical-sized pond (e.g. Pond 6) by 10 cm in a 24 hour period, together with flexible pipe at least 100 m long, should be kept on site at all times.

Damage to sluices and drainage structures

5.9.4 Damage to sluices and drainage structures can have two consequences in respect to water management: damage preventing water being removed from a pond and damage resulting in water entering a pond. Where damage prevents water being removed from the pond at the required rate, either the mains or back-up diesel pumping systems will be utilised until the damage is repaired. Where damage results in water entering a pond the following measures will be utilised until the damage is repaired, depending upon the scale and exact nature of the problem: water will be pumped out using the mains or back-up pumps; manual means will be used to temporarily block the ingress point; or earth-moving equipment will be used to block the ingress point. In the event that either of the last two options is judged to be necessary to prevent ingress an assessment will first be made as to whether greater damage is likely to arise as a consequence of allowing water ingress or effecting a temporary block.

Pollution of water supply

5.9.5 Until construction of the station is completed, all water entering the EEA comes from rainfall. However, once the station is completed, this will be supplemented by water collected from the station roof. The method of delivery to the EEA has not been finalized; means of ensuring that polluted water is not permitted to enter the site will be resolved when this is done.

Direct pollution of water bodies in the EEA

5.9.6 Direct pollution events requiring contingency measures fall into two categories: where pollution events are observed directly and where effect on wildlife and/or flora suggests that a pollutant may be having an adverse effect. In the first instance the following course of action should be followed. The polluted water body should be isolated from the rest of the EEA (i.e. no water should be pumped in or out). The pollutant and the pollutant source should be identified. If the pollutant is still entering the water body/site measures should be taken to taken to stop further entry so long as this can be accomplished safely. If the pollutant cannot readily and safely be identified, steps to identify the pollutant should be followed (see below). Appropriate measures to remove the pollution and reverse any adverse ecological effects should then be initiated – such measures will be specific to the nature and scale of the pollution incident.

5.9.7 If the event that adverse effects on wildlife or flora are suspected to be a consequence of pollution but the cause of pollution is not apparent, in situ testing of water quality parameters detailed in Section 7.2.39 should be carried out and water samples should be collected for testing at a HOKLAS approved laboratory prior to determination of appropriate control and remediation measures.

5.9.8 In all cases, and if there is any indication that wildlife is being or is likely to be adversely affected appropriate steps should be taken to minimize contact between wildlife and the pollution source.

5.9.9 If the pollutant is identified as being chemical waste defined by the Waste Disposal (Chemical Waste) (General) Regulation a licensed chemical waste collector should employed to effect removal.

Invasion by exotic or other undesirable plant or animal species

5.9.10 Should the cover of exotic or other undesirable plant species exceed Action Levels specified in Appendix 2 and/or should adverse ecological effects arising from the presence of exotic or undesirable plant species be identified, measures should be initiated to remove or limit their presence. Such measures may include cutting, weeding or (in the case of aquatic species) use of herbivorous fish as a biological control agent. Other potential measures, for example, adjustments to the water management regime, may be considered on a case-by-case basis but should not normally include use of herbicides.

5.9.11 Should individuals or populations of exotic or undesirable animal species be identified, control measures should be determined on a case-by-case basis. The following paragraphs detail measures that have been instituted to control two instances of exotic/undesirable animal species in the EEA and serve as methodological models for responding to individual large mammals and an exotic insect population.

5.9.12 *Feral dogs*: feral dogs periodically appear on site. These are undesirable as they have direct adverse impacts on other wildlife (especially nesting birds) and also may cause extensive disturbance. All sightings and locations of feral dogs on site are logged. A humane dog trap on loan from AFCD is maintained on site and checked on the daily basis. Trapped dogs are handed over to AFCD.

5.9.13 *Red Imported Fire Ants:* Red Imported Fire Ants were reported from widespread locations in Hong Kong during the 2004-05 dry season, these were the first reports from Hong Kong of what is a significant pest in many countries. In March 2005 nests of Red Imported Fire Ants were found within the EEA. In addition to the risks that Red Imported Fire Ants may pose to humans, Red Imported Fire Ants are known to predate ground-nesting birds and herpetofauna as well as having adverse effects on native invertebrates in other countries to which they have been introduced and it is considered desirable to control infestations in Hong Kong. Accordingly the following control measures (agreed between KCRC and AFCD) directly targeting Red Imported Fire Ant nests are to be taken.

5.9.14 Checks for Red Imported Fire Ant nests are to be undertaken on a regular basis from the start of the dry season. Once nests have been located, bait ("Justice") is to be placed in immediate proximity to nests and covered with mesh to prevent accidental ingestion by small mammals or birds. Treatment is only to be undertaken at times when no rainfall is forecast for the subsequent four days. Following treatment, nests are to be checked after an interval of 2-3 weeks (or as per the manufacturers instructions) and if necessary bait should be reapplied

5.9.15 Spraying with pesticide, which may be appropriate elsewhere, is not desirable in the EEA due to risk of adverse effects on aquatic life. For the time being, at least, measures to control Red Imported Fire Ants should not be undertaken during the wet season. This is primarily because nests are difficult to locate at this time when vegetation cover is higher and denser, and also due to potential problems with the bait being washed into water bodies during heavy rainfall. It would also appear that numbers of Red Fire Ants are suppressed during the wet season, although spot checks should be considered during any unusually dry wet season.

Disease

5.9.16 A small number of diseased individuals is inevitable in any wildlife population. Contingency measures in respect of disease are, however, required to respond to outbreaks of disease which may affect a large number of individuals or where there is a risk of transfer to humans.

5.9.17 At the present time (and for the foreseeable future) there is a significant risk of a human influenza epidemic in Hong Kong arising from the transfer of avian influenza virus to humans. Accordingly, contingency measures to deal with this threat will remain in place for, at least, the period covered by this issue of the HCMP, as is described below.

5.9.18 *Avian Influenza Virus (AIV)* has been known to affect a number of bird species for many years. A strain of the virus, H5N1 has been found that has been able to adapt to human hosts and has resulted in human mortality in Hong Kong. Regular monitoring of the EEA for evidence of H5N1 in the bird population is undertaken by means of collection of faecal and blood samples for testing for AIV. A total of 3,179 samples were sent to Hong Kong University for analysis during the 2004-05 dry season and all tested negative for the virus. However, a total of four dead birds found on the site in 2002, 2004 and 2005 have tested positive for H5N1.

5.9.19 The following protocol for monitoring incidence of disease has been discussed and agreed with AFCD and is to be operated in co-operation with AFCD and Hong Kong University (HKU).

- All staff working on the EEA site will maintain vigilance in checking for sick and dead birds. If a sick or dead bird is found it is not to be touched; any such bird will be collected by AFCD for treatment or post mortem analysis and testing for avian diseases, especially avian influenza.

- Faecal samples from large waterbirds will be collected on site by AEMS staff for analysis by HKU or AFCD. In addition, small-scale trapping, licensed by AFCD, will be conducted in order to obtain cloacal swabs for analysis by HKU. Such trapping will only take place when it can be conducted without interfering with management activities in the EEA or causing disturbance to birds.

- Close liaison will be maintained with WWFHK staff at Mai Po Nature Reserve in the event of any disease outbreaks.

- Finally, should there be any unusually high numbers of sick or dead birds that test positive for AIV, appropriate measures to minimise the scale of any outbreak by reducing bird attraction will be determined in consultation with AFCD.

Flooding and other consequences of storms

5.9.20 In the event that a heavy rainfall event or typhoon is forecast (Red or Black Rainstorm Warning, Special Announcement on Flooding in the Northern New Territories or Typhoon Signal No. 3) the EEA should be checked to ensure that all water control structures are functional and that no loose materials which may interfere with drainage or pose a hazard are present on site. If appropriate, pre-emptive measures to lower water levels by pumping or opening of sluices should be carried out.

5.9.21 Once conditions are safe, the EEA should be checked for any incidence of flooding or other damage. Water levels in ponds should be adjusted to target levels by pumping or adjustment of sluices. If any flooding has

taken place, pond bunds, sluices and other water control structures should be checked for any damage and repairs should be undertaken. In the event that a Typhoon Signal No. 3 or higher was hoisted such checks should extend to all structures and trees on site. If flooding has involved intrusion of water from outside the EEA, repair of external bunds should be a priority. If such flooding has resulted in materials (such as litter or Water Hyacinth (an exotic plant species)) being brought onto the site these should be removed.

Fire damage

5.9.22 Fires are frequently deliberately set around commercial fish ponds by farmers in order to control vegetation. Such fires may spread into the EEA and result in damage to vegetation, direct mortality to wildlife and short-to-medium term loss of wildlife habitat. Contingency measures in respect of fires are as follows:

- On the south side of the EEA (the most likely direction for fires to spread from) a clear firebreak should be maintained by cutting and clearance of grass and other herbaceous vegetation. In the long term the risk of fires spreading onto the site should be minimized by planting a tree belt along the south side of the site (such a tree belt will suppress flammable grass and, although it may be damaged by a fire, such damage is likely to be temporary).

- The risk of spread of fire within the site is minimized by maintaining short grass on most of the internal bunds.

- If a fire is observed within the EEA or an uncontrolled fire appears to be spreading towards the EEA, Fire Services should be called and should be given access to the site if this is required.

6. MANAGEMENT STRATEGY

6.1 Management Regime Programme

6.1.1 KCRC's contractor will undertake the management regime with instructions to be given by the Resident Engineer or his representative. KCRC's Adaptive Ecological Management Specialist (AEMS) will be responsible for monitoring the implementation of the HCMP, reporting to KCRC and issuing appropriate advice as required. Such advice will include determining appropriate management actions on a day-to-day basis taking into account feedback from monitoring activities and reporting by the contractor and will include the necessary responses to the outcome of monitoring where it is found that Action Levels and Limits as defined in Appendix 2 are exceeded.

6.1.2 As is noted in paragraph 5.8.1, the HCMP will be reviewed and updated on a six monthly basis.

6.2 Management Actions

6.2.1 A list of standard management actions that must be undertaken for the EEA is provided in Table 6.1.

6.2.2 Note that this list of standard management actions does not include adaptive enhancement management of the EEA fishponds by stocking and drain-down. Stocking and drain-down regime will be programmed on a monthly basis. Programming will cover target water levels, drain-down dates and stocking quantities and dates. Drain-down and stocking will be monitored and adjustments will be made on a weekly basis or more frequently if required.

6.2.3 Vegetation shall only be removed by cutting and removal of roots / rhizomes by hand or machine (e.g. backhoe). Routine use of herbicides is not allowed, but may be considered if a particular problem arises in the future (e.g. to treat invasive species). Grass cuttings and other herbaceous vegetation (but not woody vegetation and any plant roots or rhizomes) may be used on-site to improve water quality where agreed by the AEMS.

6.2.4 Any waste material removed from the EEA must be disposed of at a Government approved site.

Table 6.1 *Standard management actions for the EEA.*

	Action	Frequency	Notes
	Water Control		
W1	Measure water levels and adjust sluice heights or pump accordingly to meet target levels (see Appendix 2)	Weekly and/or within 24 hours of heavy rainfall events*	Target levels to be set and reviewed monthly in accordance with adaptive drain-down regime
W2	Measure water quality to cover most critical concerns for short term management (pH, BOD, salinity)	Monthly or as directed by the resident engineer on advice from the AEMS	More frequent measurements required when active steps to adjust water quality are being taken
W3	Inspect condition of water control structures and water courses and repair / maintain as necessary	Monthly	Also to be inspected after lowering of Typhoon Signal No. 3
W4	Inspect condition of pumps and water supply structures and repair / maintain as necessary	Every six months at start of wet and dry season	
W5	Clear sluices	Weekly	Also after flooding / heavy rainfall and lowering of Typhoon Signal No. 3
	Structural maintenance		
S1	Inspect condition of paths / bunds and repair / maintain as necessary	Every 6 months	Also after any flood events and lowering of Typhoon Signal No. 3
S2	Inspect condition of bunds and repair / maintain as necessary	Monthly	Also after any flood events
	Vegetation management		
V1	Cutting or pruning and removal	According to direction of the RE or his representative on the advice of the AEMS	
V2	Removal of exotic / undesirable invasive plants (weeding)	According to direction of the RE or his representative on the advice of the AEMS	
V3	Pest control	According to direction of the RE or his representative on the advice of the AEMS	

	Action	Frequency	Notes
	Other actions		
O1	Inspect for dumping / rubbish and remove	On all visits	Consult management team regarding water pollution or toxic materials
O2	Inspect / maintain signs, gates and fences	Monthly	
O3	Check site for presence of sick or dead birds or mammals	On all visits	Systematic checks to be undertaken when high risk of disease outbreaks
04	Bait and check dog trap	Daily	If trap is set

* A heavy rainfall event if defined as 100 mm of rainfall falling within 24 hours in the Northwest New Territories.

7. MONITORING

7.1 General Requirements

7.1.1 The following sections define the ecological monitoring requirements for the EEA to establish that enhancement measures are implemented and enhancement targets are met. Ecological monitoring in the Lok Ma Chau area has been undertaken since April 2000. Data collected during the period from April 2000 – May 2001 was presented in the EIA Report (BBV 2001a). Subsequently, as well as ongoing monitoring using the same methodology as that used for the baseline monitoring, data was collected describing the results of enhancement management of fishponds in the EEA area during October 2001 – April 2002 (BBV 2002a) and during the first three years of operation of the EEA from August 2002 – July 2005 (AEC 2003, AEC 2004, AEC in prep.). Together, this data has been used to define Action and Limit Levels for ecological issues (see Appendix 2).

7.1.2 Ecological monitoring is required in order to ensure that the requirements of this HCMP are met, in particular in respect of use by target species, but also in respect of other wildlife of conservation importance identified in the EIA Report and subsequent surveys. The main components of this work are:

- Monitoring of birds using the EEA with particular reference to effectiveness of management measures; together with monitoring of birds at the two Control Areas of commercial fishponds detailed in Section 3.3 of this HCMP to demonstrate the success of the EEA enhancement measures. In addition, surveys will be conducted at Mai Po Nature Reserve to monitor wintering Black-faced Spoonbills. These surveys are necessary to validate the success of the EEA.

- Monitoring of Eurasian Otter, dragonflies and herpetofauna within the EEA and the Lok Ma Chau study area; together with monitoring at the two Control Areas to demonstrate the success of the EEA enhancement areas.

- Monitoring of establishment of appropriate conditions in the EEA fishponds to support the target wildlife species detailed above. Monitoring will cover habitats and vegetation cover, plant community composition, aquatic invertebrates, benthic invertebrates, fish stocks and soil and water quality.

7.1.3 The details of the location and timing of ecological baseline monitoring and the methods used described below are complementary to those provided in the Environmental Monitoring and Audit Manual (EM & A Manual). Monitoring areas are detailed in Figure 5.

7.2 Habitat and Species' Attributes to be Monitored

7.2.1 Monitoring is carried out of the ecological attributes detailed below:

Monitoring of target bird species

7.2.2 Monitoring of the 26 target bird species listed in Table 2.3 is required in order to demonstrate success in reaching the target of the EEA supporting twice the number of individuals of the target species as commercial fishponds (expressed as birds ha^{-1}). Accordingly, monitoring is conducted in the EEA and in Control Areas of commercial fishponds at Mai Po San Tsuen (MPST) and San Tin (ST). Because the target bird species differ greatly in their abundance, detectability and their response to disturbance a combination of count methods is required. Count methods for the 26 target bird species are summarised in Table 7.1 and described in more detail below.

Table 7.1 *Avifauna monitoring methodology*

Species	**Count Methodology**		**Notes**
	LMC	**Control**	
Great Cormorant	Tower counts*	MPST tower count / ST transects	
Grey Heron	Tower counts*	MPST tower count / ST transects	
Great Egret	Tower counts*	MPST tower count / ST transects	
Little Egret	Tower counts*	MPST tower count / ST transects	
Chinese Pond Heron	Full site transect	MPST & ST transects	
Black-faced Spoonbill	Tower counts*	MPST tower count / ST transects/MP roost count	
Common Teal	Tower counts & full site transect	MPST tower counts / ST full site transect	Compare & review methods at LMC
Greater Spotted Eagle	Tower count	MPST tower count / ST transect	Also relate to HK status
Imperial Eagle	Tower count	MPST tower count / ST transect	Also relate to HK status
Eurasian Hobby	Utilise all observations	Utilise all observations at MPST & ST	Also relate to HK status (very low density species)
Japanese Quail	Full site transect	MPST & ST transects	
Eurasian Coot	Tower counts & site transect	MPST tower counts / ST site transect	Compare & review methods at LMC
Pheasant-tailed Jacana	Tower counts & site transect	MPST tower counts / ST site transect	Compare & review methods at LMC
Greater Painted-snipe	Site transect / trapping	MPST & ST transects	Cryptic. Also monitor breeding activity
Black-winged Stilt	Tower counts & site transect	MPST tower counts / ST site transect	Compare & review methods at LMC. Also monitor breeding activity
Pintail Snipe	Site transect	MPST & ST transects	
Swinhoe's Snipe	Site transect	MPST & ST transects	
Common Snipe	Site transect	MPST & ST transects	
Richard's Pipit	Site transect	MPST & ST transects	
Bluethroat	Trapping	MP reedbed	Cryptic
Common Stonechat	Site transect	MPST & ST transects	
Pallas's Grasshopper Warbler	Trapping (incl. reedbed)	MP reedbed	Cryptic
Zitting Cisticola	Site transect	MPST & ST transects	
Japanese Yellow Bunting	All observations	All observations	Also relate to HK status
Red-billed Starling	Site transect	MPST & ST transects	
Black-naped Oriole	Site transect	MPST & ST transects	Also monitor breeding activity and HK breeding status

* Transect in Compartment C

Tower counts

7.2.3 The following methodology follows that used during initial management measures conducted in winter 2001-2002 (BBV 2002a) and during the first three years of operation of the EEA (AEC 2003, AEC 2004, AEC in prep.). Tower hide counts are required for those species (large waterbirds and eagles) which are most susceptible to disturbance. Use of a hide is required in order to ensure that the observer does not disturb any birds using the ponds, whilst a tower is necessary to monitor a suite of ponds from a single location. Monitoring is conducted by a single observer using a tripod-mounted telescope. During each visit the observer shall keep the study ponds under observation from just after dawn to mid-morning (c. 06.30 – 10.00) to coincide with the daytime period during which most birds feed. During each survey visit the observer shall conduct five sweeps during which all birds using the ponds are counted. Only birds actually using the EEA shall be counted (i.e. flying birds except foraging raptors are ignored).

7.2.4 Tower counts have previously been utilised in order to monitor numbers of Great Cormorants, Grey Herons, Great Egrets, Little Egrets, Black-faced Spoonbills and Greater Spotted and Imperial Eagles. It is proposed to extend the range of species counted to include Common Teal, Eurasian Hobby, Eurasian Coot, Pheasant-tailed Jacana and Black-winged Stilt. These species will also be monitored during site transects and the relative merits of the two count methods (ease of counting and accuracy) will be assessed after 12 months (i.e. December 2007).

7.2.5 Tower count monitoring at LMC is conducted two times per week. This is a reduction from three times per week at LMC during the construction stage. It is considered that this reduction in frequency is appropriate as conditions on site will now be more stable (hence there will be less rapid changes in bird numbers).

7.2.6 Tower count monitoring methodology at the MPST Control Area follows that at Lok Ma Chau and is conducted from a similar observation tower. Monitoring is undertaken once per week. As noted in paragraph 3.3.3 it was not possible to secure a suitable location for erection of an observation tower at ST, so the survey there is conducted by means of a walked transect (see below). Since only a single count can be undertaken per survey visit during a walked transect, the survey area has been increased to cover a larger area to compensate. As far as possible, observations are carried out at LMC and the two Control Areas simultaneously to make the findings directly comparable. Tower hide positions and the boundaries of the Control Areas are shown in Figure 5.

Site transects

7.2.7 This monitoring is required to determine numbers of those smaller species which be counted from a tower. It is also required in Compartment C of the EEA which is too far from the Tower for birds to be counted from there

and at ST where it was not possible to find a suitable location for a tower. Birds using the reedbed to the east of the station should also be counted; whilst this is not part of the EEA, it is stated in the EIA Report that this area will retain its baseline ecological value and it is necessary to demonstrate that, as well as fulfilling its water polishing function, it continues to provide habitat for wetland fauna. The methodology follows that used within the Lok Ma Chau area in the Baseline Study and subsequently; this will assist in the interpretation of trends in bird numbers during the course of the Spur Line project.

7.2.8 Surveys will be undertaken throughout the EEA and the reedbed. During each survey visit, the surveyor visits each pond and identifies to species level all birds present. In addition to target bird species, counts shall be made of all waterbirds, species of conservation importance (following Fellowes *et al.* 2002) and any other unusual bird species (the same methodology as was followed in the baseline survey). Where possible, each pond is surveyed from one point, the most accessible on the transect route, to reduce disturbance and to reduce the risk of double counting. If required, the surveyor adjusts his position (if part of the pond is out of sight, or if closer views of a bird are required in order to confirm identification). If it is considered that birds have already been counted on other ponds, these will be ignored. If ponds contain large numbers of birds these are surveyed at a distance to avoid disturbing birds and to further reduce the possibility of double counting. Where necessary, ponds that have been found to hold large numbers of birds earlier on a visit are revisited if there is a suspicion that birds have moved within the study area during the course of the survey. In general, flying birds are not recorded unless they are clearly foraging and associated with the habitat.

7.2.9 Site transects will be undertaken once per week in the EEA and the Water Polishing Reedbed, MPST and at ST. Because MPST is a relatively small area the transect may be undertaken directly after the tower count; however the count in the EEA should be undertaken on a different day.

Trapping

7.2.10 Some target bird species which utilise marsh and reedbed habitat, notably Greater Painted-snipe, Bluethroat and Pallas's Grasshopper Warbler are highly cryptic. These species also utilize well vegetated fishpond edges where they tend to be more conspicuous, hence are likely to be comparatively under recorded in the densely vegetated areas within the EEA and within the Water Polishing Reedbed. Bird trapping within these habitats is highly effective for detecting such cryptic species, and this is known to be the case in Hong Kong. Acccordingly, monitoring will be undertaken through trapping with mist nets in suitable areas within the EEA and the Water Polishing Reedbed twice per month from mid November through to the end of April. Trapping will be undertaken using mist nets operated by experienced personnel holding a valid permit to trap birds for scientific purposes (issued by AFCD under Section 15 of the Wild Animals Protection Ordinance Cap 170).

7.2.11 The length of mist net used, duration of each trapping event and location of mist nets will be standardized. The control area for this species will be Gei-wai No. 8 at Mai Po NR which comprises a large reedbed where standardized sampling of birds (including Bluethroat) through mist-netting is undertaken, accordingly a density (individuals/meter of net/hour) can be calculated for both areas and compared directly.

Monitoring of Eurasian Otter within the EEA and Control Areas

7.2.12 Monitoring of mammals within the EEA and the Lok Ma Chau area is focused on the use of the area by Eurasian Otter *Lutra lutra*. The monitoring technique is primarily camera-based and represents an extension of the study conducted from December 2001 – April 2002 (BBV 2002b). Five combined camera and infra-red monitor sets are deployed. These are set up in semi-permanent positions (i.e. they may be moved occasionally for operational reasons or in response to previous survey findings). Cameras positions will normally be in Compartment A (where Eurasian Otter is a primary target species and artificial holts have been constructed), however cameras may also be located in Compartments B and C in response to previous survey findings. The cameras are fixed at an appropriate height so as to maximise chances of obtaining photographs of otters as well as other mammal species such as Leopard Cat *Prionailurus bengalensis* and Small Asian Mongoose *Herpestes javanicus*. The infra-red monitors have an effective range of up to 8m for animals within this size range. Cameras are checked and films changed once per week.

7.2.13 When cameras are set, signs of fresh otter activity (such as spraints and paw prints) are searched for and recorded, together with any other signs of recent mammal activity. Any spraints found are photographed, collected and analysed to determine dietary composition. Prints are photographed and measured to determine their size and hence to provide an indication of the number of individuals of a species which are present.

7.2.14 At the San Tin Control Area the use of monitoring cameras was attempted during the first months of operation of the EEA but was discontinued for security reasons (several cameras were stolen). Cameras continued to be deployed at Mai Po San Tsuen until 2005, but again there was a significant problem of cameras being stolen or disturbed. As a consequence and since mammal monitoring in the EEA is non-quantitative in any case, monitoring in the control areas is now restricted to searches for signs of mammal activity as detailed in paragraph 7.2.13.

Monitoring of Dragonflies and Butterflies within the EEA and Control Areas

7.2.15 Dragonflies and butterflies are surveyed during the period from March to November covering the main period of emergence and activity. Transect surveys are undertaken once per month during March and September to November and twice per month during the peak period of dragonfly

emergence in April to August. Survey duration is approximately 6 hours, commencing at 08.00 hours.

7.2.16 During the surveys a fixed survey route is followed. All dragonfly species observed are identified and all sexually mature male and ovipositing female individuals counted. All butterfly species are identified and numbers are estimated quantitatively or semi-quantitatively. Dragonfly exuviae are also recorded qualitatively. Habitat use and breeding activity is recorded, as well as evidence of breeding success in the form of final instar larval exuviae, which are collected and identified.

7.2.17 For dragonflies, transect surveys in the EEA are supplemented by quantitative monitoring of emergence using of exuviae emergence traps. Monitoring is concentrated in Compartment C but includes monitoring locations in Compartments A and B for comparative purposes. Traps are located in Ponds 13, 14 and 17 in Compartment C, Pond 2 in Compartment A (where water levels are expected to remain relatively stable) and Pond 7 in Compartment B (a typical actively managed pond which will be drained down at least once per year). Eight traps are used in each pond except for the small Pond 13 where four traps are used. Traps are inspected twice per week and all exuviae are collected for subsequent laboratory identification and counting.

7.2.18 The survey periods detailed above have been amended slightly following review of the pattern of dragonfly activity in the EEA during 2002-04 (AEC 2003, AEC 2004). Proposed trials with exuviae traps and screens were detailed in Issue 9 of the HCMP and the use of traps is now incorporated in the long-term monitoring methodology.

Monitoring of Herpetofauna within the EEA and Control Areas

7.2.19 Herpetofauna surveys focus on breeding amphibians and the reptile community. Two half day day-time surveys (primarily aimed at detecting reptiles are to be conducted each month during April to November. Surveys will take place during 10.00 – 14.00 hours, the peak period of reptile activity. Two half day night-time surveys (primarily aimed at detecting breeding amphibians) are to be conducted each month during the period from March to August. Night time surveys will be undertaken during 18.00 to 22.00 hours and focus on the detection of vocalising amphibians. During the surveys a fixed survey route is walked. All reptiles and amphibians observed or heard are identified, and their abundance estimated. Habitat use and breeding activity are recorded.

7.2.20 These survey periods were amended slightly following review of the pattern of herpetofauna activity in the EEA during 2002-04 (AEC 2003, AEC 2004).

Surveys at Mai Po to monitor wintering Black-faced Spoonbills

7.2.21 This aspect of monitoring is critical to assess the effectiveness of

management measures aimed at this globally endangered species. Weekly counts at Mai Po Nature Reserve, where most of the wintering spoonbills roost, are undertaken to provide data on the numbers present in Hong Kong. This permits the numbers present in the EEA to be placed in context. Numbers of this species fluctuate rapidly during the winter, and thus regular monitoring is required.

7.2.22 Surveys are conducted covering the whole of Mai Po Nature Reserve, during which time all spoonbills present will be counted. The timing of the counts coincides with the period when most spoonbills are likely to be present, which is generally during the middle part of the day or over the high tide period.

7.2.23 Counts are conducted once per week from mid-October to the end of May.

Monitoring of aquatic invertebrates in the EEA

7.2.24 Sweep-netting is used to sample aquatic species in the water column and clinging to vegetation at the water-bund interface. The sweep-net will be a D-shaped net of 30 cm diameter with a 1 mm mesh. Each sample comprises two 2-metre sweeps of the net from which all captured specimens are removed. The first sweep is carried out at the water surface and the second as close to the pond bed as possible. Each set of sweeps is taken along the water-bund interface. Five randomly located replicate samples are taken from each pond.

7.2.25 Samples are placed in labelled containers together with preservative for transporting to the laboratory. Once in the laboratory, specimens are rinsed in water, placed on a white sorting tray and sorted for identification to species level using a binocular microscope. Where partial body parts are identified, only heads are counted.

7.2.26 The number of each macro-invertebrate species is ascertained for each replicate sample for all taxa groups. A total dry weight biomass is determined for each of the above groups.

7.2.27 The number and species of any fish captured incidentally during the sampling are also recorded.

7.2.28 Review of invertebrate sampling data collected since 2002 demonstrates that invertebrate diversity in stocked fishponds is relatively low but this does not adversely affect their function in providing habitat and food for birds. Accordingly, more invertebrate sampling should be conducted in the marsh and reedbed areas (where there is less baseline data and where higher diversity can be predicted). Aquatic invertebrates will be sampled in each pond once per year at the end of the wet season (August/September) and twice per year (at the end of the wet season and the end of the dry season (March/April) in marsh and reedbed areas.

Methodology for monitoring benthic invertebrates

7.2.29 Cylindrical benthic cores 10 cm in diameter and 10 cm depth are taken from the substrate at the base of the ponds to obtain quantitative data on benthic invertebrate populations. Five randomly located replicate cores are collected from each pond shallows. Core contents are bagged and stored in a cooler for subsequent sorting. Samples are analysed as for sweep netting.

7.2.30 Review of invertebrate sampling data collected since 2002 demonstrates that invertebrate diversity in stocked fishponds is relatively low but this does not adversely affect their function in providing habitat and food for birds. Accordingly, more invertebrate sampling should be conducted in the marsh and reedbed areas in Compartment C (where there is less baseline data and where higher diversity can be predicted). Aquatic invertebrates will be sampled in each pond once per year at the end of the wet season (August/September) and twice per year (at the end of the wet season and the end of the dry season (March/April) in marsh and reedbed areas.

Methodology for monitoring freshwater fish

7.2.31 During stocking, a random sample of 50 specimens of each species are wet-weighed and measured (length), prior to release into the pond. Throughout the year throw and drag-netting are carried out every two months at each stocked pond. A fishing throw-net with a mesh size of 30 mm, a diameter of 4.22 m and a surface area of about 14 m^2 is used to catch larger fish and a drag net of mesh size < 10 mm is used to sample smaller fish and shrimps. Five randomly-placed replicates with each net are conducted in each pond. Fish are identified to species and their weight and length recorded and then released back into the pond.

Monitoring of habitats in the EEA

7.2.32 Habitat monitoring is conducted at six monthly intervals at the end of the wet season (September) and the end of the dry season (March) to confirm that habitat area requirements of the Environmental Permit are met.

Monitoring of vegetation cover in the EEA

7.2.33 Vegetation cover in the EEA is monitored at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). Vegetation cover will be mapped showing extent of vegetation in bunds, in ponds and on riversides. Mapping will distinguish between areas of trees/woody plants, areas of vegetation over 10 cm in height, areas of vegetation less than 10 cm in height and areas which are free of vegetation.

Monitoring of microhabitat structure and floristics of marsh areas (Compartment C)

7.2.34 More detailed habitat and vegetation monitoring is required in the marshland areas (Compartment C). In these areas three important plant community parameters in a wetland system will be monitored and evaluated as follows:

- Plant species diversity,
- Plant community physical structure, and
- The invasion of non-native species.

7.2.35 *Plant species diversity*: permanent transects will run through each marsh area (two in Pond 13 and eight in each of the other marsh areas). As far as possible transects should cover the full range of microhabitats in each marsh and should be not less than 6 m in length. The transect lines will be stratified into the three sub-habitat types and information on the floristic and structural characteristics of each sub-habitat type will be collected from two 1 m x 1 m quadrats established along both sides of the transect line and at least 3 metres apart. Within each sampling quadrat, the following information will be collected:

- Identity and total number of plant species;
- Percentage cover of bare ground, leaf litter cover and coverage by each species following the Domin cover scale;
- The tallest height of each plant species identified (to the nearest cm).

From these surveys a full plant list will be provided for each of the land parcels.

7.2.36 Monitoring will be conducted in all Ponds twice per year, once during the wet season and once during the dry season.

7.2.37 *Mapping of habitat characteristics of marsh areas and occurrence of invasive species:*will be undertaken twice per year at the end of the wet season and the end of the dry season; the following characteristics will be recorded:

- % of each habitat
- % of open water
- % of shallow water (0-30cm)
- % of medium depth water (30 – 100cm)
- % of deep water (>100cm)
- % of open bare wet mud
- % of bare dry mud
- % cover of plant species in deep water
- % cover of plant species in medium depth water
- % cover of plant species in shallow water
- % cover of plant species in dry areas
- % of undesirable and exotic species

Pedology Monitoring

7.2.38 Pond sediment in each pond will be monitored yearly in the early wet season. This is a reduction from twice yearly sampling undertaken during the construction period as review of data collected so far has demonstrated that in the absence of earthmoving activities sediment parameters are stable except when ponds are drained. Three sediment samples will be collected from each pond and sent to a HOKLAS accredited laboratory for analysis. The following parameters will be monitored (see also Appendix 2 concerning Action and Limit levels):

- % volatile solids
- Oxidation/Reduction (Redox) potential
- pH
- Total nitrogen
- Total oxidized carbon
- Total phosphorus
- Total reactive phosporus

Monitoring of Water Quality and Hydrology of Fishponds

7.2.39 In situ water quality will be measured in each pond once per month. The following parameters will be monitored (see also Appendix 2 concerning Action and Limit levels):

- Temperature
- pH
- salinity
- turbidity
- Dissolved oxygen

7.2.40 Additional measurements of these parameters should also be made in order to inform management decisions (e.g. fish stocking programme) and in response to unexpected events (e.g. algal blooms or fish die-offs).

7.2.41 In addition, every six months (end of the wet season and end of the dry season) water samples will be sent to a HOKLAS accredited laboratory for analysis. This is a reduction from bi-monthly sampling undertaken during the construction period as review of data collected so far has demonstrated that, other than short term changes after drain-down and refilling, water chemistry is rather stable and bi-monthly sampling is not required to inform management decisions. The following parameters will be monitored (see also Appendix 2 concerning Action and Limit levels):

- Ammoniacal nitrogen
- Biochemical oxygen demand
- Total oxidized nitrogen
- Total phosphorus
- Total reactive phosphorus (orthophosphate)

Review of wildlife and habitat monitoring programme and consequent adaptive management

7.2.42 Findings of the wildlife and habitat monitoring programme detailed above will be reviewed on a weekly basis by the AEMS who will use the data collected to identify necessary adjustments to the management regime (see Section 7.3, below).

7.2.43 The wildlife and habitat management programme has been substantially reviewed since Issue 10 of the HCMP to coincide with the completion of most of the programmed enhancement works and the extension of wildlife targets to cover all targeted species detailed in the EIA Report. It is intended that the monitoring programme detailed above should be followed throughout 2006, following which a review will again be undertaken and adjustments will be made to the HCMP if required.

7.3 Monitoring and Adaptive Management Supervision

7.3.1 The progress of the management regime detailed in Section 5 and the monitoring regime detailed in Sections 7.1 and 7.2 will be supervised by the AEMS who will report to KCRC. The AEMS will be responsible for the supervision of the HCMP monitoring programme and will be responsible for giving appropriate advice to the Resident Engineer on the adaptive management regime who will then issue the necessary instructions to the contractor.

7.3.2 The AEMS will require to undertake the following:

Weekly Review of Conditions in the EEA

7.3.3 The AEMS will review on a weekly basis the management activities undertaken by the Contractor. The review will cover the following:

- Contractor's progress in the implementation of construction works, planting etc. during the previous week.
- Contractor's management activities undertaken during the previous week.
- Any reportable incidents during the previous week: including human disturbance, interaction with the main construction contract, adverse weather events, accidental or deliberate damage to mitigation areas, leakages and water quality problems.

Weekly Review of Wildlife Monitoring Activities Undertaken

7.3.4 The AEMS will review on a weekly basis the wildlife monitoring activities undertaken. The review will cover the following:

- Monitoring team's weekly report of utilisation of the EEA and the control areas by target bird species, together with other observations logged by the monitoring team in these areas (for example disturbance, response to drain-down etc.).

- Monitoring team's report of other wildlife monitoring activities (including bird surveys of the Lok Ma Chau study area, Black-faced Spoonbill roost counts, report camera surveillance of otters and other mammals, amphibian and invertebrate surveys.

Weekly Inspection and Review of the EEA and Control Areas

7.3.5 The AEMS will conduct on at least a weekly basis an inspection visit to the mitigation and control areas to verify Reports from the Contractor and Monitoring Team and to confirm that the EEA is being operated correctly. Inspection visits will focus, in particular, on the following:

- Progress in the implementation of management works.

- Condition of mitigation areas; in particular where active management (for example fish stocking, drain-down, refilling, fertilisation) is underway, has recently been completed or may be required to commence shortly.

- Items or issues not necessarily covered within the routine management and reporting responsibilities of the Contractor and the Monitoring team; for example stochastic factors judged to be influencing utilisation of the EEA and Control Areas by target waterbird species.

- Opportunities presented for changes to or refinement of the management regime to better meet mitigation targets.

Issue of Prescriptions for the EEA

7.3.6 Based on the foregoing, the AEMS will then be responsible for issuing routine prescriptions for the EEA as follows:

- Instructions to the contractor (through the Resident Engineer) covering management and maintenance requirements, including routine management activities such as drain-down and refilling, stocking, fertilisation, vegetation management and response to events such as adverse weather, fires or other damage to habitats and equipment.

- Instructions to the monitoring team covering the programme to monitor drain-down and other adaptive management measures as well as variations in other monitoring activities in the light of changing circumstances.

7.3.7 Prescriptions will typically be issued for a four week period, but where appropriate may be issued more frequently. Prescriptions issued and their implementation will be described and explained in Monthly Monitoring Reports (see below).

Reporting

7.3.8 The AEMS will prepare a Monthly Monitoring Report for the EEA. This Report will include a summary of the field data collected, performance in respect of species targets, an interpretation of the data with respect to Action and Limit Levels for ecological attributes and recommendations for remedial or other action to be taken.

7.3.9 In addition this Monitoring Report will review any Contractor's Progress Report (if available) and will detail recommendations for the forward programming of the Contractor's management activities. These programmed management activities will cover the current six-month wet or dry season period and will be rolled forward and / or modified as required according to progress in meeting targets and management objectives.

7.3.10 This Monthly Monitoring Report will form the ecological element of the monthly EM&A Report which will be submitted to the Environmental Committee. The latter Committee will monitor environmental aspects of the Spur Line construction project on behalf of Advisory Council on the Environment (ACE).

7.3.11 On an annual basis the AEMS is required to review the information collected to date from the ecological monitoring programme, the construction programme, site activities and wetland management actions and to assess the degree of success of the active HCMP. The AEMS will propose modifications to the HCMP as required to improve the management of the wetland. The information used for this purpose and the proposals made will be the basis for presentations to the Environmental Committee as required.

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APPENDICES

Appendix 1
Marsh Profiles and Planting Plans

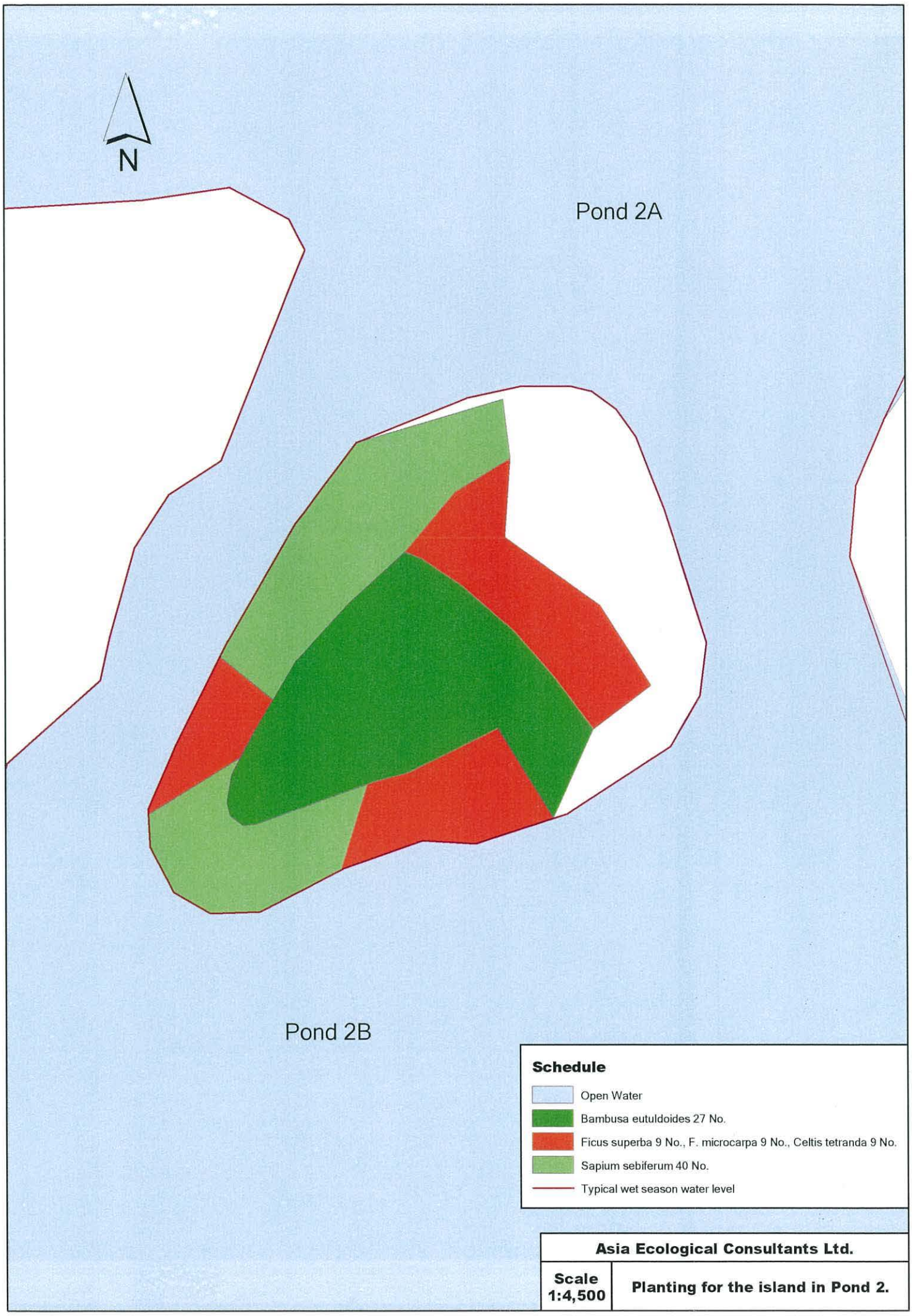
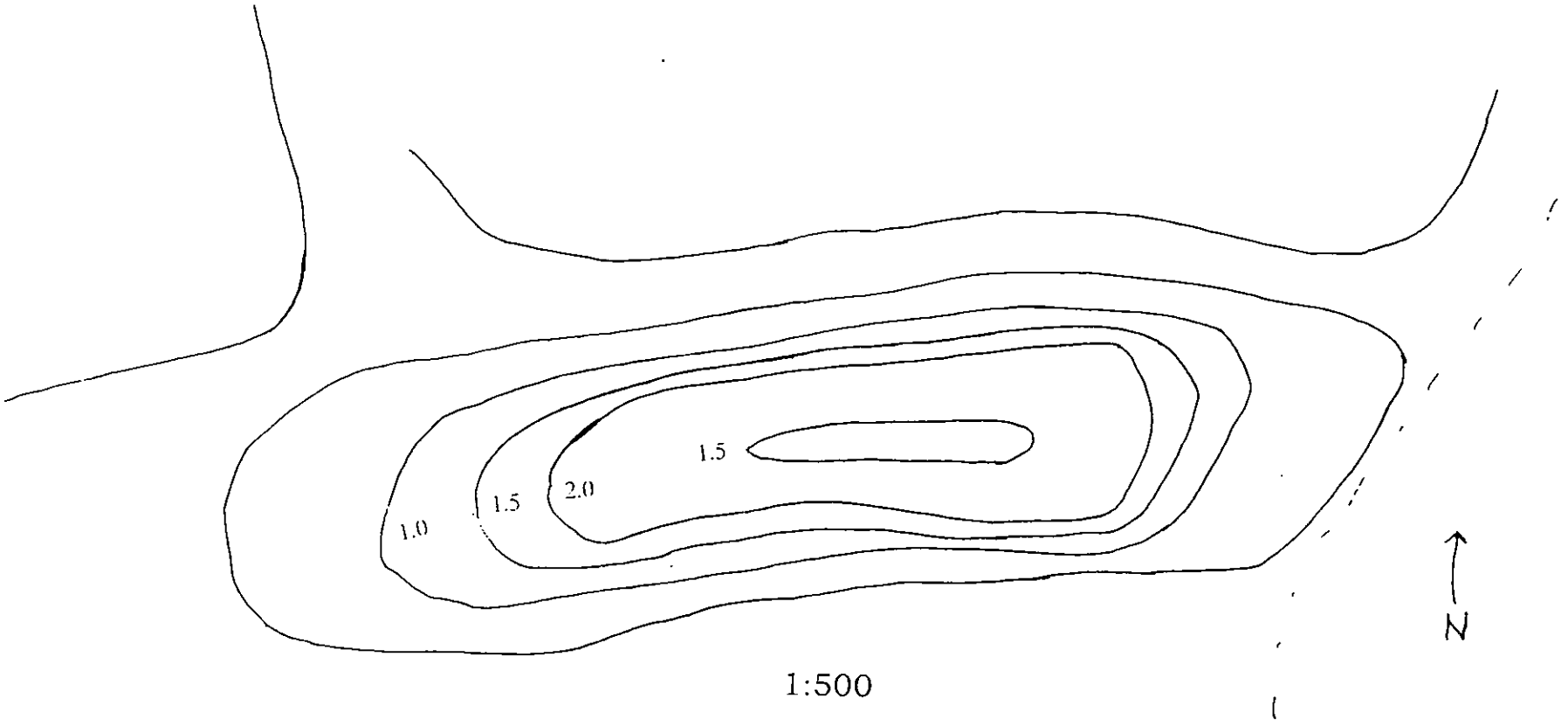

N
Pond 2A
Pond 2B
Schedule
Open Water
Bambusa eutuldoides 27 No.
Ficus superba 9 No., F. microcarpa 9 No., Celtis tetranda 9 No.
Sapium sebiferum 40 No.
Typical wet season water level
Asia Ecological Consultants Ltd.
Scale 1:4,500
Planting for the island in Pond 2.

Figure A1.1 Pond 5 Proposed levels



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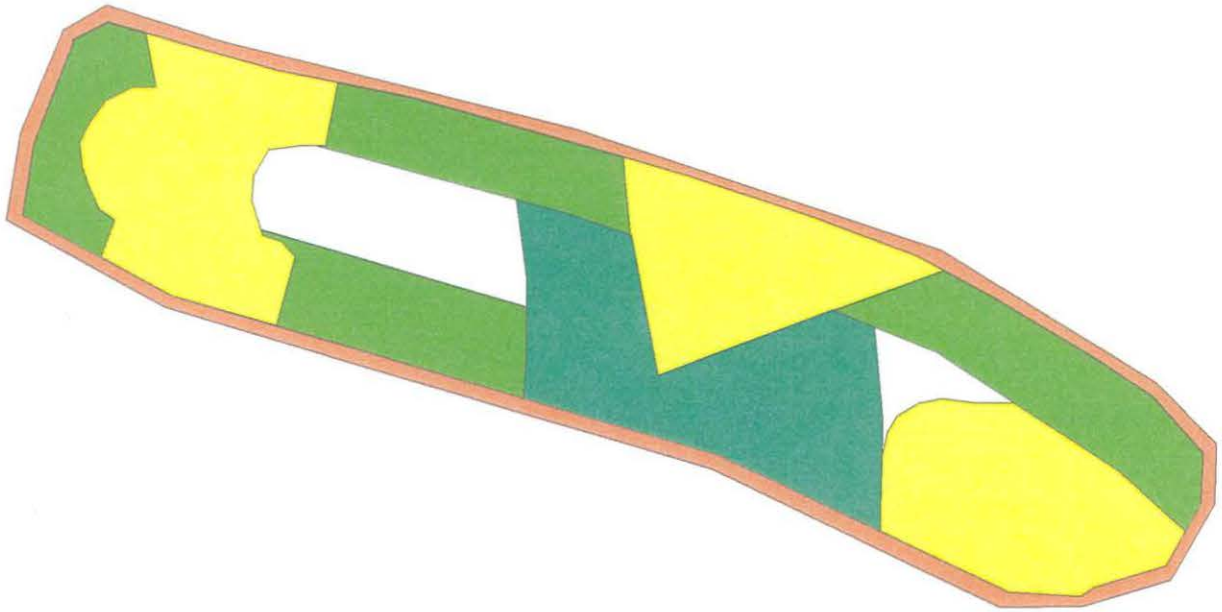


N

Key to planting mixes

- Mix A
- Mix B
- Mix C
- Mix D

Asia Ecological Consultants Ltd.

Scale 1:500	Figure A1.3 Pond 5 Planting Plan

Figure A1.2 *Section of Pond 5 showing proposed profile. Note: final levels to be adjusted on site if necessary*

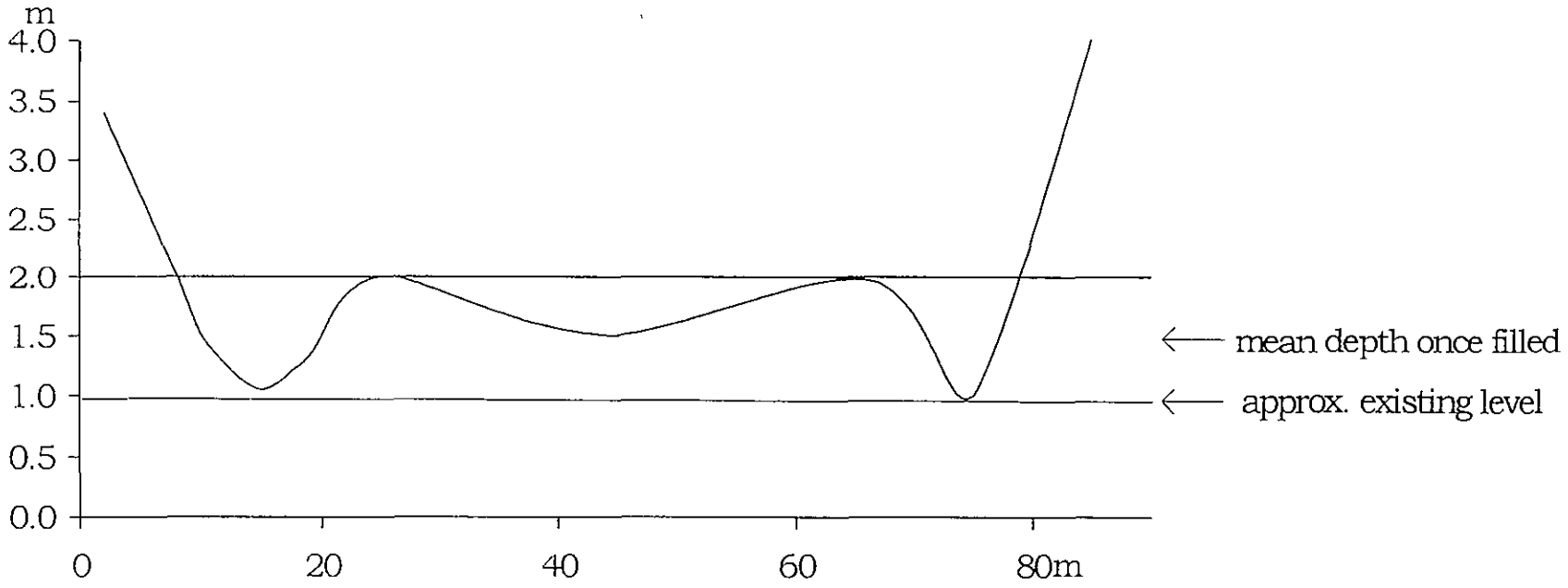
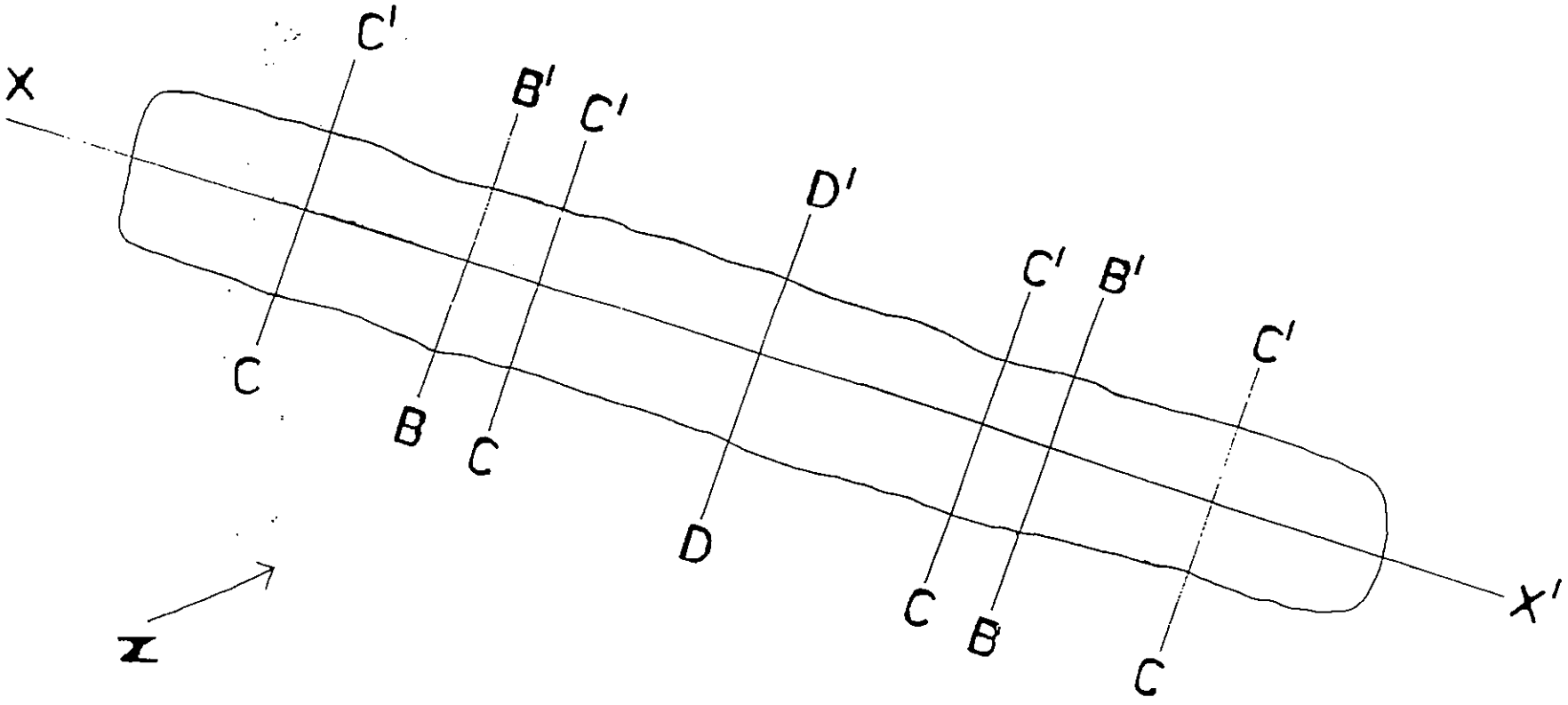


Figure A1.4 *Plan of Pond 12 showing longitudinal section X-X' and transverse sections B-B', C-C' and D-D'. See section drawings for section details.*



Scale 1:1500

Figure A1.5 *Pond 12 Section X-X'*

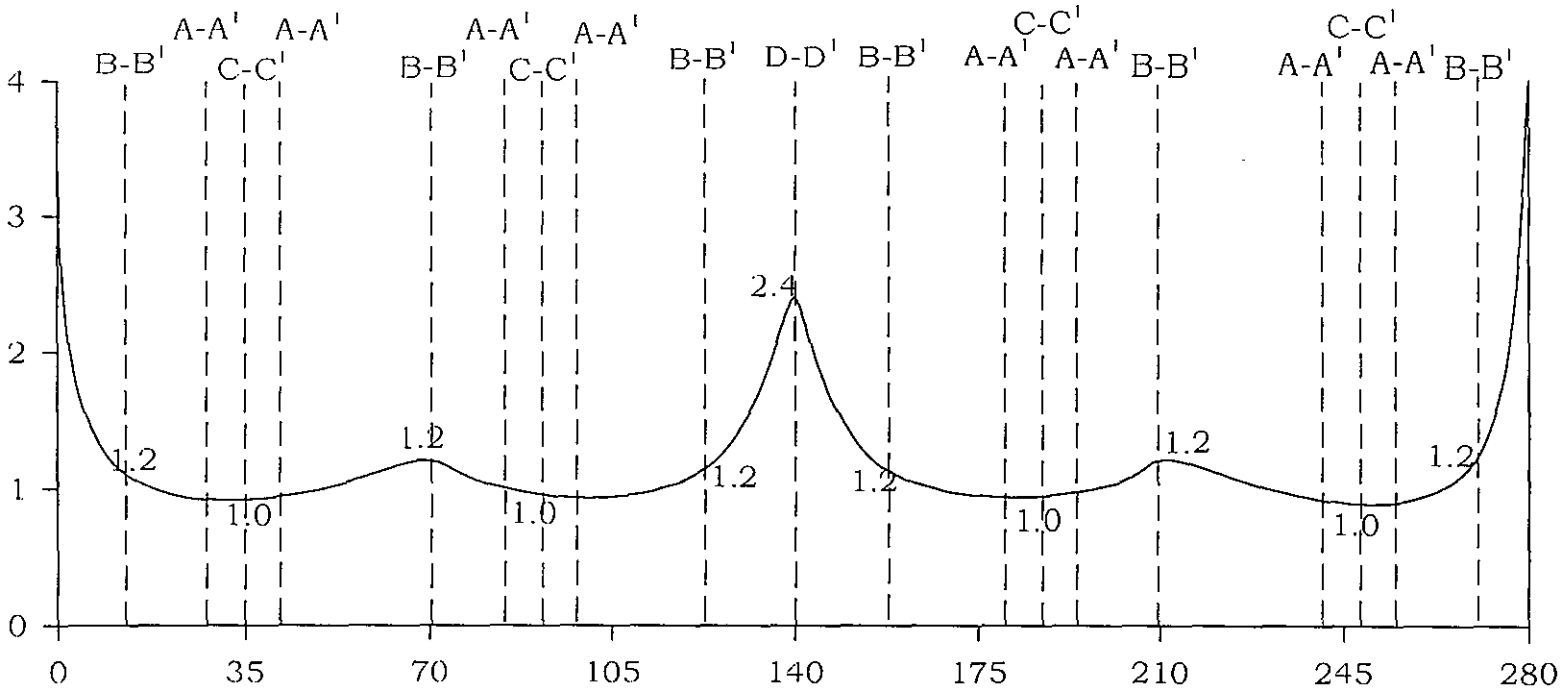
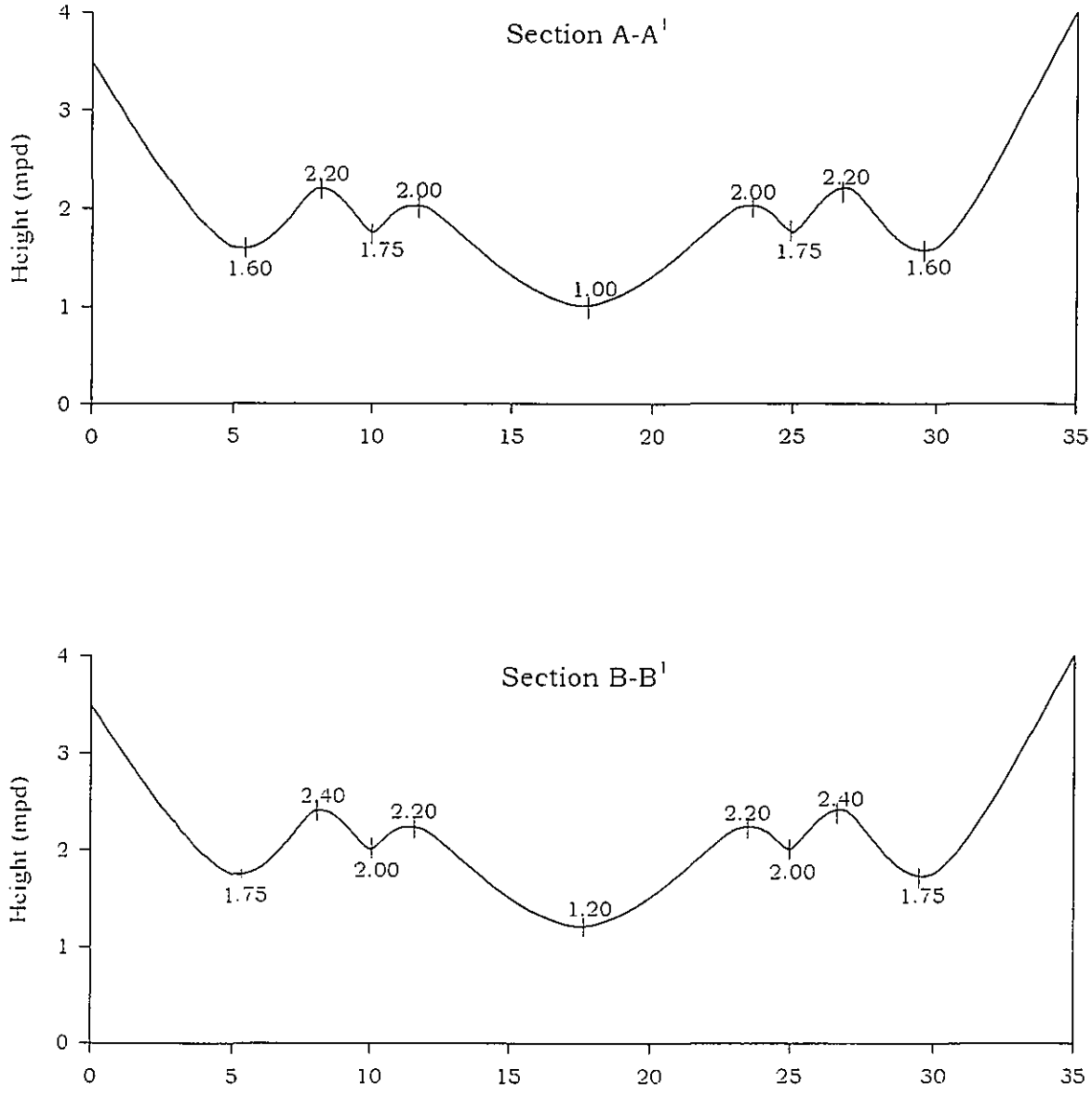


Figure A1.6 *Pond 12 Transverse Sections*



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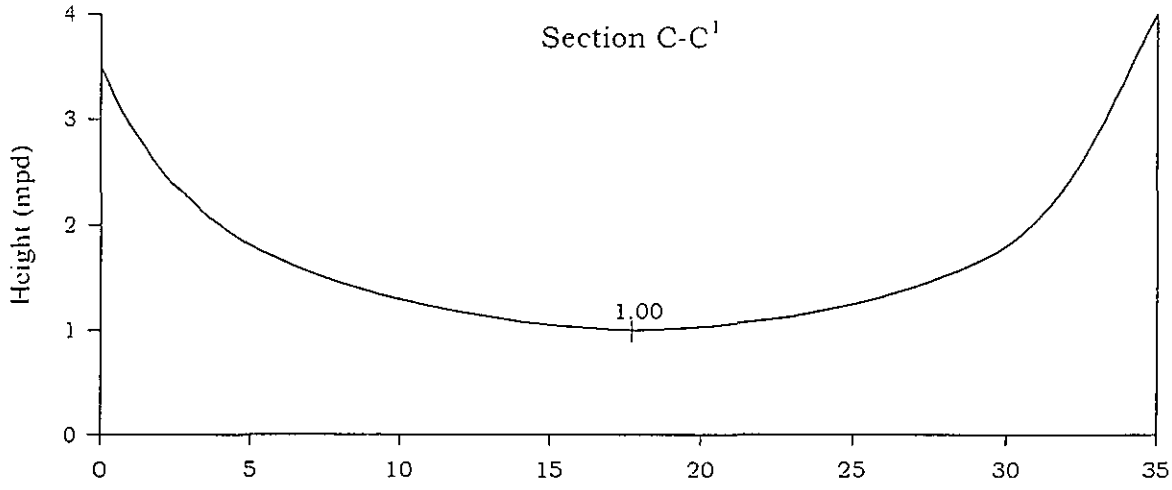

Section C-C'
Height (mpd)
4
3
2
1
0
1.00
0
5
10
15
20
25
30
35

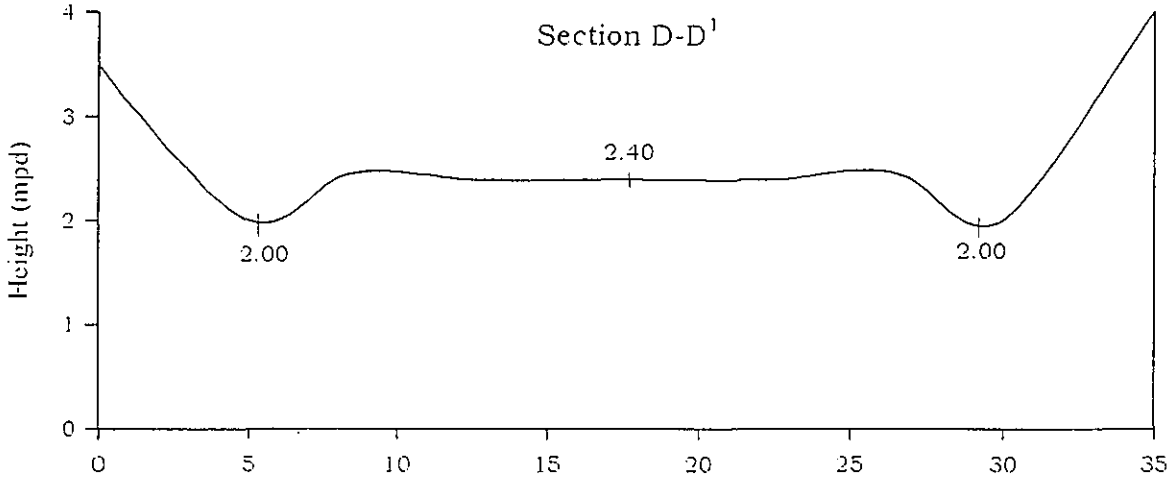

Section D-D'
Height (mpd)
4
3
2
1
0
2.40
2.00
2.00
0
5
10
15
20
25
30
35

Table A1.1 *Pond 5 Planting Schedule.*

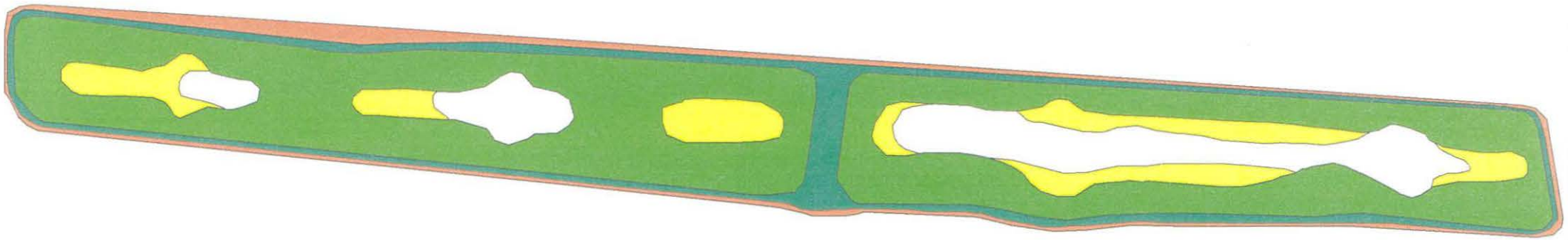
Mix/species	Size	Shoots	Density / sq m	% cover	Block size
Mix A					
Ludwigia adscendens	20	5	25	100	-
Mix B					
Polygonum barbatum	20	5	16	50	100
Polygonum glabrum	20	5	16	50	100
Mix C					
Cyperus malaccensis	40	5	16	50	50
Mix D					
*Paspalum distichum**	N.A.	N.A.	*	100	N.A

* Broadcast grass seed mix

Table A1.2 *Pond 12 Planting Schedule.*

Mix/species	Size	Shoots	Density / sq m	% cover	Block size
Mix A					
Cyperus malaccensis	40	3	16	10	100
Equisetum debile	20	5	16	10	50
Ludwigia adscendens	20	5	25	10	100
Polygonum barbatum	20	5	16	20	200
Polygonum glabrum	20	5	16	20	200
Polygonum hydropiper	20	5	16	20	200
Sagittaria trifolia	20	3	16	10	50
Mix B					
Blyxa japonica	20	5	25	10	50
Ludwigia adscendens	20	5	25	20	100
Polygonum barbatum	20	5	16	20	200
Polygonum glabrum	20	5	16	20	200
Polygonum hydropiper	20	5	16	10	200
Lindernia crustacea	**20**	**3**	**16**	**10**	**50**
Aponogeton natans	**20**	**3**	**16**	**10**	**50**
Mix C					
Bacopa monnieri	20	5	25	30	200
Commelina diffusa	20	3	16	30	100
Eleocharis plantagineiformis	20	5	16	20	100
Hygrophila salcifolia	10	5	25	10	50
Polygonum hydropiper	20	5	16	10	50
Mix D					
*Paspalum distichum**	N.A.	N.A.	*	100	N.A

* Broadcast grass seed mix



N

Key to planting mixes

- Mix A
- Mix B
- Mix C
- Mix D

Asia Ecological Consultants Ltd.

Scale 1:1,000	Figure A1.7 Pond 12 Planting Plan

Table A1.3 *Main Marsh Phase 1 Planting Schedule.*

Mix / species	Size	Shoots	Density / sq m	% cover	Block Size
1. Lightly vegetated with bare areas (permanently damp).					
Bacopa monnieri	20	5	25	10	50
Hygrophila salicifolia	10	5	25	10	50
2. Lightly vegetated with bare areas (seasonally wet).					
Bacopa monnieri	20	5	25	20	50
Cyperus iria	20	3	16	10	50
Fimbristylis ferruginea	20	5	25	10	50
Floscopa scandens	20	5	25	10	50
3. Well vegetated (permanently damp).					
Bacopa monnieri	20	5	25	10	100
Commelina diffusa	20	3	16	10	100
Chrysopogon aciculatus	20	5	16	10	50
Ludwigia octovalis	20	5	16	10	100
Alisma canaliculatum	20	5	25	20	100
Philydrum lanuginosum	40	3	16	10	100
Polygonum glabrum	20	5	16	20	100
Sagittaria trifolia	20	3	16	10	50
4. Well vegetated (seasonally wet).					
Cyperus malaccensis	40	3	16	20	100
Cyperus iria	40	3	16	10	50
Fimbristylis ferruginea	20	5	25	10	50
Ludwigia antipoda	20	5	25	5	50
Polygonum dichotomum	20	5	16	10	100
Polygonum hydropiper	20	5	16	20	100
Polygonum glabrum	20	5	16	20	200
Sagittaria trifolia	20	3	16	5	50
5. Tall marsh (largely wet but partially dry in mid-winter).					
Bacopa monnieri	20	5	25	5	50
Cyperus malaccensis	40	3	16	20	100
Eleocharis spiralis	20	5	16	10	100
Equisetum debile	20	5	16	10	50
Ludwigia adscendens	20	5	25	5	50
Polygonum glabrum	20	5	16	30	100
Floscopa scandens	20	5	16	10	100
Schoenoplectus mucronatus	40	3	16	10	100
6. Floating marsh					
Euryale ferox	n.a.	2	4	100	n.a.
Nymphaea sp.	n.a.	2	4	100	n.a.
Nelumbo nucifera	n.a.	2	4	100	n.a.
7. Reedbed.					
Phragmites spp.	n.a.	-	4	100	n.a.

Underground Pipe

Surface Ditch

Underground Pipe

Planting mixes

- 1
- 2
- 3
- 4
- 5
- Phragmites spp.
- Euryale ferox
- Nelumbo nucifera
- Nymphaea sp.
- Water
- Marsh Area Phase 2

Asia Ecological Consultants Ltd.

Scale 1:1,000	Figure A1.8 Main Marsh planting plan (Phase 1)

Appendix 2
Event and Action Plan for Ecological Issues

Appendix 2
Event and Action Plan for Ecological Issues
(Note: Action and Limit Levels will be reviewed after 12 months (end 2006))

Ecological attribute	Action Level	Limit Level	Action Plan / Contingency Plan (where appropriate)
Habitats in EEA			
Proportion of EEA consisting of wetland habitats	< 90% with surface water, hydric soils and vegetation dominated by obligate or facultative wetland plants	< 75% with surface water, hydric soils and vegetation dominated by obligate or facultative wetland plants	Adjust water management to increase wetland area / regrade to enlarge ponds area
Proportion of ponds under an active drain-down regime in Compartments A & B	< 70% of ponds under an active drain-down regime with conditions suitable for fish stocking	< 50% of ponds under an active drain-down regime with conditions suitable for fish stocking	Bring ponds into active management regime by manipulation of water levels and water quality and fish stocking
Proportion of shallow water in ponds in Compartments A & B	< 20% of the fishpond area (excluding bunds) consists of water < 50 cm depth	< 10% of the fishpond area (excluding bunds) consists consists of water < 50 cm depth	Lower water levels in short term / regrade bunds in long term
Vegetation cover in EEA			
Percentage of bunds with vegetation cover	< 20% of internal bunds with vegetation cover	< 10% of internal bunds with vegetation cover	Planting or hydro-seeding
	>30% of internal bunds with vegetation cover > 10 cm height	>50% of internal bunds with vegetation cover > 10 cm height	Cutting
Percentage of pond sides with vegetation cover in Compartments A & B	< 20% of pond sides with vegetation cover	< 10% of pond sides with vegetation cover	Planting or hydro-seeding
	> 40% of pond sides with vegetation cover	> 50% of pond sides with vegetation cover	Cutting or stocking with herbivorous fish
Percentage of ponds with vegetation cover in Compartments A & B	< 10% of pond area with vegetation cover	< 5% of pond area with vegetation cover	Planting or hydro-seeding
	> 20% of pond area with vegetation cover	> 30% of pond area with vegetation cover	Cutting or stocking with herbivorous fish
Percentage of undesirable / exotic plant species	> 10% of vegetation in ponds / on pond sides or on bunds	> 20% of vegetation in ponds / on pond sides or on bunds	Cutting or stocking with herbivorous fish
Plant community composition & structure in ECA			
Proportion of wetland plants in Compartment C	< 80% of vegetation facultative or obligate wetland plants	< 60% of vegetation facultative or obligate wetland plants	Amend vegetation management regime / Planting

Ecological attribute	Action Level	Limit Level	Action Plan / Contingency Plan (where appropriate)
Numbers of Target Bird Species in ECA			
Numbers of target bird species	Performance target for any species not met for any three consecutive months	Performance target for any species not met in any twelve month period	Review adaptive management regime / accelerate attraction measures e.g. stocking / drain-down
Abundance / diversity of invertebrate in ECA			
Species richness and diversity of aquatic invertebrates	Numbers or diversity < 75% sample in previous comparable season in any pond / marsh / reedbed area	Numbers or diversity < 50% sample in previous comparable season in any pond / marsh / reedbed area	Adjust water quality / vegetation cover / adjust drain-down regime
Species richness and diversity of benthic invertebrates	Numbers or diversity < 75% sample in previous comparable season in any pond / marsh / reedbed area	Numbers or diversity < 50% sample in previous comparable season in any pond / marsh / reedbed area	Adjust water quality / adjust drain-down regime
Fauna and flora of the ECA			
Species richness and diversity of dragonflies	Numbers or diversity < 75% of previous wet season	Numbers or diversity < 50% of previous wet season	Adjust water and vegetation management regime / use experience to adjust ECA design
Species richness and diversity of reptiles and amphibians	Numbers or diversity < 75% of previous wet season	Numbers or diversity < 50% of previous wet season	Adjust water and vegetation management regime / use experience to adjust ECA design
Hydrology in the EEA			
Per cent surface water	Surface water is present over <90% of the pond area except during programmed drain-down periods	Surface water is present over <75% of the pond area except during programmed drain-down periods	Pumping to redistribute water
Wet and dry season surface water level for Ponds	Water level in pond between 70 cm and 20 cm < lowest point on bund	Water level in pond between 40 cm and 10 cm < lowest point on bund	Pumping to redistribute water
Water Chemistry in the IEA			
Mean salinity	Salinity > 1 pp thousand	Salinity > 3 pp thousand	Water mixing / drain and refill; review causes of problem, prepare and implement contingency plan if problem persists

Ecological attribute	**Action Level**	**Limit Level**	**Action Plan / Contingency Plan (where appropriate)**
Mean pH	pH outside range 6.0 – 8.5	pH outside range 5.5 – 9.0	Lime/ add peanut residue / mix water / drain and lime
Mean dissolved oxygen	Dissolved oxygen < 1.0 mg/l	Dissolved oxygen < 0.5 mg/l	Amend fertilisation and stocking regime / pump & mix water / aeration
Mean ammonia concentration	< 0.1 mg/l	< 0.3 mg/l	Avoid fish stocking until restored, water mixing
Mean total oxidised nitrogen concentration	< 0.1 mg/l	< 0.3 mg/l	Avoid fish stocking until restored, water mixing, water changing
Mean total phosphorus concentration.	< 0.5 mg/l	< 1.0 mg/l	Avoid fish stocking until restored, water mixing, water changing
Mean orthophosphate concentration	< 0.01mg/l	< 0.03 mg/l	Avoid fish stocking until restored, water mixing, water changing