BINNIE BLACK & VEATCH

0136/EIA/1/Issue 2
Agreement No. CE 79/96-03
Yuen Long Bypass Floodway
Feasibility Study
assessment of Ecological Mitigation Measures
Final Report

Binnie

Binnie Black & Veatch Hong Kong Limited

A Black & Veatch Company

TERRITORY DEVELOPMENT DEPARTMENT

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Report Authorized For Issue By:

For and on Behalf of
Binnie Black & Veatch Hong Kong Limited

Binnie Black & Veatch Hong Kong Limited

CONTENTS

	Name	Signature	Date
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Reviewed	Nick Townsend		28.6.00

CONTENTS
(Cont'd)

FIGURES

1. INTRODUCTION

1.1 The Yuen Long Bypass Floodway (YLBF or "the Floodway") was planned to relieve the flooding which regularly occurs in the Yuen Long area during severe storms. The Floodway runs along the southern side of the Yuen Long Highway, beneath Castle Peak Road and Route 3 before joining the tidal portion of the Kam Tin Main Drainage Channel.

1.2 An EIA (BBV, 1998) was carried out on the optimized Floodway alignment that followed a tight curve east after the Floodway passed beneath Route 3. This routing minimized potential ecological impact on the fishponds in the area, thereby reducing the area of land required for compensation of lost habitat.

1.3 The ecological mitigation proposed in the EIA included areas of marshcrete to be incorporated into the channel design, thus extending the channel boundary to include two fishponds south of Route 3 and a stretch of fishponds between the channel and Route 3 to the north of the road. This ecological mitigation was shown to minimize residual impacts from the Floodway construction and operation, by providing sufficient area and quality of habitat within the vicinity of the channel. The EIA was endorsed by ACE on 28 September 1998 and approved by EPD on 17 October 1998.

1.4 However, the resumption of land for the proposed mitigation works involves the compulsory purchase of private lands which shall be the last resort to provide land for public project based on the principle of minimum land resumption. TDD decided to review the proposed mitigation measures for the Floodway to avoiding the costs and lengthy legal process associated with the compulsory purchase of private lands. The shifting of the ecological mitigation measures of the original scheme from private lots to near-by government lots that fringe the Floodway is considered.

1.5 The Study Area is shown on Figure 1.1. This Study aims to review the ecological mitigation measures proposed in the EIA, to recommend a new package of mitigation measures which will not require the resumption of private land other than that needed for the construction of the drainage channel, and to determine the extent of the changes required to achieve the following objectives:

(i) Ensure a Floodway arrangement that achieves the necessary flood control measures for Yuen Long area.
(ii) Review and identify the optimum alignment of the Floodway, taking into account the ecological impacts as well as hydraulic considerations.
(iii) Develop a mitigation strategy for ecological impacts that minimizes residual impacts resulting from the construction and operation of the floodway and will not require resumption of private land.
(iv) Exhaust all possible on-site mitigation options before off-site mitigation is considered.

(v) Where possible, keep mitigation areas contiguous with existing scheme.
(vi) Take full account of mitigation measures for other projects in the area
(vii) Ensure other potential environmental impacts resulting from alternative Floodway routes and associated ecological mitigation measures are minimized.

1.6 Following a description of the original ecological mitigation design proposed in the EIA and the requirements for compensating loss of area and function, a review of the philosophy behind the location of the box culvert below Route 3 and the route of the channel will be presented. The potential for alteration of the alignment within given hydraulic constraints will be reviewed to determine if alternative routes with less ecological impact are available. The resulting ecological envelope for the ecological surveys is defined as a result of the potential alternative alignments for study.

1.7 A description of the environmental conditions of the existing study area will include details of projects in the area, the associated mitigation measures and land ownership status. This will be supplemented by current ecological survey data that has been carried out in the last few weeks. The ecological value of all areas within the defined ecological envelope will be evaluated so that the value of habitat lost can be defined and an appropriate area and design of compensation area identified.

1.8 A conceptual design for the ecological mitigation area will be developed, describing construction and operation requirements, management responsibilities and overall residual impacts of the project. Residual impacts on the existing habitat will also be reviewed to demonstrate that there has been no overall change in the degree of environmental impacts compared with the original scheme presented in the EIA.

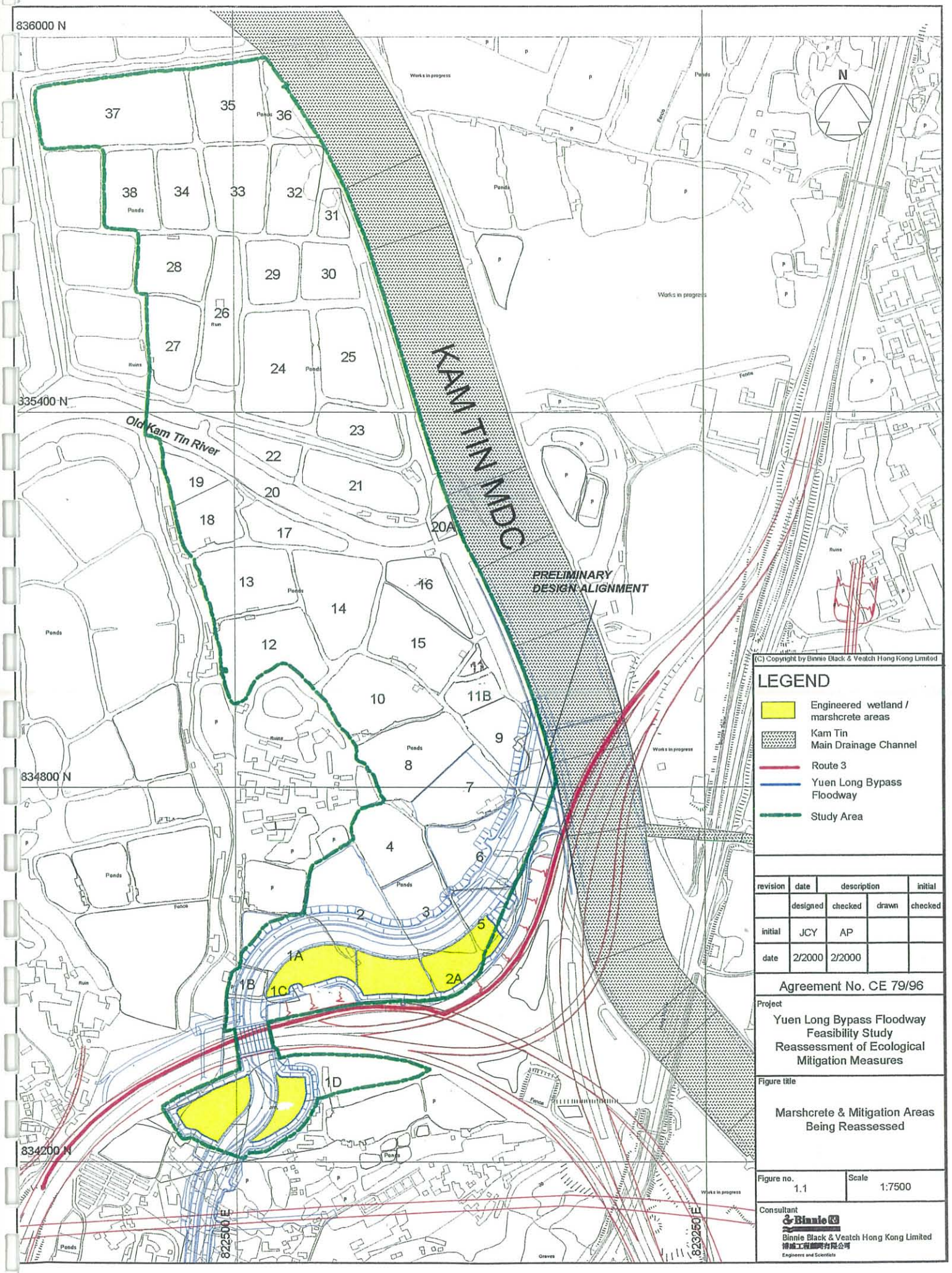
Proposed Mitigation Areas Requiring Reassessment

1.9 This reassessment applies only to the 3.0 ha of ecological mitigation measures (shown in Figure 1.1) located to the north of Castle Peak Road. That is:

i) the "marshcrete" mitigation area between ch 2 +800 and ch 2 +950 (i.e. south of the box culvert); and,

ii) the "marshcrete" mitigation area between ch 3 +050 and ch 3 +500 (i.e. north of the box culvert).

1.10 If the marshcrete areas cannot be incorporated into the design of the Floodway, other wetland areas have to be found in the vicinity of the Project which adequately reprovide the habitat and feeding ground lost under the original unmitigated Project. All other mitigation originally planned i.e. grasscrete lining and landscaping (atop the revetments), will prevail unchanged.



LEGEND

- Engineered wetland / marshcrete areas
- Kam Tin Main Drainage Channel
- Route 3
- Yuen Long Bypass Floodway
- Study Area

revision	date	description		initial
	designed	checked	drawn	checked
initial	JCY	AP		
date	2/2000	2/2000		

Agreement No. CE 79/96

Project

Yuen Long Bypass Floodway Feasibility Study Reassessment of Ecological Mitigation Measures

Figure title

Marshcrete & Mitigation Areas Being Reassessed

Figure no.	Scale
1.1	1:7500

Consultant

Binnie Black & Veatch Hong Kong Limited
博威工程顧問有限公司
Engineers and Scientists

2. BACKGROUND TO STUDY/REVIEW OF ORIGINAL EIA ECOLOGICAL MITIGATION

2.1 The major ecological impacts resulting from the implementation of the Floodway involved destruction of fishponds to the south and north of Route 3. The concept for ecological mitigation presented in the EIA was based on replacing the impacted habitat north of Route 3 (which comprised largely abandoned fishponds and ponds held inactive by virtue of an "easement" for Route 3 construction), with a more ecologically diverse, and therefore more valuable habitat, close to the area of habitat loss. The area of the proposed, more valuable compensatory habitat, could therefore be smaller than the area originally impacted.

Mitigation Measures Prescribed in the EIA (1998)

2.2 The main features of the compensation areas are described in the following (paras. 2.2.1 to 2.2.22) abbreviated extract from (paras. 5.5.6 to 5.6.4) of the EIA Report. (BBV, 1998)

Extracted Text

2.2.1 Close liaison between the engineers and the environmental team at an early stage, resulted in the YLBF alignment north of Route 3 (to its confluence with the KT MDC) being pulled in closer to the new highway (shown in Figure 2.1). This has two benefits:

(a) fragmentation of the active fishponds north of the floodway is avoided; and
(b) the works are moved further away from the *fung shui* knoll biodiversity locus and further into the most disturbed zone near Route 3.

2.2.2 On a habitat-by-habitat level it was proposed that the construction methods should as closely as possible reproduce the materials and environment that previously existed. As far as is practicable, it was a high priority to avoid creating a sterile concrete trapezoidal channel which would serve only to reinforce the fragmentary barrier unavoidably formed by the Yuen Long Highway and Route 3.

Minimisation

2.2.3 The alignment utilised the ponds used as fill storage areas (and other disturbed ponds) for the Route 3 project. The works therefore, were confined to an area already subjected to severe disturbance over a period of several seasonal cycles. Similarly, by aligning the Floodway contiguously with Route 3 (which will cause disturbance to the adjacent reinstated fishponds in the future), the YLBF Project by design utilised an ecologically blighted area.

2.2.4 Straightforward reinstatement of the fishponds within this blighted area would have resulted in a loss of habitat value over that pre-existing the Route 3 project.

2.2.5 The preliminary tree survey, showed that up to 400 trees would be lost as a result of this Project. The landscaping proposals included restoration of the tree numbers by replanting atop both revetments of the whole Project alignment and within the strip of land between the road/footpath edges and the site limit. By using selected tree species the intention was to enhance the ecological value of the Project environs.

Compensation

2.2.6 Habitat creation in the form of planting with grasscrete was considered to provide a post-project net engineering/ecological benefit. Monocultured planting along the whole alignment will be avoided.

2.2.7 The aim of the following mitigation was to:

(a) provide a "softer" engineering solution;
(b) which leads to a more natural landscape;
(c) which, in turn, provides a riparian habitat that becomes more naturalistic as it matures.

Mitigation Measures

Grasscrete

2.2.8 The preferred channel lining medium was grasscrete, which could be installed on both the sides and the channel base for most of the alignment. Grasscrete has several benefits: it allows percolation of rainfall through to the groundwater; it enables growth of a variety of grasses, sedges and reeds through the open spaces; which, in turn provides a habitat for invertebrates (insects) and higher fauna such as birds (Traditionally, grasscrete has used a standard commercial hydroseeding mix intended to secure soil rather than benefit wildlife).

2.2.9 Table 2.1 summarizes a list of grasses and sedges to be used for the Floodway which have a variety of benefits including rhizomous root systems (which helps to prevent erosion), shade tolerance, affinity for damp conditions and saline tolerance (which may be useful at the downstream end of the YLBF). The use of grasscrete in the YLBF was adopted from chainage 1.34 km to 3.545 km. At this Preliminary Design Stage the incorporation of trees along the revetments was restricted to the confining embankment crown due to common concerns.

Table 2.1
Preferred habitat and possible benefits of selected grasses and sedges

Plant species	Habitat and benefits
Gramineae	Grasses
Alpuda mutica	Woodland edge perennial; good fodder
Eremochloa ciliaris	Sandy rocky areas; good fodder
Ischaemum rugosum (Salisb.) var. segetum	Damp places including stream banks; good fodder
Saccharum spontaneum	Vigorous coloniser of bare ground; extensive root system
Arundinella setosa	Woodland edge perennial
Cyrtococcum patens	Woodland edge; good fodder
Digitaria longiflora	Open land; good fodder
Digitaria radicosa	Open fields and shady places; good fodder
Echinochloa crus-galli	Swampy ground; good fodder
Hymenachne amplexicaulis	Marshy ground and ponds; useful fodder
Isachne globosa	Woodland and damp ground
Oplismenus compositus	Shady areas under trees; excellent fodder
Ottochloa malabarica	Woodland edge perennial; good fodder
Panicum repens	Rhizomous perennial; good fodder
Paspalum conjugatum	Creeping grass with long stolons
Paspalum distichum	Wet places, long creeping stolons, extensive rhizomes; good fodder
Paspalum longifolium	Marshy and dry ground
Sacciolepis indica	Drained land; good fodder
Setaria italica	Used as food for caged birds
Leersia hexandra	Perennial of damp ground/standing water
Eragrostis atrovirens	Open pastures; **much sought after by birds**
Leptochloa chinensis	Paddy fields; good fodder
Zoyzia matrella	Sand near the sea, well developed rhizomes
Cynodon dactylon	Perennial forming dense sward, **used to bind soil**
Phragmites communis	Marshy ground; habitat for marsh birds
Phragmites karka	Marshy ground; habitat for marsh birds
Phyllostachys nidularia	Aggressive rhizome system; planted to stabilise slopes
Cyperaceae	Sedges
Carex cruciata	Woodland edge perennial, stout rhizome
Cyperus difformis	Annual found in paddy fields or watersides
Cyperus malaccensis Lam. var.brevifolium	Perennial at riversides and damp swampy soils, long woody rhizome
Cyperus polystachyos	Perennial of seashores or sandy soils
Cyperus radiatus (C. imbricatus Retz)	Perennial of paddy fields or damp areas
Cyperus rotundus	Perennial of hillsides and near water, creeping rhizomes
Eleocharis acicularis	Paddy fields, ponds and wet soil
Fuirena umbellata	Woods, and damp and swampy ground
Kyllinga monocephala	Perennial of grassland, well developed rhizome
Scirpus erectus	Swampy land or near paddy fields

Source: Griffiths, D.A. (1983) *Grasses & Sedges of Hong Kong*. Urban Council - Hong Kong

Marshcrete

2.2.10 In two areas (the fishpond south of the Route 3 box culvert, and the fishponds north of Route 3 - see Figures 2.2 and 2.3) it was proposed that "marshcrete" (inundated or irrigated grasscrete) be used to provide an off-line wetland area.

2.2.11 The marshcrete was to be watered mainly by recirculation of a proportion of the pumped flows from the low flow pumping station, and also from local run-off. These nutrient-rich low flows will be used to fertilize the aquatic marsh plants in the wetland areas.

2.2.12 A range of freshwater plants (including grasses, reeds, sedges and some small herbs) are widespread in the SAR which are: native species; pollution and saline tolerant; spread via rhizomes (and hence can be trimmed without any detriment to the plant); non-invasive; usually fairly short; and can assist in the clean up of enriched waters. The off-line marshcrete areas were not part of hydraulic conveyance of flood flows and thus even abundant growth will not obstruct the flow. It was therefore envisaged that the marshcrete areas will require minimum maintenance and should be allowed to mature.

2.2.13 Species chosen to protect the marshcrete areas would have to be able to withstand submergence to different degrees depending on their position with respect to the water level[i]. The seasonally flooded off-line areas could have been protected with fast growing reeds, sedges and grass to add to the strength of the bank through reinforcement of the soil by the roots. A range of suitable plants is given in Table 2.2.

[i] Morgan, R.P.C. & Rickson, R.J. (1995) Water Erosion Control. In: Morgan, R.P.C. & Rickson, R.J. (eds.) *Slope Stabilization and Erosion Control: A Bioengineering Approach* E&FN Spon, London

Table 2.2
Aquatic Flora Beneficial to Fauna

Plant Species	Ecological and other Benefits
Acorus gramineus *#	Rhizomous, so binds substrate; eaten by herbivores
Alocasia odora ***#	Tuberous root stock - thrives next to eutrophic streams
Alopecurus aequalis **#	Soil binder, confers stability on wet muddy ground
Bacopa monniera *#	Survives prolonged inundation; eaten by ducks
Callitriche stagnalis **#	Water birds feed on stems; enriches oxygen to water
Carex spp. *#	Rhizomous; marsh birds eat nutlets
Chara spp. +	Fish spawning ground; eaten by water birds
Colocasia esculenta *#	Rhizomous
Cyperus spp. *#	Rhizomous; food for aquatic birds
Eleocharis spp. *#	Rhizomous; food for aquatic birds
Equisetum debile *#	Food for birds and herbivorous animals
Eriocaulon spp. *#	Leaves eaten by ducks
Fimbristylis spp. #	Nutlets eaten by water birds
Fuirena umbellata #	Nutlets eaten by birds
Juncus spp. #	Rhizomous; seeds eaten by birds, shoots by herbivores, submerged parts shelter fish spawning
Leersia hexandra #	Ducks eat young succulent parts
Nasturtium officinale #	Food for ducks and small aquatic animals
Nelumbo nucifera *#	Rhizomous; shelters amphibians and fish
Nymphaea spp. *#	Rhizomous
Panicum repens #	
Papsalum distichum #	
Phragmites communis #	Feeding ground for marsh birds
Polygonum hydropiper #	Food for aquatic birds and herbivores
Ranunculus scleratus # *,**	Food for aquatic birds and herbivores; also feeding ground for fish
Rhynchospora spp. #	Nutlets eaten by birds
Rumex maritimus #	Nutlets eaten by wild fowl
Sagittaria sagittifolia #	Rhizomous; eaten by herbivores
Salvinia natans *	Eaten by ducks
Scirpus erectus #*	Rhizomous; nesting for birds; food for herbivores
Vallisneria spiralis #	Food and shelter for fish and aquatic animals

*** Fast flowing water
** Slow flowing water
* Stagnant water
+ Deep water
# Shallow water/water margins

2.2.14 In the wetland area between the outer revetment of the YLBF meander and Route 3 embankment (Figures 2.2 and 2.3), the swathe closest to Route 3 would have been planted with riparian trees tolerant of seasonal flooding. This would provide both a noise and visual buffer between the engineered wetland and the highway.

Tree Planting

2.2.15 A list of Hong Kong plants has been identified which are attractive to birds[ii] and other fauna, these are listed in Table 2.3. Floral species were to be selected from this list for planting atop the grasscrete embankment of the YLBF and along the Route 3 bund.

2.2.16 According to the CES report (1995), all the heron nests in the northern area of Route 3 (in the area around north Au Tau) were constructed in stands of bamboo. Several bamboo species were recommended for revegetation of drainage channels and pond edges, including: *Bambusa chungii, Bambusa sinospinosa, Bambusa texilis* and *Dendrocalamus latiflorus*. Other riparian tree species recommended were *Cleistocalyx operculata, Syzigium jambos, Sterculia lanceolata* and *Sapium sebiferum*.

[ii] Corlett, R.T. (1993) Plants attractive to frugivorous birds in Hong Kong. *HK Nat. Hist. Soc.*, 19:115-116

Table 2.3
Flora beneficial to fauna

Plant Species	
Trees	Small trees
*Bischofia trifoliata**	*Bridelia tomentosa***
Camellia hongkongensis+	*Homalium cochinchinensis+*
*Celtis sinensis***	*Lithocarpus corneus+*
*Cinnamomum camphora***	*Mallotus paniculata***
Cleistocalyx operculata+	*Rhus chinensis***
*Diospyros morrisiana***	Shrubs
*Evodia meliaefolia**	*Litsea rotundifolia***
Ficus microcarpa+	*Rhaphiolepis indica***
*Ficus superba***	*Rhodomyrtus tomentosa***
Glyptostrobus pensilis+	Bamboo
*Ilex rotunda**	*Bambusa chungii++*
*Litchi chinensis+**	*Bambusa sinospinosa ++*
*Macaranga tanarius***	*Bambusa texilis++*
*Machilus breviflora***	*Dendrocalamus latiflorus++*
Salix babylonica+	
*Sapium discolor***	
*Sapium sebiferum***	
*Schefflera octophylla***	
Sterculia lanceolata+	
*Syzigium jambos+**	

* Attractive to frugivorous birds, (Thrower, S.L. 1988. *Hong Kong Trees - Omnibus Volume.* Urban Council.)
\+ Riparian plant, (Thrower, S.L. 1988. *Hong Kong Trees - Omnibus Volume.* Urban Council.)
** Attractive to frugivorous birds, (Corlett, R.T. 1993)
++ Ardeid nesting bamboos, (CES. 1995)

Funding, Implementation Management and Maintenance of Ecological Mitigation Measures

2.2.17 The ecological mitigation measures proposed for this project included the following:

(a) use of grasscrete for lining the sides and base of the floodway (dry grasscrete) excluding the dry weather flow channel and a 5 m wide maintenance track along the channel base;

(b) creation of marshland type habitat off-line through the use of submerged grasscrete (marshcrete) with planting of marsh tolerant grasses and other low to medium height vegetation; and

(c) soft landscaping along the banks of the channel to encourage diversity of fauna and flora.

2.2.18 Maintenance work for the grasscrete within the main channel section by DSD will involve grass cutting and sediment removal. Very little if any maintenance would be required for the off-line wetland areas, which at most would involve periodic sediment removal and occasional grass cutting. It was envisaged that this area should be left to mature and should be inspected annually by an ecologist to monitor the ecological progress of the areas and identify any maintenance required. RSD would have been responsible for the maintenance of all soft landscaping works at the top of the channels.

Residual Impacts

2.2.19 The residual impacts are quantified and valued in Table 2.4.

Table 2.4
The Predicted Residual Value
of the Project's Mitigation Measures

Habitat	Area (ha) unless stated	Value
Existing (affected)		
Village	3.0	Low
Abandoned agriculture	4.0	Low-medium
Stream/riparian	0.1	Low
Lotus ponds	1.0	Medium
Route 3 disturbed fishponds	9.0 [1]	Low-Medium
(Trees across all habitats)	(400 trees)	
Replacement		
Grasscrete	6.8	Medium
"Re-circulated" Marshcrete	3.0	Medium-high
Trees	2500 trees	Medium

[1] Includes area to be used for offline marshcrete

2.2.20 Of the existing habitats, village and stream/riparian are of a low ecological value and thus do not require any mitigation. The fishponds were re-watered at the end of 1998 which (regardless of whether they are actively farmed) will increase the ecological value of this habitat over a period of time. The lotus ponds although small in area, are of medium ecological value. The total habitat area requiring mitigation is 14 ha.

2.2.21 The proposed mitigation measures included grasscrete (which if mixed grasses and sedges are used, would be of medium value, i.e. greater than that of abandoned agricultural land because of the improved linkage), and marshcrete (which would exceed the value of the fish pond habitat because of greater diversity, and the increase in habitat size). The planting of 2,500 trees would be in part mitigation for the loss of 400 trees as a result of the Project, and part landscaping enhancement. The tree planting would also provide linkage between the various habitats both created as part of the Project and existing outside the Project. The grasscrete and marshcrete total habitat area resulting from this Project would have been 9.8ha of medium and medium-high value ecological habitat. This contrasts with the loss (resulting from the Project) of 14 ha of largely low-medium value habitat. Whilst it would appear that there was an overall loss of 4.2 ha of low-medium value habitat, it was considered that the increased value of the created habitat (in conjunction with the landscaping trees and improved ecological linkage), at least balanced/compensated for the value of the Site's original habitats. Thus with the implementation of the proposed mitigation measures it was considered that the residual impact of the project was negligible.

2.2.22 The mitigation measures including re-alignment, grasscreting, marshcreting and tree planting would not only result in negligible ecological impacts but have led to a general habitat enhancement along the whole 3.8 km corridor.

Revision of Mitigation Measures

2.3 As described earlier, the resumption of private land for the proposed mitigation works shall only be the last resort when government land is exhausted. It necessitates alternative sites for ecological mitigation to be identified. A review of possible changes in the channel alignment is also required to ensure the alignment selected is optimum in terms of meeting the hydraulic constraints while minimizing ecological impacts.

2.4 Any changes in the alignment and ecological mitigation measures must be addressed in accordance with the requirements of the EIA Ordinance, which states, in Section 13 (5) that:

2.5 "*The Director may amend the environmental permit* (which is issued upon completion and approval of the EIA*) without calling for an environmental impact assessment report if the applicant satisfies him that:-*

(a) *there is no material change to the environmental impact of the project with the mitigation measures in place; and*
(b) *the project complies with the requirements described in the technical memorandum.*"

2.6 In the EIA Ordinance, "material change" is defined as:

"*a physical addition or alteration to a designated project which results in an adverse environmental impact as defined in the technical memorandum.*"

2.7 In the case of the YLBF, the proposed alternative ecological mitigation area and design, to be developed in the current study, must provide, at least, an equivalent degree of ecological compensation to that proposed in the EIA. In addition, any proposed change in the Floodway alignment (if this is shown to be necessary) must ensure that there are no adverse effects on the environment after mitigation measures are put in place. Fulfillment of these requirements will ensure that the proposed change will not cause "*an adverse environmental impact*" and will therefore not be classified as a material change.

Original Habitats Requiring Reprovisioning in the EIA

2.8 The total area to be mitigated was calculated (BBV, 1998) to be 14ha, comprising:

(i) 1.0 ha of lotus ponds;

(ii) 9.0 ha of disturbed fishponds; and

(iii) 4.0 ha of agricultural land.

Requirements for Mitigation under this Reassessment

2.9 With the unavailability of the fishpond area originally proposed to be developed as marshcrete under the original EIA (see Table 2.5, below), the area to be mitigated for is now the physical area occupied by the Floodway channel alone including the additional confining bund. This amounts to approximately 7.0 ha of fishponds. An additional feature under the EIA was that the marshcrete would provide a water clean-up function through infiltration and pollutant absorption. This function should be included in any proposed changes in the mitigation area.

Table 2.5 Change of function of affected ponds without EIA mitigation

Pond	Function with EIA mitigation	Function without EIA mitigation
1A	The northwest corner of the pond would be outside the floodway revetment. The remainder of the pond would be split between floodway and marshcrete.	The northwest and southeast corners of the pond would be outside the floodway revetment.
1B	Almost entirely taken up by the floodway.	Almost entirely taken up by the floodway.
1C	Mostly occupied by marshcrete	Almost entirely occupied by revetment
2	The northern part of the pond would be outside the floodway revetment. The remainder of the pond would be split between floodway and marshcrete.	The northern and southern parts of the pond would be outside the floodway revetment.
2A	Entirely occupied by marshcrete. CLP pylon.	The southern part of the pond would be outside the floodway revetment. CLP pylon.
3	The northern part of the pond would be outside the floodway revetment. The remainder of the pond would be split between floodway and marshcrete.	The northern part of the pond would be outside the floodway revetment.
5	Almost entirely taken up by the floodway – with small area of marshcrete.	Almost entirely taken up by the floodway.
6	Almost entirely taken up by the floodway. The northwest corner of the pond would be outside the floodway revetment	Unchanged.
9	Southeast corner occupied by floodway revetment. CLP pylon	Unchanged.

2.10 Restoration of Ponds 1A and 2 was undertaken as a part of the EIA for the Route 3 construction to the satisfaction of their owner. Unfortunately, this restoration was not required by the owner to extend to restoring their function (as fishponds) or ecological value. Technically, therefore, the baseline for assessment of impacts on these ponds must be based on their assumed restoration. Pond No. 6 was fully restored to its operating depth much earlier under Route 3 and the assessment of impacts on Pond 6 for this Study is based on its existing ecological valve.

2.11 The purpose of this Study is to find an area contiguous with the alignment of the YLBF for the relocation of the wetland mitigation. This area should at least be of an equivalent ecological value to either the original habitat, or the originally proposed mitigation and provide all the functions of the originally proposed mitigation habitat. Since the area to the north of Route 3 is predominantly fishponds, it should be possible (land ownership permitting) to achieve this requirement relatively easily.

ORIGINAL REVIEW REPORT ALIGNMENT

REVISED PRELIMINARY DESIGN ALIGNMENT

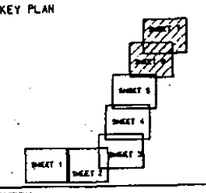
NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.
2. ALL LEVELS ARE IN METERS ABOVE PRINCIPAL DATUM (mPD).
3. GRID LINES ARE HONG KONG METRIC GRID 1980.

LEGEND:

- PROPOSED SITE LIMIT
- DIRECTION OF FLOW
- BOX CULVERT
- PROPOSED SLOPE
- EXISTING SLOPE
- AREA TO BE FILLED TO ADJACENT GROUND LEVEL
- ENGINEERED WETLAND/MARSHCRETE AREA
- LIMIT OF RIGHT OF TEMPORARY OCCUPATION
- PROPOSED LEVEL
- EXISTING LEVEL (OBTAINED FROM SITE VISIT)
- VC VEHICULAR CROSSING
- PC PEDESTRIAN CROSSING
- R.L. TOP OF ROAD LEVEL
- P.L. TOP OF FOOTPATH LEVEL
- OTHER PROJECTS UNDER PRESENT/FUTURE CONSTRUCTION

KEY PLAN



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THIS MAY BE A REDUCED SIZE DRAWING. VERIFY SCALES SHOWN BEFORE SCALING THE DRAWING.

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initial	AJT	CWC	YLL	CWC	
date	01/98	01/98	01/98	01/98	

AGREEMENT NO. CE 79/96

project

YUEN LONG BYPASS FLOODWAY FEASIBILITY STUDY

EIA STUDY REPORT

Figure title

ENVIRONMENTAL MITIGATION MEASURES

REVISED CHANNEL ALIGNMENT

Figure no. 2.1

Scale 1:3000

新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE
拓展署
Territory Development Department, Hong Kong

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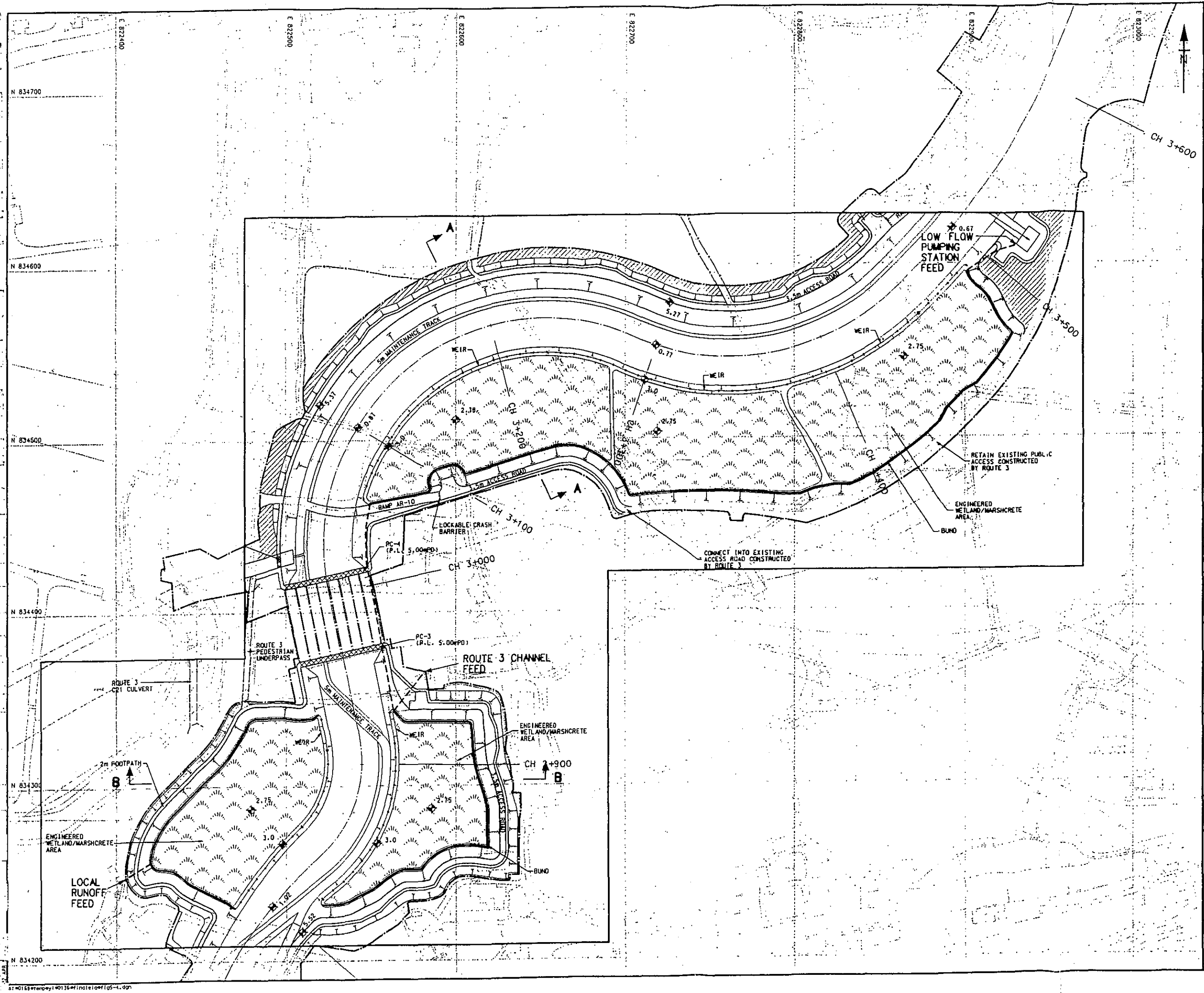

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4. DRAWING MODIFIED FROM ORIGINAL PRELIMINARY LAYOUT FIGURE 4.7.

LEGEND:

- PROPOSED SITE LIMIT
- DIRECTION OF FLOW
- WETLAND AREA
- BOX CULVERT
- PROPOSED SLOPE
- EXISTING SLOPE
- AREA TO BE FILLED TO ADJACENT GROUND LEVEL
- LIMIT OF RIGHT OF TEMPORARY OCCUPATION
- PROPOSED LEVEL
- EXISTING LEVEL (OBTAINED FROM SITE VISIT)
- VC VEHICULAR CROSSING
- PC PEDESTRIAN CROSSING
- R.L. TOP OF ROAD LEVEL
- P.L. TOP OF FOOTPATH LEVEL
- OTHER PROJECTS UNDER PRESENT/FUTURE CONSTRUCTION
- PIPE
- U-CHANNEL
- 0.5m HIGH WALL

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project

YUEN LONG BYPASS FLOODWAY FEASIBILITY STUDY

EIA STUDY REPORT

Figure title

ENVIRONMENTAL MITIGATION MEASURES

OFF-LINE WETLAND AREA PLAN

Figure no. 2.2

Scale 1:1000

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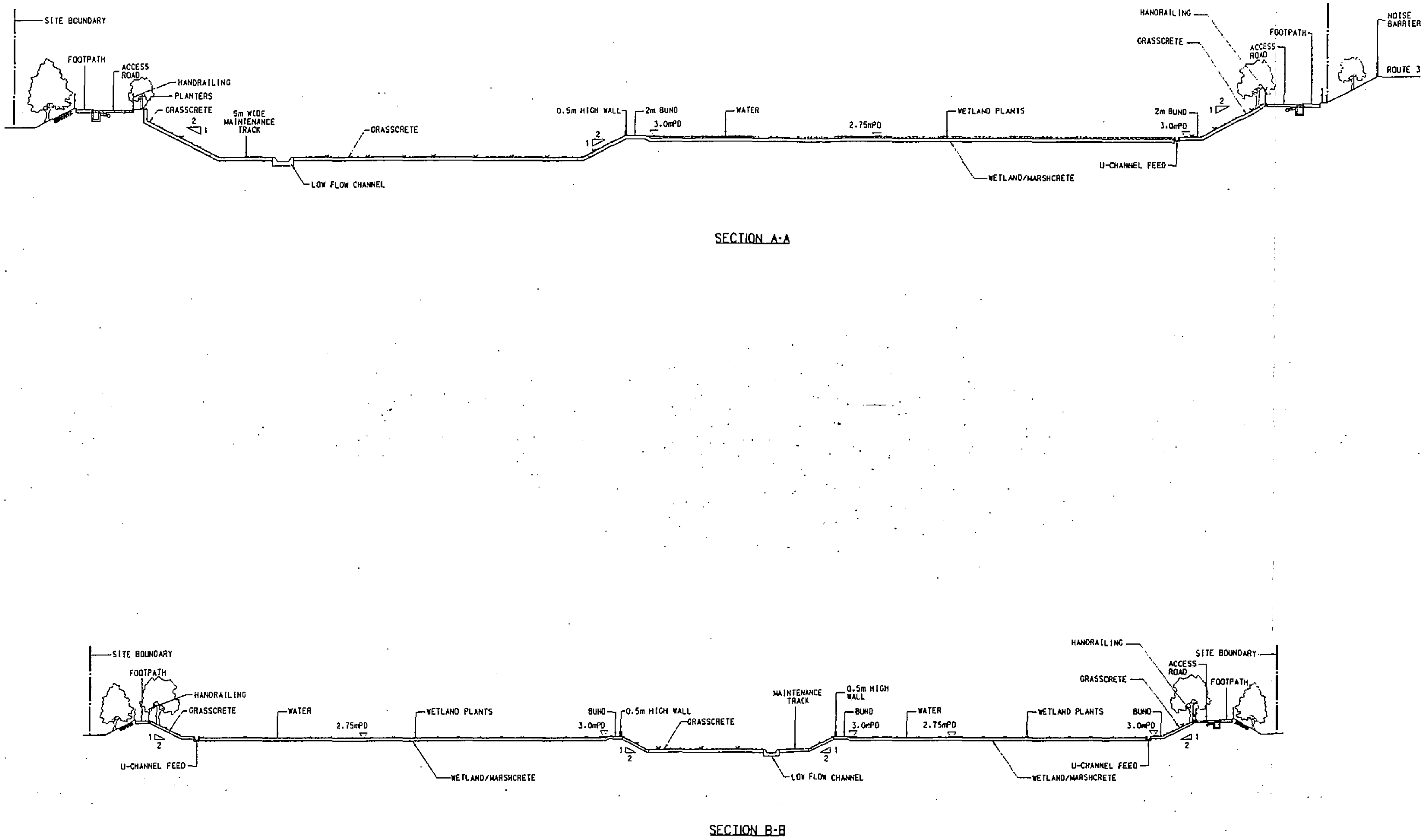

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YUEN LONG BYPASS FLOODWAY FEASIBILITY STUDY

EIA STUDY REPORT

figure title

ENVIRONMENTAL MITIGATION MEASURES

OFF-LINE WETLAND AREA DETAILS

figure no.	scale
2.3	N.T.S.

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3. REVIEW OF EXISTING ALIGNMENT

3.1 Development of Existing Alignment

Draft Review Report

3.1.1 Four alignment options of the Floodway have been considered and discussed briefly in the Draft Review Report issued in November 1997. The four alignment options were compared on planning, technical, environmental and land requirement considerations. Ultimately, Option 3 was chosen as the preferred alignment. The details of the options are as follows:

Option 1

i) Option 1 is shown on Figure 3.1. This alignment takes the Floodway along the northern edge of the Yuen Long Highway (YLH) collecting all flows from the box culverts passing underneath the highway. It then crosses Castle Peak Road to the west of the Pok Oi Interchange and runs along the northern edge of Route 3, until it connects with the Kam Tin MDC. The alignment encroaches into newly planned development areas to the south and to the north of the Castle Peak Road. It would obstruct the potential development. The height of the crossing point under Castle Peak Road is restricted due to the low level of the existing road which would increase hydraulic headloss. The flows passing through box culverts under the YLH would require tight transition curves in order to convey the flows into Floodway. This would also increase hydraulic headloss and is unsatisfactory in term of hydraulic performance.

Option 2

ii) Option 2 is shown on Figure 3.2. This alignment takes the Floodway along the northern edge of the YLH, again collecting all flow from the box culverts passing under the highway. It then crosses underneath the YLH and crosses Castle Peak Road to the east of Pok Oi Hospital. It then continues in a northerly direction until it passes under Route 3 and then follows the northern edge of the Route 3 until it connects into Kam Tin MDC. Similar to the Option 1, the alignment would obstruct the potential development to the south of Castle Peak Road. Moreover, it would necessitate an additional crossing point under the YLH which would increase the construction cost and cause impact to the existing YLH traffic during the construction of the Floodway.

Option 3

iii) Option 3 is shown on Figure 3.3. This alignment runs the Floodway along the southern edge of the YLH collecting flows before they pass into the box culverts of the highway. It then crosses Castle Peak Road to the east of Pok Oi Hospital and continues in a northerly direction until it crosses Route 3. The Floodway then follows the northern edge of the Route 3 until it connects into Kam Tin MDC.

Option 4

iv) Option 4 is shown on Figure 3.4. This alignment runs the Floodway to the far south of the YLH and then crosses Castle Peak Road to the east of Pok Oi Hospital and continues in a northerly direction until it crosses Route 3. The Floodway then follows the northern edge of the Route 3 until it connects into Kam Tin MDC. More land resumption is required due to increased length of the Floodway and loss of beneficial use to be made of land already resumed under the YLH. Furthermore, the alignment would form another barrier or constraint on future development plans.

EIA Study

3.1.2 During the preparation of the EIA Study of the Floodway in June 1998, north of the Route 3, the preferred Option 3 is further revised in order to reduce the impacts to the natural environment, as shown on Figure 3.5.

3.2 Review of Existing Alignment

Alignment to the north of Route 3

3.2.1 The currently proposed alignment of the Floodway to the north of Route 3 was chosen to minimize the area of sterilized land between Route 3 and the Floodway. This alignment also satisfies the hydraulic requirements and is the same width as one described as Option 3 in the Draft Review Report issued in November 1997. Figure 3.6 shows the proposed arrangement of the Floodway without the proposed engineered wetland as shown in the original EIA report. The southern boundary of the Floodway is limited by the existing CLP pylon and hence there is no scope to move the alignment further south without affecting this pylon.

3.2.2 Additionally, the curvature chosen for the section of the Floodway between the pylon and the box culvert under Route 3 is already very tight, taking into account the velocity of flow in the Floodway during peak flow. The curvature of the Floodway immediately before discharging into the Kam Tin MDC is designed to ensure the Floodway merges with the MDC at a shallow angle to minimize any turbulence and hydraulic losses to the flow in the MDC.

3.2.3 As a result, taking into account the various constraints and hydraulic consideration of the Floodway, the currently proposed alignment for the section of the Floodway to the north of Route 3 is considered to be the optimum alignment. Locating this section of Floodway closer to Route 3 would require relocating the existing pylon, or adversely affect the hydraulics of the Floodway or of the receiving MDC.

3.2.4 The alternative arrangement considered in the original Engineering Review Report of routing the Floodway further north as shown on Figure 3.7 would run much closer to the *fung shui* knoll and have much more significant impact to the natural environment and the *fung shui* associated with this small hill. (The issue of the ecological value of various areas will be discussed in further detail in subsequent sections). In view of the much more significant impact to the natural environment of this alternative alignment of the Floodway into the MDC, this alignment is not preferred.

Alignment to the south of Route 3

3.2.5 The currently proposed alignment of the Floodway to the south of Route 3 was chosen to minimise land resumption and encroachment into existing village properties. The alignment is kept as close as possible to the existing toe of the YLH with sufficient room to be allowed for widening of YLH in future.

3.2.6 Moreover, the alignment will form part of the buffer which may be necessary for noise mitigation between YLH and any future development to the south of the highway.

3.2.7 The alternative alignment is to run along the northern edge of the YLH which would restrict potential development of the planned development areas 12, 13 and 14 located to the north of the YLH. Moreover, tight transition curves of drainage channel/box culvert are required to convey all flows from the box culverts passing underneath the YLH to the Floodway, they would induce high headlosses and thus higher banks of Floodway are required.

3.2.8 Another alternative arrangement of routing the alignment further south of the YLH will result in a longer route in order to tie to the proposed crossing under Castle Peak Road. It will involve more land assumption and no use made of land already resumed under the YLH. Moreover, it would form another barrier or constraint in future development plan to the south of YLH.

3.2.9 As a result, taking into accounts the various constraints and hydraulic consideration of the Floodway, the currently proposed alignment for the section of the Floodway to the south of Route 3 is considered to be the optimum alignment.

Location of the Crossing under Route 3

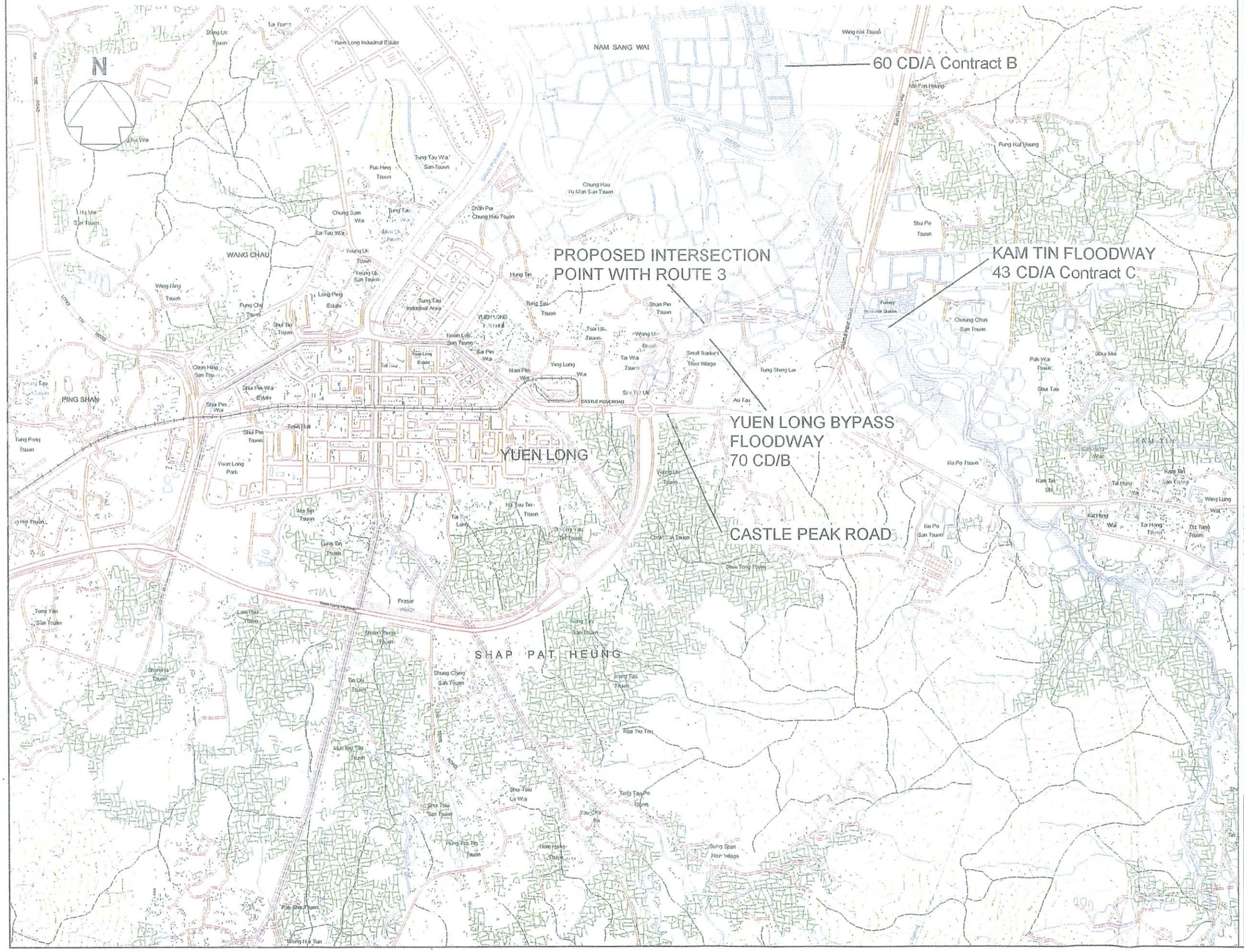
3.2.10 The location of the crossing is governed by the constraints imposed by the existing site conditions and the arrangement of Route 3 itself.

(i) As shown on Figure 3.8 a row of buildings are built along the northern side of Castle Peak Road except a narrow strip of land (to the east of the existing Pok Oi Hospital and to the west of San Kong Hotel) where no buildings are located on it. This location of the crossing is the only place where the Floodway can cross the existing Castle Peak Road without the need to resume any private buildings. The area to the west of Pok Oi Hospital is occupied by the Small Traders New Village and the nearby YLH roundabout. This limits the option of locating the box culvert between the Pok Oi Hospital and the Route 3 viaducts. To the east of the currently proposed crossing location, Route 3 branches out into an interchange with the New Territories Circular Road. Hence locating the crossing further to the east will result in more crossings under existing roads. The foundations of the viaducts prevented the routing of the Floodway to the east of the current position.

(ii) The vertical alignment prevents the location of the crossing to the west, as the top slab of the current box culvert is already at a level immediately underneath the existing pavement of Route 3. With the vertical alignment of Route 3 rising towards the east, it is not possible to move the crossing further to the west without affecting the vertical alignment of Route 3, which has already opened to traffic.

(iii) The alignment of the box culvert (as constructed), matches the pre-existing natural drainage channel and is thus optimal for the original drainage basin for the whole area.

3.2.11 In view of the above, it is concluded that the alignment selected for the section of the Floodway during the preparation of the EIA (BBV, 1998) is the optimum alignment, taking into account the various constraints, and that any revised ecological mitigation measures proposed should be based on the current alignment of the Floodway.



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YUEN LONG BYPASSS FLOODWAY
FEASIBILITY STUDY

figure title

YUEN LONG BYPASS
FLOODWAY
OPTION 1

figure no. 3.1

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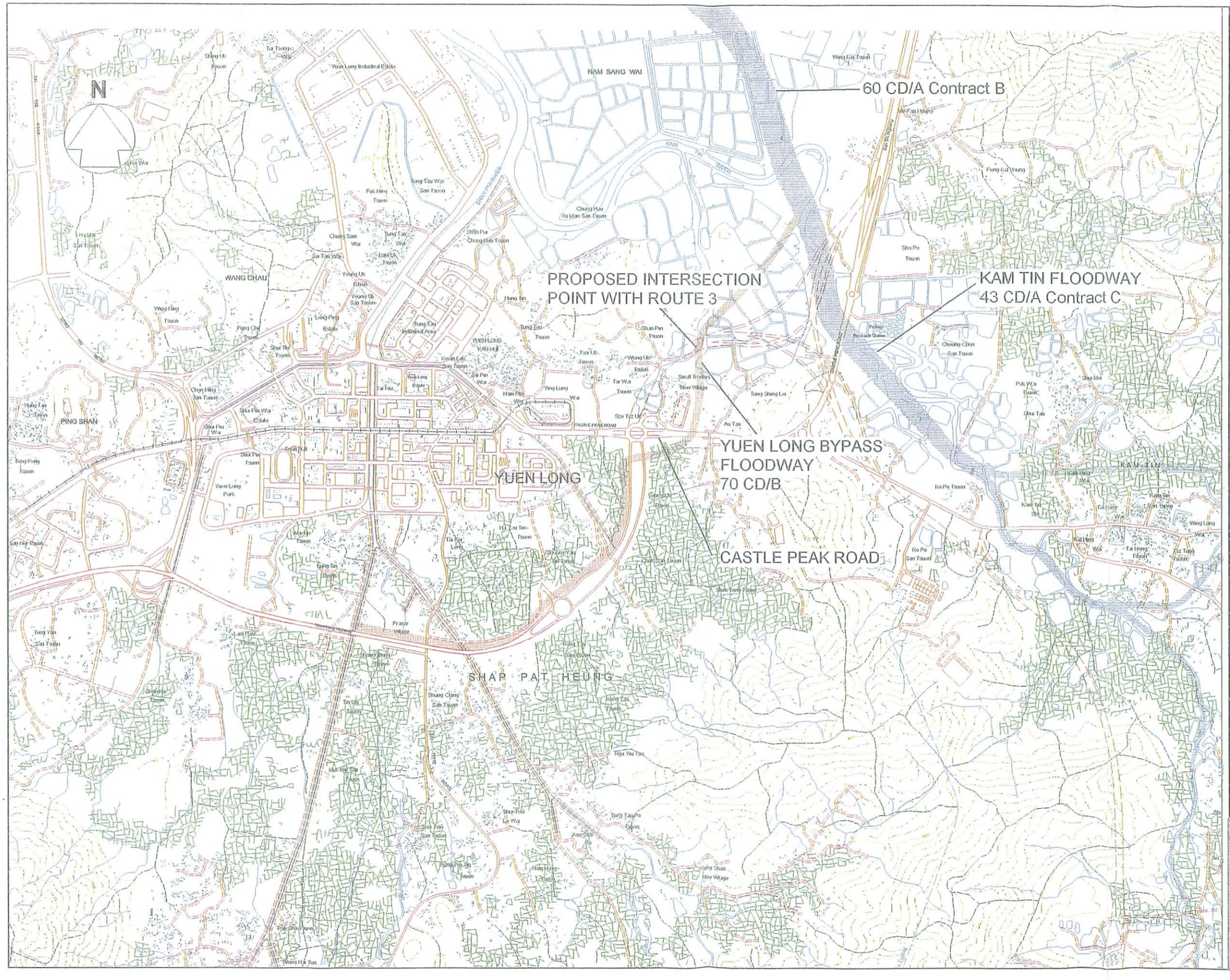

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FEASIBILITY STUDY

figure title

YUEN LONG BYPASS
FLOODWAY
OPTION 2

figure no. 3.2

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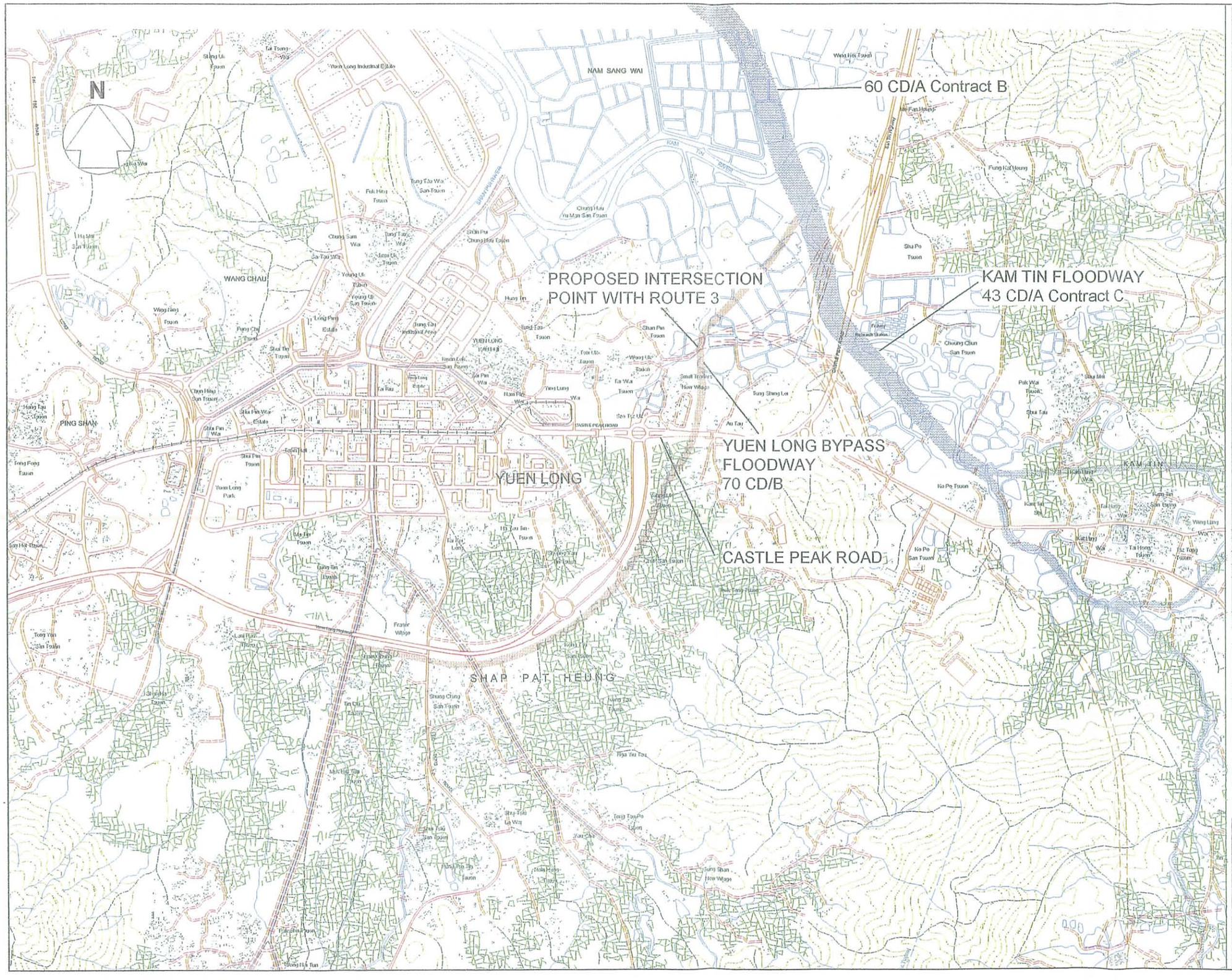

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YUEN LONG BYPASSS FLOODWAY
FEASIBILITY STUDY

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YUEN LONG BYPASS
FLOODWAY
OPTION 3

figure no.	scale
3.3	N.T.S

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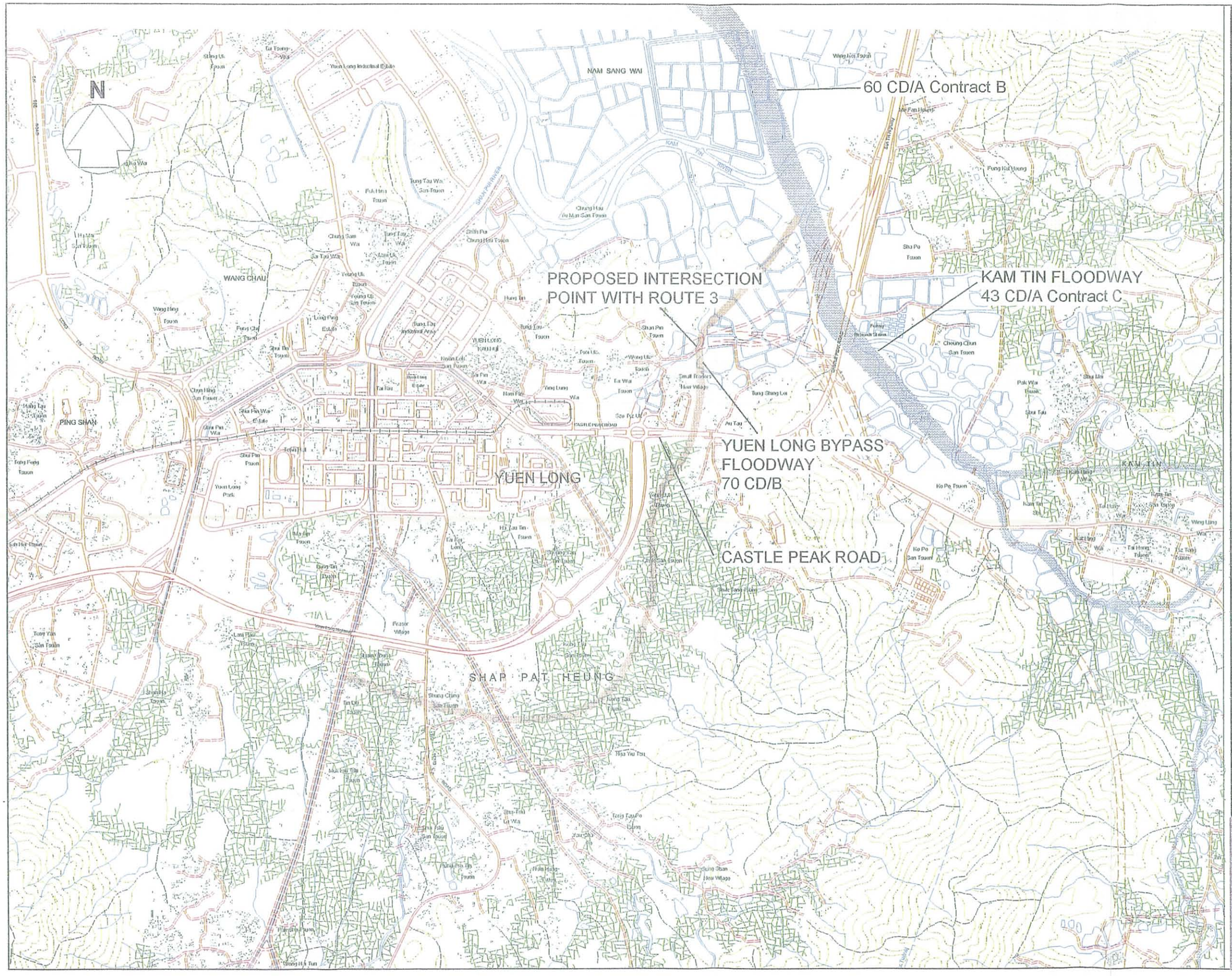

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YUEN LONG BYPASSS FLOODWAY
FEASIBILITY STUDY

figure title

YUEN LONG BYPASS
FLOODWAY
OPTION 4

figure no. 3.4

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LEGEND:

- PROPOSED SITE LIMIT
- DIRECTION OF FLOW
- BOX CULVERT
- PROPOSED SLOPE
- EXISTING SLOPE
- AREA TO BE FILLED TO ADJACENT GROUND LEVEL
- ENGINEERED WETLAND/MARSHCRETE AREA
- LIMIT OF RIGHT OF TEMPORARY OCCUPATION
- PROPOSED LEVEL
- EXISTING LEVEL (OBTAINED FROM SITE VISIT)
- VC VEHICULAR CROSSING
- PC PEDESTRIAN CROSSING
- R.L. TOP OF ROAD LEVEL
- P.L. TOP OF FOOTPATH LEVEL
- OTHER PROJECTS UNDER PRESENT/FUTURE CONSTRUCTION

KEY PLAN

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YUEN LONG BYPASS FLOODWAY FEASIBILITY STUDY

EIA STUDY REPORT

figure title

YUEN LONG BYPASS FLOODWAY REVISED CHANNEL ALIGNMENT IN EIA STUDY

figure no. 3.5

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PRELIMINARY SITE LIMIT

PROPOSED CHANNEL ALIGNMENT

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REASSESSMENT ECOLOGICAL MITIGATION REPORT

Figure title

REVISED ARRANGEMENT TO THE NORTH OF ROUTE 3

(WITHOUT WETLAND)

Drawing no. 3.6

Scale 1:1500 A1 1:3000 A3

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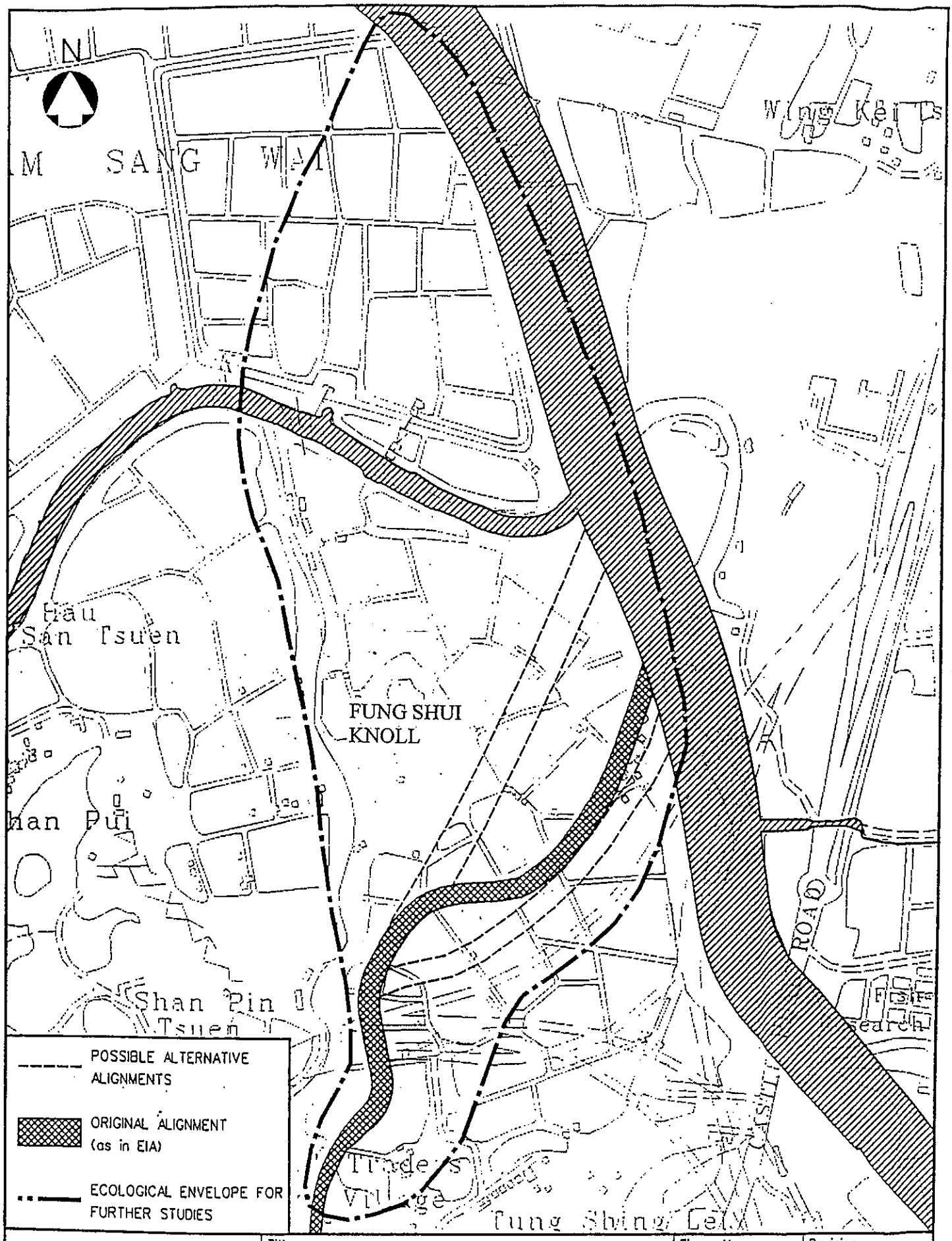

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Title :

ALTERNATIVE FURTHER ARRANGEMENT TO THE NORTH OF ROUTE 3

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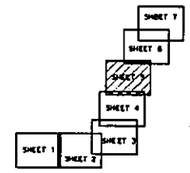
LEGEND:

- PROPOSED SITE LIMIT
- DIRECTION OF FLOW
- BOX CULVERT
- PROPOSED SLOPE
- EXISTING SLOPE
- AREA TO BE FILLED TO ADJACENT GROUND LEVEL
- LIMIT OF RIGHT OF TEMPORARY OCCUPATION
- PROPOSED LEVEL
- VC VEHICULAR CROSSING
- PC PEDESTRIAN CROSSING
- R.L. TOP OF ROAD LEVEL
- P.L. TOP OF FOOTPATH LEVEL
- OTHER PROJECTS UNDER PRESENT/FUTURE CONSTRUCTION

KEY PLAN



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YUEN LONG BYPASS FLOODWAY FEASIBILITY STUDY

ENGINEERING REPORT

Figure title

PRELIMINARY LAYOUT NEAR CASTLE PEAK ROAD

Figure no. 3.8

Scale 1 : 1000 A1 1 : 2000 A3

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4. LAND STATUS WITHIN STUDY AREA

4.1 In order to avoid further conflict regarding land ownership or other potentially conflicting administrative statutory designation, this Section of the report will investigate and map the distribution of:

(i) private and government land;

(ii) zoning of land under the Outline Zoning Plan;

(iii) protected areas; and,

(iv) areas already prescribed as mitigation under other projects.

Private & Government Land Distribution

4.2 Figure 4.1 shows the ponds and other related land within the Study Area, known to be in either private or government ownership. With the exception of ponds 21 and 22, the land to the north of the old Kam Tin River is in private ownership. Similarly, ponds 1 - 10 (with the exception of 1B, 1C, 2A and 9) are also in private ownership. Ponds 11 - 19, and the old Kam Tin River are government owned.

4.3 As discussed in paragraphs 1.4 and 2.3, all alternative mitigation options will be sought within government landholdings.

Zoning of Land within Study Area

4.4 The Outline Zoning Plan for the Study Area (extracted from Plan No. S/YL - NSW/1) is shown in Figure 4.2. For most of its length (north of Castle Peak Road), the YLBF alignment is within an area designated "U" (undetermined). The convergence point with the MDC straddles the boundary between "O" (open space) to the south; and, "CA" (conservation area) to the north. There are no changes to the OZP as this is the same version shown in the Yuen Long Bypass Floodway Feasibility Study EIA (1998). Furthermore, District Planning Office have confirmed that no planning permission has been granted within the Study Area. Two separate applications for a change of land-use (for the ponds north of the old Kam Tin River; and for Ponds 1A & 2) have been rejected.

Protected Areas

4.5 In addition to the area described in the previous paragraph, designated "CA" (conservation area) under the OZP, there are two zones of conservation importance in the Study Area (also illustrated on Figure 4.2). At the time of the original EIA (1998), the boundary of Buffer Zone 2[iii] abutted the northern bank of the Kam Tin River and was therefore outside the scope of the EIA.

Wetland Buffer Area

4.6 The boundaries of the Ramsar associated zones (along with the nomenclature) were revised in 1999, and are thus of relevance to this Study. The Wetland Buffer Area (which has a similar function to Buffer Zone 2, under the old system) now extends as far south as Route 3. Of the WBA the guidelines state that "a substantial amount of the fishponds within the WBA have already been lost over time through filling, and certain areas have been degraded by the presence of open storage use, these degraded areas may be considered as target areas to allow an appropriate level of residential/recreational development so as to provide an incentive to remove the open storage use and/or to restore some of the fishponds lost".

Wetland Conservation Area

4.7 The Wetland Conservation Area (which has a similar function to Buffer Zone 1) has been extended into the Project area following the western bank of the Kam Tin MDC. The presumption of the Wetland Conservation Area is that development is limited to that which "supports the conservation of the ecological value of the area, or the development is an essential infrastructural project with overriding public interest"[iv]. Clearly, the YLBF falls into the latter category.

Implications of the WCA & WBA on other developments

4.8 While the WCA and WBA zones do not prevent the construction of "essential infrastructural projects" such as the YLBF, there will be implications on the restriction of future development of the land through which the YLBF alignment runs north of Route 3.

iii TPB PG-NO. 12A (Revised November 1994), *Town Planning Board Guidelines for Application for Developments with Deep Bay Buffer Zones under Section 16 of the Town Planning Board Ordinance.*

iv TPB PG-NO. 12B (Revised April 1999), *Town Planning Board Guidelines for Application for Developments with Deep Bay Area under Section 16 of the Town Planning Board Ordinance.*

Mitigation Under Other Projects

4.9 The mitigation and restoration sites of other projects in the vicinity of the YLBF ecological mitigation are shown in Figure 4.3.

Route 3

4.10 Ponds 1A, 2 and 6 were temporarily used to store rockfill at the time of the original EIA. According to CES (1995) p. 7-15, "The Franchisee is required to return the ponds to their original condition including the quality of the water" and "Ponds required temporarily during construction of the Works, but not required for the on-going maintenance and operation of the Constructed Facilities, shall be reinstated to their original conditions including provision of suitable enhancements to improve their ecological value, as determined by the Detailed Environmental Impact Assessment". Following the completion of Route 3, the reprofiled ponds were rewatered in accordance with the contract. Despite the completion of the temporary easement and return to the owners, pisciculture has not been resumed. Each of these three ponds will be impacted by the preliminary design alignment of the YLBF.

Kam Tin MDC

4.11 Ponds 16, 11 and 11B were temporarily resumed for the Kam Tin MDC project and have now been restored. Three strips of landscape planting have been implemented on the outside of the MDC service road. Between a third and half of the planned southern strip of landscaping will be unavoidably lost as a result of the YLBF convergence with the MDC. However, it should be noted that landscaping mitigation under the YLBF compensates the loss of 400 trees by the planting of 2,500 trees along the crest of both banks. There will be a large net gain of trees as a result of the YLBF project landscaping.

Summary

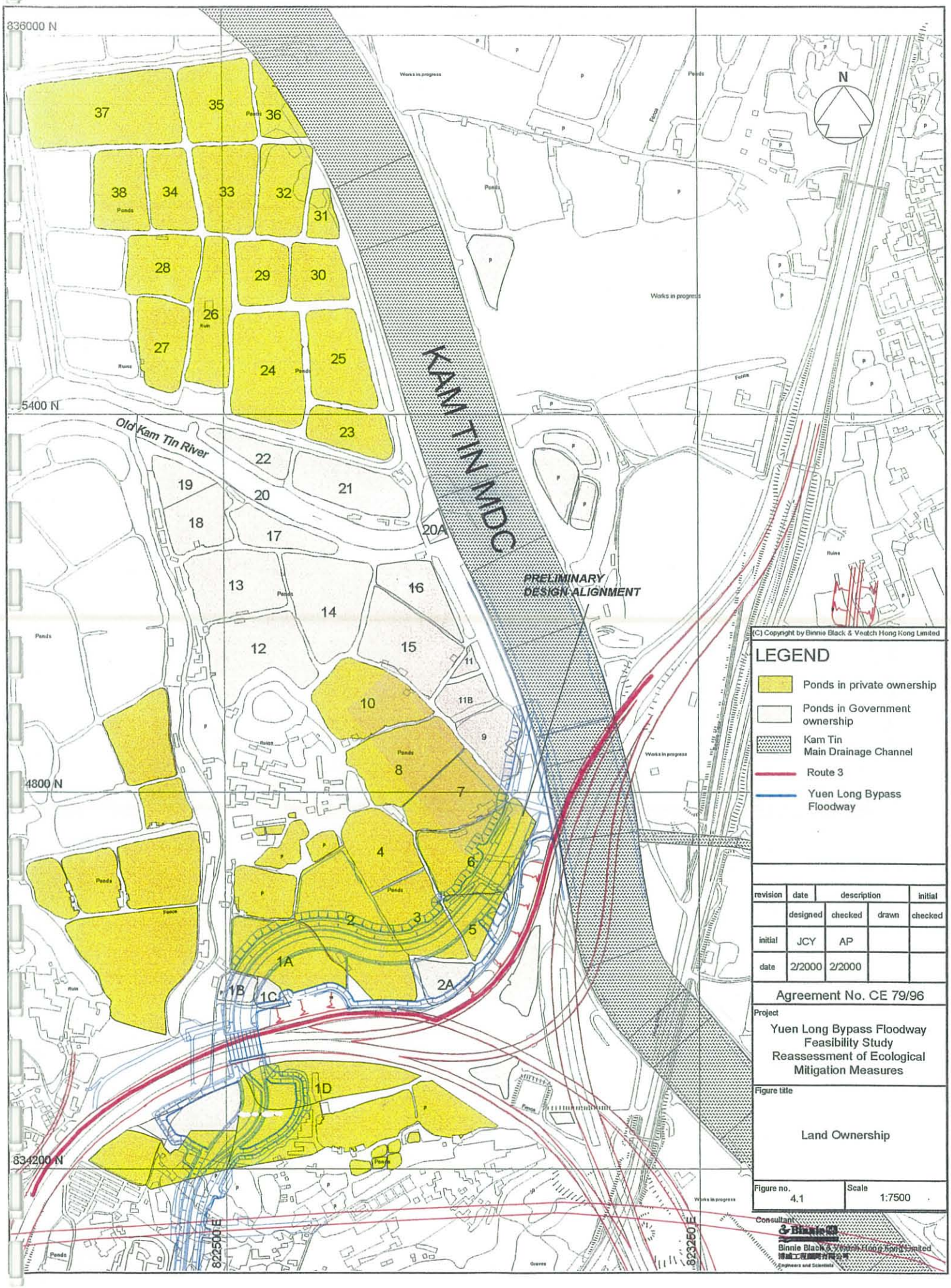
4.12 The ownership, statutory designation and mitigation status of other projects in the vicinity of the YLBF Project is summarised in Table 4.1.

Table 4.1
Summary of Land Status North of Route 3

Pond No.	OZP designation	Protected status	Mitigation under other projects
Private ownership			
1A	U	WCA/WBA	R3 - restored
1D	U	None	
2	U	WCA/WBA	R3 - restored
3	U	WCA/WBA	
4	U	WCA	
5	U	WCA/WBA	
6	U	WCA	R3 - restored
7	U	WCA	
8	U	WCA	
10	U	WCA	
23	REC	WCA	
24	REC	WCA	
25	REC	WCA	
26	REC	WCA	
27	REC	WCA	
28	REC	WCA	
29	REC	WCA	
30	REC	WCA	
31	REC	WCA	MDC - restored
32	REC	WCA	MDC - restored
33	REC	WCA	
34	REC	WCA	
35	REC	WCA	
36	REC	WCA	MDC - restored
37	REC	WCA	
38	REC	WCA	
Government ownership			
1B	U	WBA	
1C	U	WBA	
2A	U	None	
9	CA	WCA	
11	CA	WCA	MDC - restored
11B	CA	WCA	MDC - restored
12	CA	WCA	
13	CA	WCA	
14	CA	WCA	
15	CA	WCA	
16	CA	WCA	MDC - restored
17	CA	WCA	
18	CA	WCA	
19	CA	WCA	
20	CA	WCA	
20A	CA	WCA	
21	REC	WCA	
22	REC	WCA	

U - undetermined zoning
REC - Recreation
CA - Conservation Area
WCA - Wetland Conservation Area
WBA - Wetland Buffer Area

R3 - restored - Ponds restored under Route 3 project
MDC - restored - Ponds restored under Kam Tin MDC



LEGEND

- Ponds in private ownership
- Ponds in Government ownership
- Kam Tin Main Drainage Channel
- Route 3
- Yuen Long Bypass Floodway

revision	date	description		initial
	designed	checked	drawn	checked
initial	JCY	AP		
date	2/2000	2/2000		

Agreement No. CE 79/96

Project

Yuen Long Bypass Floodway Feasibility Study Reassessment of Ecological Mitigation Measures

Figure title

Land Ownership

Figure no.	Scale
4.1	1:7500

Consultant

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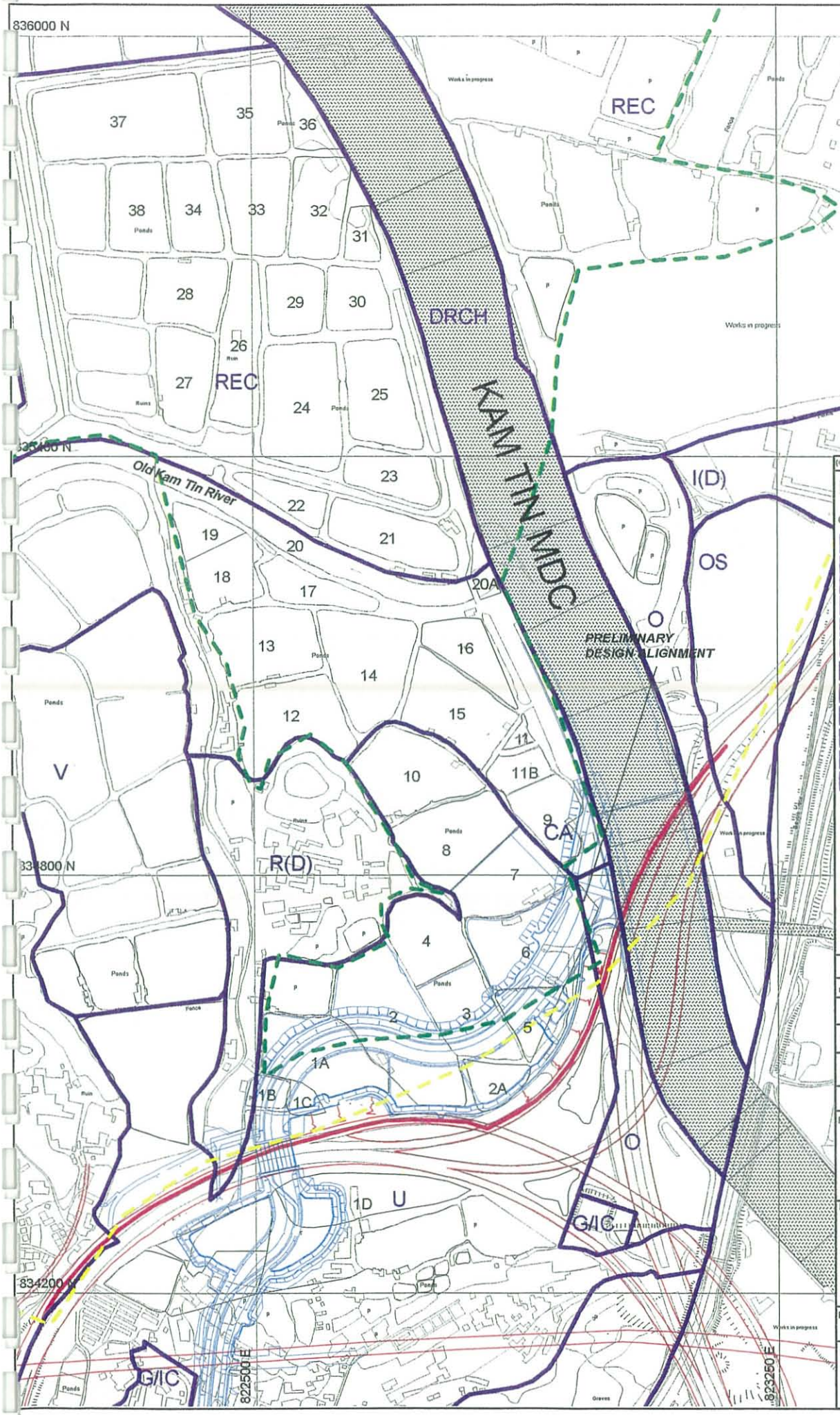
Engineers and Scientists



LEGEND

OZP Zones

- CA — Conservation area
- DRCH — Drainage channel
- G/IC — Government/Institution/Community
- GB — Green belt
- I(D) — Industrial (Group D)
- O — Open space
- OS — Open storage
- R(C) — Residential (Group C)
- R(D) — Residential (Group D)
- REC — Recreation
- U — Undetermined
- V — Village type development

- Kam Tin Main Drainage Channel
- Boundary of Wetland Buffer Area (WBA)
- Boundary of Wetland Conservation Area (WCA)
- Route 3
- Yuen Long Bypass Floodway

revision	date	description		initial
	designed	checked	drawn	checked
initial	JCY	AP		
date	2/2000	2/2000		

Agreement No. CE 79/96

Project

Yuen Long Bypass Floodway Feasibility Study Reassessment of Ecological Mitigation Measures

Figure title

OZP & Ramsar Conservation and Buffer Areas

Figure no.	Scale
4.2	1:7500

Consultant

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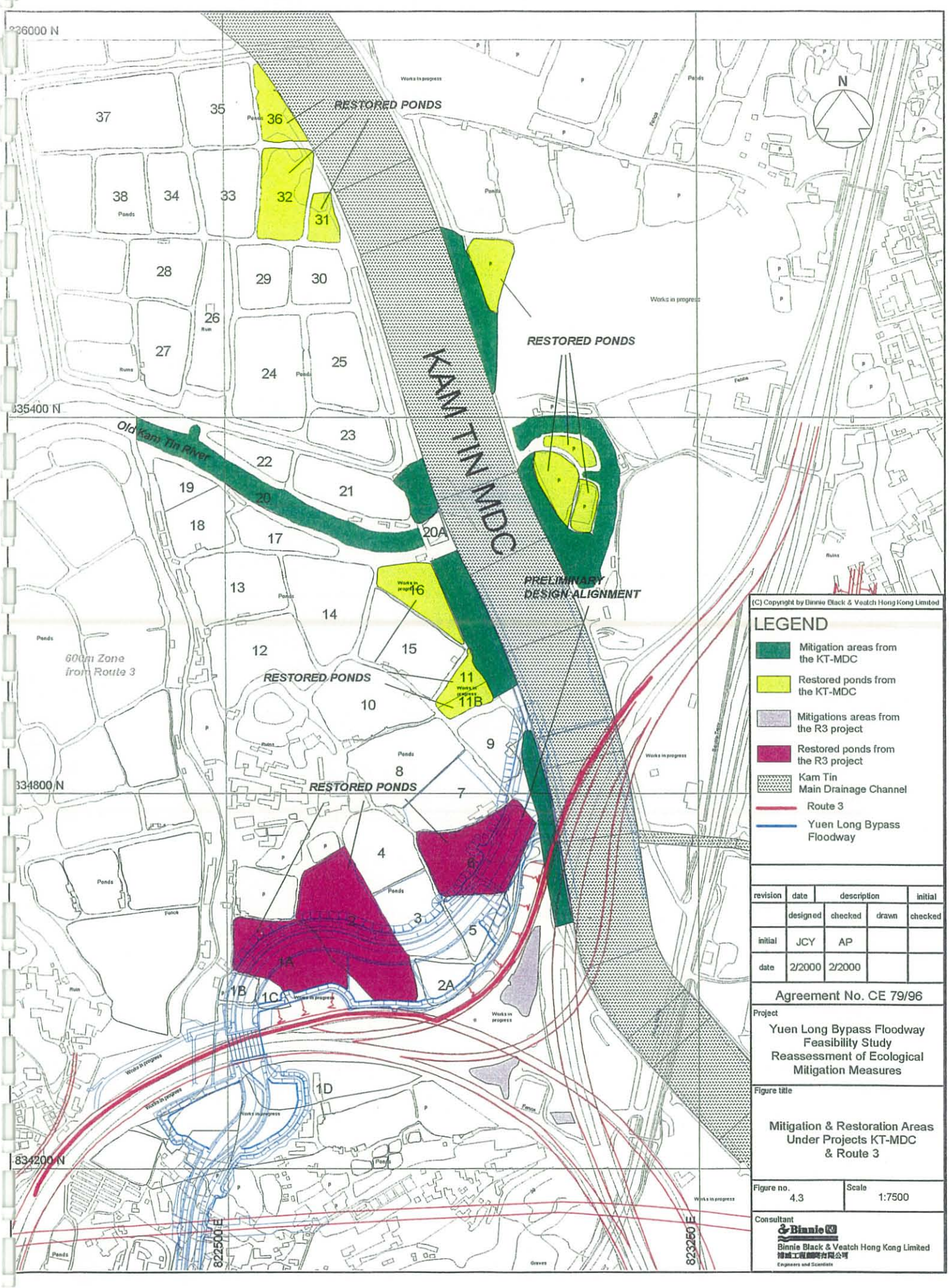
Engineers and Scientists


836000 N
835400 N
834800 N
834200 N
822500 E
823250 E
RESTORED PONDS
RESTORED PONDS
RESTORED PONDS
RESTORED PONDS
KAM TIN MDC
PRELIMINARY DESIGN ALIGNMENT
Old Kam Tin River
600m Zone from Route 3
N
(C) Copyright by Binnie Black & Veatch Hong Kong Limited
LEGEND
Mitigation areas from the KT-MDC
Restored ponds from the KT-MDC
Mitigations areas from the R3 project
Restored ponds from the R3 project
Kam Tin Main Drainage Channel
Route 3
Yuen Long Bypass Floodway
revision
date
description
initial
designed
checked
drawn
checked
initial
JCY
AP
date
2/2000
2/2000
Agreement No. CE 79/96
Project
Yuen Long Bypass Floodway Feasibility Study Reassessment of Ecological Mitigation Measures
Figure title
Mitigation & Restoration Areas Under Projects KT-MDC & Route 3
Figure no.
4.3
Scale
1:7500
Consultant
Binnie Black & Veatch Hong Kong Limited
Engineers and Scientists

5. SURVEY RESULTS AND DATA EVALUATION

Survey area

5.1 The development of alternative ecological mitigation measures for the Floodway requires a thorough understanding of the existing ecological conditions of the area. Accordingly, field surveys were undertaken within a defined Study Area (Figure 5.1), which encompassed the extremes of the potential alternative Floodway alignments, together with alternative potential compensation areas, for which detailed ecological information was required in order to evaluate the value of proposed compensation measures. In addition, bird surveys were extended to a more remote area from the potential alignments and compensation areas, in order to provide a comparative data on bird use away from Route 3. This major highway is considered to be having an impact on the utilisation by birds of the main Study Area.

Survey Period

5.2 The field survey period extended from December 1999 to April 2000. The first part of this period (December to February) is typically one where most birds wintering in Hong Kong occur at their peak numbers and the co-ordinated waterfowl count in Deep Bay generally shows the largest numbers of waterfowl are present in mid-January (Carey 1999). The period from March to April is the peak spring passage period for most migrant bird species in Hong Kong (Carey *et al.* in prep.). Reptiles and amphibians are active and vocal in March and April (G. Reels pers. obs.). Survey during April also allows the determination of the breeding bird community, which may differ substantially from that present in winter (Carey *et al.* in prep). Whilst there is an upsurge of species diversity of flying butterflies and dragonflies from April, at least for butterflies it is probable that further species would have been observed had the study extended through the summer months (Walthew 1997). Accordingly, for these taxa groups a longer study period would have been ideal. Similarly, for birds, it is likely that autumn passage migrants would show a different species mix and numbers than that observed in spring (Carey *et al.* in prep). However, based on an evaluation of the findings of the study and the habitats in the area, it is considered unlikely that a longer survey period would materially affect the conclusions reached with respect to all taxa groups studied. Full details of the dates of field surveys are provided at Table 5.1 whilst results of the various taxa groups surveyed are presented below.

Table 5.1 Field Survey Programme

Taxa group	Survey dates
Birds	4 Dec, 9 Dec, 16 Dec, 22 Dec, 29 Dec, 6 Jan, 13 Jan, 19 Jan, 27 Jan, 3 Feb, 9 Feb, 15 Feb, 23 Feb, 4 Mar, 10 Mar, 17 Mar, 23 Mar, 31 Mar, 5 Apr, 11 Apr, 21 Apr, 30 Apr.
Mammals	29 Mar, 31 Mar*, 11 Apr, 12 Apr*, 18 Apr, 18 Apr*, 19 Apr, 21 Apr, 24 Apr, 24 Apr*.
Reptiles/ Amphibians	29 Mar, 31 Mar*, 11 Apr, 12 Apr*, 18 Apr, 18 Apr*, 19 Apr, 21 Apr, 24 Apr, 24 Apr*.
Butterflies/Dragonflies	29 Mar, 11 Apr, 18 Apr, 19 Apr, 21 Apr, 24 Apr.

* Indicates night survey. A small number of casual observations obtained at other times during the survey period have also been included.

Taxa groups surveyed

5.3 These surveys covered a range of taxa groups considered to provide an appropriate baseline for assessing the ecological importance of a study area within the Deep Bay ecosystem: birds, mammals, reptiles, amphibians, butterflies and dragonflies. These taxa were selected for study because: their status in Hong Kong is relatively well known (hence observations can be evaluated in the context of Hong Kong status); identification criteria are established for most species; and, especially in the case of birds, the Deep Bay area is known to be of international and regional importance for a number of species. In addition, butterflies and dragonflies are considered to be useful indicator groups for the assessment of invertebrate biodiversity.

Birds

5.4 For the bird survey all ponds and intervening bund areas in the area to the south of the Kam Tin River (Ponds 1 to 19 and "Ponds" 20 and 20A - the Kam Tin River itself) were surveyed on each visit. Ponds 21 to 37 north of the Kam Tin River were surveyed during the period from 4th December 1999 to 13th January 1999 primarily in order to compare the use of these ponds by waterbirds with those south of the river. All birds species present were recorded, whilst numbers and locations of wetland-dependent bird species using the area regularly were recorded. A more detailed analysis was undertaken of the occurrence of four[v] key wetland-dependent species. These are defined in this context, as species considered to be globally threatened (Collar et al. 1994), or for which Deep Bay supports

[v] The Phase 1 Interim Report listed five key species. The additional species, Great Egret *Egretta alba* was found not to be present in numbers sufficient to justify its inclusion within this category. Great Egret is discussed under the category of Wetland-Dependent Species occurring regularly within the Study Area.

populations meeting the *Ramsar Convention* criterion 3c, namely 1% of the regional or flyway population (Rose and Scott 1997, Carey and Young 1999).

5.5 A full list of bird species recorded in the study area is provided in Table 5.2. This Table also indicates those wetland-dependent species that occurred in the study area on a regular basis (shown in italics) and the Key Species defined above (shown in bold text). The findings with respect to individual species are discussed below.

Table 5.2
List of bird species recorded in Study Area December 1999 - April 2000

Species English name	Species scientific name	Status in Study Area
**Little Grebe*	*Tachybaptus ruficollis*	Breeding resident
***Great Cormorant**	*Phalacrocorax carbo*	Regular winter visitor
**Black-crowned Night Heron*	*Nycticorax nycticorax*	Regular non-breeding visitor
**Cattle Egret*	*Bubulcus ibis*	Infrequent non-breeding visitor
***Chinese Pond Heron**	*Ardeola bacchus*	Breeding resident
***Little Egret**	*Egretta alba*	Breeding resident
**Intermediate Egret*	*Egretta intermedia*	Infrequent non-breeding visitor
**Great Egret*	*Egretta alba*	Infrequent non-breeding visitor
***Grey Heron**	*Ardea cinerea*	Regular winter visitor
**Eurasian Wigeon*	*Anas penelope*	Regular winter visitor
**Common Teal*	*Anas crecca*	Regular winter visitor
*Northern Pintail	*Anas acuta*	Occasional winter visitor
*Northern Shoveler	*Anas clypeata*	Occasional winter visitor
*Eastern Marsh Harrier	*Circus spilonotus*	Occasional winter visitor
Common Kestrel	*Falco tinnunculus*	Occasional winter visitor
**White-breasted Waterhen*	*Amaurornis phoenicurus*	Breeding resident
**Common Moorhen*	*Gallinula chloropus*	Breeding resident and winter visitor
**Eurasian Coot*	*Fulica atra*	Regular winter visitor
*Oriental Pratincole	*Glareola maldivarum*	Occasional passage migrant
**Little Ringed Plover*	*Charadrius dubius*	Breeding resident and winter visitor
**Temminck's Stint*	*Calidris temminckii*	Infrequent winter visitor
**Common Snipe*	*Gallinago gallinago*	Infrequent winter visitor
*Marsh Sandpiper	*Tringa stagnatilis*	Occasional winter visitor
**Green Sandpiper*	*Tringa ochropus*	Regular winter visitor
*Wood Sandpiper	*Tringa glareola*	Occasional winter visitor
**Common Sandpiper*	*Actitis hypoleucos*	Regular winter visitor
Oriental Turtle Dove	*Streptopelia orientalis*	Regular winter visitor
Spotted Dove	*Streptopelia chinensis*	Breeding resident
Indian Cuckoo	*Cuculus micropterus*	Occasional summer visitor
Common Koel	*Eudynamys scolopacea*	Breeding resident
Greater Coucal	*Centropus sinensis*	Breeding resident
Savanna Nightjar	*Caprimulgus affinis*	Occasional, resident
Little Swift	*Apus affinis*	Non-breeding resident

Species English name	Species scientific name	Status in Study Area
**White-throated Kingfisher*	*Halcyon smyrnensis*	Breeding resident
**Common Kingfisher*	*Alcedo atthis*	Breeding resident and winter visitor
**Pied Kingfisher*	*Ceryle rudis*	Breeding resident
Eurasian Wryneck	*Jynx torquilla*	Occasional winter visitor
Barn Swallow	*Hirundo rustica*	Breeding summer visitor
Richard's Pipit	*Anthus richardi*	Regular winter visitor
Olive-backed Pipit	*Anthus hodgsoni*	Infrequent winter visitor
Red-throated Pipit	*Anthus cervinus*	Regular winter visitor
White Wagtail	*Motacilla alba*	Breeding resident
**Yellow Wagtail*	*Motacilla flava*	Regular winter visitor
Grey Wagtail	*Motacilla cinerea*	Infrequent winter visitor
Red-whiskered Bulbul	*Pycnonotus jocosus*	Breeding resident
Chinese Bulbul	*Pycnonotus sinensis*	Breeding resident
Sooty-headed Bulbul	*Pycnonotus aurigaster*	Breeding resident
Siberian Rubythroat	*Luscinia calliope*	Occasional winter visitor
**Common Stonechat*	*Saxicola torquata*	Regular winter visitor
Oriental Magpie-robin	*Copsychus saularis*	Breeding resident
Dusky Thrush	*Turdus naumanni*	Occasional winter visitor
*Zitting Cisticola	*Cisticola juncidis*	Occasional winter visitor
Plain Prinia	*Prinia inornata*	Breeding resident
Yellow-bellied Prinia	*Prinia flaviventris*	Breeding resident
Japanese Bush Warbler	*Cettia diphone*	Infrequent winter visitor
*Pallas's Grasshopper Warbler	*Locustella certhiola*	Occasional winter visitor
*Black-browed Reed Warbler	*Acrocephalus bistrigiceps*	Occasional passage migrant
*Oriental Reed Warbler	*Acrocephalus orientalis*	Occasional passage migrant
Common Tailorbird	*Orthotomus sutorius*	Breeding resident
**Dusky Warbler*	*Phylloscopus fuscatus*	Regular winter visitor
Masked Laughingthrush	*Garrulax perspicillatus*	Breeding resident
Great Tit	*Parus major*	Breeding resident
Japanese White-eye	*Zosterops japonicus*	Breeding resident
Long-tailed Shrike	*Lanius schach*	Breeding resident
Black Drongo	*Dicrurus macrocercus*	Breeding summer visitor
Common Magpie	*Pica pica*	Breeding resident
Large-billed Crow	*Corvus macrorhynchus*	Breeding resident
*Collared Crow	*Corvus torquatus*	Occasional non-breeding visitor
**Red-billed Starling*	*Sturnus sericeus*	Infrequent winter visitor
**White-shouldered Starling*	*Sturnus sinensis*	Summer visitor, possibly breeding
White-cheeked Starling	*Sturnus cineraceus*	Regular winter visitor
Crested Myna	*Acridotheres cristatellus*	Breeding resident
Eurasian Tree Sparrow	*Passer montanus*	Breeding resident
White-rumped Munia	*Lonchura striata*	Breeding resident
Scaly-breasted Munia	*Lonchura punctulata*	Breeding resident
Black-faced Bunting	*Emberiza spodocephala*	Regular winter visitor

* Species marked thus are wetland-dependent (or largely wetland-dependent in Hong Kong). All wetland dependant species noted in this table other than those listed as occasional visitors are discussed below, either as Key Species (indicated in bold type, Column 1), or as other wetland-dependent species occurring regularly in the Study Area (indicated in italic type Column 1).

Key Bird Species

5.6 In the overall context of the objective of TPB PG No. 12B to maintain wetland function within the Wetland Buffer Area (WBA), it is important to focus mitigation measures where they may be predicted to have the greatest benefit to the integrity of the Ramsar Site and its hinterland. The targeting of mitigation towards species for which the Ramsar Site is of global importance is considered to be a useful basis for initial identification of achievable mitigation targets. For the present study, therefore, particular attention has been paid to the needs of Key Bird Species as defined in para. 5.4 (above) and the opportunities for habitat provision or enhancement for these species. The needs of other wetland-dependent species (both birds and other taxa groups) may then be incorporated within this overall strategy by modification of targets (in particular by micro-habitat design) to minimise residual adverse impacts and maximise conservation benefits across the community as a whole.

Great Cormorant *Phalacrocorax carbo*

5.7 During the period from 1993/94-97/98 the average peak winter count of Great Cormorants in the Deep Bay area was 6310 birds. This is the most significant concentration east of Turkmenistan and constitutes 6.3% of the east/south-east Asian wintering population and 1% of the Northern Hemisphere population (Carey and Young 1999).

5.8 The Great Cormorant is solely a winter visitor to Hong Kong. The vast majority of the Hong Kong population winters in Deep Bay where it utilises two communal night-time roosts, one at Mai Po and a smaller one at Nam Sang Wai (Carey *et al.* in prep). The Nam Sang Wai roost utilises large Eucalyptus trees to the west of the Study Area and contained up to 1800 birds during the study period. Whilst the majority of Great Cormorants feed in estuarine waters in Deep Bay it has been estimated that 11.9% of birds utilise fishponds for feeding (AFD 1997). This ratio is broadly reflected in the present Study up to 171 birds (c. 8-9 % of the roost population) was observed on ponds, mostly to the north of the Kam Tin River.

5.9 In general the Great Cormorant showed a clear preference for the ponds to the north of the Kam Tin River, with Ponds 26, 35 and 37 being particularly important. Within the main Study Area south of the Kam Tin River, significant numbers were observed only in December on Pond 19. Up to 40 birds were present south of the meander, probably taking advantage of a fish-kill or fish availability as a consequence of deoxygenation of the water. This was apparently caused by dumping of soil and construction debris in association with bund widening (see Appendix 1).

5.10 This species is relatively intolerant of human activities and average flushing distance was 170m (Appendix 1). This intolerance of human activity is reflected in the very low numbers using the main Study Area. With respect to Ponds 1D, 3, 4, 6-10 and 15, the physical characteristics of the ponds would appear to render them suitable for Great Cormorant use. Thus, it appears that the principal factor inhibiting their use is the disturbance impact of Route 3 (Appendix 1) compounded by disturbance impact from the use of the MDC roadway and squatter housing in the area. However, other factors such as the fish population of these ponds may be involved, and it is noted that, as with some ardeid species, Great Cormorants utilised Pond 19 (which is only 4,630 square metres area and is close to houses) when fish were readily available following deoxygenation. Great Cormorants are also known to avoid smaller ponds (Appendix 1), and it is likely that Ponds 1B, 1C, 2A, 5, 11 and 11B are probably too small to be favoured by this species. Ponds 1A and 2 have not been returned to use as functional fishponds following Route 3 construction and contain insufficient water depth for Great Cormorant use, irrespective of other factors. A further factor affecting distribution may be proximity to the night roost at Nam Sang Wai, with larger numbers using ponds close to the roost.

Chinese Pond Heron *Ardeola bacchus*

5.11 During the period from 1990-97 the average peak winter count of Chinese Pond Herons in the Deep Bay area was 327 birds, representing 1% of the east/south-east Asian wintering population (Carey and Young 1999).

5.12 The Chinese Pond Heron is typically a solitary feeder, utilising a range of wetland habitats including freshwater marsh, fishponds, drainage channels.

5.13 Though it is widely distributed in the Deep Bay area, this species occurs at low densities, and it less often occurs in concentrations taking advantage of temporary feeding opportunities than, for example, Little Egret[vi]. It is, however, relatively tolerant of human activity and will utilise water bodies which are surrounded by trees or overhanging vegetation.

5.14 Numbers of this species recorded within the main Study Area south of the Kam Tin River ranged from zero to 31 birds (mean of ten birds) representing up to around 10% of the Deep Bay population during winter 1999-2000 (Carey 2000). Accordingly, of the Key Species considered, the Study Area is of greatest relative importance in respect to the proportion of the numbers considered to present in Hong Kong which it holds.

[vi] Scientific names of all bird species are listed in Table 5.2

5.15 Birds were recorded on 18 ponds south of the Kam Tin River (as well nine ponds north of the River), but on most of these numbers were very low with an average of fewer than one bird present per visit. The main area utilised was on either side of the Kam Tin River, notably Ponds 16, 18, 20, 22 and 27. Numbers at these ponds generally comprised at least 67% of birds present in the study area, with numbers at individual ponds and on the meander varying from visit to visit. This perhaps suggests the birds' movements in response to disturbance and temporary feeding opportunities such as the fish-kill at Ponds 18 and 19.

5.16 Interestingly, there was some evidence of greater utilisation of ponds closer to Route 3 later in the study period, in particular Pond 1D which held birds during most visits in March and April, with a maximum of nine birds present on 17th March. Conceivably, this change in the pattern of occurrence could have been connected with the establishment of an egretry during this period (see para 5.17 below).

5.17 During April it was found that Chinese Pond Herons were nesting alongside Little Egrets at the egretry to the west of Ponds 8 and 10. When the egretry was surveyed on 11 April at least three pairs of Chinese Pond Herons were nesting. An average of 144 pairs of this species was recorded breeding in Hong Kong during the period 1990-95 (Young and Cha 1995) and 99 pairs were recorded in 1999 (Wong *et al.* 1999).

5.18 Little relationship between pond size and numbers was observed for this species (Appendix 1), apart from a suggestion that the largest ponds were avoided to some extent. As might be anticipated, given this species' relative tolerance of human activity, mean flushing distance was relatively low at 130m. During most of the study period very few birds were observed on those ponds closer than 200m to Route 3 and most observations were in the area from 400m to 1000m from this road, suggesting that disturbance from this road was inhibiting use by this species.

5.19 However, there was increased use of some of these ponds, especially 1D, during March and April, suggesting that other factors such as food availability or proximity to breeding sites may also be significant. Nevertheless, during this period some of the ponds closest to Route 3 (Ponds 1A, 1C, 2, 2A, 5, 6 and 9), were not observed to be used by Chinese Pond Herons. Whilst Ponds 1C, 2A and 5 are probably too small and/or overgrown to be favoured by Chinese Pond Herons, regardless of anthropogenic influences, absence of Chinese Pond Herons from these other ponds suggests that unsuitable conditions, combined with the effects of Route 3 remained a significant factor. In particular, Ponds 1A and 2 probably contained insufficient water to support feeding activity by Chinese Pond Herons.

Little Egret *Egretta garzetta*

5.20 During the period from 1990-97 the average peak winter count of Little Egrets in the Deep Bay area was 1478 birds, representing 1% of the east/south-east Asian wintering population (Carey and Young 1999)

5.21 Whilst this species feeds in a range of wetland habitats, it particularly favours commercial fishponds and *gei-wais* and is an opportunistic feeder flocking at temporarily abundant resources such as those provided by the draining down of ponds.

5.22 This species was widely recorded within the Study Area, being seen on 20 ponds in the main study area south of the Kam Tin River. The opportunistic feeding behaviour of this species is reflected in its readily taking advantage of the fish-kill, which occurred at Ponds 18 and 19. At these ponds numbers increased from no more than five individuals during the early part of the study period to 80 birds on each pond on 13th January after fish had died (or were perhaps forced close to the surface due to deoxygenation of the water following dumping). As a consequence of this opportunistic feeding behaviour numbers of birds recorded on Ponds within the main Study Area varied markedly from a maximum of 199 birds on 13th January to a single bird on 19th January. The peak count of 199 birds represents 13.5% of the average peak winter count of this species during 1990-97 (Carey and Young 1999) and, coincidentally, also represents 13.5% of the total number of Little Egrets recorded during the January 2000 Inner Deep Bay Waterfowl Count (Carey 2000).

5.23 During March 2000, it was observed that an egretry, primarily occupied by Little Egrets, was in the process of formation in trees and bamboo to the southwest of Ponds 8 and 10. This appears to be a new egretry site, as Young and Cha (1995) or, more recently by Carey (1998) or Wong et al. (1999) recorded no egretry here. A maximum total of 78 adult Little Egrets was recorded in the egretry on 31st March and a total of 41 nests were counted on 11th April. During the period from 1990 to 1995 between 100 and 334 pairs of Little Egrets nested in Hong Kong (mean of 226 nests during this period). Numbers of this species in Hong Kong have shown an irregular, though broadly downward, trend subsequently and only 176 pairs were recorded in 1999 (Wong *et al.* 1999). Of this total only 68 pairs were present in the Deep Bay area and the largest Little Egret colony (at Mai Po village) contained 39 pairs. The new egretry within the Study Area is, therefore, of major significance within Hong Kong, holding 18% of the mean breeding population during 1990-95 and 23% of the 1999 Hong Kong and 60% of the 1999 Deep Bay population.

5.24 Of the species under consideration, the Little Egret was the most tolerant of human disturbance with a mean flushing distance of 120m. During the earlier part of the study period few birds were recorded within 400m of Route 3 suggesting that this road, perhaps linked with other human activities in the southern part of the Study Area, may have had some deleterious effect. This effect was less apparent once the egretry became established, suggesting that proximity to the egretry was a factor encouraging birds to feed nearby. However, numbers of birds feeding in certain ponds, notably Ponds 1A, 2, 3-6 and 11-15 remained relatively low suggesting that the relative scarcity of this species in these ponds was primarily a factor of the absence of its preferred habitat types.

Grey Heron *Ardea cinerea*

5.25 During the period from 1990-97 the average peak winter count of Grey Herons in the Deep Bay area was 1322 birds, representing up to 5.3% of the east/southeast Asian wintering population (Carey and Young 1999).

5.26 Up to 12 Grey Herons were found in the main Study Area (to the south of the Kam Tin River) the average number recorded was 3.6 individuals. However, since Grey Herons are primarily winter visitors to Hong Kong (Carey *et al.* in prep) only one or two birds were recorded per visit after mid-March. Whilst only small numbers of birds were recorded south of the Kam Tin River, the survey of Ponds 21-37 during December and January, showed that these ponds were important for Grey Herons. The ponds held an average of 55 birds, representing just under 5% of both the average Deep Bay winter population and the population during winter 1999/2000 (Carey and Young 1999, Carey 2000

5.27 It is considered that much feeding activity of Grey Herons in Hong Kong is nocturnal (Carey *et al.* in prep.) and, during the day, this species favours areas undisturbed by humans for roosting and loafing. It seems likely, therefore, that the ponds to the north of the Kam Tin River may form an important daytime refuge area for this species and the birds present may carry out much of their feeding along the MDC under cover of darkness. Birds do feed on fishponds, however, and in such circumstances typically feed solitarily on larger ponds where their larger size, together with their ability to plunge dive allows them to feed in water bodies unavailable to smaller Ardeids.

5.28 Observations within and near the study site showed that the majority of the Grey Herons in the area left within the hour prior to dusk. Most birds departed towards the Deep Bay area, but many also headed towards the Kam Tin Valley. These observations would support the assumption that the Nam Sang Wai area is primarily a daytime roost for this species.

5.29 Grey Herons are very intolerant of human disturbance and the average flushing distance recorded in this Study is, at almost 250m, the greatest of the Key Species considered here.

5.30 Taking the foregoing factors into account, it is unsurprising that the observations of Grey Herons were concentrated to the north of the Kam Tin River with the greatest numbers recorded on Ponds 26, 27, 29, 34 and 37. There was some evidence that birds favoured larger ponds. However, the most significant factor was undoubtedly remoteness from human disturbance with no birds recorded within 600m of Route 3 and a clear positive correlation with increasing distance from the road and other human activities in the southern part of the Area. Pond 26, which held an average of 14 birds in December and January generally held the largest numbers, this pond combined the merits of freedom of disturbance with the availability of an abandoned building which was used for roosting and loafing.

Other wetland-dependant bird species regularly occurring in the Study Area and significant observations of other bird species

5.31 As discussed in para. 5.6 (above), it is suggested that compensation measures should, primarily be focussed towards the Key Species. It is also necessary to assess potential impacts on all regularly occurring wetland-dependent bird species and to develop, where possible, compensation measures which will eliminate residual adverse impacts on these species. Such measures may be such that they can be accommodated within those measures proposed for the Key Species or they may require species-specific proposals within a part of the Study Area or microhabitat design. Significant observations of these additional wetland-dependent bird species are considered below. Except where otherwise stated, observations of these species relate to the area to the south of the Kam Tin River (Ponds 1-19) and the Kam Tin River itself ("Ponds" 20 and 20A). Where observations suggest that the occurrence or numbers of a species present in the Study Area are of, at least, local significance, this is clearly noted below.

Little Grebe *Tachybaptus ruficollis*

5.32 A maximum of 19 adult birds was recorded on 4th March. Regular observations suggested that there were five pairs breeding in the Study Area, with single pairs on Ponds 4, 5 and 6 and two pairs on Ponds 16/17. A pair with two young was noted on Pond 5 on 21st and 30th April and two nests were found on Pond 17 on 30th April. Whilst this species is probably under-recorded during standard waterfowl surveys, typical mid-winter counts for the Deep Bay area are of around 100 birds, and a count of 162 birds in November 1999 was considered to be relatively high (Carey 2000). The numbers present in the Study Area therefore may be significant in a Hong Kong context.

Black-crowned Night Heron *Nycticorax nycticorax*

5.33 A roost of up to 11 birds of this predominantly nocturnal heron was present adjacent to Pond 17 from 31st March to 30th April (the end of the study period). Like the Grey Heron, it is likely that Black-crowned Night Herons feed in the MDC at night. Black-crowned Night Herons are notoriously hard to census accurately and Hong Kong counts show wide fluctuations. For example, only two birds were recorded in Deep Bay during the March 2000 Waterfowl Count (Carey 2000), but it is known that winter counts of this species bear little relation to the numbers present (Carey *et al.* 1999). Against this background, it is hard to assess the importance of this roost objectively. Given that the breeding population in Hong Kong has declined substantially in recent years to only 295 pairs in 1999 (Wong *et al.* 1999) it would be prudent to assume that the roost is of at least local significance.

Cattle Egret *Bubulcus ibis*

5.34 Two birds were noted in the egretry to the west of Ponds 8 and 10 on one date, but there was no evidence of breeding. In 1999, 119 pairs of Cattle Egrets were recorded breeding in Hong Kong, of which only 24 pairs were found in the Deep Bay area (Wong *et al.* 1999).

Intermediate Egret *Egretta intermedia*

5.35 There were three observations of up to two birds between 19th January and 10th March. Intermediate Egrets are scarce passage migrants and winter visitors in Hong Kong (with no confirmed breeding records) (Carey *et al.* in prep.).

Great Egret *Egretta alba*

5.36 The Phase 1 Interim Report treated the Great Egret as a Key Species. However, with a maximum count of 8 birds (on 13th January) and a mean count of only 1.3 birds, such treatment is now considered inappropriate. To put these numbers in context, during the period from 1990-97 the average peak winter count of this species in the Deep Bay area was 529 birds, representing up to 5.3% of the east/south-east Asian wintering population (Carey and Young 1999).

5.37 Observations within the Study Area were scattered with (as for other Ardeids), relatively few sightings from those ponds closest to Route 3. A temporary concentration of eight birds at or near Pond 18 on 13th January was doubtless a consequence of a supply of readily available fish due to deoxygenation also noted with respect to numbers of Little Egrets. Compared with other species of Ardeids present in Deep Bay in winter, this species is relatively less dependent upon fishponds and other non-tidal habitats and more often uses the inter-tidal zone (Carey *et al.* in prep). It is, therefore, unsurprising that it was only recorded in small numbers in the Study Area.

Eurasian Wigeon *Anas penelope*

5.38 Up to 12 birds were recorded on Ponds 17 and 20 between 16th December and 27th January. Eurasian Wigeon is a winter visitor to Hong Kong; the five-year mean of peak winter counts in Deep Bay during the period 1993-94 to 1997-98 was 2420, comprising 0.25 - 2.4% of the East Asian population (Carey and Young 1999).

Common Teal *Anas crecca*

5.39 Up to ten birds were recorded on Pond 17 during the period from 4th December to 17th March. Common Teal is a winter visitor to Hong Kong; the five year mean of peak winter counts in Deep Bay during the period 1993-94 to 1997-98 was 4005, comprising 0.4 - 4% of the east Asian population (Carey and Young 1999).

White-breasted Waterhen *Amaurornis phoenicurus*

5.40 The White-breasted Waterhen is the most widespread breeding Rail in Hong Kong, and is very tolerant of disturbance and degradation of wetlands. It was relatively scarce in the Study Area with up to four birds recorded during the study period at Ponds 5 and 7 and in the Kam Tin River ("Ponds 20 and 20A). The latter site regularly held two birds, suggesting that a breeding pair was present at this location.

Common Moorhen *Gallinula chloropus*

5.41 The Common Moorhen breeds regularly in the Deep Bay area and larger numbers occur in winter (Carey *et al.* in prep.). The peak number counted during Waterfowl Counts in winter 1999 -2000 was 171 birds. Up to 34 birds were recorded in the Study Area, with regular observations of up to five birds on Pond 1D and a concentration on Pond 17 during most of the study period. Numbers on Pond 17 peaked at 31 on 4th March. Whilst numbers of this rather skulking species are probably underestimated during standard Waterfowl Counts, the concentration of birds on Pond 17 is clearly of at least local significance.

Eurasian Coot *Fulica atra*

5.42 Up to two Eurasian Coots were recorded on Ponds 5, 10, 12, 18, 19 and 20 during the period from 4th December to 19th January. The peak number recorded of Eurasian Coots recorded in Deep Bay during Waterfowl Counts in winter 1999 - 2000 was 654 birds (Carey 2000).

Little-ringed Plover *Charadrius dubius*

5.43 Up to 21 birds were regularly recorded in the Study Area, on Ponds 1A (peak of 15 birds), Pond 2 (peak of 20 birds) and on the Kam Tin River (one bird). Evidence of breeding was recorded at all three of these sites. Little-ringed Plovers are one of only two wader species that now breed regularly in Hong Kong (Carey *et al.* in prep.). The breeding population is poorly known as breeding birds typically utilise ephemeral sites such as landfills prior to vegetation becoming established. The peak count of the species during Waterfowl Counts in winter 1999 - 2000 was 202 birds (Carey 2000). This is known to be a significant underestimate, as these counts do not include areas such as the MDC at Kam Tin, which regularly holds over 50 birds (M.R. Leven pers. obs.).

5.44 The Little-ringed Plover is one bird species that has undoubtedly benefited from the low water levels in Ponds 1A and 2, as they require open non-vegetated areas for feeding and breeding. In view of the absence of data on both wintering and breeding populations it is difficult to assess the importance of the population of the Study Area, but it would be prudent to assume that it is of local significance.

Temminck's Stint *Calidris temminckii*

5.45 Temminck's Stints were recorded irregularly on Pond 1A: six birds on 15 February, eight on 31st March and three on 5th April. Temminck's Stints are a rather scarce winter visitor to Hong Kong, favouring shallows and edges of fishponds and other areas of still, fresh or brackish water. A peak count of only 19 birds was recorded in Deep Bay during Waterfowl Counts in winter 1999 - 2000 (Carey 2000). The habits and habitat preferences of this species result in it being under-recorded during these counts - for example birds, which were not enumerated during these counts were present on temporary ponds within the proposed Tin Shui Wai Wetland Park site during January 2000 (M.R. Leven pers. obs.). As with the preceding species, in the absence of firm data, it is prudent to assume that the Study Area is of local importance for this species.

Common Snipe *Gallinago gallinago*

5.46 Up to three birds were recorded irregularly on Ponds 1A and 17 and alongside the Kam Tin River. Common Snipes are not well recorded during Waterfowl Counts as many individuals occur on wet agricultural land (Leven 1998). The sporadic occurrences within the Study Area are not considered to be significant.

Green Sandpiper *Tringa ochropus*

5.47 Up to six birds were recorded in the Study Area throughout the study period (at Ponds 1A, 1B, 2 and, especially on Ponds 16-19 and on the Kam Tin River). This species is not adequately surveyed by Waterfowl Counts as small numbers of birds occur widely in the Deep Bay area, feeding opportunistically around fishponds, in creeks and on other small water-bodies, often in degraded habitats such as drainage channels.

Common Sandpiper *Tringa hypoleucos*

5.48 Up to six birds were recorded in the Study Area, with a similar distribution to the previous species, occurring on Ponds 1A, 7, and 16-17 and on the Kam Tin River. Like the Green Sandpiper, as a consequence of this scattered distribution, Common Sandpiper is not adequately surveyed by Waterfowl Counts as small numbers of birds occur widely in the Deep Bay area, feeding opportunistically around fishponds, in creeks, drainage channels and on other small water-bodies.

White-throated Kingfisher *Halcyon smyrnensis*

5.49 Single birds were recorded on Pond 1A on 31st March and 5th April and on the Kam Tin River ("Pond" 20) on 5th April and 21st April, with breeding suspected on the Kam Tin River on the latter date. Whilst still widespread, this species has declined in Hong Kong as a breeding bird since the 1930s (Carey *et al.* in prep.) and it would be appropriate to avoid adverse impacts on known breeding sites.

Common Kingfisher *Alcedo atthis*

5.50 Up to five birds were recorded from Ponds 1A, 1D, 2, 7, 15, 17 and on the Kam Tin River. Two birds recorded at Pond 16 on 30th April were exhibiting breeding behaviour. Whilst still widespread, especially as a winter visitor, this species has declined in Hong Kong as a breeding bird since the 1930s (Carey *et al.* in prep.) and it would be appropriate to avoid adverse impacts on known breeding sites.

Pied Kingfisher *Ceryle rudis*

5.51 Up to three birds were recorded in the Study Area, all on Ponds 8 and 12-14 and on the Kam Tin River from 4th March to the end of the study period. The concentration of records suggests that breeding might occur in this area. The Pied Kingfisher is a scarce breeding bird in Hong Kong, being largely confined to Deep Bay and Starling Inlet (Carey *et al.* in prep.) and adverse impacts on known breeding sites should be avoided.

Yellow Wagtail *Motacilla flava*

5.52 The Yellow Wagtail is a common winter visitor and an abundant passage migrant throughout wetlands in the northern New Territories, especially favouring wetland agriculture, fishpond bunds and drained fishponds (Carey *et al.* in prep.). Small numbers of this species were widespread in the Study Area but no notable concentrations were observed.

Common Stonechat *Saxicola torquata*

5.53 The Common Stonechat is not strictly a wetland-dependent species, as it occurs widely in dryland and abandoned agricultural areas (Leven 1998). Nevertheless, fishpond bunds form an important habitat for this species in Hong Kong (Carey *et al.* in prep.). Up to 11 birds were recorded in widely scattered locations in the Study Area suggesting that this area is (as might be anticipated), suitable wintering habitat for this migrant species.

Dusky Warbler *Phylloscopus fuscatus*

5.54 The Dusky Warbler is an abundant winter visitor to wetlands in Hong Kong. Though it will utilise vegetated fishpond bunds especially where there is some shrub growth, it occurs in largest numbers in reedbeds and mangroves (Carey *et al.* in prep.). Small numbers of Dusky Warblers were recorded widely in the Study Area, but the grass-covered bunds are not this species' favoured habitat.

Red-billed Starling *Sturnus sericeus*

5.55 Up to 20 birds were recorded irregularly feeding along the Kam Tin River and up to ten birds were seen at Pond 17 on two occasions. This species is listed as Near-threatened by Collar *et al.* (1994) and the Hong Kong wintering population of up to at least 3,000 birds is almost certainly of international importance (Carey *et al.* in prep.). Red-billed Starlings typically feed along the edges of fishponds, creeks and other wetland sites with abundant invertebrates (Carey *et al.* in prep.). Whilst the

numbers of Red-billed Starlings recorded in the Study Area are not large, in view of its global status, loss of feeding habitat for this species should be avoided.

White-shouldered Starling *Sturnus sinensis*

5.56 Two birds were seen at Pond 1A on 11th April; whilst on the Kam Tin River two birds were recorded on 21st April with four seen there on 30th April. On this last date the birds were behaving as if breeding. White-shouldered Starlings were not considered to be wetland-dependent by earlier observers in Hong Kong, but this species is now largely restricted to wetland areas, especially as a breeding bird and breeding numbers have declined substantially in the 20th century (Leven 1998, Carey *et al.* in prep.). All breeding sites of this species are now of at least local significance in Hong Kong.

Other bird species

5.57 The occurrence of other bird species not discussed above is listed at Table 5.2. These species are birds: which are common and widespread in Hong Kong according to Carey *et al.* (in prep.) and for which the populations within the Study Area are not significant on even a local basis; or, species for which isolated occurrences within the Study Area are similarly not of significance. It should be noted, however, that the study period did not cover autumn migration at which time a number of species, notably Warblers *Acrocephalus* and *Locustella* and Buntings *Emberiza* are known to use fishpond bunds in large numbers. Based on comparison of the habitats in the Study Area with similar habitats elsewhere it seems likely that the Study Area could hold significant numbers of these species at this time.

Mammals

5.58 Larger mammals (e.g. Mongooses, Civets, Otter, Leopard cat, Wild boar, Barking deer) were surveyed by day, searching for signs such as scats, diggings and burrows, and by night.

5.59 Only one large mammal was observed, a Small Asian Mongoose *Herpestes javanicus* recorded at Pond 8 on 5th April. The Small Asian Mongoose is widespread in the Deep Bay area (Reels 1996). The busy roads to the south and east, and the broad channel to the north of the site undoubtedly act as barriers to larger mammal species. Several rats (*Rattus* sp.) were observed at various locations across the Study Area. However, since identification of rats, mice and shrews was not part of the study brief, no attempt was made to identify them.

5.60 Numerous bats were observed foraging for insects over the ponds during every night visit to the Study Area. Significantly, on 31 March a dead bat was found in a roosting posture on a wooden ceiling beam in a derelict building located on the bund between Pond 1A and Pond 2. This bat was photographed *in-situ* and then collected. It was subsequently passed on to Dr. Gary Ades (of Kadoorie Farm & Botanic Garden), the acknowledged authority on Hong Kong bats. Dr. Ades identified the bat as Yellow House-bat *Scotophilus kuhlii*. This species has only been recorded from 3 other locations in the New Territories in Hong Kong, and its status locally is presently considered rare (Ades, 1999).

5.61 Since all bats are protected under the *Wild Animals Protection Ordinance*, the derelict building in which the bat was found represents a potentially important roost. This insectivorous bat species typically roosts in old buildings, which have concealed roof spaces. Colonies may consist of a few individuals or number several hundred. Yellow House-bats have been seen foraging along watercourses in the northern New Territories and also foraging around fairly disturbed abandoned agricultural fields. Since, as with most bat species, the roost sites are one of the major limiting factors to distribution and survival in Hong Kong, the loss of any known or potential roost sites should be considered seriously. Although no further evidence of current use by bats was found, it is possible that the building is used seasonally.

Reptiles

5.62 Reptiles were surveyed by active searching in appropriate microhabitats during day and night visits to the Study Area. The findings are as shown on Table 5.3:

Table 5.3
Reptiles recorded at the Yuen Long Bypass Floodway site, Mar-Apr 2000

Species	Common name	Location	Number
Chinemys reevesii	Reeves' Terrapin	Northern bund of Pond 1D	1
Gekko chinensis	Chinese Gecko	Road to east of Pond 5	1
Hemidactylus bowringii	Bowring's Gecko	Derelict land to east of Pond 6 Derelict building between Ponds 1A and 2	1 2
Eumeces chinensis	Chinese Skink	Northern bund of Pond 15 Edge of Pond 1C	1 1
Scincella reevesii	Reeves' Smooth Skink	Derelict building between Ponds 1A and 2	1 (gravid female)
Xenochrophis piscator	Checkered Keelback	Pond 1C	1
Ramphotyphlops braminus	Common Blind Snake	Bund between Ponds 11B and 8 Northern bund of Pond 1 Derelict building between Ponds 1A and 2	2 1 2

5.63 All of the reptile species encountered are common and widespread in lowland Hong Kong (Karsen *et al.*, 1998). However, Reeves' Terrapin may be declining locally due to competition from the introduced North American Red-eared Slider *Trachemys scripta* (Karsen *et al.*, 1998). Other common species not recorded during the survey which might be expected to be present in the study area include Changeable Lizard *Calotes versicolor* Chinese Water Snake *Enhydris chinensis*, Indo-chinese Ratsnake *Ptyas korros* and Common Ratsnake *Ptyas mucosus*.

Amphibians

5.64 Amphibians were surveyed visually and aurally during day and night visits to the Study Area. Findings were as follows:

Table 5.4
Amphibians recorded at the Yuen Long Bypass Floodway site, Mar-Apr 2000

Species	Common name	Location	Number (estimate)
Bufo melanostictus	Asian Common Toad	Ponds 1A, 1B, 1C, 1D, 2, 5, 17	numerous (>50)
Rana guentheri	Gunther's Frog	Ponds 1, 1A, 1B, 1C, 1D, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 17	abundant (>100)
Polypedates megacephalus	Brown Tree Frog	Ponds 1A, 1C, 2	<5
Kalophrynus interlineatus	Spotted Narrow-mouthed Frog	Ponds 1A, 1B, 1C, 2, road by Pond 5	numerous (>50)
Kaloula pulchra	Asiatic Painted Frog	Drainage channel to south of Pond 2	3

5.65 Five species of amphibian were recorded at the Study Area. The most notable of these was the Spotted Narrow-mouthed Frog, which was calling in large numbers at the southern end of the Study Area by mid-April. This species appears to be confined to the northern New Territories locally (Karsen *et al.*, 1998; Lau & Dudgeon, 1999). The Asiatic Painted Frog was first seen and heard calling after the heavy rains of mid-April, also at the southern end of the Study Area. Brown Tree Frogs were heard from late March. Asian Common Toad and Gunther's Frog are very common and widespread throughout lowland Hong Kong, particularly in the New Territories. The Paddy Frog *Rana limnocharis* might also be expected at the Study Area, but was not recorded during the survey.

Odonates (Dragonflies & Damselflies)

5.66 The study area supports a large number of lentic habitat dragonfly species, with 21 species recorded out of a potential total of around 30 (see Wilson, 1995).

Table 5.5
Odonates recorded at the Yuen Long Bypass Floodway site, Mar-Apr 2000

Species	Location	Number (estimate)	Breeding activity observed
Agriocnemis pygmaea	Ponds 1C, 15	2	
Ischnura senegalensis	Ubiquitous	very abundant ('000s)	✓
Ceriagrion auranticum	Ponds 1A, 1C, 1D, 2, 4, 5, 6, 12, 15, small pond north of 2	numerous (>50)	✓
Anaciaeschna jaspidea	Ponds 1A, 1D, 5, 6	4	
Anax guttatus	Ponds 1A, 1D, 2, 17	6	
Anax parthenope	Ponds 1C, 2	3	
Epopthalmia elegans	Ponds 1A, 1D, 6	5	
Sinictinogomphus clavatus	Ponds 1A, 1D, 6	6	✓
Brachydiplax chalybea	Ponds 1C, 1D, 2, 12, 17, small pond north of 2	frequent (>20)	
Orthetrum sabina	Ubiquitous	abundant ('00s)	✓
Acisoma panorpoides	Ponds 1D, 17	3	✓
Brachythemis contaminata	Ubiquitous	abundant ('00s)	✓
Crocothemis servilia	Ponds 1C, 1D, 2	6	
Diplacodes trivialis	Ponds 1, 1A, 1B	3	
Neurothemis tullia	Ponds 1B, 2	2	
Pseudothemis zonata	Ponds 1D, 12, village area (female)	4	
Trithemis aurora	Ponds 1A, 1C, 1D	5	
Rhyothemis variegata	Ubiquitous	abundant ('00s)	
Pantala flavescens	Ponds 1A, 2, 2A, 9, 15	>10	
Tramea virginia	Ubiquitous	numerous (>50)	✓
Tholymis tillarga	Subway between Ponds 1B and 1D	1	

5.67 Wilson (1997) regards most of these species as 'Common' or 'Abundant' in Hong Kong, with the exceptions of *Agriocnemis pygmaea*, *Epopthalmia elegans*, *Sinictinogomphus clavatus*, *Acisoma panorpoides* and *Neurothemis tullia*, which are all rated as 'Fairly Common'. All five of these species were recorded in the southern part of the Study Area (*Agriocnemis pygmaea* and *Acisoma panorpoides* were also recorded from elsewhere in the Study Area).

Butterflies

5.68 Butterflies were very poorly represented across the Study Area, primarily due to low floral diversity, although timing of the survey would also be a factor, and it is probable that a survey later in the year would yield more species.

Table 5.6
Butterflies recorded at the Yuen Long Bypass Floodway site, Mar-Apr 2000

Species	Common name
Graphium agamemnon	Tailed Jay
Graphium sarpedon	Common Bluebottle
Papilio clytia	Common Mime
Papilio demoleus	Lime Butterfly
Papilio helenus	Red Helen
Papilio polytes	Common Mormon
Delias pasithoe	Red-base Jezebel
Eurema hecabe	Common Grass Yellow
Pieris canidia	Indian Cabbage White
Hestina assimilis	Red Ring-skirt
Junonia almana	Peacock Pansy
Mycalesis mineus	Dark-brand Bush Brown
Zizeeria maha	Pale Grass Blue

5.69 Among the 13 species encountered during the survey, the most abundant were the Indian Cabbage White *Pieris canidia* and the Pale Grass Blue *Zizeeria maha*. All species encountered are common or very common in Hong Kong (e.g. Walthew, 1997; Bascombe *et al.*, 1999). Six species were strong-flying papilionids that may not have bred at the Study Area.

Ecological importance of the Study Area

5.70 Whilst the Study Area primarily comprises anthropogenic habitats, and is much affected by disturbance, particularly from Route 3, it nevertheless contains much of ecological value. The additional fieldwork undertaken since the preparation of the Phase 1 Interim Report has been valuable in highlighting substantial differences between the summer and winter bird communities (with the Study Area being of greater importance in summer); and in providing information as to the Study Area's importance for other taxa groups. The Study Area can be subdivided as follows:

Area directly affected by the proposed route of the Bypass Floodway (Ponds 1-3, 5, 6 & 9)

5.71 Winter season fieldwork in this area suggested that use of this area by Key Bird Species was extremely limited. This was considered to be a consequence of the fact that the area was impacted by the following factors:

(i) Direct disturbance from Route 3;

(ii) Human activity around houses and other buildings;

(iii) Low water levels in Ponds 1A and 2 previously affected by the construction of Route 3 (apparently due to ponds' owner no longer wishing these to be used as fishponds);

(iv) Restored pond remnants arising from construction of the MDC are less attractive to Key Species than full size working ponds.

5.72 Whilst spring season fieldwork showed relatively little use of this area by the Chinese Pond Heron and Little Egret, the two breeding Key Bird Species (the other two species Great Cormorant and Grey Heron are largely winter visitors), utilisation of this area was distinctly greater than in winter. Reasons for this change are not certain but may be a consequence of greater food availability in summer in the partially restored ponds, increases in water levels due to rainfall, natural successional recovery and proximity to the newly established egretry. The changes in numbers of these species using this area (and the remainder of the Study Area) are detailed in Table 5.7.

Table 5.7
Comparison of Pond Utilisation by Chinese Pond Heron and Little Egret in winter (December 1999 - February 2000) and spring (March - April 2000) (average number of birds per pond)

Area	Winter		Spring	
	Chinese Pond Heron	*Little Egret*	*Chinese Pond Heron*	*Little Egret*
Ponds 1-3, 5-6 & 9	0.02	0.08	0.26	0.19
Ponds 4,7, 8, 10 & 11	0.24	0.13	0.32	0.57*
Ponds 12-15	0.25	0.08	0.06	0.31
Ponds 16-19	1.73	4.38	0.42	0.64
Kam Tin River	1.54	1.81	0.44	0.61

* Total does not include up to 78 birds present in egretry

5.73 However, perhaps partly as a consequence of the fact that the southern Ponds (in particular the larger Ponds 1A and 2) have not resumed commercial fish production, these ponds do have considerable value for other wetland-dependent bird species, in particular waders and especially Little-ringed Plover. They are also the most ecologically valuable part of the site, so far as bats, reptiles, amphibians and dragonflies are concerned. These ponds are generally shallower and contain more structurally diverse vegetation than other ponds in the Study Area which (with the notable exception of Pond 17 at the northern end) were usually characterised by steep regular banks overgrown with impenetrable stands of tall grasses (although Pond 9 was planted with short mango trees). The derelict building between Ponds 1A and 2 is potentially an important bat roost and is also a rather good herpetological site (Bowring's Gecko, Reeve's Smooth Skink and Common Blind Snake were all recorded here). Reeves' Terrapin was observed at Pond 1D and nowhere else on the site. Spotted Narrow-mouthed Frog, Asiatic Painted Frog and Brown Tree Frog were only recorded at the southern ponds, and the highest dragonfly diversity, including the most notable species, is to be found in Ponds 1A-D and 2.

Ponds 4 and 7 - 15

5.74 These ponds share the relatively low numbers of Key Bird Species of the most southern ponds and differ primarily in the fact that, with the exception of Pond 9 (which is planted with Mango Trees) and the restored Ponds 11 and 11B they are steep-sided and thickly vegetated with long grass. The lack of habitat diversity provides few niches for wildlife and, unlike the southern ponds, recent construction activities have not provided the incidental wildlife benefits that these ponds have accrued. Ponds 8 and 10 are, however, immediately adjacent to a new egretry which contains at least 41 pairs of Little Egrets and three pairs of Chinese Pond Herons. This egretry is of considerable significance within the context of the Ramsar Site and Hong Kong as a whole.

5.75 With the notable exception of the egretry, factors inhibiting wildlife use are considered to be:

(i) Unsuitable habitat-type, in terms of fishpond profile and management regime:

(ii) Human activity;

(iii) Disturbance from Route 3.

Ponds 16-19 and Kam Tin River ("Ponds" 20 and 20A)

5.76 This area is the main zone utilised for feeding by Chinese Pond Herons and Little Egrets, especially in winter. The former species undoubtedly benefits from the high edge to area ratio of the small ponds (Carey and Young 1999) and the feeding opportunities provided by the Kam Tin River. Little Egret appears to have benefited from the short-term effects of dumping adjacent to Ponds 18 and 19 creating a temporarily abundant food supply. The same factors encouraging use by these species probably militate against use Grey Herons and Great Cormorants. With respect to other wetland-dependent bird species, these ponds contain a characteristic array of species that typically use fishponds, and support a notable concentration of Common Moorhens that may be of local significance. The "globally near-threatened" Red-billed Starling uses this area in small numbers.

Ponds 21 - 37

5.77 Initial fieldwork carried out in this area during the earlier part of the Study (until 13th January) is primarily of value in providing an indication of the possible disturbance effects from Route 3 and other anthropogenic factors operating in the main Study Area. The most notable difference observed at Ponds 21 - 37 was the significantly higher utilisation by more disturbance-sensitive species, notably Great Cormorant and Grey Heron.

Value of area to be lost as a consequence of the construction of the Bypass Floodway

5.78 The section of the YLBF north of Pok Oi passes through an area of fishponds which shows a relatively low level of utilisation by Key Bird Species. As is discussed above, this is considered to be primarily a consequence of the ongoing disturbance caused by Route 3; exacerbated in some areas by other human activities. Whilst the lack of commercial fishpond production at Ponds 1A and 2 probably inhibits use by two Key Bird Species (Chinese Pond Heron and Little Egret) it has, serendipitously, created suitable habitat for a range of other wildlife: notably reptiles, amphibians, butterflies, dragonflies and some bird species, in particular wading birds which favour shallow areas of fresh or brackish water. Also in this area, the presence of a Yellow House-bat utilising an abandoned dwelling is presumably also consequence of Route 3 construction leading to the dwelling being abandoned.

Impacts on individual species

5.79 Potential adverse impacts of the proposed YLBF route north to Pok Oi Hospital on species considered to be of conservation importance are summarised in Table 5.8.

Table 5.8
Potential adverse impacts of proposed YLBF route north to Pok Oi Hospital on species of conservation importance if no mitigation measures are implemented

Species	Permanent impact	Construction impact	Notes
Birds			
Little Grebe	Loss of breeding habitat for 2 prs. (Ponds 5 and 6)	Loss of breeding habitat for 2 prs. and disturbance of one pr. (Pond 7)	Also limited loss of winter foraging area
Great Cormorant	None	None	Species unlikely to use areas close to Route 3
Cattle Egret	None	Potential	Potential disturbance impact if Cattle Egret uses egretry in future years
Chinese Pond Heron	Limited loss of feeding habitat	Disturbance of feeding habitat; disturbance to breeding birds	Egretry is 170m from proposed YLBF route
Little Egret	Limited loss of feeding habitat	Disturbance of feeding habitat; disturbance to breeding birds	Egretry is 170m from proposed YLBF route
Grey Heron	Limited loss of feeding habitat	Limited disturbance of feeding habitat	Species likely to use areas close to Route 3 in small numbers only
White-breasted Waterhen	Limited loss of breeding / foraging areas	Limited loss of breeding / foraging areas	Species relatively insensitive to disturbance
Common Moorhen	Loss of breeding and foraging habitat (primarily at Pond 1D)	Limited loss of breeding / foraging areas	Not present in significant numbers in disturbed areas
Little Ringed Plover	Loss of foraging areas for c. 20 birds and several breeding pairs (Ponds 1A and 2)		Species relatively insensitive to disturbance; numbers may increase during construction period
Temminck's Stint	Loss of foraging areas (up to 8 birds on Pond 1A)	Loss of foraging areas	
Mammals			
Yellow House Bat	Loss of roost site (Pond 1A/2)	Loss of roost site and loss of feeding areas	
Amphibians			
Spotted Narrow-mouthed Frog	Loss of habitat (Ponds 1A, 1B, 1C, 2,5	As permanent impact	
Dragonflies			
Acisoma panorpoides	Loss of breeding habitat (Pond 1D)*	As permanent impact	
Agriocnemis pygmaea	Loss of breeding habitat (Pond 1C)*	As permanent impact	
Epopthalmia elegans	Loss of breeding habitat (Ponds 1A, 1D and 6)*	As permanent impact	
Neurothemis tullia	Loss of breeding habitat (Ponds 1B and 2)*	As permanent impact	
Sinictinogomphus clavatus	Loss of breeding habitat (Ponds 1A, 1D and 6)*	As permanent impact	

* Dragonfly records are ascribed to ponds where adults were recorded. Breeding may not necessarily have taken place at these ponds but probably occurred nearby.

Wildlife species previously discussed in the survey report, which do not appear on this list, are not considered to be vulnerable to significant potential adverse impacts.

5.80 Adverse ecological effects of the proposed route north to Pok Oi Hospital would, therefore, include the following:

(i) Limited direct and indirect effects on foraging areas for Key Bird Species (principally Chinese Pond Herons and Little Egrets);

(ii) Potentially significant disturbance effects on an egretry significant at a Hong Kong level, primarily to Little Egrets;

(iii) Loss of a roost site for the Yellow House-bat, considered to be rare in Hong Kong

(iv) Habitat loss for bird, amphibian and dragonfly species making use of the wetlands formed by the Ponds 1A - 2.

5.81 For the key bird species, however, the adverse ecological effects are limited by the cessation of commercial fishpond operations in the ponds directly affected by the construction of Route 3 (albeit this has inadvertently created suitable habitat for other taxa) compounded by the ongoing disturbance arising from the operation of Route 3. Compensatory wetland provision for the YLBF should, therefore, seek not only to mitigate for direct fishpond habitat loss, but also to address the requirement to restore the wetland function within the Study Area with respect to the targeted Key Species.

Proposed habitat replacement and targeted Key Species

5.82 No true baseline survey data is available for the fishpond area around the Au Tau prior to the construction of Route 3 that could provide a basis for assessment of compensation of wetland to be lost. For the purposes of the present assessment Ponds 1A and 2 were assessed based on their assumed restoration.

5.83 Of the species in question, it is considered that the sensitivity of Grey Heron and Great Cormorant to disturbance is such that they could not be predicted to use the affected areas in significant numbers even if the habitat had been reinstated to a level suitable for these species. However, Little Egret and, especially, Chinese Pond Heron could be expected to utilise these areas subject to reduced levels of use as a consequence of the disturbance impacts from Route 3.

Development of alternative mitigation measures

Original mitigation measures

5.84 The prime concern of the original mitigation was to avoid taking the Floodway close to the *fung shui* knoll, and thus preserve the ecological integrity of the ponds surrounding the knoll. The marshcrete mitigation proposed in the EIA (BBV, 1998) was not intended to be "like-for-like" replication of lost habitat, but proposed easily maintained, in-channel, soft-engineering that was appropriate to its proximity to the disturbance generated by the operation of Route 3. It was recognised that feeding opportunities for wading birds is limited to shallows (or pond edges), and the inundated marshcrete offered more extensive feeding opportunities such as are found in wet agricultural land. The issues arising from land ownership (which have prompted this reassessment) have given rise to the opportunity to move mitigation into a habitat of potentially higher value. This opportunity is explored in the following paragraphs.

Compensation requirements for the mitigation area

5.85 Given the evidence above that there is a disturbance corridor due to Route 3, any mitigation areas within that corridor will be unlikely to serve any compensatory purpose in respect of the Key Species in the absence of measures to reduce disturbances. Given that the Grey Heron and Great Cormorant require largely undisturbed habitats, the mitigation areas should focus on enhancing habitat for the Little Egret and Chinese Pond Heron. Further refinement should address habitat creation for other species (notably amphibians and dragonflies) which will also be able to utilise the enhanced areas.

5.86 Chinese Pond Heron and Little Egret were both found to occur in very low densities up to about 600m from Route 3. As such, it is considered that the main mitigation areas should be at least 600m from Route 3 (Figure 5.1). However with some modification of the fishponds slightly closer to Route 3 and the MDC, i.e. ponds 11 to 15, these ponds would be suitable for mitigation purposes. The numbers of each species using the area to be affected by the YLBF, and their area proposed is shown in Table 5.10.

Table 5.9
Number of Key Species in ponds affected by the floodway and in the proposed mitigation area

Species	Number of Birds in area affected by floodway[1]	Number of birds in proposed mitigation area[2]	Ratio
Cormorant	0	34	-
Chinese Pond Heron	2	35	18
Little Egret	8	27	3
Grey Heron	1	3	3

[1] Ponds 1A, 1B, 1C, 1D, 2, 2A, 3, 5, 6, 7 and 9.
[2] Ponds 9, 11, 11B, 12, 14 and 15

5.87 Table 5.9 shows that changes in habitat type in the revised mitigation area, (which is outside the area affected by the Floodway), needs to enhance the higher value ponds (12, 14 and 15) to compensate for lost ecological function of the marshcrete or the existing habitat. Given that the area for mitigation is approximately the same as the area directly affected by the Floodway.

5.88 The revised mitigation measures will be directed towards the Chinese Pond Heron and Little Egret, which would benefit most from changes in habitat type and food availability through changed management of the ponds. These species will benefit from the appropriate contouring of fishponds, draw down regimes designed to enhance food availability and physical measures to reduce disturbance. It is proposed that habitat creation or enhancement should be targeted at providing appropriate conditions for these species, together with other wetland-dependent species in the Study Area that have comparable habitat requirements.

Habitat type for mitigation areas

5.89 It is apparent that the habitat type within the Study area has, on average, very high intrinsic ecological value. While in some areas this is compromised by disturbance, or modification due to infrastructure projects, there would appear to be no reason to change from a fishpond type habitat to any other in the fishponds where birds are currently feeding. This high ecological value is widely recognised within Hong Kong (PlanD Study on the Ecological Value of Fish Ponds in the Deep Bay Area 1998). Compensation of fishpond loss in an area of ponds with relatively low usage due to physical characteristics (e.g. steep edges making foraging impossible) is the most suitable compensation technique in the current instance. The only other habitat type within the study area (abandoned river channel) was also found to

have high ecological value, and this has been considered in the possible recreation of marshcrete and reedbed type habitat which has originally proposed in the EIA for the function of water clean-up. The area for reedbed would be limited in area, would be close to the Floodway channel, and would have functions of water clean-up and provide a barrier for disturbance from sources such as the MDC and Route 3. In addition it will provide important habitat for migrant, wetland-dependent, passerine birds such as *Acrocephalus* and *Locustella* warblers. Whilst these species were not recorded in the present Study, it is predicted that it is likely that they will occur in significant numbers in the YLBF corridor in autumn, and it is, therefore, appropriate to reprovide suitable habitat for these species. The habitat types for mitigation therefore fall into 2 categories:

(i) enhancement of fishponds through change in profile and management regime, and

(ii) construction of a marshcrete and reedbed area for water clean-up and a barrier to disturbance.

Location of mitigation areas

5.90 Given the constraints noted above, the *ideal* location of the revised mitigation area should fulfil the following criteria:

(iii) greater than 600m from Route 3 and/or in a relatively undisturbed area
(iv) have significant enhancement potential
(v) be on Government Land

Areas identified for mitigation

5.91 Based on the requirements stated above it is considered that within the study area, ponds 11 to 15 provide a suitable location for mitigation. This area is divided into two areas:

(vi) for ecological mitigation through fishpond enhancement
(vii) for water clean-up mitigation through reedbed establishment.

5.92 Separation of these functions is required because of the location of the area now available for compensation. The reedbed will be located in an area close to the channel to minimize the amount of pumping which would be required to feed water into this area for the purpose of water clean-up. This area is still disturbed by the presence of Route 3 and adjacent roads, and is therefore not suitable for full ecological mitigation, although these areas will fulfill a valuable function in providing habitat for less disturbance-sensitive bird species (as noted above). An

area of less disturbed fishponds has been selected for ecological compensation of the Key Species, the smaller ardeids and also provide compensatory habitat for amphibians, dragonflies and other impacted bird species such as Little Grebe, Common Moorhen and waders. Use of these functioning ponds as water clean-up would degrade those ponds; and is impractical due to their distance from the YLBF.

5.93 The methodology for selecting alternative mitigation sites seeks to utilise and exhaust all available parcels of Government land. In respect of water clean-up opportunities, this report proposes to use Ponds 9, 11 and 11B for modification to reedbeds for water clean-up purpose while Ponds 12, 14 and 15 are proposed to be enhanced for ecological mitigation (see Figure 5.1). These ponds fall within an area zoned "Conservation Area" ("CA") on the draft Nam Sang Wai Outline Zoning Plan (OZP) No. S/YL-NSW/1. These water clean-up and ecological mitigation works can generally be considered as environmental improvement works to be carried out by Government departments. According to the General Notes of the OZP, such environmental improvement works are always permitted and no planning permission is required. Table 5.10 shows the area of each pond and the proposed use of each pond in the mitigation scheme. Ponds 1C and 2A were not found to be viable for inclusion in the alternative mitigation plan.

Table 5.10
Ponds proposed for mitigation

Pond	Area (m^2)	Current Habitat Type	Proposed Mitigation
9	7370	Pond (managed) CLP pylon	Partially infill the pond and plant as a reedbed to compensate for removal of marshcrete under previous mitigation
11/ 11B	2685/ 2298	Pond half-filled with water, no fish stock.	Partially infill the pond and plant as a reedbed to compensate for removal of marshcrete under previous mitigation
12	16591	These ponds are rainfilled and have some fish stock in them, but are not managed.	These ponds will be reprofiled and managed as fishponds for ecological purposes.
14	16973		
15	15172	Rainfilled pond, with some fish stock but not managed	This ponds will be managed to improve food availability, and surrounded by a reedbed margin to provide shelter and a physical barrier to disturbance.
Total	61,089		

* 1520m^2 of Pond 9 will be lost to the northern revetment of the Floodway, but a similar area can be required by incorporating the bund separating Ponds 9 and 11B into the clean-up area (see Figures 5.1 and 5.3).

5.94 In addition, Pond 9 is in the process of being established as an actively managed pond. A pylon is present in the centre which may inhibit some birds using the area. It is proposed that this pond be included in the reedbed water clean-up mitigation area.

5.95 Clearly, several ponds suggested for mitigation are less than 600m from Route 3. While this is within the disturbance corridor, and therefore reduces the enhancement potential of these sites, it does not prevent this. In particular with respect to provision for amphibians, dragonflies, Little Grebes and Common Moorhens which are either not disturbance-sensitive, or are less sensitive than ardeids. Based on the low numbers of key species within the area to be lost, the proposed mitigation area is considered to be adequate area for mitigation.

5.96 Other potential locations for mitigation do not exist within the current study area, due to a combination of private ownership and/or current high ecological value, which offers little opportunity for enhancement.

5.97 From Table 5.11 it is clear that Ponds 12-15 were found to hold very low numbers of both Little Egret and Chinese Pond Heron. This is in stark contrast to Ponds 18 and 19, which, due to the circumstances discussed above, were used by very high numbers of these two species. Thus it would appear that enhancement is a viable option at Ponds 12-15, and within the limits required for mitigation.

Table 5.11
Numbers of Chinese Pond Heron and
Little Egret utilising Ponds 12-15 and 18-19

	Pond 12	Pond 13	Pond 14	Pond 15	Pond 18	Pond 19
Little Egret						
Average per visit	0.05	0.2	0.3	0.1	4.3	5.1
Maximum	1	2	2	2	80	80
Chinese Pond Heron						
Average per visit	0.2	0.1	0.1	0.2	1.2	0.8
Maximum	2	2	2	3	10	6

Type of mitigation

Ecological Enhancement

5.98 Enhancement of Ponds 12, 14 and 15 (as shown in Figure 5.2) should comprise three changes in pond structure and management:

(i) Increase area of shallow water available for foraging
(ii) Control over timing and duration of drainage
(iii) Control of vegetation on bunds

5.99 By reducing the angle of the banks, and the incorporation of berms within the pond design, there will be a greater area available for foraging ardeids. All other factors being equal, a larger pond will have more potential for enhancement than a smaller one; more species and numbers of birds are likely to utilise a larger pond. For two ponds the same size, the pond with lower level of use may have more potential for enhancement by habitat improvement (though other factors such as proximity to housing may have effects which cannot be adjusted significantly). Based on observations during the field visits, the banks of Ponds 12 and 14 are rather steep, which may be a contributory factor towards the low number of ardeids present.

5.100 In addition, Pond 15 will be modified to provide reedbed around the margins as protection from disturbance sources. Enhancement should be targeted at species which are apparently more tolerant of Route 3 such as Little Egret and Chinese Pond Heron, rather than the more disturbance sensitive Great Cormorant, Great Egret and Grey Heron. The effects of Route 3 are thus proposed to be avoided by targeting of mitigation rather than directly reducing the Route 3 effect. The latter option is somewhat problematic, at least on a large scale, as the measures which would be most likely to reduce the impact of the road, such as tree planting or creation of other visual or sound barriers would themselves inhibit use by large waterbirds. However, limited local use of mounding or tree planting could usefully be considered in specific locations to reduce the adverse effects of Route 3 at the detailed habitat design stage. This will encourage the use of the pond by the Key Species, and may also have the indirect effect of enhancing the use of ponds such as Pond 16 to the north.

5.101 Part of Pond 15 will be managed to form a network of shallow pools which will provide breeding habitat for dragonflies and amphibians as well as feeding habitat for wading birds including Temminck's Stint, snipe and Common and Green Sandpipers. Shallow seasonal pools from which predatory fish are absent, with patches of marshy emergent vegetation on the edges and in the shallowest reaches, will satisfy the breeding requirements for Spotted Narrow-mouthed Frog.

5.102 Such seasonally inundated conditions may not, however be suitable for colonisation by the dragonflies *Acisoma panorpoides*, *Agriocnemis pygmaea*, and *Neurothemis tullia*. Although these are tropical species, and multivoltinism been demonstrated at least for *A. pygmaea* (albeit in permanently inundated conditions) (Corbet, 1999), it is uncertain whether these species are capable of breeding in seasonal wetlands. At any rate, the much larger *Epopthalmia elegans* and *Sinictinogomphus clavatus* certainly require permanently inundated conditions in order to breed, and therefore establishment of permanent ponds is also desirable in the mitigation area. These should have gently sloping, shallow banks with (ideally) submerged as well as emergent vegetation, as the majority of lentic habitat odonate larvae dwell in the shallow vegetated zone in depths of up to 1 metre (Corbet, 1999). To enhance chances of survivorship, efforts should be made to exclude predatory fish from the ponds.

5.103 During the process of drainage of a commercially operated fishpond, large numbers of non-commercial fish become available for ardeids. A similar event at ponds 18 and 19 (see above) resulted in large numbers of foraging Little Egrets and Chinese Pond Herons. By staggering the drainage time of Ponds 12, 14 and 15, and if possible, extending the duration of the process, large amounts of suitable food can be made available for ardeids. Although it is recognised that this will only cover a relatively small period during the winter, this drainage process is an integral aspect of the winter foraging behaviour of ardeids within the Deep Bay area. Whilst it is proposed to operate ponds 12, 14 and 15 as a single water body for most of the time (during periods of high water availability) the process of bund redistribution should be designed to leave the lower levels of the bunds intact. During dewatering the relict structure of the three ponds will re-appear in the form of three discrete (albeit shallow) water bodies. The final dewatering can then be organised sequentially to maximise feeding opportunity and even out the supply of food upon full exposure of each pond bottom.

5.104 Mitigation for the loss of the roost of Yellow House Bat could include;

(i) erection of bat boxes on nearby buildings, or suitable trees;
(ii) bat roosts built into the design of stream bridges; and
(iii) reconstruction of simple building, designed for bats.

5.105 It is proposed that the feasibility of these options and selection of a preferred option should be undertaken at the project detailed design stage. Mitigation measures should be in place before the roost site is demolished. Solutions may include erection of bat boxes on nearby abandoned buildings as an interim measure prior to implementation of a permanent solution.

Water Clean-up

5.106 An additional function of the Ponds 9, 11 and 11B which will include areas of reedbed, is the clean-up of polluted water passing through the vegetation (as shown in Figure 5.3). A pumping station (Archimedian screw) was provisioned at the inflatable dam as part of the original mitigation scheme. As in the previous mitigation plan, diversion of part of this flow through the reedbed area to be established under this mitigation, will provide both the water clean-up function originally proposed in the EIA, and subject to the quality achieved may provide a supplemental water source for the fishponds to be managed under the proposed mitigation scheme.

Disturbance impacts during the construction period

5.107 Limited disturbance impacts during the construction period will not, for most species, be significant. However, since at least one building is known to have been used as a bat roost, all abandoned buildings (of which there are a number on the site) should be dismantled carefully to allow any bats still within to escape during destruction. Permanent or temporary mitigation measures to provide alternative bat roosts should be implemented prior to any building demolition.

5.108 Should the new egretry adjacent to the *fung shui* knoll remain in the breeding season before construction of the YLBF commences, the construction process should be phased so that piling (which will generate loud noises) be restricted to the months outside the period of egretry occupation from March to July. The northern and western boundary of the works area should be clearly defined and no activities by construction personnel should be permitted to the north and west of this boundary. No dogs should be permitted on site at any time. Water levels in ponds which are not part of the works area (Ponds 4, 8, and 10) should be maintained at normal summer (wet season) levels during the period from March to August i.e. these ponds (4, 8 and 10) should not be used by the contractors as any form of Works or storage area.

Summary

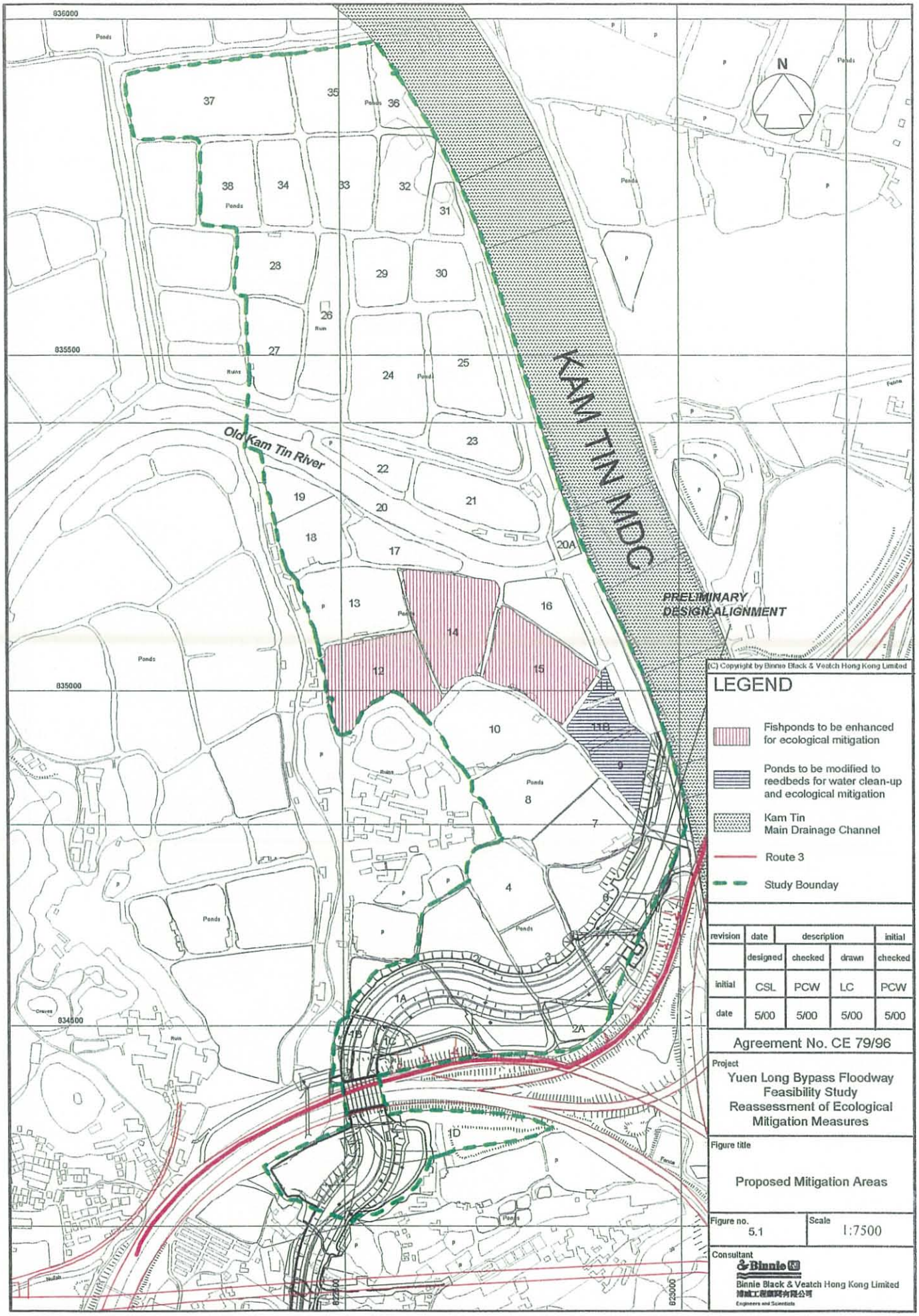
5.109 Table 5.12 summarises the mitigation of impacts resulting from the construction of the Floodway.

Table 5.12 Summary of effects of mitigation measures to reduce or eliminate adverse impacts of proposed YLBF route on species of conservation importance

Species	Potential permanent impact / Effects of mitigation	Potential construction impact / Effects of mitigation	Residual impacts
Birds			
Little Grebe	Loss of breeding habitat for 2 prs. (Ponds 5 and 6) / Fully mitigated by proposed pond enhancement	Disturbance of one pr. (Pond 7) / Fully mitigated by measures to maintain water levels and prevent disturbance	Insignificant, during construction period only
Great Cormorant	None / limited additional habitat created	None	None
Cattle Egret	None	Potential disturbance impact if Cattle Egret uses egretry in future years / fully mitigated by measures to restrict construction activities during period of egretry occupation	None
Chinese Pond Heron	Limited loss of feeding habitat / Fully mitigated by proposed pond enhancement	Disturbance of feeding habitat; disturbance to breeding birds / Disturbance to breeding birds fully mitigated by measures to restrict construction activities during period of egretry occupation	Limited loss of feeding habitat during construction period only
Little Egret	Limited loss of feeding habitat / Fully mitigated by proposed pond enhancement	Disturbance of feeding habitat; disturbance to breeding birds / Disturbance to breeding birds fully mitigated by measures to restrict construction activities during period of egretry occupation	Limited loss of feeding habitat during construction period only
Grey Heron	Limited loss of feeding habitat / Fully mitigated by proposed pond enhancement	Limited disturbance to feeding habitat / no mitigation measures	Limited loss of feeding habitat during construction period only
White-breasted Waterhen	Limited loss of breeding and foraging areas / Fully mitigated by proposed pond enhancement	Limited loss of breeding and foraging areas / Some reduction in loss achieved by site management proposals	Very limited loss of breeding and feeding habitat during construction period only
Common Moorhen	Loss of breeding and foraging habitat (primarily at Pond 1D) / Fully mitigated by proposed pond enhancement	Loss of breeding and foraging habitat / Some reduction in loss achieved by site management proposals	Limited loss of breeding and foraging habitat during construction period only
Little Ringed Plover	Loss of foraging areas for c. 20 birds and several breeding pairs (Ponds 1A and 2) / Limited foraging areas around proposed enhanced ponds	No loss	Significant permanent loss of foraging areas and breeding sites
Temminck's Stint	Loss of foraging areas (up to 8 birds on Pond 1A) / Fully mitigated by proposed pond enhancement	Loss of foraging areas / Some reduction in loss achieved by site management proposals	Limited loss of feeding habitat during construction period only
Mammals			
Yellow House Bat	Loss of roost site (Pond 1A/2) / Fully compensated by specific measures to construct alternative roost site	Loss of roosts and feeding areas / Alternative temporary or permanent roost sites to be constructed prior to any building demolition	Limited loss of feeding areas during construction period only

Species	Potential permanent impact / Effects of mitigation	Potential construction impact / Effects of mitigation	Residual impacts
Amphibians			
Spotted Narrow-mouthed Frog	Loss of habitat (Ponds 1A, 1B, 1C, 2,5 / Fully compensated by pond enhancement	Loss of habitat / Some reduction in loss achieved by site management proposals	Loss of habitat during construction period only
Dragonflies			
Acisoma panorpoides	Loss of breeding habitat (Pond 1D)* / Fully compensated by pond enhancement	Loss of habitat / Some reduction in loss achieved by site management proposals	Loss of habitat during construction period only
Agriocnemis pygmaea	Loss of breeding habitat (Pond 1C)* / Fully compensated by pond enhancement	Loss of habitat / Some reduction in loss achieved by site management proposals	Loss of habitat during construction period only
Epopthalmia elegans	Loss of breeding habitat (Ponds 1A, 1D and 6)* / Fully compensated by pond enhancement	Loss of habitat / Some reduction in loss achieved by site management proposals	Loss of habitat during construction period only
Neurothemis tullia	Loss of breeding habitat (Ponds 1B and 2)* / Fully compensated by pond enhancement	Loss of habitat / Some reduction in loss achieved by site management proposals	Loss of habitat during construction period only
Sinictinogomhus clavatus	Loss of breeding habitat (Ponds 1A, 1D and 6)* / Fully compensated by pond enhancement	Loss of habitat / Some reduction in loss achieved by site management proposals	Loss of habitat during construction period only

Wildlife species previously discussed in the survey report which do not appear on this list are not considered to be vulnerable to significant potential adverse impacts.



LEGEND

- Fishponds to be enhanced for ecological mitigation
- Ponds to be modified to reedbeds for water clean-up and ecological mitigation
- Kam Tin Main Drainage Channel
- Route 3
- Study Bounday

revision	date	description		initial
	designed	checked	drawn	checked
initial	CSL	PCW	LC	PCW
date	5/00	5/00	5/00	5/00

Agreement No. CE 79/96

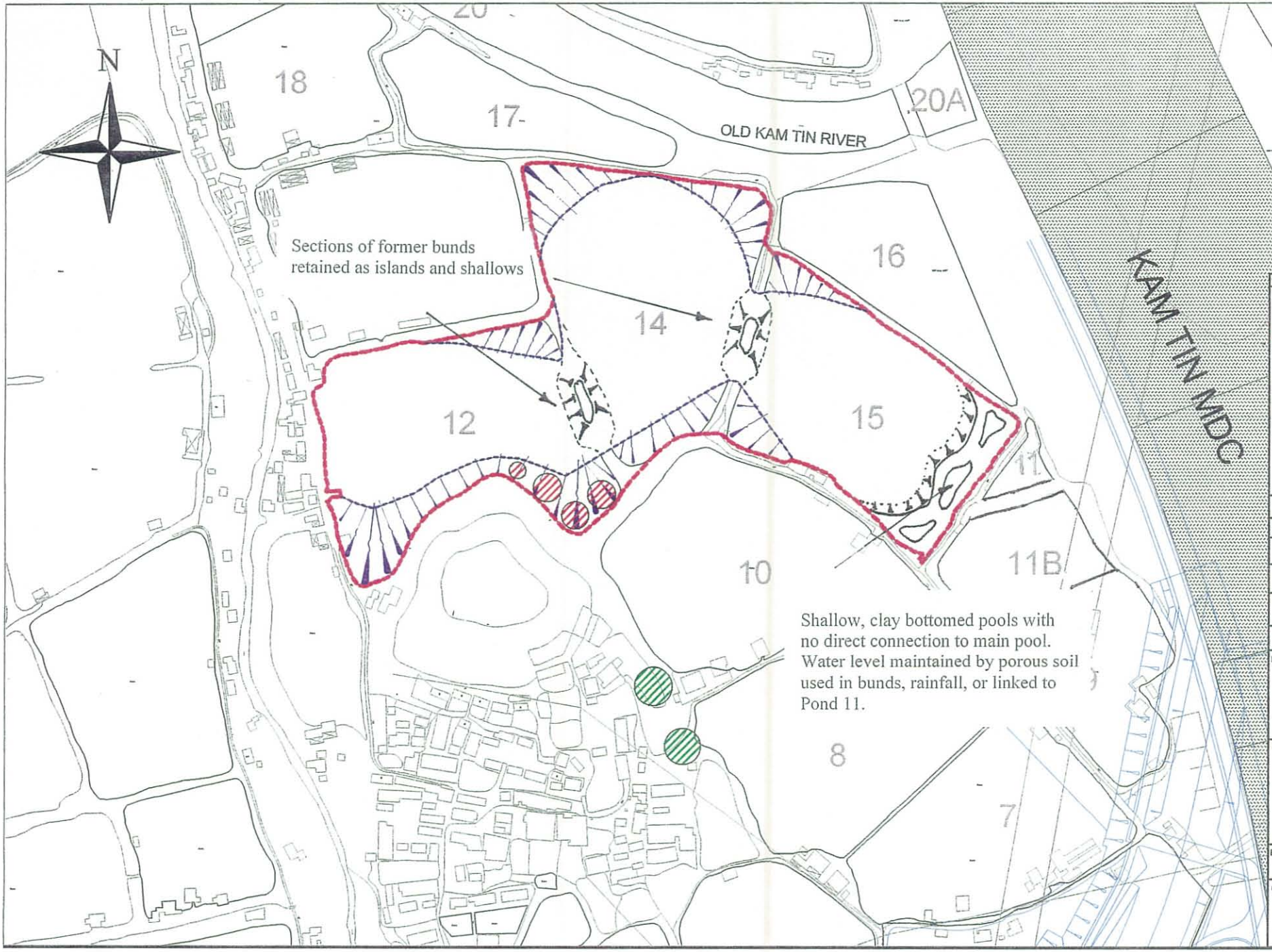
Project
Yuen Long Bypass Floodway
Feasibility Study
Reassessment of Ecological
Mitigation Measures

Figure title
Proposed Mitigation Areas

Figure no. 5.1

Scale 1:7500

Consultant
Binnie Black & Veatch Hong Kong Limited
Engineers and Scientists



LEGEND

- Ecological Mitigation Area
- Kam Tin Main Drainage Channel
- Additional Bamboo planting
- Bamboo with Nesting Little Egrets
- Gradually sloping pond margins using bund material
- Yuen Long Bypass Floodway

revision	date	description		initial
	designed	checked	drawn	checked
initial	JCY	AP		
date	2/2000	2/2000		

Agreement No. CE 79/96

Project

Yuen Long Bypass Floodway Feasibility Study Reassessment of Ecological Mitigation Measures

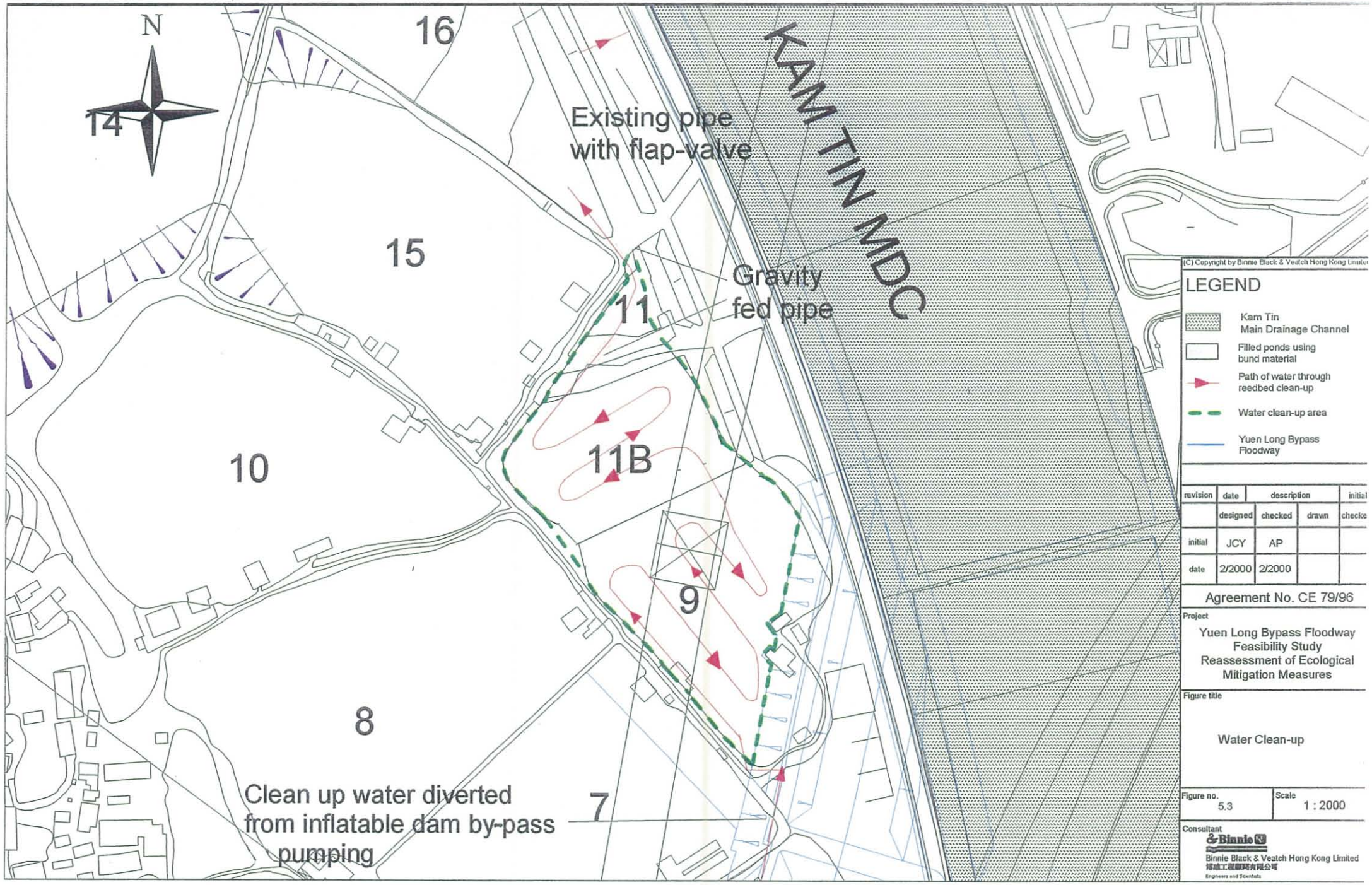
Figure title

Fishpond Enhancement

Figure no.	Scale
5.2	1:3000

Consultant

Binnie Black & Veatch Hong Kong Limited
博賓工程顧問有限公司
Engineers and Scientists



LEGEND

- Kam Tin Main Drainage Channel
- Filled ponds using bund material
- Path of water through reedbed clean-up
- Water clean-up area
- Yuen Long Bypass Floodway

revision	date	description		initial
	designed	checked	drawn	checke
initial	JCY	AP		
date	2/2000	2/2000		

Agreement No. CE 79/96

Project

Yuen Long Bypass Floodway
Feasibility Study
Reassessment of Ecological
Mitigation Measures

Figure title

Water Clean-up

Figure no.	Scale
5.3	1 : 2000

Consultant

Binnie Black & Veatch Hong Kong Limited
Engineers and Scientists

6. DEVELOPMENT OF MITIGATION MEASURES

Management and Maintenance Responsibilities

6.1 The management and maintenance activities for each of the ecological compensation areas described above are shown in Table 6.1.

Table 6.1 Management and Maintenance Responsibilities of Proposed Mitigation Measures

Area	Maintenance required	Agent
Ecological mitigation areas and water clean-up reedbed	Management of bunds	AFCD
	Clearance of excessive vegetation	AFCD
	Desedimentation of ponds	AFCD
	Harvesting of reedbed vegetation	AFCD
Water supply infrastructure to reedbed	Clearance of silt/detritis from conduits, drains and pipes.	AFCD

6.2 The Project Proponent of the Floodway will be responsible for the implementation of the proposed ecological mitigation measures. Reprofiling would be carried out as part of the initial mitigation measures. Once undertaken, it is envisioned that minimal vegetation management is all that will be required on a regular basis. Approximately every five years, ponds will have to be drained down, and accumulated sediments (primarily organic material) will require to be removed and pond contours regraded.

6.3 However longer term management of the ponds, in particular their operation as fishponds for ecological purposes, needs to be carried out by AFCD.

6.4 The potential to reduce human activity is limited as such activity mostly constitutes the disturbance effects of those who live and work in the area. However, as is known from elsewhere in the Deep Bay area, fish farming and wildlife conservation are compatible activities, so long as a limited disturbance to wildlife is tolerated and illegal activities (such as using lines strung with fish hooks to deter bird use) are prevented. No generic activities to reduce human disturbance are, therefore, proposed, though at the stage of detailed design of mitigation measures some site-specific measures may be considered.

6.5 With respect to maintenance for enhanced ponds it is suggested that their design is undertaken in such a way that routine maintenance is restricted to periodic drain-down, sediment removal and vegetation management.

6.6 Prior to the outcome of the Wetland Compensation Study this work could be undertaken by AFCD which has the expertise to do this. An appropriate management regime would be resolved in close collaboration with AFCD at the detailed design stage. The long term management of wetlands in Hong Kong is the subject of an on-going Wetland Compensation Study which will recommend the organisation and mechanism for managing these valuable ecological resources in Hong Kong. Table 6.2 sets out the revised implementation schedule as a result of the reassessment of ecological mitigation.

Table 6.2 Revised Implementation Schedule

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
		Water *Construction mitigation measures* With reference to Table 4.10 of the EIA study report and section 4.7 of the EM&A manual the Contractor shall submit to the Engineer and the Environmental Manager at least six (6) weeks prior to construction a total of five (5) copies of a method statement with accompanying drawings to illustrate the adequacy of the provision of water quality mitigation measures to be implemented as designated in items (a) to (l) below. These drawings and method statement must be agreed and certified by the Environmental Manager. A certified copy must be deposited with the Director of Environmental Protection one month before construction starts.						
Table 4.10	4.7	(a) The Contractor shall ensure that works within the Yuen Long Bypass Floodway take place in the dry season as far as practicable or else additional temporary works such as cofferdam or temporary earth bund will be required to minimise runoff and pollution from the works entering the water column. Water collecting behind the cofferdam shall be either pumped onto the land-bank or collected, settled and pH adjusted to 8.5 or less before being allowed to enter the channels.	whole site/all times	CC		✓		ProPECC PN 1/94

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
		(b) Open stockpiles of construction materials (e.g. aggregates, sand and fill material) on site shall be protected from erosion during rainstorms. Measures shall be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system. Hydroseeding should be used where practical.	whole site/all times	CC		✓		ProPECC PN 1/94
Table 4.10	4.7	(c) The transport of sediment to the environment shall be minimised by the installation of appropriate sediment traps within the drainage system. Sediment traps shall be designed with adequate capacity.	whole site/all times	CC		✓		ProPECC PN 1/94
		(d) Wastewater generated from the washing down of mixer trucks and drum mixers and similar equipment should be recycled. The discharge of wastewater should be kept to a minimum.	whole site/all times	CC		✓		--
		(e) Wastewater generated from construction activities should be discharged into an excavated sedimentation pit prior to discharge. The pit should be unlined to allow for infiltration of water into the ground and setting of concrete before disposal.	whole site/all times	CC		✓		--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres		Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
						Des	C	O	
		(f)	In the case of an unlined pit for all types of wastewater being settled out, water infiltration into the ground requries a license from EPD under the WPCO regulations. Where a license cannot be obtained, or if water re-use is practiced, the pit may need to be lined, which requires more frequent removal of the contents.	whole site/all times	CC		✓		WPCO
Table 4.10	4.7	(g)	Oil interceptors shall be provided in Site compounds and regularly emptied to prevent release of oils and grease into the surface water drainage system after accidental spillages. The interceptor shall have a bypass to prevent flushing during periods of heavy rain. Oil and fuel bunkers shall be bunded to prevent discharge due to accidental spillages or breaching of tanks.	whole site/all times	CC		✓		ProPECC PN 1/94

EIA Ref	EM&A Log Ref	Environmental Protection Meausres		Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
						Des	C	O	
		(h)	Any waters entering the storm drains must have a pH less than 8.5. Under normal circumstances, surplus wastewater may be discharged into foul sewers after treatment in silt removal and pH adjustment facilities (to within the pH range of 6 to 9). Disposal of wastewater into storm drains will require more elaborate treatment. Surface run-off should be segregated from the concrete batching plant and casting yard area, if used, and diverted to the stormwater drainage system. Surface run-off contaminated by materials in a concrete batching plant or casting yard, if used, should be adequately treated before disposal into stormwater drains.	whole site/all times	CC		✓		ProPECC PN 1/94
		(i)	Runoff should be prevented from entering adjacent ponds through construction of bunds between works areas and ponds.	whole site/all times	CC		✓		--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres		Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
						Des	C	O	
Table 4.10	Section 4.7	(j)	The Contractor shall take all reasonable measures to minimise adverse impacts resulting from construction activities associated with the removal of sediments. These measures shall include ensuring that all plant and equipment and working methods meet the following criteria.	whole site/all times	CC		✓		-
		•	utilising appropriate suspended solids containment screen while removing sediment.						
		•	minimise disturbance of the channel bed while dredging;						
		•	minimise leakage of dredged sediment during lifting through the use of closed grabs where practical;						
		•	prevent the overflowing of any hopper used to contain removed sediments.						
		(k)	The Contractor shall be responsible for disposing of all dredged sediments at an appropriate location depending on the volume and composition of the material.	whole site/all times	CC		✓		--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
Table 4.10	4.7	(l) If any office, works area canteen or toilet facilities are erected, foul water effluent should be directed to a foul sewer or to a sewage treatment facility either directly or indirectly by means of pumping or other means approved by the Engineer.	whole site/all times	CC		✓		ProPECC PN 1/94
		Operational mitigation measures With reference to Table 4.11 and Figures 5.4 and 5.5 in the EIA Study Report, the Detailed Design Engineer (DDE) shall deposit scaled location and detail drawings with the Director of Environmental Protection at least one month before the commencement of construction showing the design of the water clean-up and ecological mitigation as specified in items (a), (b) and (c) below and in the section on ecological mitigation in this schedule. The drawings shall be submitted to the Environmental Manager for prior approval and certification.						
Table 4.11	-	The Contractor should incorporate permeable areas along the channel banks such as grasscrete, as described in the Ecology section of this Implementation Schedule.	whole site Des&C stages	DDE/CC	✓	✓		--
		Some water flow from the Archimedian Screw should be directed so that water is diverted for water clean-up, and reedbed habitat for invertebrates and wetland-dependent passerine bird species.	whole site Des&C stages	DDE/CC	✓	✓		--
		Ponds 9, 11 and 11B will be incorporated into the design to provide a water clean-up area (Figures 5.1 and 5.3 in the Reassessment).	whole site Des&C stages	DDE/CC	✓	✓		--

<table>
<tr><th>EIA Ref</th><th>EM&A Log Ref</th><th>Environmental Protection Meausres</th><th>Location/ Timing</th><th>Implementation Agent</th><th colspan="3">Implementation Stages</th><th>Relevant Legislation and Guidelines</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Des</td><td>C</td><td>O</td><td></td></tr>
<tr><td>Table 4.11</td><td></td><td>Monitoring

Baseline monitoring of DO Turbidity, pH, NH_4-N and Temperature at the immediate mixing zone (W_1) shall be undertaken by the ET, during mid ebb tide for a period of two consecutive weeks at a frequency of once per day. The samples shall be taken at mid depth.</td><td>monitoring locations/specified times</td><td>ET</td><td></td><td></td><td></td><td>--</td></tr>
<tr><td>Table 4.11</td><td>4.5</td><td>Impact monitoring should be carried out as follows:
<table>
<tr><th>Location</th><th>Parameters</th><th>Frequency</th></tr>
<tr><td rowspan="2">All Site Discharges including ultimate discharge into Kam Tin River</td><td>Turbidity, PO, pH, Temperature</td><td>Once per week (during mid ebb at ultimate discharge)</td></tr>
<tr><td>Oil and grease, SS</td><td>Once per month (during mid ebb at ultimate discharge)</td></tr>
<tr><td>Mixing Zone of YLBF and Kam Tin River[1]</td><td>PH, Temperature, NH4-N, DO Turbidity</td><td>Once per week during mid ebb</td></tr>
<tr><td colspan="3">[1] Mixing zone is taken to be 10 m downstream from the floodway discharge part</td></tr>
</table></td><td>monitoring locations/specified times</td><td>ET</td><td></td><td>✓</td><td></td><td>--</td></tr>
</table>

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
Table 4.11	4.6	Data obtained from impact monitoring should meet the compliance criteria for each parameter. Should the monitoring results of the water quality parameters at any designated monitoring stations indicate that the water quality criteria are exceeded, the actions in accordance with the Action Plan should be carried out.	monitoring locations/specified times	ET		✓		--
	6.1.3	<u>Ecology</u> *Construction mitigation measures* An Ecologist should be included in detailed design team. With reference to Section 5.5 of the EIA Study Report and Section 6.2 of the EM&A Manual, the Detailed Design Engineer will deposit with the Director of Environmental Protection scaled location and detail drawings at least one month before construction commences. These drawings shall show all ecological mitigation measures for the Project. The drawings shall demonstrate conformance with the measures in the EIA study report and shall be certified by the Environmental Manager.	Des	DDE	✓			--
5.5.6	6.2	The alignment of northern channel section should be routed as close as possible to Route 3 to minimise impact on fish ponds (Figure 5.2 in EIA).	specified locations/Des&C stages	DDE/CC	✓	✓		--
5.5.12 - 5.5.14	6.2	Grasscrete should be incorporated in the channel design on sides and base of channel between ch 1+340 and 3+545.	specified locations/Des&C stages	DDE/CC	✓	✓		--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
5.5.15 - 5.5.19	6.2	(Figures 5.1 in this Reassessment). "Recirculated" water should be pumped from pumping station to supply water to the clean-up area (Ponds 9, 11 and 11B) in association with local runoff.	specified locations/Des&C stages	DDE/CC	✓	✓		--
5.5.14 - 5.5.19	6.2	Ponds 12, 14 and 15 will be reprofiled.	specified locations/Des&C stages	DDE/CC	✓	✓		--
5.5.20	6.2	Suitable tree species should be planted along the channel banks which are attractive to fauna. Species should be selected from species list given in Table 5.15 of EIA;	Specified locations/Des&C stages	DDE/CC	✓	✓		--
5.5.25 - 5.5.26	6.2	*Operation mitigation measures* Maintenance of water clean-up areas should be carried out during the operational phase in the form of (i) grass cutting and (ii) sediment removal from the water supply infrastructure to the reedbed.	Specified locations/O	(i) AFCD (ii) AFCD			✓	--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
		Monitoring						--
	6.1	An ecological baseline survey of the proposed YLBF alignment (north of Castle Peak Road) has been undertaken (Dec 1999-April 2000).	Monitoring locations/specified times	ET				--
		Ecological monitoring will be required during the construction phase.	Monitoring locations/specified times	ET				--
		• Monitoring of usage of the egretry on a monthly basis from March to August				✓		--
		• Monitoring of condition and fauna of fish ponds to the south of the Kam Tin River on a monthly basis during the construction period				✓		
		• Monitoring of bat boxes or other measures to protect bat populations during the construction period				✓		
		During the first 2 years (commencing immediately after project completion), quarterly floral and faunal surveys shall be carried out by (or under the supervision of) an ecologist of at least three years local experience (vetted by AFCD if necessary).					✓	
	6.1	The floral survey shall monitor the dominance, height and density of naturally colonising wetland plant species, using 1 m quadrats at three points within the clean-up reedbed in Ponds 9, 11 and 11B (to be decided in agreement with AFCD during detailed design).	Monitoring locations/specified times	ET			✓	--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
		Faunal surveys shall include monitoring of bird, reptile, amphibian, butterfly and dragonfly numbers within the entire channel and mitigation areas. Birds should be surveyed on a bi-monthly basis and bird occurrence should be assigned to locality and habitat type. Breeding behaviour should be recorded where appropriate. In addition, utilisation of the adjoining egretry should be surveyed on a monthly basis between March and July. Bat use should be monitored by the bi-monthly inspection of bat boxes or other measures to create roosts. Bats should be trapped to confirm identity if necessary. Reptiles and amphibians should be monitored by day/night surveys twice during the wet season (April/May and July/August). Butterflies and dragonflies should be monitored by field surveys four times during the warm season in April/May, June/July, August/September and October/November.	Monitoring locations/specified times	ET			✓	--
		Attention shall be drawn to dominant species (and their density), and the occurrence (if any) of rarities and protected species, and the activities of fauna (breeding/feeding/courting etc.). Any other outside influencing factors (pollution, development etc.) should be highlighted.	Monitoring locations/specified times	ET			✓	--
		For the next three years, the surveys shall be conducted on an annual, early wet season (May-June) cycle. Any other outside influencing factors (pollution, nearby development etc.) should be highlighted.	Monitoring locations/specified times	ET			✓	--
	6.1	The baseline data prior to the Project commencement will be available for reference.	Monitoring locations/specified times	ET			✓	--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
		Landscape & Visual Impacts With reference to Section 9.6 of the EIA Study Report and Chapter 7 of the EM&A Manual, the Detailed Design Engineer shall deposit with the Director of Environmental Protection, scaled location and landscape report drawings and a landscape report demonstrating conformance with the requirements of the EIA study. The drawings and landscape report shall have prior approval and certification by the Environmental Manager.		DDE	✓			
9.6.2	Chapter 7	Soft landscaping measures should be used, employing native plant species to restore green landcover and enhance the vegetated, rural environment. This includes tree/shrub planting and hydroseeding in the peripheral site area, the proposed embankment slopes, footpath sides and access roads.	Whole site/C	CC		✓		--
9.6.7	Chapter 7	Pollution tolerant wetland species should be planted in engineered wetland areas.	Fishpond area/C	CC		✓		--
9.6.7	Chapter 7	After completion of construction works, the drained fishponds to the north of the YLBF site (north of Route 3), should be restored.	Fishpond area/C	CC		✓		--
9.6.8	Chapter 7	The recreational opportunities presented by the reprovisioning of public open space affected by the YLBF, should be considered.	Specified locations/Des&C stages	DDE/CC	✓	✓		--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
9.6.9	Chapter 7	The exterior of the pumping station, handrailings and parapets shall be painted in a colour so as to minimise visual impact. Trees and shrubs may be planted around the pumping station to soften the visual impact of the structure.	Pumping Station, handrailings & parapets/C	CC		✓		--
9.6.10	Chapter 7	The inclusion of small areas of stone finishing, to soften the visual impact of the channel, should be examined.	specified locations/Des	DDE	✓			--
9.6.11	Chapter 7	In the interests of conservation and preservation, the large *Ficus Microcarpa* and six protected species should be retained as described in the Tree Survey Report (Report No. 0136/TSR/Issue 1). Eleven protected tree species should be transplanted.	specified locations/Des	DDE	✓			--
9.6.13	Chapter 7	Top soil and fishpond bund material should be retained and used in any landscape mitigation measures, and for reprofiling Ponds 9, 11, 11B, 12, 14 and 15. Detailed landscape design should be carried out by a landscape architect.	Whole site/C	CC		✓		-- --
		Monitoring						
	7.1	During the soft landscape establishment and maintenance, each of the following stages shall be subject to the inspection and approval of the landscape architect before commencement of the next stage of works.	specified locations/C	ET		✓		--

EIA Ref	EM&A Log Ref	Environmental Protection Meausres	Location/ Timing	Implementation Agent	Implementation Stages			Relevant Legislation and Guidelines
					Des	C	O	
9.6.13	7.1	1. After checking of setting out of planting areas and subgrade levels, and setting out of any additional planting and drainage prior to placing topsoils.	specified locations/C	ET		✓		--
		2. At completion of soil preparation prior to planting.	specified locations/C	ET		✓		--
		3. After planting, staking and tying prior to placing mulch.	specified locations/C	ET		✓		--
		4. At completion of works	specified locations/C	ET		✓		--
		5. At completion of each three month period of the maintenance works.	specified locations/O	ET			✓	--
		Maintenance works landscaping monitoring should be carried out in accordance with the General Schedule of Maintenance Works.	specified locations/O	ET			✓	--

Note This Implementation Schedule is based on information provided in the EIA and EM&A for the preliminary design and will be subject to review during subsequent stages of the project.

* Des=Design; C=Construction; O=Operation;
Territory Developments Department (TDD) is the ultimate agent responsible for the implementation of the mitigation measures during design and construction stages. The Detailed Design Engineer (DEE), Construction Contractor (CC), Engineer's Representative (ER) and Environmental Team (ET) will be employed by TDD in due course.
DSD is responsible for maintenance of the concrete channel during operation stage.

! TDD has agreed to provide interim maintenance responsibility until a permanent maintenance authority has been designated for such sites under the Wetlands Compensation Study

WPCO Water Pollution Control Ordinance

7. RESIDUAL IMPACTS

7.1 The original ecological compensation measures proposed in the EIA provided an alternative habitat that compensated (on-site, and easily maintained) for the habitat lost under the Floodway alignment. In the same way, the revised ecological mitigation area and design proposed in this study, has been designed to enhance the ecological value of an existing habitat to an equivalent degree to that impacted by the Project. Compensation in terms of ecological value thus ensures that the residual impacts from the construction and operation of the Floodway are minimized. The proposed mitigation will also compensate for changes in impact and associated mitigation provided by the originally proposed marshcrete area, i.e. a water clean-up function.

7.2 With respect to impacts on individual species, the measures proposed are predicted to eliminate any residual impacts through habitat loss with the exception of loss of breeding and feeding habitat for Little Ringed Plovers. As is noted in Section 5, this species breeds opportunistically on ephemeral open areas. Its presence as a breeding species at Ponds 1A and 2 is an incidental consequence of their not being restored to fishpond use. Since the baseline for mitigation measures for the YLBF project is taken as restored fishponds, the loss of breeding habitat for this species is, as a corollary, not catered for in the mitigation proposals.

7.3 Table 7.1 summarises the original and revised ecological mitigation proposed for the Floodway.

Table 7.1
Summary of Original and Replacement Mitigation
for Yuen Long Bypass Floodway

	Type	Area (ha)	Ecological Value	Maintenance Requirement
Original mitigation	Marshcrete+	3.0	Moderate-high	Annual cropping of vegetation - refuse clearance as required
	Trees*	2.5k	Moderate	Normal landscape maintenance
	Grasscrete	6.8	Moderate	Annual cropping
Replacement mitigation	Reed bed+	1.2	Moderate-high	Regular cropping of vegetation - refuse clearance as required
	Enhanced ponds	4.9	High	Annual strimming of bunds
	Trees*	2.5k	Moderate	Normal landscape maintenance
	Grasscrete	6.8	Moderate	Annual cropping

\+ Incorporating water clean-up function with ecological compensation
* Trees given as numbers planted

7.4 The major ecological benefits that will be provided as a result of the proposed mitigation are:

(i) Enhancement of an area of fishponds which are currently underutilized by avifauna, for reasons of lack of availability of food.
(ii) An increase in the overall area of ecologically valuable sites.
(iii) Improved linkage between ecologically valuable areas.
(iv) Provision of a reedbed area for water clean-up.
(v) Additional barrier landscaping from the reedbed around the fishpond mitigation area.
(vi) An additional type of reedbed habitat which can be utilized by a number of species in the area.
(vii) Landscaping along both sides of the Floodway channel will provide greater degree of protection from disturbance to fauna feeding in the channel.
(viii) A defined maintenance and management regime for the Floodway channel and the ecological compensation areas will improve the long-term ecological (and amenity) value of the area.

7.5 Additional benefits include the re-use of on-site fishpond bund material to reduce the depths of Ponds 9, 11 & 11B, and to provide shallow margins to Ponds 12, 14 & 15 precludes the requirement to dispose off-site. Surplus material resulting from the pathway of the YLBF will be redistributed to the mitigation ponds. Similarly, material from the separating bunds to be removed (wholly, or in part) between Ponds 9, 11 & 11B and Ponds 12, 14 & 15, will be re-used to reprofile the ponds.

7.6 All or any adverse environmental impacts as a result of the reassessment, have been avoided with the implementation of the alternative mitigation proposed. The proposal to enhance fishponds is, itself, a recognition of the way in which opportunities for mitigation for the effects of wetland loss or damage has evolved in Hong Kong in the last few years. As AFCD is aware, recent successes (such as the enhancement of Pond 20 at Mai Po) have demonstrated that such enhancement can be spectacularly successful. The relocation of the mitigation away from Route 3 and into the Wetland Conservation Area has given additional scope to ecologically enhance fishponds owned by Government.

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END OF TEXT

Appendix I

Raw data and graphs of preliminary avifauna surveys

Appendix 1

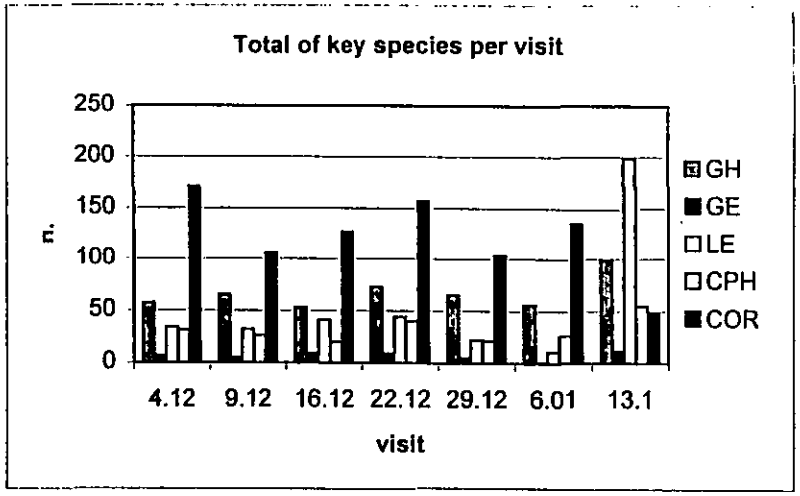
Summary of Avifaunal use of Ponds north of Route 3

Common Name	Scientific name	Number of Ponds per Species	1A	1B	1C	1D	2	3	4	5	6	7	8	9	10	11A	11B	12	13	14	15	16	17	18	19	20	20A	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Little Grebe	*Tachybaptus ruficollis*	20						1	1	1	1	1	1	1							1	1	1							1	1	1	1	1		1	1			1			1	1	
Great Cormorant	*Phalacrocorax carbo*	18							1			1							1	1	1			1	1	1					1	1	1	1	1		1				1	1		1	1
Cattle Egret	*Bubulcus ibis*	0																																											
Chinese Pond Heron	*Ardeola bacchus*	21													1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1		1	1	1	1		1						
Little Egret	*Egretta garzetta*	24											1	1	1			1	1			1		1	1	1			1	1	1	1	1	1	1	1	1			1	1	1	1	1	1
Intermediate Egret	*Egretta intermedia*	2	1																						1																				
Great Egret	*Egretta alba*	13						1												1	1	1		1	1	1			1		1		1	1							1			1	
Grey Heron	*Ardea cinerea*	23						1							1	1				1	1			1	1	1			1	1	1	1	1	1	1	1	1		1	1	1	1		1	1
Purple Heron	*Ardea purpurea*	1																																						1					
Eurasian Wigeon	*Anas penelope*	3																					1			1										1									
Falcated Duck	*Anas falcata*	1																																					1						
Common Teal	*Anas crecca*	6																					1					1	1			1	1				1								
Spot-billed Duck	*Anas poecilorhyncha*	1																																					1						
Northern Pintail	*Anas acuta*	3					1																1											1											
Northern Shoveler	*Anas clypeata*	1																					1																						
Black Kite	*Milvus migrans*	1																															1												
Eastern Marsh Harrier	*Circus spilonotus*	2																								1														1					
Common Buzzard	*Buteo buteo*	1																																											1
Osprey	*Pandion haliaetus*	2																																	1						1				
Common Kestrel	*Falco tinnunculus*	1							1																																				
White-breasted Waterhen	*Amaurornis phoenicurus*	4							1			1														1	1																		
Common Moorhen	*Gallinula chloropus*	11				1	1				1					1						1	1			1										1	1		1	1					
Eurasian Coot	*Fulica atra*	6								1					1			1						1	1	1																			
Oriental Pratincole	*Glareola maldivarum*	1					1																																						
Little Ringed Plover	*Charadrius dubius*	3	1				1																			1																			
Temminck's Stint	*Calidris temminckii*	1	1																																										
Common Snipe	*Gallinago gallinago*	4	1																				1			1											1								
Marsh Sandpiper	*Tringa stagnatilis*	1	1																																										
Green Sandpiper	*Tringa ochropus*	10	1				1															1	1	1	1	1	1	1				1													
Wood Sandpiper	*Tringa glareola*	1	1																																										
Common Sandpiper	*Actitis hypoleucos*	7	1									1										1	1			1	1	1																	
Common Black-headed Gull	*Larus ridibundus*	2																														1								1					
Indian Cuckoo	*Cuculus micropterus*	1																						1																					
Savanna Nightjar	*Caprimulgus affinis*	1	1																																										
White-throated Kingfisher	*Halcyon smyrnensis*	5	1																							1		1	1											1					
Common Kingfisher	*Alcedo atthis*	7	1			1	1					1											1			1	1																		
Pied Kingfisher	*Ceryle rudis*	7											1						1	1	1					1							1			1									
Eurasian Wryneck	*Jynx torquilla*	1			1																																								
Barn Swallow	*Hirundo rustica*	1																												1															
Richard's Pipit	*Anthus richardi*	6	1				1						1						1										1			1													
Olive-backed Pipit	*Anthus hodgsoni*	2	1				1																																						
Red-throated Pipit	*Anthus cervinus*	7	1				1					1							1										1						1	1									
White Wagtail	*Motacilla alba*	6	1				1			1					1											1	1																		
Yellow Wagtail	*Motacilla flava*	21	1				1		1		1				1		1	1			1		1		1	1	1		1		1			1		1			1	1	1		1	1	
Grey Wagtail	*Motacilla cinerea*	6	1															1						1		1							1								1				
Siberian Rubythroat	*Luscinia calliope*	1																					1																						
Bluethroat	*Luscinia svecica*	1																																				1							
Common Stonechat	*Saxicola torquata*	19	1		1	1	1			1	1	1		1	1	1	1	1			1	1	1			1	1					1					1								
Dusky Thrush	*Turdus naumanni*	1															1																												
Zitting Cisticola	*Cisticola juncidis*	6					1																								1	1				1	1		1						
Japanese Bush Warbler	*Cettia diphone*	2																				1				1																			
Pallas's Grasshopper Warbler	*Locustella certhiola*	2																								1												1							
Lanceolated Warbler	*Locustella lanceolata*	1																																							1				
Black-browed Reed Warbler	*Acrocephalus bistrigiceps*	2																				1																1							
Paddyfield Warbler	*Acrocephalus agricola*	1																																				1							
Oriental Reed Warbler	*Acrocephalus orientalis*	1																								1																			
Yellow-browed Warbler	*Phylloscopus inornatus*	1																					1																						
Dusky Warbler	*Phylloscopus fuscatus*	5													1							1	1			1	1																		
Collared Crow	*Corvus torquatus*	3	1																							1													1						
White-cheeked Starling	*Sturnus cinerea*	1																			1																								
White-shouldered Starling	*Sturnus sinensis*	1																								1																			
Red-billed Starling	*Sturnus sericeus*	6	1						1														1			1			1			1													
Black-faced Bunting	*Emberiza spodocephala*	6					1	1		1			1		1	1																													
Species per Pond			20	0	2	3	14	4	6	5	4	7	5	3	9	5	4	6	6	5	9	11	17	9	9	28	8	4	10	5	8	12	9	8	6	10	10	4	8	9	8	3	3	6	4

Where "1" indicates the presence of a species in a pond.

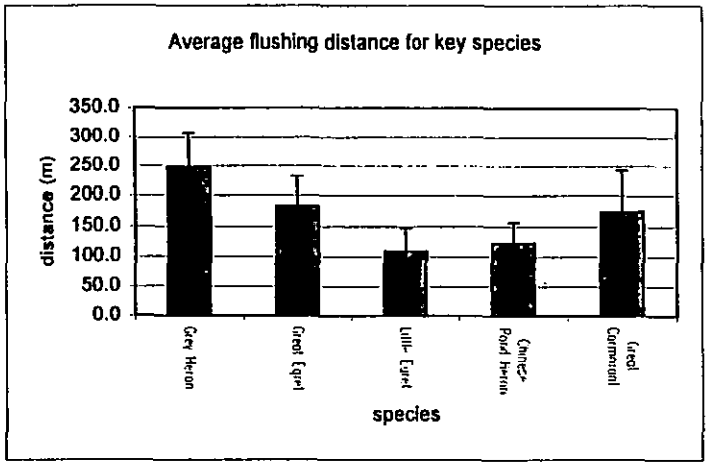
Appendix 1: Total number of key species recorded during each site visit

	average	*tdev*	4.12	9.12	16.12	22.1	29	6.01	13.1
GH	*67*	*16*	57	65	53	73	65	56	99
GE	*6.9*	*3.6*	7	5	9	9	5	1	12
LE	*55*	*65*	34	32	41	44	22	11	199
CPH	*31*	*12*	31	26	20	40	21	26	55
COR	*121*	*40*	171	106	127	157	104	135	49



Appendix 1: Flushing Distances for key species observed

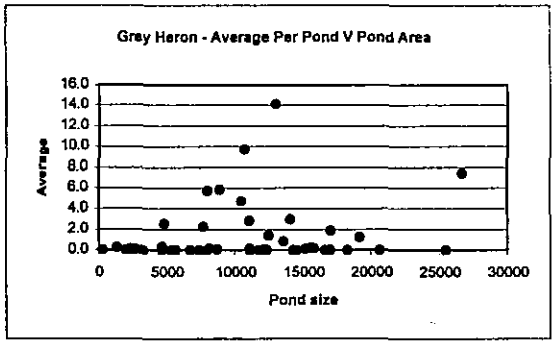
species	Grey Heron	Great Egret	Little Egret	Chinese Pond Heron	Great Cormorant
average	246.6	183.3	109.4	122.9	175.0
stdev	60.3	49.4	37.7	34.2	67.9
max	325	275	150	150	300
min	100	150	50	50	75
n.	61	7	9	25	22
	125	250	150	150	200
	325	150	150	150	200
	325	150	150	150	200
	325	175	100	150	200
	325	175	100	150	200
	325	175	50	150	200
	325	275	75	150	150
	325		100	150	75
	325		150	150	75
	325			150	75
	325			125	150
	200			125	150
	125			125	150
	150			125	150
	100			125	150
	275			75	150
	275			75	100
	275			100	150
	275			75	300
	275			50	300
	275			50	300
	250			100	250
	250			150	
	200			150	

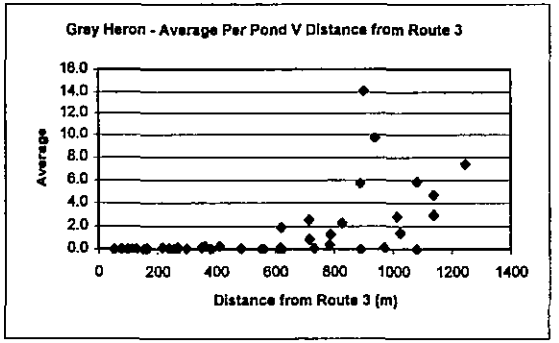


Appendix 1 : Relationship Between Number of Grey Heron and Distance From Route 3 or Pond Area

	dist from R3	average	Area m	average	4.12	9.12	16.12	22.12	29.12	6.01	13.1	19.1	27.1	3.2	9.2	15.2	23.2	4.3	10.3	17.3	23.3	31.3	5.4	11.4	21.4	30.4
Egretry	269	0.0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	300	0.0	270	0.0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1A	100	0.0	20632	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1B	77	0.0	2398	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1C	54	0.0	1975	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1D	102	0.0	14263	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	130	0.0	25479	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2A	52	0.0	4634	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	162	0.0	11979	0.0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	255	0.0	11148	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	81	0.0	5620	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	114	0.0	18268	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	168	0.0	12318	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8	269	0.2	15809	0.2	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0
9	156	0.0	7370	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	363	0.3	15555	0.3	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	1	0	1	0
11	239	0.1	2685	0.1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
11B	218	0.1	2298	0.1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
12	555	0.0	16591	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	624	0.0	14534	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	487	0.0	16973	0.0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	350	0.1	15172	0.1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
16	383	0.0	7938	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	615	0.0	6704	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	733	0.1	8684	0.1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	785	0.4	4630	0.4	0	1	0	1	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
20	621	1.9	17024	1.9	6	2	1	3	6	0	5	0	0	0	0	1	1	0	10	2	1	1	1	1	0	1
20A	412	0.3	1326	0.3	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	562	0.0	11782	0.0	0	0	0	0	0	0	0															
22	715	2.6	4809	2.6	3	3	3	4	0	3	2															
23	618	0.1	8135	0.1	0	0	1	0	0	0	0															
24	788	1.3	19179	1.3	0	3	1	0	0	0	5															
25	716	0.9	13565	0.9	0	0	0	0	0	3	3															
26	902	14.1	13007	14.1	7	15	10	25	15	17	10															
27	939	9.7	10707	9.7	5	7	8	15	6	2	25															
28	1015	2.9	11095	2.9	5	4	0	0	3	2	6															
29	889	5.7	8008	5.7	7	8	9	5	11	0	0															
30	827	2.3	7675	2.3	2	3	3	0	5	0	3															
31	892	0.0	3253	0.0	0	0	0	0	0	0	0															
32	971	0.1	11108	0.1	0	0	0	0	0	1	0															
33	1026	1.4	12477	1.4	2	2	1	2	0	2	1															
34	1082	5.9	8897	5.9	3	2	1	2	3	10	20															
35	1139	3.0	14068	3.0	3	3	2	5	0	5	3															
36	1081	0.0	5311	0.0	0	0	0	0	0	0	0															
37	1246	7.4	26709	7.4	8	8	8	6	10	6	6															
38	1138	4.7	10510	4.7	6	4	5	5	6	4	3															
	total	65.8	482572	65.8	57	65	53	73	65	56	99	9	0	0	0	4	4	9	11	2	2	1	2	1	1	1
					4.12	9.12	16.12	22.12	29.12	6.01	13.1	19.1	27.1	3.2	9.2	15.2	23.2	4.3	10.3	17.3	23.3	31.3	5.4	11.4	21.4	30.4
		Pond 1 -20A	4		6	3	1	4	6	1	12	9	0	0	0	4	4	9	11	2	2	1	2	1	1	1
		Dec	4		2.1																					
		Jan	6		5.9																					
		Feb	2		2.3																					
		Mar	5		4.6																					
		Apr	1		0.5																					

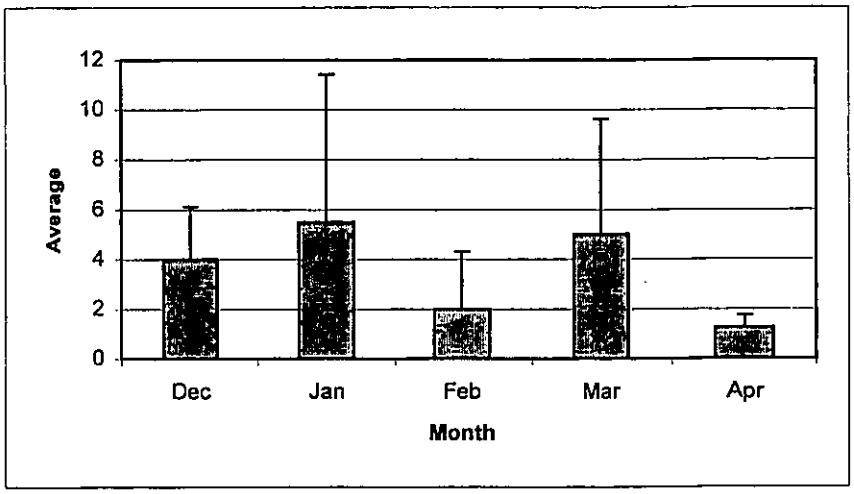
	Dec	Jan	Feb	Mar	Apr
average	4	6	2	5	1
sdev	2.1	5.9	2.3	4.6	0.5

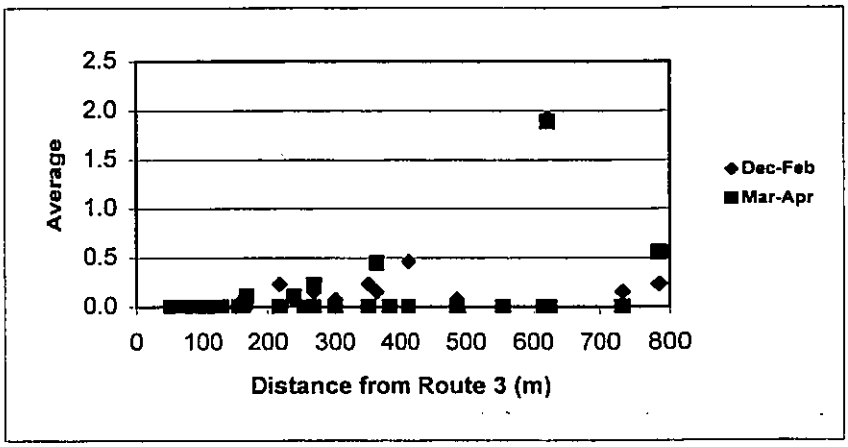




Appendix 1 : Relationship Between Number of Grey Heron and Distance From Route 3 or Pond Area

	dist from R3	Dec-Feb	Mar-Apr
	269	0.0	0.0
Egretry	300	0.1	0.0
1	100	0.0	0.0
1A	77	0.0	0.0
1B	54	0.0	0.0
1C	102	0.0	0.0
1D	130	0.0	0.0
2	52	0.0	0.0
2A	162	0.1	0.0
3	255	0.0	0.0
4	81	0.0	0.0
5	114	0.0	0.0
6	168	0.0	0.1
7	269	0.2	0.2
8	156	0.0	0.0
9	363	0.2	0.4
10	239	0.1	0.1
11	218	0.2	0.0
11B	555	0.0	0.0
12	624	0.0	0.0
13	487	0.1	0.0
14	350	0.2	0.0
15	383	0.0	0.0
16	615	0.0	0.0
17	733	0.2	0.0
18	785	0.2	0.6
19	621	1.9	1.9
20	412	0.5	0.0
20A total		3.8	3.3



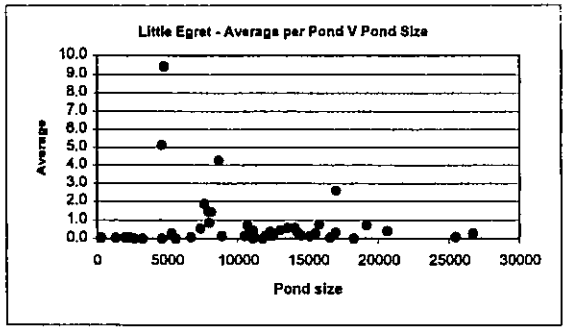


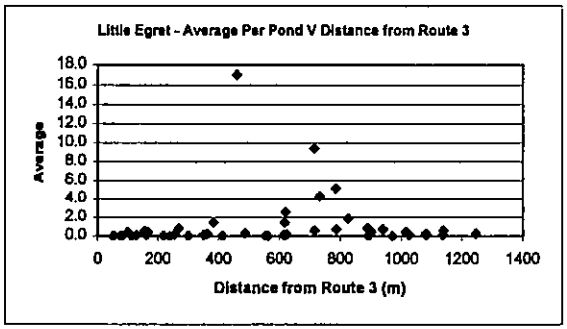
Appendix 1 : Relationship Between Number of Little Egret and Distance From Route 3 or Pond Area

	dist from R3	average	Area m	average	4.12	9.12	16.12	22.12	29.12	6.01	13.1	19.1	27.1	3.2	9.2	15.2	23.2	4.3	10.3	17.3	23.3	31.3	5.4	11.4	21.4	30.4
gretry	460	17.1	0	17.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	31	45	78	78	42	46	42
1	300	0.0	270	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1A	100	0.4	20632	0.4	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	0	0	1	0	1	1
1B	77	0.0	2398	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1C	54	0.0	1975	0.0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1D	102	0.4	14263	0.4	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	0	1	0	0
2	130	0.1	25479	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
2A	52	0.0	4634	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	162	0.1	11979	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
4	255	0.2	11148	0.2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1
5	81	0.0	5620	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	114	0.0	18268	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	168	0.4	12318	0.4	0	0	0	0	0	0	0	0	0	1	1	0	0	0	4	1	1	0	0	0	0	0
8	269	0.8	15809	0.8	0	0	1	0	0	0	0	0	1	0	0	0	0	0	4	1	3	4	0	1	1	1
9	156	0.5	7370	0.5	0	0	1	0	0	1	0	0	0	2	1	0	0	0	0	6	0	0	0	0	1	0
10	363	0.3	15555	0.3	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2	0	1	0	0
11	239	0.0	2685	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11B	218	0.0	2298	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
12	555	0.0	16591	0.0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	624	0.2	14534	0.2	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
14	487	0.3	16973	0.3	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	1	0	0	0	2	0	0
15	350	0.1	15172	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
16	383	1.5	7938	1.5	5	0	10	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	615	0.1	6704	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
18	733	4.3	8684	4.3	1	3	0	0	0	0	80	0	7	0	1	0	0	1	0	0	0	1	0	0	0	0
19	785	5.1	4630	5.1	2	0	0	0	5	1	80	0	0	5	1	0	0	14	1	0	0	1	0	0	2	1
20	621	2.6	17024	2.6	11	8	6	20	0	0	0	0	0	0	1	0	0	0	1	6	3	1	0	0	0	0
20A	412	0.0	1326	0.0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	562	0.0	11782	0.0	0	0	0	0	0	0	0															
22	715	9.4	4809	9.4	0	8	6	10	0	7	35															
23	618	1.4	8135	1.4	0	3	5	2	0	0	0															
24	788	0.7	19179	0.7	2	0	0	0	0	0	3															
25	716	0.6	13565	0.6	0	0	0	4	0	0	0															
26	902	0.4	13007	0.4	1	0	2	0	0	0	0															
27	939	0.7	10707	0.7	5	0	0	0	0	0	0															
28	1015	0.4	11095	0.4	0	0	0	3	0	0	0															
29	889	0.9	8008	0.9	1	2	0	3	0	0	0															
30	827	1.9	7675	1.9	0	4	9	0	0	0	0															
31	892	0.0	3253	0.0	0	0	0	0	0	0	0															
32	971	0.0	11108	0.0	0	0	0	0	0	0	0															
33	1026	0.1	12477	0.1	0	1	0	0	0	0	0															
34	1082	0.1	8897	0.1	1	0	0	0	0	0	0															
35	1139	0.6	14068	0.6	3	0	0	0	0	1	0															
36	1081	0.3	5311	0.3	0	0	0	2	0	0	0															
37	1246	0.3	26709	0.3	1	0	0	0	0	0	1															
38	1138	0.1	10510	0.1	0	0	1	0	0	0	0															
	total	52.7	482572	52.7	34	32	41	44	22	11	199	1	9	8	8	3	2	22	27	50	57	89	81	49	54	46
			Pond 1 -20A	35	20	14	18	20	22	3	160	1	9	8	8	3	2	22	27	50	57	89	81	49	54	46

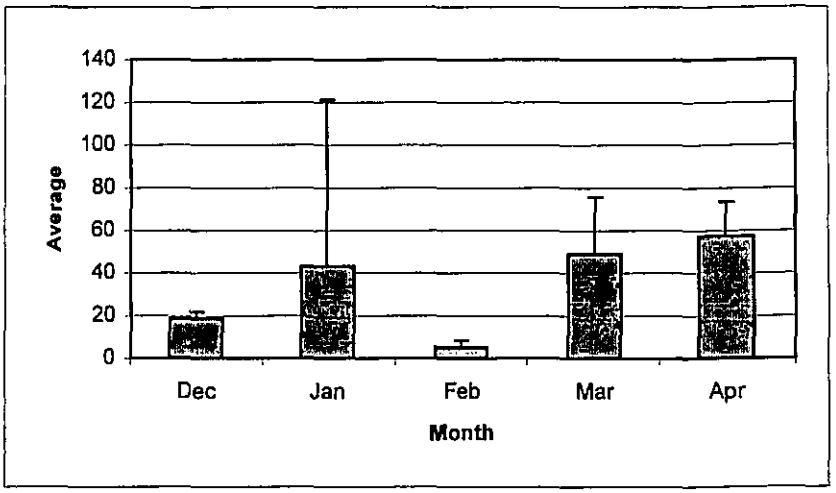
Dec	19
Jan	43
Feb	5
Mar	49
Apr	58

	Dec	Jan	Feb	Mar	Apr
average	19	43	5	49	58
sdev	3.0	77.9	3.2	26.8	16.0

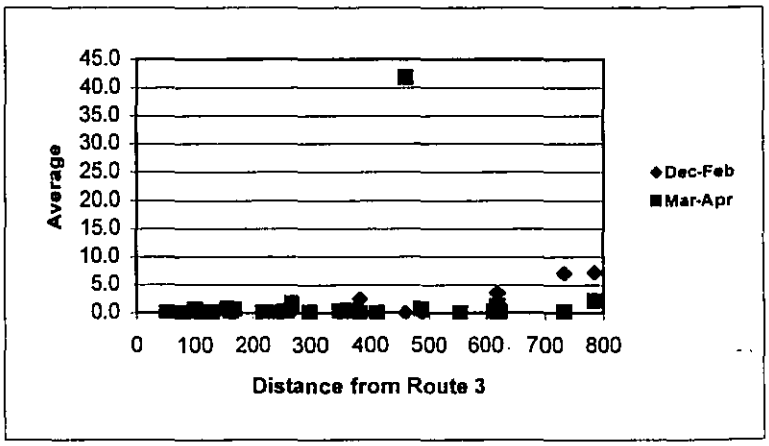




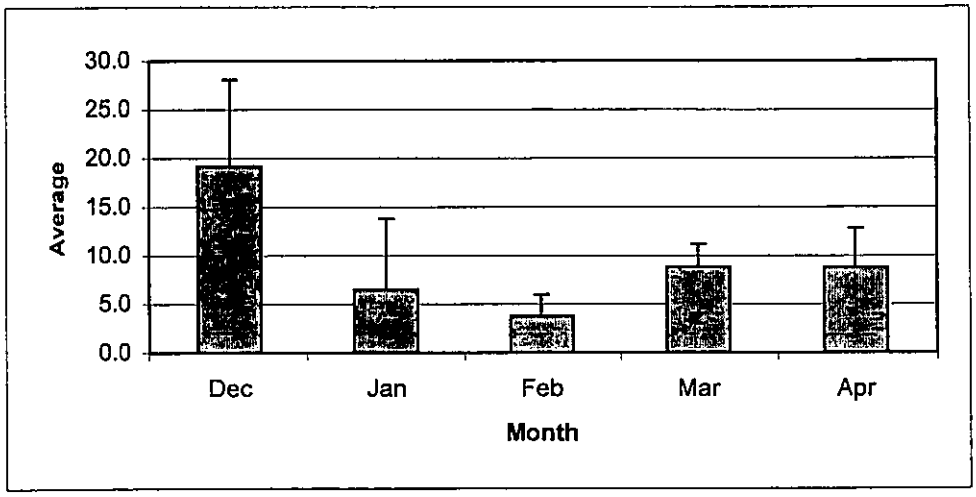
Appendix 1 : Relationship Between Number of Little Egret and Distance From Route 3 or Pond Area



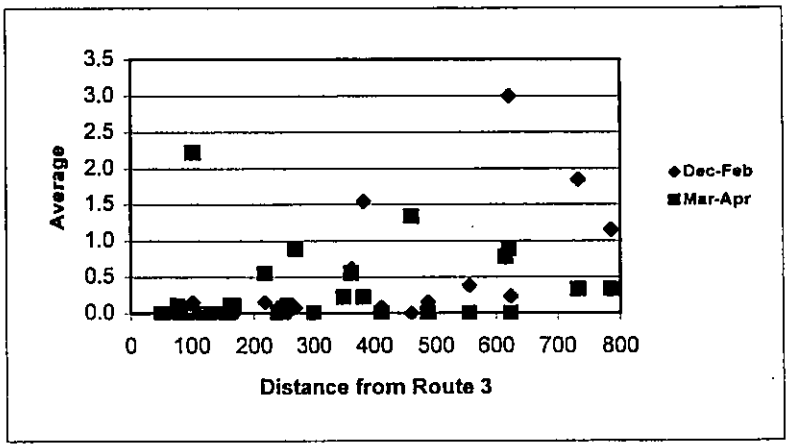
	dist from R3	Dec-Feb	Mar-Apr
gretry	460	0.0	41.8
1	300	0.0	0.1
1A	100	0.2	0.7
1B	77	0.0	0.1
1C	54	0.1	0.0
1D	102	0.2	0.6
2	130	0.0	0.2
2A	52	0.0	0.0
3	162	0.0	0.3
4	255	0.1	0.3
5	81	0.0	0.0
6	114	0.0	0.0
7	168	0.2	0.7
8	269	0.2	1.7
9	156	0.4	0.8
10	363	0.2	0.4
11	239	0.0	0.0
11B	218	0.0	0.1
12	555	0.1	0.0
13	624	0.2	0.2
14	487	0.1	0.7
15	350	0.0	0.3
16	383	2.5	0.0
17	615	0.0	0.2
18	733	7.1	0.2
19	785	7.2	2.1
20	621	3.5	1.2
20A	412	0.1	0.0
total		22.2	52.8



Appendix 1 : Relationship Between Number of Chinese Pond Herons and Distance From Route 3 or Pond



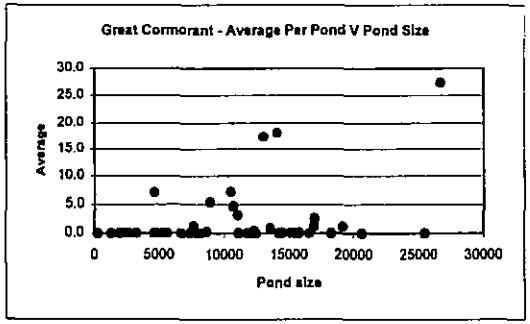
	dist from R3	Dec-Feb	Mar-Apr
Egretry	460	0.0	1.3
1	300	0.0	0.0
1A	100	0.0	0.0
1B	77	0.1	0.1
1C	54	0.0	0.0
1D	102	0.2	2.2
2	130	0.0	0.0
2A	52	0.0	0.0
3	162	0.0	0.1
4	255	0.0	0.1
5	81	0.0	0.0
6	114	0.0	0.0
7	168	0.0	0.1
8	269	0.1	0.9
9	156	0.0	0.0
10	363	0.6	0.6
11	239	0.1	0.0
11B	218	0.2	0.6
12	555	0.4	0.0
13	624	0.2	0.0
14	487	0.2	0.0
15	350	0.2	0.2
16	383	1.5	0.2
17	615	0.8	0.8
18	733	1.8	0.3
19	785	1.2	0.3
20	621	3.0	0.9
20A	412	0.1	0.0
total		10.5	8.8

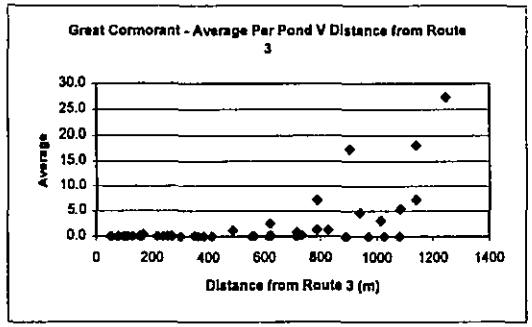


Appendix 1 : Relationship Between Number of Great Cormorant and Distance From Route 3 or Pond Area

	dist from R3	average	Area m	average	4.12	9.12	16.12	22.12	29.12	6.01	13.1	19.1	27.1	3.2	9.2	15.2	23.2	4.3	10.3	17.3	23.3	31.3	5.4	11.4	21.4	30.4
Egretry	269	0.0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	300	0.0	270	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1A	100	0.0	20632	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1B	77	0.0	2398	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1C	54	0.0	1975	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1D	102	0.0	14263	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	130	0.0	25479	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2A	52	0.0	4634	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	162	0.0	11979	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	255	0.1	11148	0.1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
5	81	0.0	5620	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	114	0.0	18258	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	168	0.4	12318	0.4	0	3	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8	269	0.1	15809	0.1	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
9	156	0.0	7370	0.0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
10	363	0.0	15555	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	239	0.0	2685	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11B	218	0.0	2298	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	555	0.0	16591	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	624	0.1	14534	0.1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
14	487	1.2	16973	1.2	0	5	9	10	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
15	350	0.1	15172	0.1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
16	363	0.0	7938	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	615	0.0	6704	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	733	0.3	8684	0.3	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	785	7.2	4630	7.2	25	35	18	40	11	11	3	0	0	8	5	0	0	2	0	0	0	0	0	0	0	0
20	621	2.6	17024	2.6	20	5	10	5	15	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
20A	412	0.0	1326	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	562	0.0	11782	0.0	0	0	0	0	0	0	0															
22	715	0.0	4809	0.0	0	0	0	0	0	0	0															
23	618	0.0	8135	0.0	0	0	0	0	0	0	0															
24	788	1.3	19179	1.3	0	0	0	0	9	0	0															
25	716	0.9	13565	0.9	0	0	0	0	1	0	5															
26	902	17.4	13007	17.4	25	10	20	30	15	22	0															
27	939	4.7	10707	4.7	15	0	8	10	0	0	0															
28	1015	3.1	11095	3.1	5	0	2	0	7	4	4															
29	889	0.0	8008	0.0	0	0	0	0	0	0	0															
30	827	1.3	7675	1.3	3	0	3	0	3	0	0															
31	892	0.0	3253	0.0	0	0	0	0	0	0	0															
32	971	0.0	11108	0.0	0	0	0	0	0	0	0															
33	1026	0.0	12477	0.0	0	0	0	0	0	0	0															
34	1082	5.4	8897	5.4	5	5	6	5	7	10	0															
35	1139	18.1	14068	18.1	25	15	20	17	15	20	15															
36	1081	0.0	5311	0.0	0	0	0	0	0	0	0															
37	1246	27.4	26709	27.4	40	18	22	25	15	60	12															
38	1138	7.3	10510	7.3	8	10	9	10	6	6	2															
	total	99.2	482572	99.2	171	106	127	157	104	135	49	3	3	9	6	0	0	3	2	1	1	0	0	0	0	0
	Pond 1 -20A		12	45	48	37	60	26	13	11	3	3	9	6	0	0	3	2	1	1	0	0	0	0	0
	Dec		43	12.7																						
	Jan		8	5.3																						
	Feb		4	4.5																						
	Mar		1	1.1																						
	Apr		0	0.0																						

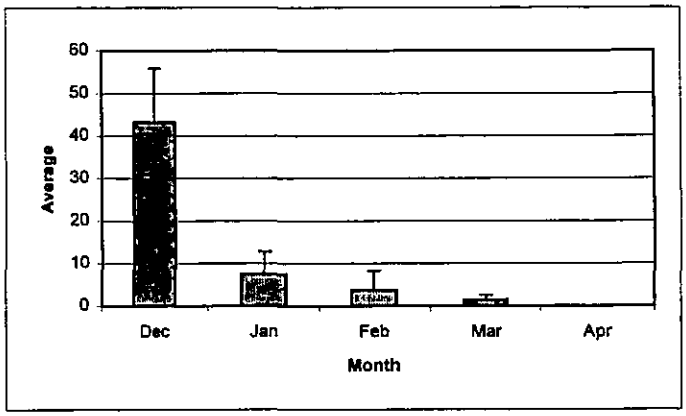
	Dec	Jan	Feb	Mar	Apr
average	43	8	4	1	0
sdev	12.7	5.3	4.5	1.1	0.0

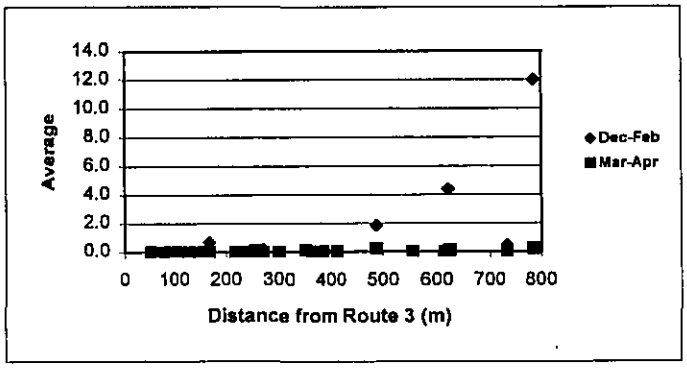




Appendix 1 : Relationship Between Number of Great Cormorant and Distance From Route 3 or Pond Area

	dist from R3	Dec-Feb	ar-Apr
Egretry	269	0.0	0.0
1	300	0.0	0.0
1A	100	0.0	0.0
1B	77	0.0	0.0
1C	54	0.0	0.0
1D	102	0.0	0.0
2	130	0.0	0.0
2A	52	0.0	0.0
3	162	0.0	0.0
4	255	0.1	0.1
5	81	0.0	0.0
6	114	0.0	0.0
7	168	0.7	0.0
8	269	0.2	0.0
9	156	0.1	0.0
10	363	0.0	0.0
11	239	0.0	0.0
11B	218	0.0	0.0
12	555	0.0	0.0
13	624	0.2	0.1
14	487	1.8	0.2
15	350	0.2	0.1
16	383	0.0	0.0
17	615	0.0	0.0
18	733	0.5	0.0
19	785	12.0	0.2
20	621	4.4	0.0
20A	412	0.0	0.0
total		20.1	0.8



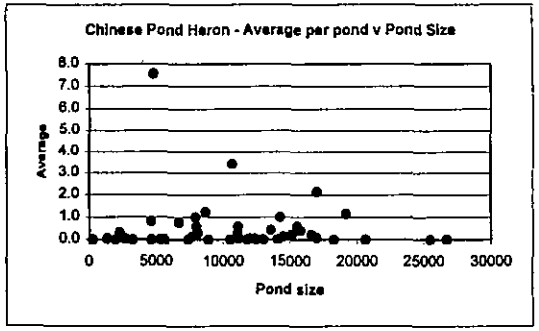


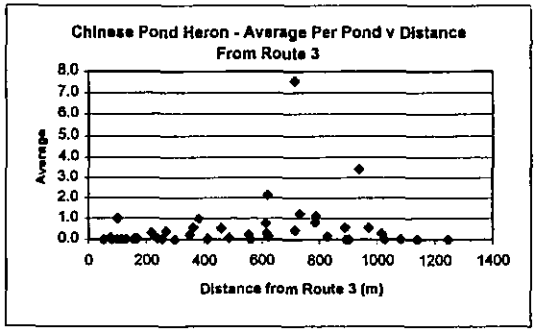
Appendix 1: Relationship Between Number of Chinese Pond Heron and Distance Route Pond

	dist from R3	average	Area m	average	4.12	9.12	16.12	22.12	29.12	6.01	13.1	19.1	27.1	3.2	9.2	15.2	23.2	4.3	10.3	17.3	23.3	31.3	5.4	11.4	21.4	31.4
Egretry	460	0.5	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	5	
1	300	0.0	270	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1A	100	0.0	20632	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1B	77	0.1	2398	0.1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	
1C	54	0.0	1975	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1D	102	1.0	14263	1.0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	9	0	0	2	4	3	1
2	130	0.0	25479	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2A	52	0.0	4634	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	162	0.0	11979	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
4	255	0.0	11148	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
5	81	0.0	5620	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	114	0.0	18268	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	168	0.0	12318	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
8	269	0.4	15809	0.4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	4	0	0	3	0
9	156	0.0	7370	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	363	0.6	15555	0.6	0	0	0	2	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	2
11	239	0.0	2685	0.0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11B	218	0.3	2298	0.3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	1	0
12	555	0.2	16591	0.2	0	0	0	2	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	624	0.1	14534	0.1	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	487	0.1	16973	0.1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	350	0.2	15172	0.2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
16	383	1.0	7938	1.0	0	5	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
17	615	0.8	6704	0.8	3	1	1	5	0	0	0	0	0	0	0	0	0	1	3	0	2	1	0	0	0	0	0
18	733	1.2	8684	1.2	0	6	0	3	0	0	10	0	0	5	0	0	0	2	0	0	0	1	0	0	0	0	0
19	785	0.8	4630	0.8	3	2	1	0	6	0	2	0	0	1	0	0	0	2	0	0	0	1	0	0	0	0	0
20	821	2.1	17024	2.1	14	0	0	19	0	0	1	0	0	0	2	3	0	0	3	3	2	0	0	0	0	0	0
20A	412	0.0	1326	0.0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
21	562	0.0	11782	0.0	0	0	0	0	0	0	0																
22	715	7.6	4809	7.6	7	0	6	5	0	20	15																
23	618	0.3	8135	0.3	0	2	0	0	0	0	0																
24	788	1.1	19179	1.1	0	3	5	0	0	0	0																
25	716	0.4	13565	0.4	0	0	0	0	0	0	3																
26	902	0.0	13007	0.0	0	0	0	0	0	0	0																
27	939	3.4	10707	3.4	0	3	0	0	0	1	20																
28	1015	0.3	11095	0.3	0	0	0	2	0	0	0																
29	889	0.6	8008	0.6	0	2	0	2	0	0	0																
30	827	0.1	7675	0.1	0	1	0	0	0	0	0																
31	892	0.0	3253	0.0	0	0	0	0	0	0	0																
32	971	0.6	11108	0.6	2	0	2	0	0	0	0																
33	1026	0.0	12477	0.0	0	0	0	0	0	0	0																
34	1082	0.0	8897	0.0	0	0	0	0	0	0	0																
35	1139	0.0	14068	0.0	0	0	0	0	0	0	0																
36	1081	0.0	5311	0.0	0	0	0	0	0	0	0																
37	1246	0.0	26709	0.0	0	0	0	0	0	0	0																
38	1138	0.0	10510	0.0	0	0	0	0	0	0	0																
	total	24.2	482572	24.2	31	26	20	40	21	26	55	0	4	6	5	3	1	9	6	12	7	10	3	12	11	9
			Pond 1 -20A	10	22	15	7	31	21	5	17	0	4	6	5	3	1	9	6	12	7	10	3	12	11	9

Dec	19.2	8.9
Jan	6.5	7.3
Feb	3.8	2.2
Mar	8.8	2.4
Apr	8.8	4.0

	Dec	Jan	Feb	Mar	Apr
average	19.2	6.5	3.8	8.8	8.8
sdev	8.9	7.3	2.2	2.4	4.0





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