PROJECT PROFILE

An Extension to the Existing Boardwalk and New Floating Mudflat Bird-watching Hide at Mai Po Nature Reserve for Education and Conservation Purposes

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WWF Hong Kong
1 Tramway Path
Central
Hong Kong

E EXECUTIVE SUMMARY

E.1 Background

E.1.1 World Wide Fund for Nature Hong Kong (WWF HK) currently operates and maintains 3 floating bird-watching hides on the edge of the inter tidal mudflat within the Mai Po Inner Deep Bay Ramsar Site. These hides and the boardwalks required to access them, have since 1986 provided students, researchers and the public an opportunity to observe and study the unique wildlife associated with the inter tidal mangrove and mudflat habitats, in particular the tens of thousands of migratory waterbirds and in doing so have significantly helped to promote awareness amongst students and the public about the conservation importance of the habitats, and the diversity and abundance of migratory waterbirds that they support.

E1.2 Their function has diminished in recent years because of the dynamic environment in which they are located. Increasing sedimentation in Deep Bay has led to a rise in the mudflat surface by some 30cm since the late 1980's. Consequently it now requires a tide height of over 2.1m (previously 1.8m) to bring the edge of the waterline to the hide and the waterbirds with it for the intended purposes. This reduced number of opportunities to see birds is further exacerbated by the fact that in winter, when Deep Bay supports the highest number of migratory waterbirds, the majority of the appropriate high tides are at night. Sedimentation has also encouraged mangrove vegetation to spread onto the open mudflat and this restricts the overall viewing area. A deterioration in air quality is also reducing visibility in the Deep Bay area.

E1.3 To overcome these problems a new bird-watching hide is required further out by the mangrove fringe in Deep Bay to provide views of the waterbirds on the mudflats over a greater range of tidal levels. An extension to the existing boardwalk network would be necessary to gain access to this proposed new hide and this in itself, would provide an additional education opportunity because students would walk through a mangrove forest of different ages.

E1.4 The existing hides would be retained at their current location because most education groups, would continue to use them. Researchers would also use these hides at higher tide levels when the mudflat in front of the proposed new hide has been covered by the tide. Therefore visitor pressure upon the new hide would be less than at the existing hides.

E.2 Scale of the Project

E2.1 The Project Area is located inside the Mai Po Inner Deep Bay Ramsar Site which contains the Mai Po Marshes SSSI & Inner Deep Bay SSSI. It is also designated as a Shorebird Flyway Network Site and an Anatidae Flyway Network Site.

E2.2 The Project comprises two elements. **(1)** A new floating bird-watching hide located further out into the Bay, north of the existing hides. The location is chosen to provide optimal education and research benefits in respect of the identified problems. The new hide will be 8.0m x 6.0m x 2.7m (LxWxH) and be fixed upon a floating pontoon base measuring 10.0m x 8.0m x 1.0m (LxWxH). **(2)** An extension to the existing boardwalk network for users to access the new hide. Three boardwalk alignment options are considered including two different design types (floating and fixed) each traversing different habitat types (inter tidal mudflat, inter tidal mangrove and inter tidal creek). The preferred Option C (after assessment) is a 580m long fixed boardwalk (1m wide x 1m high) through the mangrove habitat with a simple screen at the terminus to prevent user disturbance when entering/exiting the hide.

E.3 Planning and Implementation Process

E3.1 The bird-watching hide would be constructed over an intense 16-week work period, between July and October 2006, purposefully avoiding the peak waterbird migration season. An off-site construction area is chosen (helicopter pad/AFCD hovercraft launch area in Southern Mai Po Nature Reserve) to avoid disturbance at the more sensitive on-site inter tidal mudflat area.

- The hide will be constructed from wooden materials and green external cladding using only hand tools.
- A Government Flying Services helicopter will transport and place 6 concrete anchors (each 1m x 1m x 1m) onto the mudflat at the hide location.
- Once the hide is fully constructed, two Hong Kong Marine Police dinghies will tow the hide out to the final location (a 3-hour operation).
- Finally WWF staff will chain each concrete anchor to the hide (total 3 hour operation).

E3.2 The boardwalk would also be constructed over an intense 16-week work period, between July and October 2006, avoiding the peak waterbird migration season. Boardwalk sections would be prefabricated at the existing WWF workshop to avoid disturbance at the more sensitive on-site mangrove area and carried to the on-site construction location. The boardwalk structure would be constructed entirely from wood using only hand tools.

E3.3 All expected maintenance operations for both facilities are simple and similar to the existing ones carried out by WWF staff on other facilities within the Nature Reserve.

E.4 Conclusions of the Assessments

E4.1 The identified sensitive receivers within the Project Area are (1) Mai Po Inner Deep Bay Ramsar Site (including the Mai Po Marshes SSSI and Inner Deep Bay SSSI), (2) visitors to the Nature Reserve (including birdwatchers, educational groups and wildlife tours) and (3) a variety of flora and fauna species of conservation concern (particularly migratory waterbirds).

E4.2 All environmental impacts predicted during construction of the bird-watching hide are assessed as “very minor” because the hide would be constructed off-site, away from the inter-tidal mudflat, at a location with few sensitive receivers. The operation to transport the concrete anchors by helicopter and to tow the hide with dinghies are each of three hours duration and consequently have a temporary and minimal impact upon the surrounding environment.

E4.3 Impacts arising from normal operation of the bird-watching hide are all assessed as “very minor”. Usage is expected to be less than the existing hides (primarily because of the extra time taken to reach the hide) and therefore the frequency and duration of disturbance is reduced.

E4.4 Following an assessment of the likely environmental impacts arising from the construction and operation of the different boardwalk alignments, Option C was chosen. This is because there are 6 impacts ranked above “minor” associated with Option A, 2 ranked above “minor” for Option B and none above “minor” for Option C. The only “minor” impact for Option C relates to the trimming and pollarding of 137 mangrove plants for the access route. All plants are expected to continue to grow healthily or regenerate, so there would be no loss of any individual mangrove tree/shrub. The loss of mangrove habitat area is very minor (<0.06ha) in respect of the 394ha mangrove forest within the Ramsar Site.

E.5 Environmental Protection Measures

E5.1 WWF Hong Kong will carry out a series of measures throughout the construction and operation phases to minimise impacts. These include:

Construction

- Construction work will avoid the season for wintering waterbirds and be condensed into a 16-week work period to avoid protraction of any impact(s) to the environment.
- Government involvement (GFS and HK Marine Police) significantly reduces the amount of time involved to position the bird-watching hide on the mudflat, thus the disturbance period is shortened.
- Prefabrication of boardwalk materials at the WWF workshop and construction of the bird-watching hide at an off-site location, both reduce the overall on-site disturbance thus significantly reducing the overall environmental impact.

- On-site boardwalk construction activities would be undertaken only at low tide to prevent sediment being released into the water column.
- The original boardwalk alignment for Option C was revised to avoid the largest (and multi-stemmed) trees and subsequently the total number affected was reduced from 163 to 137.

Operation

E.5.2
- To avoid overcrowding and minimise disturbance, access to the proposed boardwalk and hide will be restricted to those people with Closed Area permits, issued by the Hong Kong Police Force.
- Retention of the existing bird-watching hides reduces the demand upon the new hide and all school groups would be accompanied by a WWF HK guide at all times.
- Maintenance work for both facilities will be carried out during low tide to avoid disturbance to waterbirds on the mudflats or inside the mangrove.
- Simple features are built into the bird-watching hide design to reduce the potential for disturbance such as wooden window shutters, wooden door handles, rubber floor mats, cushioning material surrounding the entrance/exit door frame, reduction of backlighting (through building a secondary screen inside of the main door) and avoidance of reflective display material inside the hide.
- A small screen will be constructed at the terminus of the boardwalk to reduce any potential visual and noise disturbance as users enter/exit the bird-watching hide.

E.6 Environmental Monitoring and Auditing

E6.1 An EM&A programme is proposed to address (1) an uncertain impact relating to the disturbance caused by users of the new hide upon nearby avifauna, and (2) an unproven mitigation measure relating to the expected regeneration of pollarded mangrove shrubs. If deemed necessary additional mitigation measures would be implemented.

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1. BASIC INFORMATION

1.1 Project Title

1.1.1 An Extension to the Existing Boardwalk and New Mudflat Bird-watching Hide at Mai Po Nature Reserve for Education and Conservation Purposes.

1.2 Purpose and Nature of the Project

Background

1.2.1 The Mai Po Inner Deep Bay Ramsar Site annually supports some 100,000 migratory waterbirds during passage in spring and autumn and during the winter non-breeding season. Deep Bay is also listed as a Shorebirds Network Site and an Anatidae Network Site in the East Asian – Australasian Flyway, highlighting the importance of the site for migratory waterbirds. The inter-tidal mudflat is the most important feeding and roosting habitat for many migratory waterbird species using Deep Bay, and is also where the largest numbers of birds can be observed without causing disturbance. To provide students, researchers and the public an opportunity to observe and study waterbirds using the mudflat, WWF Hong Kong has since 1986, successfully built and operated three floating bird-watching hides on the edge of the inter-tidal mangroves overlooking Deep Bay (locations shown in Appendix B: Figure 1 and view from the existing WWF Hong Kong hides shown in Appendix A: Plates 1 & 2). Sections of floating and fixed boardwalk provide access to these bird-watching hides from the Closed Area Fence, and the hides have helped to significantly promote awareness amongst students and the public about the conservation importance of the mudflat, and the diversity and abundance of migratory waterbirds that it supports. These floating bird-watching hides also allow researchers to study non-avian wildlife on the Deep Bay mudflats.

Problems Reducing the Functionality of the Existing Bird-watching Hides

Sedimentation

1.2.2 In the late 1980s, the tideline reached the floating hides when tidal height was approximately 1.8 – 1.9m. This was the preferred time for researchers and visitors to study and witness the spectacle of waterbirds in Deep Bay, as birds would stand in shallow water and wet mud along the tideline close to the front of the hides. However, due to increasing sedimentation in Deep Bay, the mudflat height in front of the floating hides has risen by some 30cm since the late 1980s and it now requires a tide height of some 2.1 – 2.2m for the tideline to reach the floating hides. Consequently, there are now fewer days each month when the tide reaches the floating hides, and thus a reduction in the number of suitable opportunities for studying and watching the waterbirds in the Bay. A secondary effect of this sedimentation is an advance of the mangrove forest, which overtime reduces the viewing area from the hides. This problem is exacerbated by the fact that in winter, when Deep Bay supports the highest number of migratory waterbirds, the majority of appropriate tides are at night.

Air pollution

1.2.3 Since winter 1978, regular surveys have been made of wintering waterbirds in Deep Bay providing invaluable estimates of the number and diversity of waterbirds wintering in the Bay and thus, the importance of Deep Bay for those waterbirds. However, over the past few years, higher air pollution levels make it very difficult to accurately carry out monthly surveys of the waterbirds in Deep Bay due to the poor visibility (Yu, 2004). Although extra counts were conducted, difficulties still existed for such waterbird monitoring programmes.

Need for the Project

1.2.4 The combined effect of ever increasing sedimentation in Deep Bay, an associated spread of mangroves and poor visibility due to a deterioration in air quality, means that it is now becoming more difficult for researchers and visitors to see birds from the existing hides (Yu, 2004). After discussions between WWF Hong Kong and a range of stakeholders, it was decided that the best

solution to overcome these problems would be build a new bird-watching hide further out on the mudflat to provide views of the waterbirds in Deep Bay over a greater range of tidal levels. An extension to the existing boardwalk network would also be necessary to gain access to the new hide.

Positive Outcomes

General

1.2.5 The proposed new hide will promote greater awareness and appreciation of the conservation importance of the inter tidal mudflat system, the waterbirds it supports and of the Ramsar Site itself because closer views are gained of the spectacle of the tens of thousands of waterbirds that utilise Deep Bay during the winter, as well as during spring and autumn passage.

Waterbird monitoring

1.2.6 The new hide will allow researchers to conduct waterbird monitoring in the area beyond the mangrove stands. For individual researchers this will provide better monitoring opportunities and ultimately a higher quality of data. For the Inner Deep Bay Ramsar Site Bird Monitoring work (subvented by Agriculture Fisheries and Conservation Department - AFCD) more comprehensive data would be obtainable.

Public awareness and educational purpose

1.2.7 The proposed new hide will allow media to film waterbirds in Deep Bay at close quarters so that the message of the importance of Deep Bay can be clearly transmitted to the public via television programmes, photographs, newspapers, magazines and other media forms. In addition, educational programmes will be conducted along the extended boardwalk allowing students and researchers to carry out field study and experimental work in a developed mangrove ecosystem. Students will therefore be able to study the succession of natural mangrove by walking through a series of different mangrove communities and structures.

1.3 Name of Project Proponent

1.3.1 World Wide Fund for Nature Hong Kong

1.4 Location and Scale of the Project

Project Area

1.4.1 The project area is located inside the Mai Po Inner Deep Bay Ramsar Site (designated in 1995). The site is also designated as Mai Po Marshes SSSI & Inner Deep Bay SSSI (1976), Shorebird Flyway Network Site (1996) and an Anatidae Flyway Network Site (2001).

1.4.2 The main areas of construction work are outside the Closed Area Fence and extend to the mangrove fringe by the mudflats of Inner Deep Bay and will comprise of an extension to the existing access boardwalk and a new floating bird-watching hide adjacent to similar facilities that have been successfully used by visitors to Mai Po Nature Reserve since 1986. The project has been developed through consultation with stakeholders including local working groups, e.g. Hong Kong Bird-Watching Society (HKBWS) who have been consulted regularly, even before the assessment process, and the general public (who participated in the October 2004 Mai Po Public Seminar). Support for the project is shown through the acceptance of the need for these facilities by the Mai Po Management Committee and letters of support from other green NGO groups in Hong Kong (HKBWS, Green Power) (Appendix C).

1.4.3 In the early planning stages several alternative options were proposed and discussed to resolve the problems identified in sections 1.2.2 – 1.2.3. To directly counteract the effect of sedimentation and reverse the diminishing usability of the existing facilities, consideration was given to lowering the height of the Ramsar Site inter tidal mudflats by dredging and then removing sediment material from Deep Bay. This option was considered to be too expensive and technically difficult resulting in an adverse impact upon all wildlife using the inter tidal mudflat system. Another

option considered the removal of a 9 hectare stand of mangrove forest from the area immediately north of the existing bird-watching hides to improve the view further towards the mouth of the Shenzhen River. However, the permanent removal of such a large area of mangrove forest would not only have a significant disturbance impact upon the wildlife currently using the area, but also to that surrounding the work area because the operation would be completed gradually over a long period of time.

Floating Bird-Watching Hide

1.4.4 The proposed bird-watching hide will be a single storey wooden hide mounted on a rectangular "yacht marina" type pontoon (Appendix B: Figure 2), similar in design principle to the existing WWF hides (Appendix A: Plate 2). The footprint of the floating hide will have dimensions of 6m x 8m (Width x Length) (Table 1) with an internal floor space of $48m^2$ (less than the largest existing hide) The dimension of each of the six concrete anchors is approximately 1m x 1m x 1m. The bird-watching hide will be 2.7m in height and have a maximum carrying capacity of 36 people at any given time (this capacity is specifically chosen to prevent excessively large groups entering the area – section 5.1.3). In collaboration with the main stakeholders, three options were considered for the location of the new hide (Appendix B: Figure 1).

Bird-watching Hide Option 1

1.4.5 To extend the existing hide and boardwalk further out onto the Deep Bay mudflats. This option was discarded because once constructed, it would lead to the loss of existing mudflat behind the hide due to mangrove colonisation on the mudflat and thus, the loss of feeding and roosting habitat for waterbirds. It would also have a negative impact upon viewing opportunities from the existing bird-watching hides on the mangrove fringe.

Bird-watching Hide Option 2

1.4.6 To build a new bird-watching hide at the edge of the mangroves but to the west, in the direction of the Shan Pui River. This option was also discarded because the birds that use the mudflat to the west of the existing bird-watching hides can also be seen from Tsim Bei Tsui, and so would not lead to any additional conservation benefit.

Bird-watching Hide Option 3

1.4.7 To build a new bird-watching hide at the edge of the mangroves but to the east, in the direction of the Shenzhen River mouth. This is the preferred option because visitors and researchers could observe and study waterbirds on the mudflats over a wider range of tidal heights. In addition, it will allow views over the northern portion of the mudflat towards the Shenzhen River mouth, an area that cannot presently be viewed from the existing hides, nor from any vantage points on the Hong Kong side of Deep Bay, and so has been excluded from regular waterbird monitoring carried out by the HKBWS. This will facilitate more accurate monitoring of the total number and diversity of waterbirds over a greater mudflat area.

1.4.8 Option 3 was agreed (with the stakeholders) as the best and most viable option from those available providing students and researchers with the best view of waterbirds and other wildlife across the Deep Bay mudflats. Therefore Options 1 and 2 are rejected and only Option 3 is incorporated into the decision making for the various boardwalk extension alignment options.

Boardwalk

1.4.9 To gain safe access to the proposed new hide at Option 3, an extension to the existing boardwalk network is required. Two principal construction design options are available:

1. Floating boardwalk. This would replicate the existing design already used inside Mai Po Nature Reserve (*gei wai* 18 and along the inter tidal creek); a series of anchored floating pontoons sections with a 40cm wide walkway in the centre (Appendix A: Plate 3a). The maximum width of this design is 3.1m.
2. Fixed boardwalk. This design would be similar to that of fixed boardwalks already present in *gei wai* 13, 14 and 16b, and through the inter-tidal mangroves; maximum of 1.0m wide at a height of approximately 1.0m from the mud surface (Appendix A: Plates 3b & 3c).

Three potential alignments are considered for the boardwalk extension to reach the location of the proposed new floating hide (Appendix B: Figure 1 & Table 1). These options are briefly outlined below:

Boardwalk Option A

1.4.10 To build a 495m fixed or floating boardwalk routed north from the existing WWF Hong Kong floating bird-watching hides, over the mudflats along the edge of the inter-tidal mangroves. The route is very sinuous and the final section must cross over the creek to reach the new bird-watching hide location.

Boardwalk Option B

1.4.11 To build a 550m fixed or floating boardwalk along the centre of the creek extending from the end of the existing floating boardwalk out to the Deep Bay mudflat/mangrove interface. Just before this boardwalk reaches the open mudflat, it will need to pass through a short (30m) section of mangrove before reaching the location for the new bird-watching hide.

Boardwalk Option C

1.4.12 To construct a 580m fixed boardwalk extending from an angle to the existing floating boardwalk, going through the inter-tidal mangroves and to the edge of the mudflats at the proposed bird-watching hide location. The route is located parallel to the creek, but at a minimum distance of 30m from it. Occasionally the route deviates away from the creek hence it is slightly longer than the adjacent 550m creek.

Table 1. Summary of the Infrastructure Dimensions and their Respective Shadow/Footprint Areas.

	Option A		Option B		Option C	Bird-watching Hide
	Fixed Design	Floating Design	Fixed Design	Mixed Design	Fixed Design	
Total Length (m)	495m	495m	550m	550m Fixed Section – 30m Floating Section – 520m	580m	8.0m 10.0 m with pontoon
Maximum Width (m)	1m	3.1m	1m	Fixed Section = 1m Floating Section = 3.1m	1m	6.0m 8.0m with pontoon
Maximum Height (m)	1m	2.6m	2.1m	Fixed Section = 1m Floating Section = 2.6m	1m	2.7m 3.7m with Pontoon
Total Shadow or Footprint Area (m^2)	$495m^2$	$1535m^2$	$550m^2$	$1642m^2$	$580m^2$	$80m^2$ including pontoon

1.5 Site History

1.5.1 At present, a floating boardwalk is used for the first 400m or so down the creek starting at the border fence. After this, the route turned south-west out of the creek through the mangrove to provide a screened approach to the rear of the existing bird-watching hides, which were located south-west of the creek. Initially, floating boardwalk units were used for this section which was around 100m long. However, later, when treated *Pinus radiate* imported from New Zealand became available at an acceptable cost on the local market, an extension from the boardwalk to the second (HKBWS) floating hide was constructed using wooden piles (220m long x 1m wide). Mangroves had to be trimmed for the boardwalk construction work, however they grew back quickly under and around the boardwalk, and now have to be regularly trimmed to prevent them blocking access.

1.5.2 The floating hides are one of the most popular and important facilities for students and other visitors to the Mai Po Nature Reserve, and allow excellent views of the tens of thousands of migratory birds on the mudflat from winter to spring.

1.6 Number and Types of Designated Projects

The proposed project is a designated project as defined under Schedule 2, Part I, Category Q - Miscellaneous, of the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499).

1.7 Name and Telephone Number of Contact Person

Reserve Officer
WWF Hong Kong
Mai Po Nature Reserve Management Office
Mai Po
Yuen Long
Contact Telephone: 2471 6306
E-mail: <bsmith@wwf.org.hk> or <maipo@wwf.org.hk>

2. OUTLINE OF PLANNING AND IMPLEMENTATION PROGRAMME

2.1 Planning and Implementation

2.1.1 The project will be managed by the Mai Po Nature Reserve Management Office, WWF Hong Kong. All detailed designs will be provided by WWF Hong Kong.

Bird-watching Hide

Stage 1

2.1.2
- The hide will be constructed over a 16 week period by the side of an inter-tidal water channel at the southern end of Mai Po Nature Reserve (Appendix A: Plate 4 & Appendix B Figure 3). The channel is used for access by AFCD's hovercrafts which are parked by a helicopter pad and used for patrols in Deep Bay. During construction, the hide will rest on the floor by the side of the channel and not obstruct AFCD hovercraft operations.
- The hide materials (timber and external cladding) will be delivered by road to the southern helicopter pad at Mai Po. The timber will be manually cut and shaped using hand saws and joined together using electric drills and metal bolts to produce a robust frame structure (or skeleton). Windows and shutters will be built into the main frame before hand nailing the external cladding onto the sides and roof of the frame. The cladding is called "Onduline", a green cardboard soaked in bitumen pressed into corrugated sheets which is used successfully on other hides inside Mai Po Nature Reserve.
- In order to provide enough buoyancy for the hide to float at high tide, a number of polystyrene blocks sealed in a fibre glass shell will be bolted onto the hide's underside. The polystyrene floats will be constructed in China and then transported to Mai Po by road. No pre-cast material will be used in the construction of the hide.

Stage 2

2.1.3
- Six concrete anchors will be built by the helicopter pad at the southern end of Mai Po close to where construction of the bird-watching hide will take place. Each anchor weighs approximately 2-tons and is needed to secure the hide at it's final operating location. The blocks (approximately 1m x 1m x 1m) will be individually lifted by helicopter out to the mudflat with the help of the Government Flying Service, and lowered onto the mudflat. The whole operation would take about 3 hrs of flying time. The GFS has experience of this work since they gave the same assistance in the construction of three previous bird-watching hides.

Stage 3

2.1.4
- Upon completion, a day will be chosen with a suitable high tide to float the hide. Then with the assistance of the Hong Kong Marine Police, two motorised rubber dinghies would tow it out to the final location in Deep Bay (Appendix B: Figure 4 & Appendix A: Plate 5). The Marine Police successfully carried out similar operations in the past to place the previous three floating hides into position in Deep Bay. The operation would be of 3 hours total duration. Once at the operating location, the hide will be attached to the concrete anchors using stainless steel chains in a matter of hours by WWF staff who have previous experience in this type of work.

Boardwalk

Stage 1

2.1.5
- Timber and other boardwalk materials will be delivered to the Reserve by road and stored in the main WWF workshop by *gei wai* 13 (Appendix B: Figure 4 & Appendix A: Plate 6). There, the timber will be cut to the desired size using a circular saw and hand saws (to minimise the time taken for on-site construction) then sections prefabricated before being manually transported out to the construction site.

Stage 2

2.1.6 • WWF staff, who are experienced in this type of work, will then construct the boardwalk commencing close to the end of the existing floating boardwalk section. The timber would need to be cut to the final correct shape using hand saws and connected together using an electric drill and metal bolts. The decking of the boardwalk will also be made of wood and nailed manually onto the main frame of the boardwalk. If a fixed boardwalk design is the preferred option, the vertical posts of the boardwalk (required to hold a cross-head and longitudinal beam which supports the main decking) will be manually placed into position by a number of WWF staff pressing the wood vertically down into the mud. As a result, there will be no need for any kind of mechanical piling to be done. A small screen on both side of the boardwalk will be constructed at the terminus of the boardwalk as it meets the bird-watching hide. This simple screen will be constructed by attaching several sheets of "Onduline" to wooden upright posts placed in the mud. It is estimated that construction of the boardwalk will take approximately 16 weeks.

2.2 Maintenance Strategy for the New Bird-watching Hide and Boardwalk

Bird-watching Hide

2.2.1 The new bird-watching hide will follow the same design principles that proved successful and effective from past management experience of the existing hides. Therefore, all potential maintenance operations have been carried out numerous times by WWF staff and should be 'familiar' operations (replacing wooden floor beams or individual roof sheets, repairing shutter hinges or internal seats, etc.). All maintenance work would be undertaken during periods of low tide in Deep Bay to avoid disturbance to waterbirds. All repair or replacement materials can be easily sourced locally, and will be carried out using hand tools causing minimal noise disturbance.

Boardwalk

2.2.2 Similarly, the extended boardwalk will follow existing design principles hence all potential maintenance works (replacing hand rails, floats, beams or sections of decking, etc.) are familiar operations. From a practical management perspective, a fixed boardwalk design will require less long-term attention than a floating design. The estimated annual maintenance cost of a floating boardwalk would be approximately HK$5,250 per 100m section (based on the average annual maintenance cost of a similar section of the existing floating boardwalk in 2004-05), which is 30% more than a fixed design.

2.2.3 In order to maintain open access along the boardwalk routes, overhanging vegetation would need to be trimmed, particularly during summer months once every 3 to 4 years. Boardwalks located along the creek (floating or fixed), require additional management to clear away man-made debris and dead tree branches snagged on the structure. Presently, WWF staff perform an annual clearance of all obstructive matter along the entire length of the creek. This is an essential operation to ensure that flushing operations on several upstream *gei wai* are not impeded.

Maintenance of Mangrove Seedlings on the Mudflat

2.2.4 Under the current Mai Po Management Plan (WWFHK, 2006a), mangrove seedlings settled upon a 33ha area on the Inner Deep Bay mudflat are cleared each autumn. This maintains the mudflat area surrounding the existing bird-watching hides as a feeding area for migratory and wintering waterbirds. This management has been carried out on an annual basis since 1986, in accordance with the Management Plans for the Mai Po Inner Deep Bay Ramsar Site (Aspinall Clouston, 1997), as well as for the Mai Po Nature Reserve (WWFHK, 2006a). For example, in October 2005, about 35,000 mangrove seedlings were managed across a 33 ha mudflat area in front of the existing bird-watching hides (WWFHK, 2006b). In order to maintain the mudflat in front of the new bird-watching hide, further mangrove seedling management is required in the area immediately surrounding the hide once operational. The additional 10 ha area requires

about 18 man-days to manage annually (Appendix B: Figure 5).

2.3 Project Programme

It is hoped that the project can commence by mid-August and be completed by October 2006 (Table 2).

Table 2. Schedule of Works.

Works	2006								
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Application process									
Tentative project approval									
Order materials									
Construct boardwalk (16 weeks)									
Construct hide (off-site, 16 weeks)									
Opening									

2.4 Project Interfaces

There are no known interactions with other projects on-going during the same period that need to be considered.

3.1 MAJOR ELEMENTS OF THE SURROUNDING ENVIRONMENT

3.1 Air

Existing Environment

3.1.1 No residential or industrial uses are located within the area because of restrictions imposed by planning law designed to retain the high conservation value of the land. The only source of emissions affecting ambient air quality are permit holding vehicles (Hong Kong Police Force, WWF Hong Kong and AFCD) using the Closed Area Fence patrol road and AFCD hovercrafts situated beside this road in southern Mai Po Nature Reserve.

Sensitive Receivers or Parts of the Natural Environment

3.1.2 According to the criteria set out in the Technical Memorandum on Environmental Impact Assessment (TM-EIA), Representative Air Sensitive Receivers (ASRs) identified within 300m of the Project limit are the Mai Po Inner Deep Bay Ramsar Site, Mai Po Marshes SSSI, and Inner Deep Bay SSSI.

3.2 Noise

Existing Environment

3.2.1 The dominant noise pollution sources within the area are vehicles using the Closed Area Fence road and AFCD hovercrafts but these are irregular (operated on a needs only basis) and localised (section 3.1.1).

Sensitive Receivers or Parts of the Natural Environment

3.2.2 Representative Noise Sensitive Receivers (NSRs) within a 300m limit of the Project have been identified according to the TM-EIA criteria and included site inspections and a review of land use plans. The Mai Po Inner Deep Bay Ramsar Site, Mai Po Marshes SSSI, and Inner Deep Bay SSSI are identified as NSRs. In addition, visitors to the Nature Reserve; public visitors, birdwatchers, wildlife tour groups and educational visits, are identified as NSRs because excessive noise detracts from their experience. Fauna species are also identified as NSRs (considered in greater detail in section 3.5).

3.3 Water

Existing Environment

3.3.1 Deep Bay is part of the Pearl River estuary, which is the largest river in southern China and drains an area of some 450,000 km². The estimated annual flow is 308 billion cubic metres. Deep Bay has a total catchment area of 112 km², a maximum tidal range of some 2.8 m and water retention time in the order of 15 days. The Project Area (300m zone) occupies a small proportion of Inner Deep Bay and comprises the wetland habitat types inter tidal mudflat, inter tidal creek and *gei wai*. Major rivers and tributaries flowing into Deep Bay include;

- The Shenzhen River, which has the River Indus and Ganges as major tributaries from Hong Kong, and the rivers Buji and Shawan as major tributaries arising from the Shenzhen Special Economic Zone, P.R. China.
- The Yuen Long River (Shan Pui River) and the associated Kam Tin River which join to form a common tidal creek (Yuen Long Creek) before entering Deep Bay, 3 km to the south of the Shenzhen River.
- The Dasha River, located in northwestern Deep Bay about 10 km west of the Shenzhen River.

3.3.2 The Deep Bay Water Quality Control Zone has poor water quality, with high levels of nitrogen and hypoxia in the summer months (EPD, 2004). The levels of BOD_5, *E. coli* and nutrients also indicate serious organic pollution. This poor water quality in Inner Deep Bay is a result of the

continuous discharge of untreated, or only partially treated organic waste from unsewered villages and livestock farms on both the Hong Kong and Shenzhen sides of the catchment. There is also some discharge of industrial effluents via rivers and streams into the head of the bay (EPD, 2004). Dissolved oxygen, biochemical oxygen demand and chlorophyll *a* levels within the Ramsar Site in 2005, are of "serious concern" (University of Hong Kong, 2006).

Sensitive Receivers or Parts of the Natural Environment

3.3.3 The inter tidal water system within the Mai Po Inner Deep Bay Ramsar Site, Mai Po Marshes SSSI, and Inner Deep Bay SSSI is a sensitive receiver and highly susceptible to water pollution incidences.

3.4 Waste

Existing Environment

3.4.1 The only waste generated in the area is from habitat management operations within the Mai Po Nature Reserve and predominantly comprises natural vegetation.

Sensitive Receivers or Parts of the Natural Environment

3.4.2 The Mai Po Inner Deep Bay Ramsar Site, Mai Po Marshes SSSI, and Inner Deep Bay SSSI are identified as sensitive receivers to waste products which could potentially contaminate soils and also detract from the areas natural beauty.

3.5 Ecology

Existing Environment

3.5.1 To determine the existing habitat types and flora and fauna species of potential importance that may be affected by the Project, a literature review of Government and private sector reports, independent and Government published literature, academic studies, vegetation maps, aerial photographs and land use maps (Appendix F) was carried out within the Study Area.

Habitat

3.5.2
- Four broad habitat types are found within the Study Area. These are inter-tidal mangrove, inter-tidal mudflat, inter-tidal creek and *gei wai* (Duke & Khan, 1999). All habitats excluding inter tidal creek are of regional importance (WWFHK, 2006a).
- Classification of the inter tidal mudflat area had to be verified on-site because it occupies an ecotone area in close proximity to mangrove habitats and contains young mangrove plants. Because the mangrove plants are either seedling or sapling and no other pioneering vegetation is present, the 'inter tidal mudflat' classification is appropriate.

Flora

3.5.3
- Over 220 species of plant are found within Mai Po Nature Reserve (Appendix D: Table D1.1) (WWFHK, 2006a).
- The main mangrove species within Deep Bay are *Kandelia obovata*, *Acanthus ilicifolius*, *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera gymnorrhiza*, *Excoecaria agallocha* and *Heritiera littoralis*. These are considered 'regionally important – moderate' (WWFHK, 2006a). Mangrove associates include *Clerodendrum inerme*, *Derris trifoliata*, *Acrostichum aureum*, *Canavalia maritima* and *Cerbera manghas*.
- Vegetation associated with the inter-tidal mudflat is mangrove seedling comprising 80% *K. obovata* and 20% *A. ilicifolius* (Anon, 2005). Small patches of Reed Grass (*Phragmites australis*) grow in close proximity to the mangrove edge.

Avifauna

3.5.4
- Over 380 bird species have been recorded from the Deep Bay area (WWFHK, 2006a) (Appendix D: Table D1.2). This forms 89% of the Hong Kong total. About 80% of the species are migrants which breed in northern China, Russia, Korea and Japan, and either visit the area for the winter, or pass through in spring and autumn on migration (Melville & Morton, 1982).
- Deep Bay supports large numbers of wintering waterbirds, with a peak of over 67,000 in January 1996, but which now averages some 54,000 individuals. During spring passage, up to 10,000 shorebirds may be recorded at any one time, and it is estimated that a total of 20,000 – 30,000 pass through. The area regularly supports 20 threatened bird species (Table 3) and 28 species whose recorded number is greater than 1% of their estimated population along the East Asian-Australasian Flyway (Carey and Young, 1999).
- It is noted that these large numbers of waterbird recorded from Deep Bay are distributed across all of the Bay wetland areas, which including the Shenzhen side, incorporates an extensive 2,700 ha mudflat. The Project Area will only affect a 0.008ha area (bird-watching hide footprint: Table 1) of this mudflat and be located on the edge of the mangrove fringe.
- In particular reference to the proposed period of construction work (July to October), between 4 and 34 different species of waterbird (and wetland species of conservation concern) ranging from 235 to 3,157 individuals were recorded from the 'Ramsar inter tidal areas' each month (Anon, 2004 & 2005b). All species are of low conservation concern except Asian Dowitcher *Limnodromus semipalmatus* recorded in August 2004 (two individuals) which is a globally threatened species listed as Lower Risk – Near threatened (Birdlife International, 2000) and a singleton Black-faced Spoonbill *Platalea minor*, listed as Endangered (BirdLife International, 2000) and a Class 2 Protected Animal of the PRC.

Table 3. Avifauna of High Conservation Status within Deep Bay.

Species	Scientific name	Conservation Status*
Dalmatian Pelican	*Pelecanus crispus*	Conservation dependent
Swinhoe's Egret	*Egretta eulophotes*	Vulnerable
Japanese Night Heron	*Gorsachius goisagi*	Endangered
Oriental Stork	*Ciconia boyciana*	Endangered
Black-headed Ibis	*Threskiornis melanocephalus*	Near-threatened
Black-faced Spoonbill	*Platalea minor*	Endangered
Baikal Teal	*Anas formosa*	Vulnerable
Baer's Pochard	*Aythya baeri*	Vulnerable
Ferruginous Duck	*Aythya nyroca*	Near-threatened
Eurasian Black Vulture	*Aegypius monachus*	Near-threatened
Greater Spotted Eagle	*Aquila clanga*	Vulnerable
Imperial Eagle	*Aquila heliaca*	Vulnerable
Nordmann's Greenshank	*Tringa guttifer*	Endangered
Asian Dowitcher	*Limnodromus semipalmatus*	Near-threatened
Spoon-billed Sandpiper	*Eurynorhynchus pygmaeus*	Vulnerable
Relict Gull	*Larus relictus*	Vulnerable
Saunders' Gull	*Larus saundersi*	Vulnerable
Styan's Grasshopper Warbler	*Locustella pleskei*	Vulnerable
Japanese Paradise Flycatcher	*Tersiphone atrocaudata*	Near-threatened
Japanese Yellow Bunting	*Emberiza sulphurata*	Vulnerable

*(BirdLife International. , 2000)

Mammals

3.5.5
- Mai Po Nature Reserve holds 20 (37%) of Hong Kong's terrestrial mammal species (Appendix D: Table D1.3) (WWFHK, 2006a) although a greater number may exist in the larger Deep Bay area. Ten of these species are protected under the Wild Animals Protection Ordinance (Cap. 170) (Table 4). Chinese Otter *Lutra lutra* is listed as a threatened species (IUCN, 2004).
- Feral dog is the most common mammal within Mai Po Nature Reserve (Wildlife Conservation Foundation, 1998).

Table 4. Protected Terrestrial Mammal Species in Mai Po Nature Reserve.

Species	Scientific name
Chinese Leopard Cat	*Felis bengalensis*
Chinese Otter	*Lutra lutra*
Small Asian Mongoose	*Herpestes javanicus*
Crab-eating Mongoose	*Herpestes urva*
Small Indian Civet	*Viverricula indica*
Japanese Pipistrele	*Pipistrellus abramus*
Greater Short-nosed Fruit Bat	*Cynopterus sphinx*
Lesser Yellow Bat	*Scotophilus khuli*
Noctule Bat	*Nyctalus noctula*
Leschenault's Rousette Bat	*Rousettus leschenaultii*

Fish

3.5.6 Fish species (Appendix D: Table D1.4) known to dominate the *gei wai* inside Mai Po Nature Reserve are Mosquito Fish *Gambusia affinis*, Grey Mullet *Mugil cephalus*, Tilapia *Oreochromis mossambicus*, Small-snake Head *Channa asiatica*, *Elops saururus* and *Terapon jarbua*. Two species of mudskipper (*Boleophthalmus pectinirostris* and *Periophthalmus cantonensis*) are found abundantly on the Inter tidal mudflat areas.

Insects

3.5.7
- *Lepidoptera.* Some 23 species of butterflies have been recorded inside Mai Po Nature Reserve (Appendix D: Table D1.5), accounting for 12% of Hong Kong's total (WWFHK, 2006a). Of the recorded moth species, two (*Schrankia bilineata* and *Thalassodes maipoensis*) are only known in Hong Kong from the Nature Reserve.
- *Odonata.* Over 50 species of odonate (Appendix D: Table D1.6) have been recorded from inside Mai Po Nature Reserve (WWFHK, 2006c). This includes the rare damselfly *Mortonagrion hirosei* listed as endangered (IUCN, 2004) (note: not distributed in the Study Area).
- *Marine invertebrates***.** Some 80 species of marine invertebrates (excluding insects) have been recorded (Lee, 1993), including the crab *Parasesarma maipoensis* being of particular conservation concern (Appendix D: Table D1.7). A total of 47 morphospecies of sediment infauna (5 phyla) exist on the Ramsar Site inter-tidal mudflats, with low species richness and high dominance of pollution tolerant species (Gu, 2004). Anderson & McChesney (1999) found 32 morphospecies of benthic macrofauna in the Mai Po mangrove forest. Eleven species are considered to be of international importance (WWFHK, 2006a).

Herpetofauna

3.5.8 Twenty seven (28%) of Hong Kong's reptile and amphibians species have been recorded from inside Mai Po Nature Reserve (Appendix D: Table D1.8). Three of these are protected in Hong Kong under the Wild Animals Protection Ordinance (Cap. 170); Reeve's Turtle *Chinemys reevesi*, Chinese Soft-shelled Turtle *Trionyx sinensis* and Burmese Python *Python molurus*. Although not protected under Cap. 170, Mangrove Water Snake *Enhydris benetti* is of conservation importance because it is a little known species, with a range restricted to the coastal areas of Hainan Island, Guangdong and Fujian Provinces only.

Sensitive Receivers

3.5.9 All of the flora and fauna species of conservation concern listed in sections 3.5.2-3.5.8 are sensitive receivers although it is noted that not all species are present throughout the year due to seasonal, migratory or hibernation patterns. In addition, not all of the species are associated with the habitat types found within the Project Area and therefore may not be present.

3.6 Visual

3.6.1 ***Existing Environment or Parts of the Natural Environment***

The area is of high aesthetic quality due to the abundant natural habitats and surrounding unspoilt environment. The main man-made structures within the area include 3 floating bird-watching hides situated alongside the mangrove fringe (camouflaged with green external cladding below the surrounding mangrove skyline), sections of boardwalk (inside the mangrove forest), WWF *gei wai* huts, two police observation towers and a 5.6 metre high floodlit border security fence.

Sensitive Receivers

3.6.2 The Mai Po Inner Deep Bay Ramsar Site, Mai Po Marshes SSSI, and Inner Deep Bay SSSI are identified as sensitive receivers to inappropriate or unsightly structures which would impact negatively upon the area's natural beauty.

3.7 Existing and /or Past Land Uses Affecting the Project

3.7.1 No existing or past land uses are identified that might affect the area in which the project is proposed.

4. POSSIBLE IMPACTS ON THE ENVIRONMENT

4.1 Air Quality Impact

Construction Phase

4.1.1 There will be no air quality impacts resulting from any of the boardwalk or bird-watching hide construction activities because no construction plant or vehicles will be used.

Operation Phase

4.1.2 There will be no impact upon air quality whilst the boardwalk (all three alignment options : sections 1.4.9 – 1.4.12) and bird-watching hide are in operation.

4.2 Noise Impact

Construction Phase

4.2.1 All boardwalk materials will be pre-cut off-site at the existing WWF Hong Kong workshop located beside the FCA entrance gate (no. 107) at *gei wai* 13 (Appendix B: Figure 4 & Appendix A: Plate 6). There will be no additional noise impact upon the surrounding environment because this facility already functions as the main workshop area for WWF operations and the boardwalk related works are of a similar nature to the existing ones. The cut materials and prefabricated sections will then be carried manually along the existing floating boardwalk to the work site. Tools used for the works produce minimal levels of noise; hammer, wood saw, and hand operated spanner, and all work will be done manually by Mai Po staff who are experienced in this technique.

Boardwalk Option A

4.2.2 Noise generated from on-site construction work is likely to be low level, but potentially significant in respect of the sensitive receivers (waterbirds) on the mudflat. Even if construction activities are screened and undertaken only at low tide, the noise is likely to penetrate far into the open/exposed mudflat area.

Boardwalk Options B and C

4.2.3 Similar low levels of on-site noise are expected, but the surrounding mangrove vegetation acts as a natural noise buffer and therefore any impact will be very localised. Therefore noise impacts arising from construction work at the on-site location inside the mangrove area for Options B and C are likely to be insignificant or very minor.

Bird-watching Hide

4.2.4 The hide and 6 concrete anchors will be constructed off-site at the helicopter pad located in southern Mai Po Nature Reserve (section 2.1.3). This location is purposefully selected because it allows the hide to be constructed away from the sensitive receivers on the inter tidal mudflat. Construction work will use only hand tools (as identified in section 4.2.1) and is expected to produce minimal noise, less than that generated by the existing users (section 3.2.1).

4.2.5 The operation to tow the hide into position will be conducted at high tide and be of 3 hours duration only. Noise generated from the Marine Police dinghies is expected to be temporary and minor.

4.2.6 A GFS helicopter will transport the 6 concrete anchors (section 2.1.3) to the hide's operating location generating noise that could potentially create a disturbance to the identified NSRs (waterbirds) in the project area. However because the entire operation will only be of 3 hours duration and conducted at low tide when waterbirds are distanced from the project area any impacts will not be significant.

Operation Phase

4.2.7 Users of the boardwalk walking to and from the bird-watching hide will generate minor noise (footsteps). This noise could potentially affect waterbirds along the entire length of boardwalk Option A even with appropriate screening on the side facing the inter tidal mudflat area. For Options B and C, the surrounding mangrove vegetation provides a natural noise barrier and therefore the impact will be localised.

4.2.8 Very minor noise will be produced when users of the new bird-watching hide enter and exit the facility. Individual users of the hide are likely to be (1) experienced birdwatchers whom are familiar with appropriate bird-watching practices that include avoidance of disturbance to birds and (2) groups lead by experienced guides whom inform visitors of the need for quiet conditions to observe birds. Therefore noise is expected to be very minor and localised. As it is likely that student groups will continue to use the existing hides rather than the proposed new hide, any noise disturbance at the new hide will be further reduced.

4.3 Water Quality

Construction Phase

4.3.1 No chemical or water run-off will be generated from construction works at either the on-site or off-site construction locations. Toilet facilities at the WWF Education Centre are within sufficient distance to be used by staff workers and sewage will therefore not be a problem during all off-site and on-site construction activities.

4.3.2 Disturbance to the mud substrate beneath the boardwalk (by workers trampling) and at the location of the 6 concrete anchors for the bird-watching hide will be very minor because both activities will be conducted at low tide. In addition, all on-site boardwalk related construction work (including mangrove trimming if necessary) will primarily be conducted from the elevated boardwalk surface (as it is built) and is therefore not likely to cause any impacts of concern. The sediment disturbance relevant to alignment Option A will be more pronounced because of the addition work to erect a screen (section 4.2.2) and also more pronounced for Option B because the creek will contain water during construction and therefore the impact for both options is assessed as minor and minor-moderate accordingly. No other impacts are anticipated.

Operation Phase

<u>Boardwalk Options A and C and Bird-watching Hide</u>

4.3.3 Water movement is unlikely to be restricted by the position of alignment Option A, alongside the mangrove fringe, and positioning of Option C because it is inside the mangrove and above the majority of tidal conditions. Similarly, the bird-watching hide, being of a floating design, and situated on the edge of the mangroves is unlikely to restrict waterflow. Therefore no water related impacts are expected from the operation of boardwalk Option A or C or the bird-watching hide.

<u>Boardwalk Option B</u>

4.3.4 The vertical supports of the fixed boardwalk associated with alignment Option B would lead to a reduction in peak flow and velocity along the channel by an estimated 10%. The posts would create a blockage in the outer part of the channel reducing the channel's flow capacity. This would be even more pronounced if the posts caused mangrove branches or other debris to get caught around them underwater. The effect would be most acute at mid-flood tide or on the ebb tides as the receding water flows off the mudflat into the creek, when velocities in the creek would be at their highest, as drag is proportional to the square of the flow velocity. This would tend to cause the creek to silt up relative to adjacent creeks, which might be scoured deeper and wider due to the diverted flow. Also water exchange operations associated with *gei wai* 12 and 13 would be affected because waterflow is impeded along the channel. A floating boardwalk built down the channel for Option B, would affect surface water flow and potentially be an obstacle to floating debris, albeit at a reduced impact than the fixed boardwalk design. The impact is therefore assessed as moderate.

4.4 Waste

Construction Phase

4.4.1 The major waste will be trimmed and pollarded mangrove branches created during boardwalk construction (applicable only to alignment Option C, section 4.5.5). The quantity is likely to be small and easily manageable at the on-site location where natural material will be reduced in size to aid biodegradation. No natural waste would be generated from alignment Options A and B or bird-watching hide because any affected mangrove seedlings are stepped into the mud rather than cleared.

4.4.2 For both the boardwalk and bird-watching hide, small-scale waste includes residual construction materials such as wooden off-cuts and metal bolt ends. No chemical waste will be generated because no additional paint or preservative will be used during the construction process, particularly because all timber will be pressure treated and all external cladding (hide) will be pre-coloured prior to purchase.

Operation Phase

4.4.3 Users of the bird-watching hide may create a small volume of general litter (plastic bottles, paper, food wrapping, etc.). The impact is minor because each week, WWF staff pick up litter from all access routes and bird-watching hides within Mai Po Nature Reserve. No other waste will be generated from the boardwalk or bird-watching hide.

4.5 Ecology

Construction Phase

4.5.1 Vegetation, avifauna and benthic fauna surveys were conducted to determine the existing environmental conditions at a detailed level and to facilitate an adequate comparative assessment of the project's ecological impacts in relation to construction of different boardwalk alignment options and the bird-watching hide. A 25m zone surrounding the construction areas was employed as the limit for surveying (see Appendix E1 for methodology) which is consistent with the Lok Ma Chau Spurline EIA surveys (Black and Veatch, 2002) and in proportion to the expected scale of impacts (i.e. localised). Surveys were conducted along the three boardwalk alignment routes and at the final location of the bird-watching hide between June and October (2004 and 2005), the proposed period of construction work. No survey was necessary for the off-site boardwalk construction work at the *gei wai* 13 workshop (Appendix A : Plate 6) because the work type is similar to that already being undertaken there. No avifauna survey was necessary for the off-site bird-watching hide construction site because data could be inferred from the boardwalk data set due to habitat type similarities (i.e. inter tidal creek and inter tidal mangrove, Appendix B : Figure 3). A summary of all the ecological survey results is presented in Table 5.

Vegetation

4.5.2 Raw data associated with the mangrove seedling and sapling surveys is shown in Appendix E: Tables E2.1, E2.2 and E2.3.

Boardwalk Option A

4.5.3 It is estimated that for the fixed design boardwalk a total of 538 mangrove seedlings would be cleared and 1,669 mangrove seedlings for the floating design. No mangrove trees will be affected for the proposed boardwalk.

Boardwalk Option B

4.5.4 No mangrove (seedling or tree) will be affected along the 520m section located in the creek for both design options. The latter section of this boardwalk (fixed 30m) will go into the landward side to meet the new bird-watching hide, but because the shrub layer is low (*Acanthus ilicifolius*) and the boardwalk constructed 1m above ground level, no trimming nor pollarding is necessary.

Boardwalk Option C

4.5.5 No mangrove seedlings will be affected along the 580m alignment. A total of 137 mangrove trees, comprising 64% *Kandelia obovata*, 31% *Acanthus corniculatum* and 4% *Avicennia marina*, will be trimmed or pollarded (Table 5). *Acanthus ilicifolius* will not be affected because the final section of the boardwalk will be constructed 1m from ground level (above the vegetation).

Bird-watching Hide

4.5.6 No mangrove trees will be affected at the on-site or off-site construction location of the hide. A total of 61 mangrove seedlings are inside the footprint area of the hide at the final location and these would be cleared.

Avifauna

Boardwalk

4.5.7 Along alignment Option A, 4 bird species (9 individuals) were recorded, 8 species (24 individuals) along Option B and 3 species (17 individuals) along Option C. All bird species recorded during these inter tidal mangrove surveys are widespread in Hong Kong (Ecosystems Ltd., 2000) and are not of conservation concern (Birdlife International, 2000). Therefore all construction impacts associated with the inter tidal mangrove areas will be assessed as very minor. No birds were visually recorded in the mangrove forest and no breeding or nesting activity was observed during the quantitative survey.

Bird-watching Hide

4.5.8 At the on-site construction location a total of 6 bird species (11 individuals) were recorded from the inter tidal mangrove habitat. Avifauna species associated with the off-site construction location will be similar to those recorded from Boardwalk Option B because the habitat types are the same, but the number of individuals is expected to be less because the area of each corresponding habitat type within the Study Area is considerably smaller. All of the recorded species are of low conservation concern (Birdlife International, 2000) and therefore any impact is assessed as very minor.

Benthic fauna

4.5.9 Raw data associated with all benthic surveys is shown in Appendix E: Tables E2.6, E2.7 and E2.8.

Boardwalk Option A

4.5.10 A total of 3 crab species were recorded along the alignment at a mean density of 0.54 individuals/m^2. The dominant specie is *Illyoplax pingi* (over 90%), a common species in Deep Bay. It is estimated that some 266 crabs would be disturbed by a fixed boardwalk design and 825 by a floating design. Mudskipper density is high (in comparison to other alignment options) with *Boleophthalmus pectinirostris* being more abundant (60%) than *Periophthalmus cantonensis*. It is estimated that 532 mudskipper would be disturbed by a fixed boardwalk design and 1650 by a floating design. The alignment is associated with a high mean benthic infauna surface density (22,866 individuals/m^2) being dominated by Gastropoda and Oligochaeta. A low abundance of Polychaeta is observed - 133 individuals/m^2 (in comparison to other alignment options).

Boardwalk Option B

4.5.11 A total of 3 crab species were recorded along the alignment at a mean density of 0.30 individuals/m^2. The dominant species are *Illyoplax pingi* (74.5%) and *Uca (Deltuca) arcuata* (20.0%). It is estimated that some 164 crabs would be disturbed by a fixed boardwalk design and 490 by a floating design. Mudskipper density is very low (in comparison to other alignment options) with *Periophthalmus cantonensis* being the more abundant of the two species. It is estimated that 9 mudskipper would be disturbed by a fixed boardwalk design and 26 by a floating design. The alignment is associated with low mean benthic infauna surface density (3,537 individuals/m^2) being dominated by Gastropoda, Polychaeta and Oligochaeta.

Boardwalk Option C

4.5.12 A total of 5 crab species were recorded along the alignment at a mean density of 0.59 individuals/m^2. The dominant species are *Illyoplax pingi* (52.0%) and *Uca (Deltuca) arcuata* (36.0%). It is estimated that 143 crabs would be disturbed by the alignment. Mudskipper numbers and density are low (in comparison to other alignment options) with several unidentified juvenile specimens. It is estimated that 29 mudskipper would be affected. The alignment is associated with low mean benthic infauna surface density (4,422 individuals/m^2) being dominated by Oligochaeta, Polychaeta and Gastropoda.

Bird-watching Hide

4.5.13 A total of 3 crab species were recorded within the footprint area at a mean density of 0.78 individuals/m^2. The dominant species is *Illyoplax pingi* (98.2%). It is estimated that 62 crabs would be affected. Mudskipper density is low and it is estimated that 35 mudskipper would be affected. The footprint is associated with a very low mean benthic infauna surface density (1724 individuals/m^2) being dominated by Oligochaeta and Gastropoda.

Summary (Ecology : Construction)

4.5.14 All of the ecological survey results are summarised in Table 5 and raw data is shown in Appendix E2.

Boardwalk Option A

4.5.15 Only mangrove seedlings (no trees) will be affected or cleared under this alignment. During the construction period daily waterbird numbers range between 235 and 3,157 individuals on the "Ramsar inter tidal areas" (section 3.5.4). The proposed alignment is situated immediately alongside the inter tidal area and disturbance to these waterbirds will be expected throughout the construction phase caused by the presence of workers. Even if the boardwalk is screened from the mudflats, disturbance levels are expected to be moderate-high. Disturbance to birds associated with the inter tidal mangrove habitat is considered to be low. For the fixed boardwalk option there will be a permanent loss of 0.0064 ha of inter tidal mudflat habitat resulting from the supporting wooden piles being placed in the mud. Only temporary habitat loss would result from the floating boardwalk design (at periods of low tide when the structure rests on the mudflat surface). The impact upon benthic fauna communities is considerably higher for both boardwalk designs in relation to the other alignment options (x6.5 for Option B and x5.2 for Option C).

Boardwalk Option B

4.5.16 No mangrove trees or saplings will be cut down or removed during the construction phase along the 520m creek section as the creek is sufficiently wide for the establishment of either a floating or fixed boardwalk. Also no mangroves would be cut for the final 30m section that runs through a mangrove area covered with dense shrub vegetation (*A. ilicifolius*). Of the 3 alignment options, the highest number of individual birds and bird species affected in the inter tidal mangrove/creek area is associated with Option B, although impacts will be low level in respect of the bird species recorded and numbers counted. Because only a very small area of inter tidal mudflat is associated with Option B (980m^2), and therefore very few waterbirds, disturbance is considered minor. For the fixed boardwalk option, a permanent loss of 0.0071 ha of inter tidal creek habitat would result from the supporting wooden piles being placed in the creek's substrate. The impact upon benthic fauna is relatively low (very minor-minor) for both epifauna and infauna.

Boardwalk Option C

4.5.17 The proposed boardwalk alignment through the mangrove habitat will not cause any permanent mangrove habitat loss since no mangrove trees will be removed from the site. There will be only pollarding and trimming of 137 mangrove plants (Table 5) thus regrowth of the plants is expected. The initial alignment route affected 163 trees (19% more), but readjustments to the alignment were made to mainly exclude the larger/mature and multi-stemmed trees. The impact is considered to be minor as no tree will be removed and the Deep Bay mangroves have a high recruitment rate, with over 40,000 new mangrove seedlings being established on the mudflat every year (Anon, 2005a). The total amount of mangrove vegetation affected by construction is <0.06 ha and the loss of permanent habitat resulting from the supporting wooden piles being placed in the 'mangrove

mud' habitat is 0.0075 ha. The potential impact to birds utilising the inter tidal mudflat due to the construction of the boardwalk is assessed as minor because only a small area (980m^2) is within the Study Area. Benthic epifauna density and infauna is relatively low and therefore any impact is assessed as very minor to minor.

Bird-watching Hide

4.5.18 Off-site construction work would not impact upon avifauna in the surrounding area. On-site, mangrove seedlings need to be cleared and there would be a temporary loss of habitat at periods of low tide when the structure rests on the mudflat surface. Benthic epifauna density is relatively high, but individuals are mobile and would relocate. Conversely, benthic infauna density is very low and the impact is assessed as very minor.

Operation Phase

4.5.19 Avifauna is assessed as the principle sensitive receiver during operation of the facilities. Mobile fauna such as crab and mudskipper (which are more tolerant to disturbance than avifauna) either relocate or hide in their burrow whilst a disturbance event occurs and therefore an impact is only temporary in nature. Bird diversity inside mangrove habitats is generally very low throughout the year (WWFHK, 2005) and species are similar to those recorded during the summer surveys. The main exception being winter roosting birds. Between October 2005 and January 2006, monthly observations were made of roosting birds inside the mangrove areas associated with the Study Area. Three bird species; Common Magpie *Pica pica*, Black-collared Starling *Sturnus nigricollis* and Masked Laughingthrush *Garrulax perspicillatus*, were recorded using the mangrove areas along boardwalk alignment Options B and C. Impacts upon these birds are minor because they are common resident birds in Hong Kong, able to relocate and roosting activity occurs at dusk when the facilities are not being used. To assess the impact upon inter tidal migratory waterbirds, data was obtained from the HKBWS monthly Ramsar Site counts.

Boardwalk general

4.5.20 A fixed boardwalk requires less maintenance than a floating one because of the simplistic and non-pivoting design. This results in less long-term disturbance to the surrounding environment.

Boardwalk Option A

4.5.21 The 'minor' noise (section 4.2.7) generated by people walking along alignment Option A could cause disturbance to waterbirds on the mudflat. The construction of a screen would reduce the degree of disturbance, but a minor-moderate impact would remain and possibly impact on the visitors using the existing three bird-watching hides.

Boardwalk Options B and C

4.5.22 Users of the boardwalk will create a temporary disturbance to surrounding mangrove birds, but the impact is assessed as very minor because they are common resident birds and mobile.

Bird-watching Hide

4.5.23 The majority of migratory waterbirds utilising the inter tidal mudflats for feeding, retain a minimum distance between themselves and the nearby mangrove habitat (approximately 10m), presumably to sight potential predators. Experience has shown these birds to retain a similar distance from the existing hides although resident waterbirds such as Ardeids come much closer. Simple mitigation measures such as installing low noise wooden shutter lockers, reducing sources of backlight inside the hide and limiting the hide's capacity, lessen any potential impact caused by users. Therefore only a very minor and localised impact is expected.

4.6 Landscape and Visual Impact

Construction

4.6.1 During the boardwalk construction period, only boardwalk Alignment Option A is likely to have a visual impact within the surrounding environment because it is located in a prominent position and visible from the existing bird-watching hides. The impact is considered as minor because work activities would be invisible behind a screen (green "Onduline" sheeting) which would be

erected as construction progresses linearly out towards the proposed new hide location. The screen would reduce the length of natural mangrove forest visible to users of the other hides.

4.6.2 During construction of the bird-watching hide, the hide will be located at the helicopter pad in southern Mai Po Nature Reserve, away from all visitor groups and educational tour routes. The maximum height of the hide structure will be below the surrounding mangrove vegetation. Therefore no visual impacts will arise from the construction of the hide.

Operation Phase

4.6.3 Boardwalk Option A, situated alongside the open inter tidal mudflat, would be visible from the existing WWF floating bird-watching hides. Even with appropriate screening along the entire 495m length, (necessary to reduce noise impacts) there would be a visual loss of the natural mangrove vegetation behind. Options B and C would present no visual impact because they are surrounded by and below the height of mangrove vegetation. In addition, the wooden materials are in harmony with the surroundings.

4.6.4 A very minor visual impact is anticipated once the bird-watching hide is functional because the external cladding (section 2.1.2) of the hide is camouflaged against the mangrove forest and the overall height is below that of the surrounding mangrove trees (Appendix A: Plates 2 & 5).

Table 5. Summary of the Ecological Assessment Results during the Construction Phase.

Survey	Parameter	Option A	Option B	Option C	Bird-watching Hide
Habitat	Below shadow /footprint area	Inter tidal Mudflat	Inter tidal Creek	Inter tidal Mangrove	Inter tidal Mudflat
	Within 25m radius (approx. area)	Inter tidal Mudflat (7,300m^2) Inter tidal Mangrove (6,000m^2)	Inter tidal Mudflat (980m^2) Inter tidal Mangrove (12,700 m^2) Inter tidal Creek (1,650m^2)	Inter tidal Mudflat (980m^2) Inter tidal Mangrove (15,000m^2)	On-site - Inter tidal Mudflat (1,110m^2) - Inter tidal Mangrove (850m^2) Off-site - Inter tidal Creek (685m^2) - Inter tidal Mangrove (490m^2) - Grassy Vegetation (785m^2)
Vegetation	Total no. and species of mangrove seedlings affected[a] within the footprint/shadow area	Fixed Design 402 (74%) *Kandelia obovata* 111 (21%) *Aegiceras corniculatum* 25 (5%) *Acanthus ilicifolius* Floating Design 1247 (74%) *Kandelia obovata* 345 (21%) *Aegiceras corniculatum* 77 (5%) *Acanthus ilicifolius*	Fixed Design - None Mixed Design - None	**None**	39 (64%) *Kandelia obovata* 15 (25%) *Aegiceras corniculatum* 6 (10%) *Acanthus ilicifolius* 1 (<1%) *Sonneratia apetala*
	No. and species of mangrove trees affected	Fixed Design - None Floating Design - None	Fixed Design - None Mixed Design - None	88 (64%) *K. obovata* (65 trim, 23 pollard) 43 (31%) *A. corniculatum* (27 trim, 16 pollard) 6 (4%) *A. marina* (6 trim)	None
	Tree circumference at breast height (cm)	N.A	N.A	4 – 44.5cm (Mean = 17.6cm)	N.A
	Tree height (m)			1.8 – 5m (Mean = 4.3m)	
	Tree crown diameter (m)			0.5 – 6m (Mean = 2.4m)	
	Tree health condition[b]			9% Poor 89% Fair 2% Good	
Avifauna	No. of species (n = sample size)	Mangrove: 4 (n=5) Mudflat: 3-7 (n=3)[c]	Mangrove: 5 (n=5) Mudflat: 3-7 (n=3)[c] Creek: 4 (n=5)	Mangrove: 3 (n=5) Mudflat: 3-7 (n=3)[c]	Mangrove: 6 (n=5) Mudflat: 3-7 (n=3)[c]
	No. of individuals (n = sample size)	Mangrove: 9 (n=5) Mudflat: 230-1,130 (n=3)[c]	Mangrove: 11 (n=5) Mudflat: 235-3,157 (n=3)[c] Creek: 13 (n=5)	Mangrove: 17 (n=5) Mudflat: 230-1,130 (n=3)[c]	Mangrove: 11 (n=5) Mudflat: 230-1130 (n=3)[c]
Benthic Epifauna	No. of crab disturbed[a] (n = sample size)	Fixed Design – 266 Floating Design – 825	Fixed Design – 164 Floating Design – 490	413	62
	Crab species composition	*Ilyoplax pingi* (90.2%) *Uca (Deltuca) arcuata* (7.3%) *Perisesarma bidens/affinis* (1.2%) Unidentified (1.2%)	*Ilyoplax pingi* (74.5%) *Uca (Deltuca) arcuata* (20.0%) *Perisesarma bidens/affinis* (1.8%) Unidentified (3.6%)	*Ilyoplax pingi* (52.0%) *Uca (Deltuca) arcuata* (36.0%) *Perisesarma bidens/affinis* (10.6%) *Helice sp.* (1.3%)	*Ilyoplax pingi* (98.2%) *Varuna litterata* (0.9%) *Metaplax elegans* (0.9%)
	No. of mudskipper disturbed[a]	Fixed Design – 532 Floating Design – 1,650	Fixed Design – 9 Floating Design – 26	29	35
	Mudskipper species composition	*Periophthalmus catonensis* (27.9%) *Boleophthalmus pectinirostris* (60.0%) Unidentified (12.1%)	*Periophthalmus catonensis* (50.0%) *Boleophthalmus pectinirostris* (25.0%) Unidentified (25.0%)	*Periophthalmus catonensis* (25.0%) Unidentified (75.0%)	*Periophthalmus catonensis* (50.0%) *Boleophthalmus pectinirostris* (50.0%)
Benthic Infauna	Density of individual species (number/m^2) (n = sample size)	Gastropda – 11,817 Polychaeta – 133 Anthropda – 13 Oligochaeta – 10,876 Bivalvia – 27 Crustacea – 0 TOTAL = 22,866 (n=15)	Gastropda – 862 Polychaeta – 1,481 Anthropda – 0 Oligochaeta – 1,172 Bivalvia – 11 Crustacea – 11 TOTAL = 3,537 (n=18)	Gastropda – 774 Polychaeta – 1,813 Anthropda – 0 Oligochaeta – 1,824 Bivalvia – 11 Crustacea – 0 TOTAL = 4,422 (n=18)	Gastropda – 663 Polychaeta – 0 Anthropda – 0 Oligochaeta – 1,061 Bivalvia – 0 Crustacea – 0 TOTAL = 1,724 (n=3)

[a] – Number and/or species are estimated from the sample areas.

[b] – Poor = Rotten/dead branches observed , Fair = No rotten/dead branches, or flowers observed, Good = Healthy with no dead or rotting branches.

[c] – Mudflat data from the HKBWS (June to August 2004 : Relating to the construction phase).

4.7 Summary

4.7.1 Impacts associated with the proposed works during the construction and operational phases are assessed in accordance to the criteria listed in Annexes of the TM-EIA.

Construction Phase

Boardwalk

4.7.2 The total duration of on-site and off-site works will be 16 weeks conducted between July and October. This follows general Government guidelines to avoid the sensitive period (November to April) for migratory birds in Deep Bay and is outside the main summer bird breeding period. Any identified impact is therefore generally considered as temporary and short-term.

4.7.3 There is no preference of alignment option in respect of air quality because no impacts are expected. The impact upon water quality is very minor in Option C, but minor for Options A and minor-moderate for Option B because sediment disturbed during construction activity may enter the water column. The prominent position of alignment Option A, adjacent to the open inter tidal mudflat area, would impact visually (minor) and generate noise affecting sensitive receivers (waterbirds). Options B and C, situated inside the mangrove habitat, cause no visual impact and very minor noise.

4.7.4 In a general context, alignment Option A would impact most upon the ecology of the Project Area because waterbird and benthic fauna are considerably abundant and diverse on the inter tidal mudflat area. Mangrove vegetation would be affected in alignment Options A and C. For the latter alignment, a number of trees need to be trimmed and a selected few pollarded, but no tree will be completely removed and all are expected to grow back afterwards, hence the impact is considered as minor. Benthic fauna below the trimmed mangroves is unlikely to be affected and a study by Gladstone and Schreider (2003) reported that a reduction in the height of a mangrove forest canopy from 5 m to 1 m had no impact upon macroinvertebrate assemblages 5 years after cutting.

4.7.5 Inter tidal mudflat habitat loss would be permanent if a fixed boardwalk design is employed (<0.01 ha) and temporary if floating design, but in the context of the total area of the mudflat system in Deep Bay all are considered to be very minor. The loss of mangrove habitat along alignment Option C is similarly very minor (<0.06ha) in respect of the 394ha mangrove forest within the Ramsar Site. It is noted that according to the EIA for development of Yuen Long and Kam Tin Sewerage and Sewage Disposal Facilities (DSD, 2004), 0.94 ha of mangroves was cut and no adverse impacts were anticipated.

4.7.6 In summary, Option C has the least overall environmental impacts during the construction phase and is therefore the preferred boardwalk alignment option.

Bird-watching Hide

4.7.7 All of the environmental impacts predicted during construction of the bird-watching hide are assessed as very minor. This is because the hide would be constructed off-site, away from the inter tidal mudflat, at a location with few sensitive receivers over a 16-week period. The operation to tow the hide with dinghies and transport the concrete anchors by helicopter are each of 3 hour duration and consequently would not impact upon the surrounding environment. The footprint of the hide occupies an area of 0.0080 ha. In the context of the total area of mudflat in Deep Bay, this is considered very minor and it is noted that this “loss” is only temporary and occurs only during low tide.

Table 6. Summary of the Environmental Impacts During Construction Activities.

	Boardwalk Alignment Option			Bird-watching
CONSTRUCTION IMPACT	**A**	**B**	**C**	**Hide**
Air Quality	✕	✕	✕	✕
Noise	✔2	✔	✔	✔
Water Quality	✔1	✔1-2	✔	✔
Waste	✔	✔	✔1	✔
Ecology - Vegetation	✔	✕	✔1	✔
- Avifauna	✔2	✔	✔	✔
- Benthic Epifauna	✔2	✔	✔	✔
- Benthic Infauna	✔2	✔1	✔1	✔
Landscape and Visual	✔1	✕	✕	✕

✕ = "No impact", ✔ = "Very minor", ✔1 = "Minor", ✔2 = "Moderate", ✔3 = "Severe"

Operation Phase

Boardwalk

4.7.8 The prominent position of alignment Option A, alongside the open inter tidal mudflat, would impact visually (even with screening) upon the surrounding natural habitat. Noise created by walkers along the alignment is likely to disturb waterbirds feeding on the mudflat. Being situated inside the mangrove habitat, none of these impacts would arise from alignments B and C. Alignment Option B would cause a moderate and unacceptable impact upon water flow and sediment dynamics in the inter tidal creek.

4.7.9 Option C has the least overall environmental impacts during the operation phase and is therefore the preferred boardwalk alignment option.

Bird-watching Hide

4.7.10 Impacts arising from normal operation of the bird-watching hide are all assessed as very minor. The frequency and duration of any disturbance caused as a result of the operation of the proposed hide will be related to the number and frequency of visitors using the hide. As the new hide is farther out into Deep Bay as compared with the existing hides, it will take visitors a longer time to reach the hide. As a result, the school groups that use the floating hides will mainly use the existing hides rather than the proposed new hide because of insufficient time in their visit programme. The longer time to reach the proposed new hide may also cause a number of birdwatchers to use existing hides rather then the new hide. It is expected that researchers and the keener birdwatchers will use the proposed new hide. With fewer and less frequent visits, it is expected that any disturbance caused during the operation of the proposed new hide will be less than that at existing hides.

Table 7. Summary of the Operational Environmental Impacts.

	Boardwalk Alignment Option			Bird-watching
OPERATIONAL IMPACT	**A**	**B**	**C**	**Hide**
Air Quality	✕	✕	✕	✕
Noise	✔2	✔	✔	✔
Water Quality	✕	✔2	✕	✕
Waste	✕	✕	✕	✔
Ecology - Vegetation	✕	✕	✕	✕
- Avifauna	✔1-2	✔	✔	✔
- Benthic Epifauna	✕	✕	✕	✕
- Benthic Infauna	✕	✕	✕	✕
Landscape and Visual	✔1	✕	✕	✔

✕ = "No impact", ✔ = "Very minor", ✔1 = "Minor", ✔2 = "Moderate", ✔3 = "Severe"

5. ENVIRONMENTAL PROTECTION MEASURES

5.1 General

5.1.1 A number of environmental protection measures will be carried out by WWF HK staff throughout the construction and operation phases of both facilities. Only boardwalk alignment Option C is considered for mitigation measures because it is the preferred option (section 4.7.9) with least overall environmental impact. The major environmental issues and potential mitigation measures are summarised in the following paragraphs.

Construction Phase

5.1.2
- The duration of construction work is condensed into a 16-week intense work period to avoid protraction of any impact(s) to the environment.
- The involvement of government departments (GFS and HK Marine Police) significantly reduces the amount of time involved to position the bird-watching hide on the mudflat, thus the disturbance period is lessened to only 6 hours in total.
- Boardwalk construction activities would be limited to periods of low tide and daytime hours (07:00-19:00) Monday to Saturday only.
- Good site practice (such as carrying materials carefully, on-site daily tidiness) will be implemented to avoid any unnecessary impact upon the surrounding environment.

Operation Phase

5.1.3
- To avoid overcrowding and minimise disturbance, access to the proposed boardwalk and hide will be restricted to those people with Closed Area permits, issued by the Hong Kong Police Force.

5.2 Air Quality

Construction Phase

5.2.2 No mitigation for air quality is required because no dust nuisance or gaseous emissions would be generated from either facility.

Operation Phase

5.2.3 There would be no air quality impacts from the operation of the Project and so air mitigation measures are considered unnecessary.

5.3 Noise

Construction Phase

5.3.1 Wooden piles, required as the main vertical supports for the fixed boardwalk, would be forced into the mud manually by WWF staff. Although this method is more time consuming, WWF has intentionally adopted this method many times before in previous projects because heavier and noisier equipment (such as a post driver) would create significant noise disturbance within the Project Area.

Operation Phase

5.3.2
- Simple features are built into the bird-watching hide design to reduce the potential for noise such as wooden window shutters, wooden door handles, rubber floor mats and cushioning material surrounding the entrance/exit doorframe.
- A small screen will be constructed at the terminus of the boardwalk to reduce any potential visual and noise disturbance as users enter/exit the bird-watching hide.
- A sign will be erected some 25m before the bird-watching hide to inform users of the need for

quiet conditions as they are approaching the bird-watching hide and near the sensitive inter tidal mudflat area.

5.4 Water Quality

Construction Phase

5.4.1
- On-site boardwalk construction activities will primarily be conducted from the existing elevated boardwalk surface (as it is built). Even if WWF staff need to carry out work whilst standing on the mud floor inside the mangroves, then work would only be undertaken during low tide. Therefore any sediment disturbance would be very minor and not released into the water column.
- No other environmental protection measures are required because the construction of the boardwalk and bird-watching hide will not generate any run-off and not affect the hydrology of the channel or Deep Bay.

Operation Phase

5.4.2 No mitigation is required during the operation of the facilities because no foreseeable impact upon water quality is expected to occur.

5.5 Waste Management

Construction Phase

5.5.1
- Trimmed mangrove branches will be collected and left to rot down naturally inside the mangrove forest. The branches will be cut into small pieces to quicken decomposition processes.
- Construction of the floating bird-watching hide will be on one side of the water channel by the southern helicopter pad at Mai Po Nature Reserve and this allows all generated waste to be contained at one designated location and be cleared away everyday to prevent any impact on the environment.
- Mitigation measures to control waste will include adoption of general good housekeeping practices, sorting and segregation of wastes for reuse (*in situ* if possible) and disposal as far as practical.
- Materials for the facilities are purposefully chosen so that no painting or preservative treatment is required.

Operation Phase

5.5.2 No specific mitigation measures are proposed because the weekly litter collection is sufficient.

5.6 Ecology

Construction Phase

5.6.1
- The period of construction work is purposely chosen between July and October to avoid the migratory bird season.
- Construction of the bird-watching hide is undertaken at an off-site location away from the sensitive receivers associated with the inter tidal mudflat thus significantly reducing the overall environmental impact.
- Prefabrication of boardwalk materials at the off-site WWF workshop reduces the overall on-site disturbance.
- The original (preferred) boardwalk alignment for Option C would have resulted in the trimming of 163 trees. However to reduce the number of affected trees, the route was revised to avoid the largest (and multi-stemmed) trees and subsequently the total number was reduced to 137 (present alignment). In addition, the alignment was readjusted so that no mangrove trees with a height greater than 5.5m would be pollarded.

- No specific mitigation is required for the mangrove trees that are trimmed because no tree will be completely removed and all are expected to grow back. Any tree needing to be pollarded will be cut to 1m above ground level to avoid damage to root portion thus maximising the chance for regeneration.
- If breeding or nesting activity is encountered in the mangroves during boardwalk construction, then the works will stop at that location and not resume until breeding activity is completed. Work will however continue on other sections of the boardwalk where no breeding activity is recorded. It is noted that the works period is at the finale of the bird breeding season in Hong Kong and therefore unlikely to encounter any nesting activity.
- Preservative treated timber (TANALISED® ECOWOOD™) will be used for the boardwalk and bird-watching hide construction. The timber is derived from sustainably managed plantation and regrowth resources. This wood is commonly used in Hong Kong (e.g. for electricity poles) and at Mai Po Nature Reserve for boardwalks and other structures.

Operation Phase

5.6.2
- Maintenance work for both facilities will be carried out during low tide to avoid disturbance to waterbirds on the mudflats or inside the mangrove. At low tide, bird usage of the inter tidal mudflat area closest to the hide is very low even in the peak migration and winter season because birds primarily feed along the tide line.
- The bird-watching hide design considerations identified in section 5.3.2 serve to lessen impacts upon nearby faunal sensitive receivers, but extra measures such as the reduction of backlighting (through building a secondary screen inside of the main door) and avoidance of reflective display material inside the hide, further reduce the very minor impact.
- A far fewer number of school groups will use the proposed hide as compared with the existing floating hides because of its distance and time constraints (section 4.7.10). Access for the smaller number of school groups will be during weekdays with a WWF HK guide to be present at all times to ensure groups do not cause disturbance during their visit.
- Ecological monitoring is proposed to confirm the mangrove regeneration rate (after pollarding) and the disturbance cause (if any) of the new hide to avifauna (EM&A section 6).

5.7 Landscape and Visual

Construction Phase

5.7.1 During construction, the facilities do not impact upon the surrounding environment and therefore no mitigation measures are necessary.

Operation Phase

5.7.2 The height of the bird-watching hide is purposely designed to not break the skyline of surrounding mangrove trees and be both sympathetic and in harmony with the surrounding natural habitats. This is similar to the existing bird-watching hides (Appendix A: Plate 2) which are constructed from the same proposed green Onduline sheeting. Therefore no mitigation is required. No impact is identified for the boardwalk hence no mitigation measures are necessary.

6. ENVIRONMENTAL MONITORING AND AUDIT

6.1 Need for EM&A

6.1.1 According to the criteria set out in the Technical Memorandum on Environmental Impact Assessment (TM-EIA), an EM&A programme is appropriate for this Project because it is situated in an area of high conservation value. This Project has however purposely made decisions and chosen options that generate only minor impacts upon the surrounding environment and therefore only those impacts associated with a degree of uncertainty or unproven mitigation measures (TM-EIA – section 8.3e) need be included in the programme. Two ecological aspects are identified for monitoring and all EM&A work relating to them will be the responsibility of the WWF Hong Kong Mai Po Management Office.

6.2 Mangrove Regeneration Monitoring

6.2.1 Construction related activities along the selected boardwalk alignment (Option C) would result in the pollarding of 39 mangrove trees. Mitigation measures to promote regeneration of these trees include pollarding at a minimum height of 1m above ground level to avoid root portion damage (section 5.6.1- para. 2). This measure is expected to increase the likelihood of each tree regenerating successfully resulting in zero (or very low) mortality rate.

Methodology

6.2.2 A comprehensive data set has already been obtained earlier in this Project from the impact assessment work (Appendix E2.2) and covers the following parameters for each affected tree.

- Species
- Tree circumference at breast height (cm)
- Tree height (m)
- Tree crown diameter (m)
- Tree health condition

6.2.3 This existing data would be used as the principal baseline reference because it relates directly to the individual trees, which are coded and marked. Therefore no additional baseline monitoring is necessary.

Frequency

6.2.4 Within the 12-month period immediately following completion of boardwalk construction work, field surveys will be undertaken every 3 months at low tide to assess the regeneration rate. The first survey would be undertaken in the 1st week of February 2007 and thereafter during the 1st week of each identified month.

Parameters

6.2.5 During each survey the following key parameters will be monitored using simple measuring equipment:

- Tree circumference at pollarded height (cm) [Only required on the first survey]
- Height of pollarded cut above ground level (m) [Only required on the first survey]
- Total number of regenerating shoots
- Length of each regenerating shoots (cm)
- Tree health condition including signs of disease

Auditing of Results

6.2.6 If at the end of the 12-month monitoring period there is no regeneration associated with a particular tree, then a young healthy mangrove sapling of the same species will be planted alongside the dead tree(s) or within Mai Po Nature Reserve (*gei wai* #12) as a replacement or compensation.

Reporting

Quarterly

6.2.7 A simple summary of the Environmental Monitoring & Auditing results will be made available within 28 working days after each survey. The summary will include raw data and a 500 word (or less) interim statement. These will be sent to the AFCD and EPD representatives and posted on the WWF Hong Kong website where a dedicated webpage will be set up.

Final Report

6.2.8 A simple Final Environmental Monitoring and Audit Report shall be prepared within 28 working days of the final survey date. A copy would be sent to the AFCD and EPD representative and posted on the WWF Hong Kong website. The report shall include:

- Location of monitoring points
- Results of monitoring
- Calculation of regeneration rates
- List of contingency action taken

6.3 Avifauna Disturbance Monitoring

6.3.1 A very minor operational impact is identified upon avifauna in close proximity to the bird-watching hide. Several mitigation measures are proposed to further lessen this impact including the adoption of low noise generating materials and camouflaged exterior (section 5.7.2), reduction in backlight (section 5.6.2) and access restrictions (section 5.1.3). Consequently waterbirds are expected to retain a similar distance from the new hide as the existing hides.

Methodology

6.3.2 On a rising tide in Deep Bay the distances of selected waterbird species from the existing bird-watching hides and new hide will be estimated using a time interval system over a 1-2 hour period (Appendix B : Figure 6). Three species of predominantly resident birds - Chinese Pond Heron *Ardeola bacchus*, Great Egret *Casmerodius albus* and Little Egret *Egretta garzetta* – and three species of migratory birds – Grey Plover *Pluvialis squatarola*, Eurasian Curlew *Numenius arquata* and Common Redshank *Tringa totanus* will be observed. This survey can not be undertaken during the winter period because daytime tides over 2.1m are uncommon and therefore data could not be obtained from the existing hides. Consequently waterbirds such as Anatidae and Gulls can not be surveyed.

Frequency

6.3.3 Ten observations will be made between March and May 2007. Exact dates can not be specified because tidal conditions sometimes deviate from those predicted by the Hong Kong Observatory. This period coincides with the expected peak use of the bird-watching hides for observing or studying the main spring bird migration.

Parameters

6.3.3 During each survey (1-2 hours depending upon the tide rising rate) the closest individual of each of the target species to the 2 locations will be estimated to the nearest 5m with the aid of 10-20 small bamboo temporary markers. In addition, the main source(s) (if any) of disturbance will be noted.

Auditing of Results

6.3.4 If at the end of the monitoring work a valid statistical difference is proven between the new hide and existing hides, then further mitigation measures will be implemented before the start of the main wintering migration season (November 2007) if deemed necessary. The measures will depend upon the final report's conclusion.

Reporting

Final Report

6.3.5 A simple Final Environmental Monitoring and Audit Report shall be prepared within 28 working days of the final survey date. A copy would be sent to the AFCD and EPD representative and posted on the WWF Hong Kong website. The report shall include:

- Location of monitoring points
- Results of monitoring
- Calculation and testing of data
- List of additional mitigation measures

7. USE OF PREVIOUSLY APPROVED EIA REPORTS

7.1.1 Previous sections of this Project Profile make reference to existing EIA reports for supportive, advisory or descriptive purposes only.

7.1.2 To define the extent of the surveying zone required to determine any potential ecological impacts upon fauna (section 4.5.1), reference is made to the KCRC Lok Ma Chau Spurline EIA Report (Black & Veatch, 2002) methodology.

7.1.3 In support of the anticipated minor impact of trimming and pollarding mangrove vegetation, reference is made (section 4.7.5) to the Drainage Services Department EIA Report for the Yuen Long and Kam Tin Sewerage and Sewage Disposal Project (DSD, 2004).

8. PROJECT SUMMARY

- The Inner Deep Bay SSSI was designated in 1986 and is the largest and most important mudflat habitat for migrating waterbirds in Hong Kong. As discussed in section 5. (Environmental Protection Measures), this Project has placed great emphasis upon minimising and, where possible, avoiding impacts to the environment. Environmental protection is placed in the highest priority for the proposed boardwalk extension and location for the new bird-watching hide.

- WWF Hong Kong has successfully built, maintained and operated three floating bird-watching hides and access boardwalks in the mangrove forest and inter tidal mudflat area since 1986. This experience will be invaluable in ensuring that the new facilities function properly and to their fullest potential.

- For the selection of the boardwalk alignment, three alternative alignments have been investigated and surveyed. Based on an evaluation of the respective construction and operational environmental impacts of the three options (Tables 6 and 7), Option C is the preferred alignment as it presents the least overall impact upon the surrounding environment and sensitive receivers. The identified impacts are extremely localised, a reflection of the project's small scale, and when considered in the context of the extensive mangrove forest and inter tidal mudflat system in Inner Deep Bay are minor.

- Apart from the minimal impact upon the area's ecology and environment, significant educational benefits are gained such that the proposed alignment will pass through a diversely aged mangrove forest. The forest is composed of several native mangrove species; *Kandelia obovata*, *Aegiceras corniculatum*, *Avicennia marinal* and *Acanthus ilicifolius* growing along a height gradient. This allows student and researchers to carry out field study and experiment in a developed mangrove ecosystem for both flora and fauna composition. Students are also presented with an opportunity to study the succession of natural mangrove through a series of different communities and structures with the aid of access by the proposed boardwalk.

- The location of the proposed bird-watching hide was selected in collaboration with stakeholders and is purposeful as to maximise the benefits gained from the construction of the facilities. For the construction of bird-watching hide, advice from the HK Police and the Government Flying Services will be sought regarding any safety matters arising from using the site temporarily for the construction of bird-watching hide near the helipad to avoid any disturbance to their operations.

- An Environmental Monitoring and Audit Programme would be established to assess the effectiveness of several of the proposed mitigation measures upon the sensitive receivers. If deemed necessary, further mitigation measures would be implemented within the first 12 months of the operation period.

- The existing bird-watching hides will be kept at the same locations to provide alternative facilities for visitors and this reduces the demand upon the new facilities during potential periods of peak usage. The facilities will provide great benefits for educational programmes, improved bird-watching activities and promoting better quality and more comprehensive field-based scientific research.

APPENDIX A

PHOTOGRAPHIC PLATES

Plate 1. View of Inner Deep Bay Inter tidal Mudflat from the Existing WWF Hong Kong Bird-watching Hides.

Plate 2. View of the Existing WWF Floating Bird-watching Hides.

Plate 3a. Floating Boardwalk Design for Options A and B.

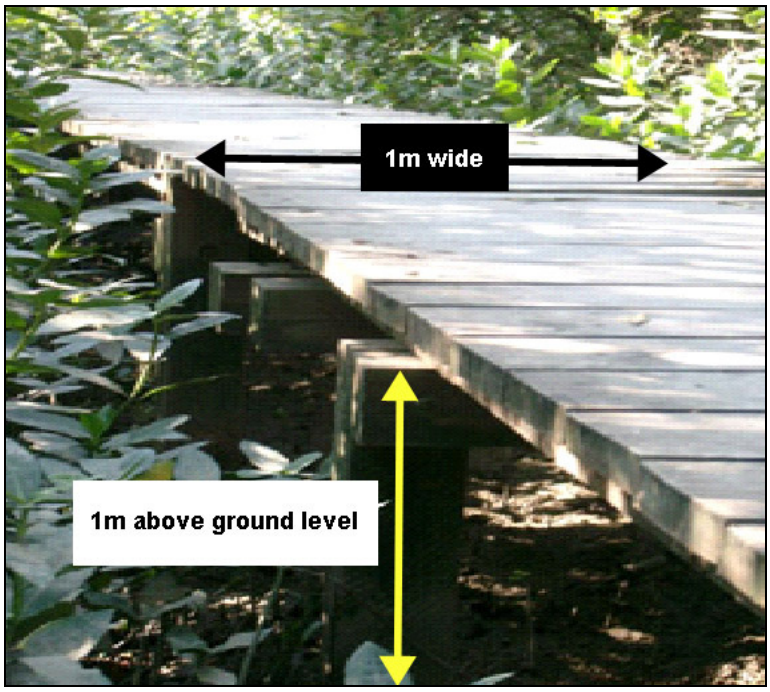


Plate 3b. Fixed Boardwalk Design for Options A, B (last 30m section) and C.

Plate 3c. Fixed Boardwalk Design for Options A, B (last 30m section) and C. (Note: The boardwalk will be 1m wide, less than that shown)

Plate 4. View of the Bird-watching Hide Construction Site (facing West).

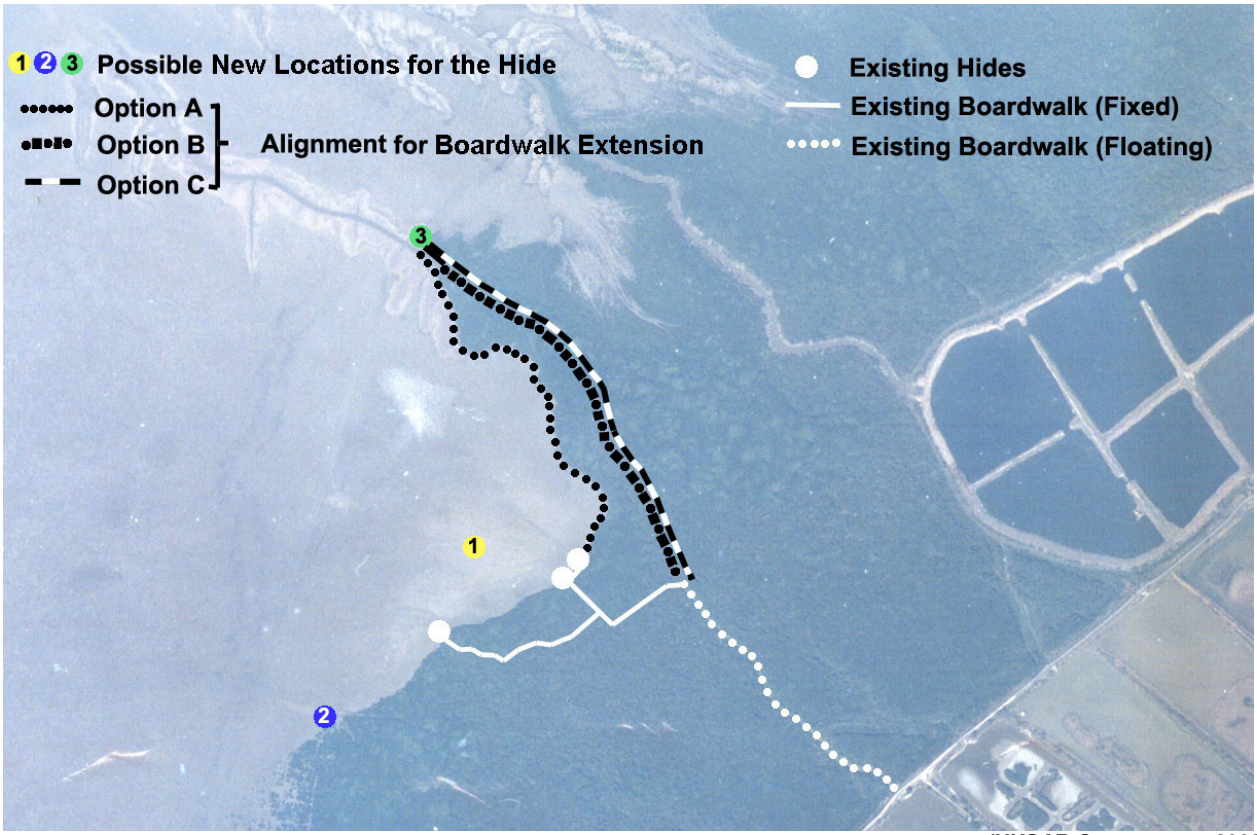
Plate 5. View of the Final Operating Location for the Bird-watching Hide.

Plate 6. View of the WWF *Gei Wai* 13 Workshop.

APPENDIX B

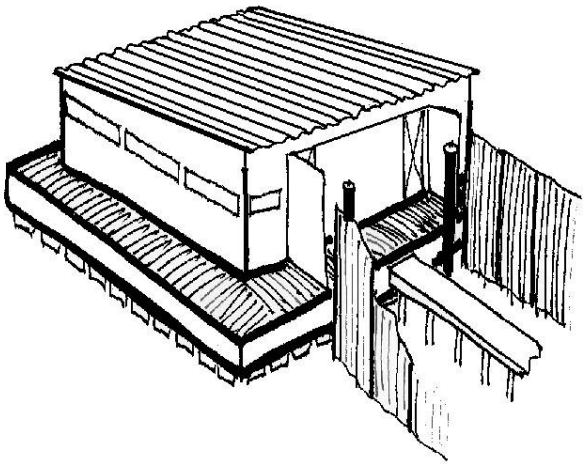
FIGURES

Figure 1. Annotated Aerial Photograph Showing the Boardwalk Alignment and Bird-watching Hide Options.



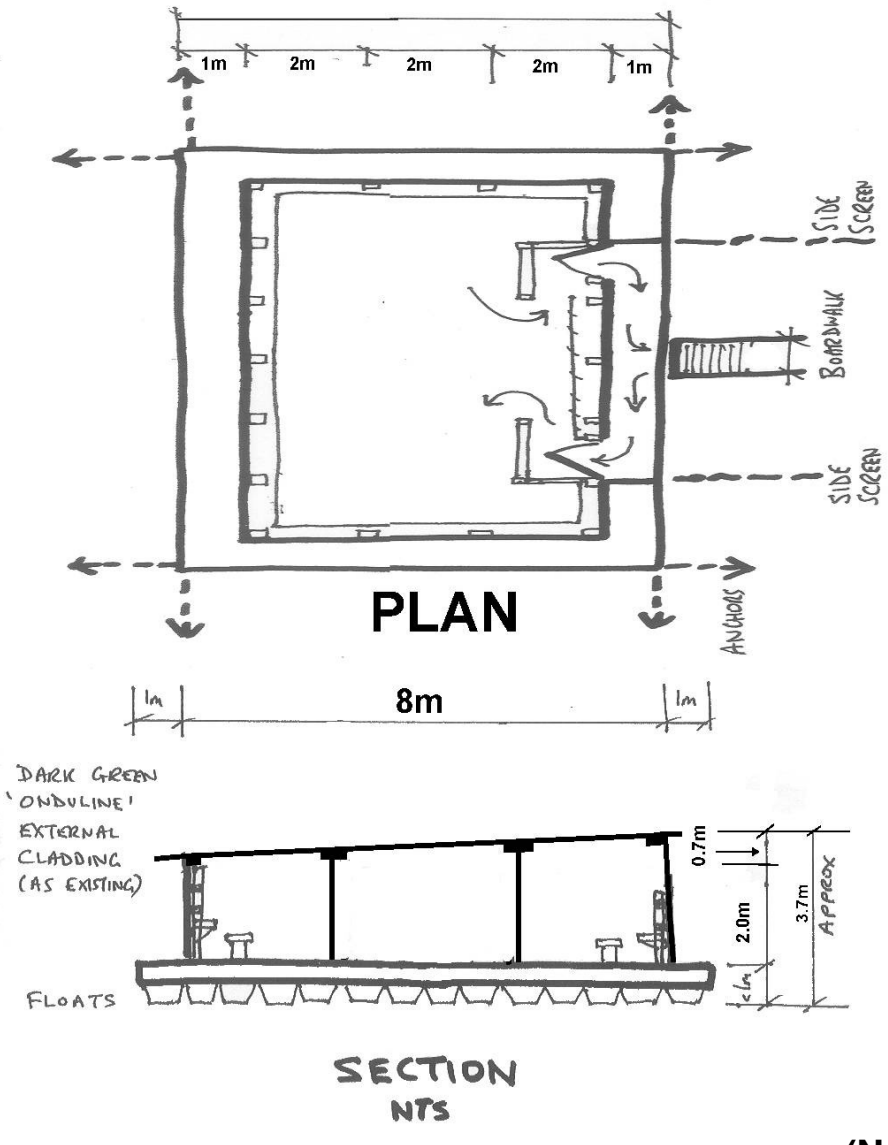
(HKSAR Government, 2003)

Figure 2. Design of the Proposed New Floating Bird-watching Hide.



(Not to Scale)

Aerial View



(Not to Scale)

Figure 3. Sketch of the Bird-watching Hide Construction Site.

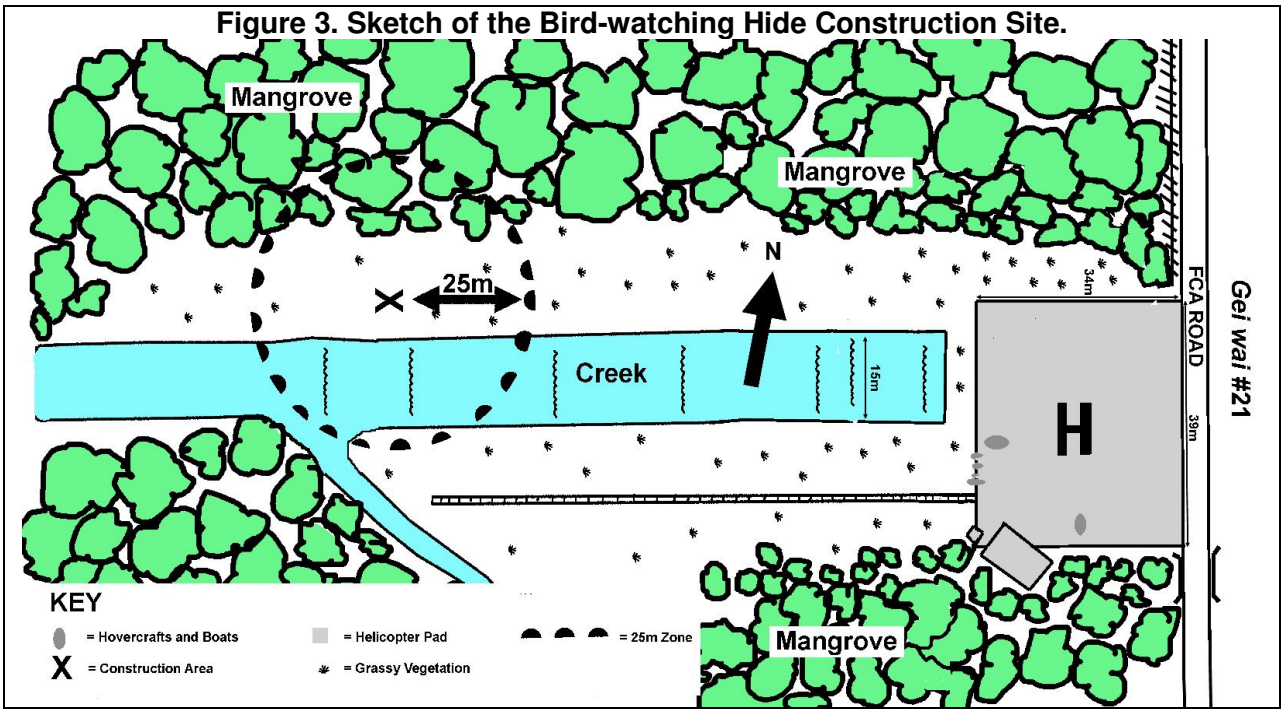


Figure 4. General Layout of the Proposed Works.

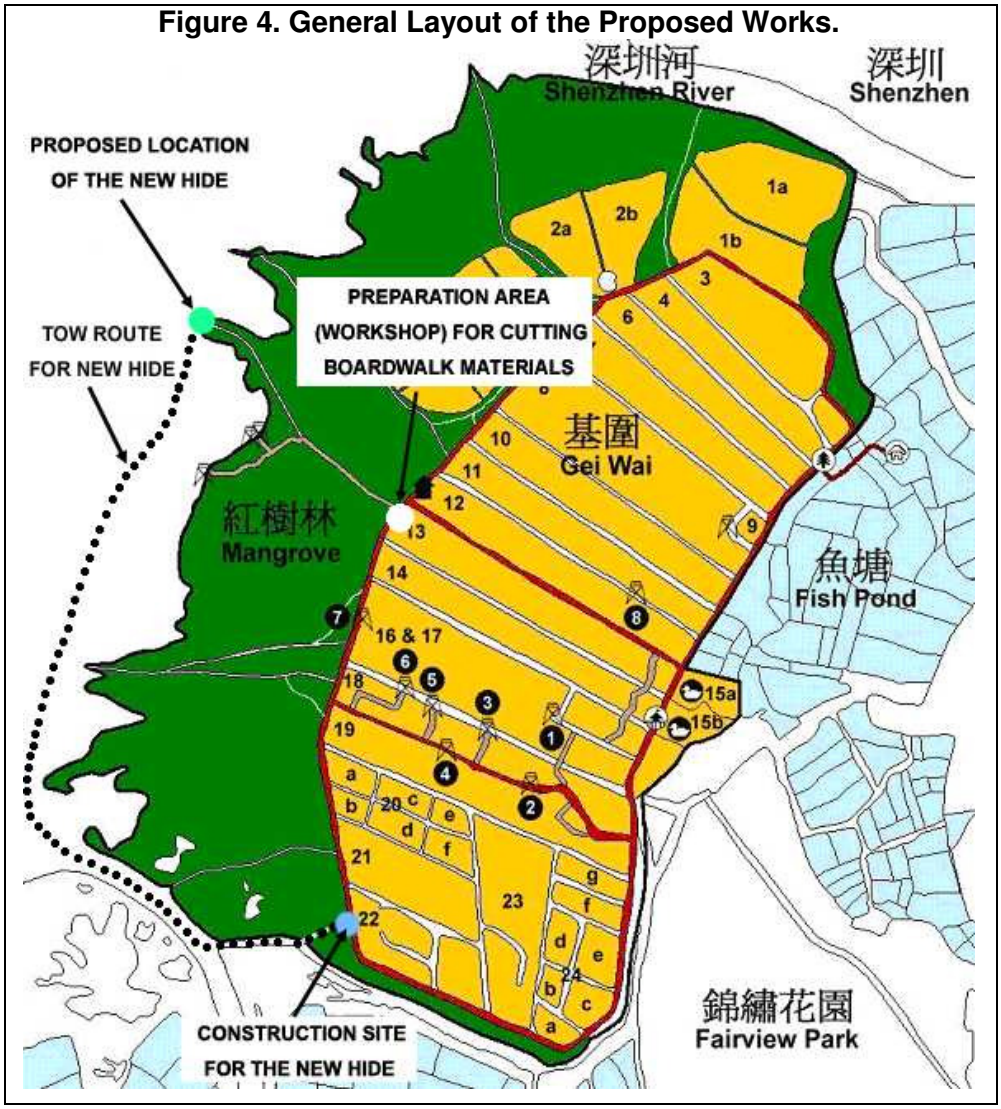


Figure 5. Areas for Existing and Proposed Mangrove Management Work.

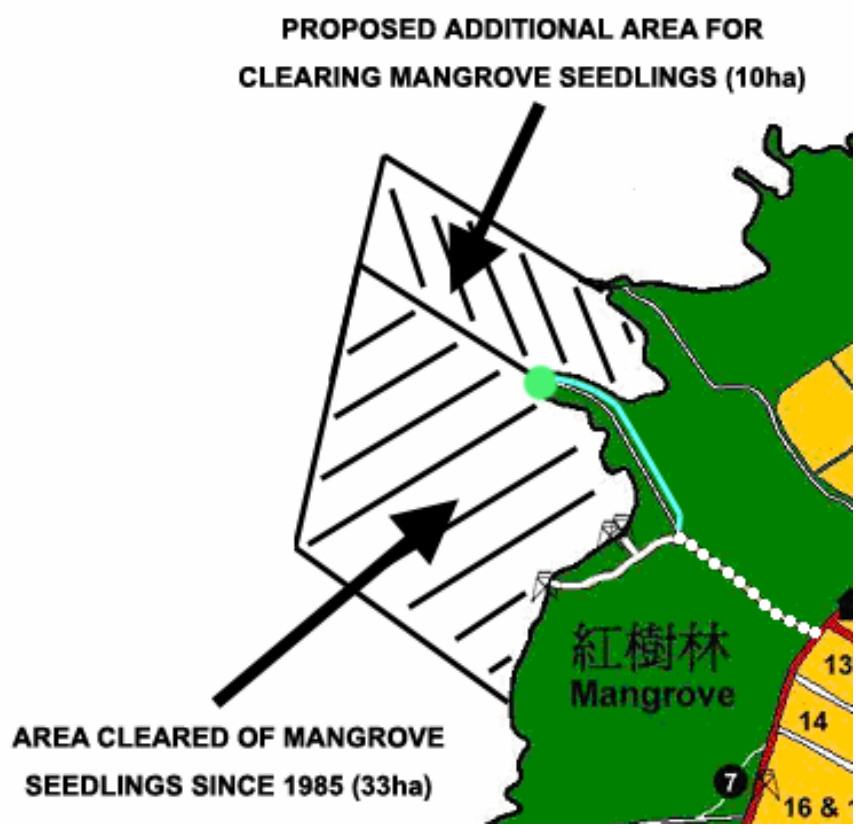
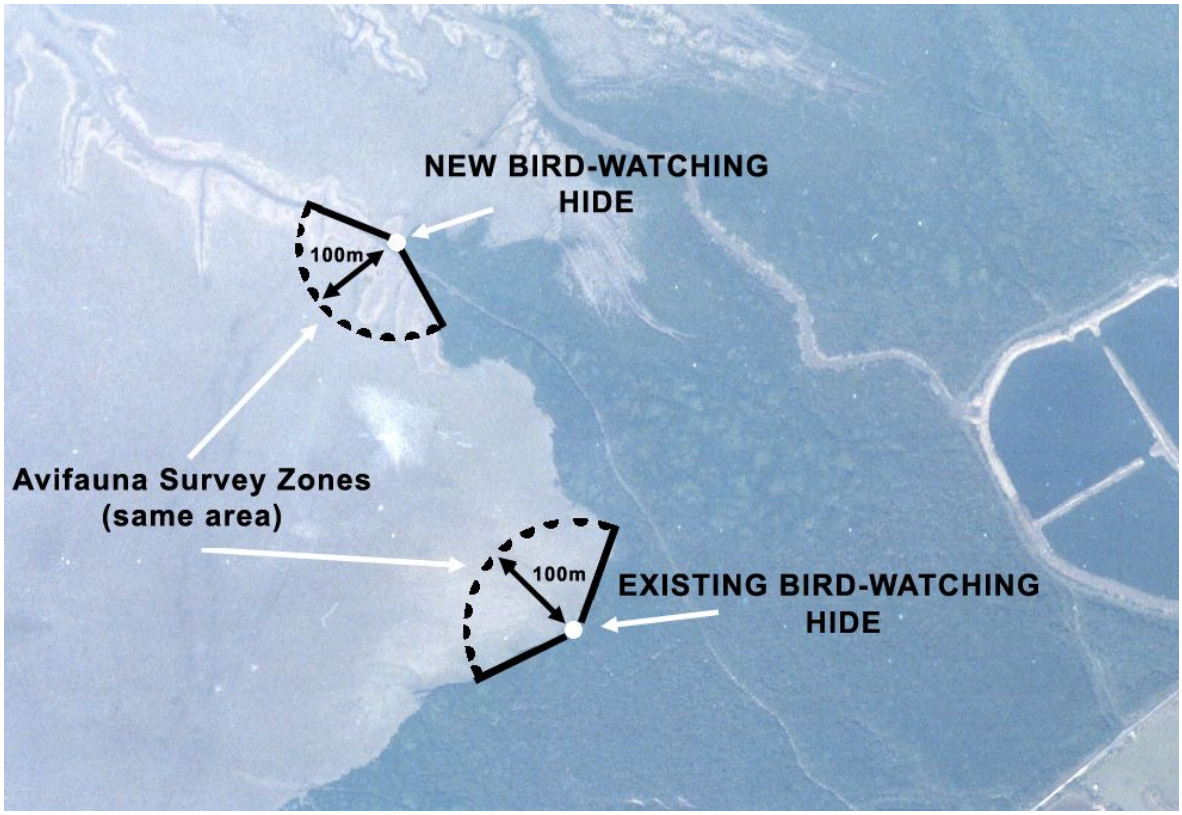


Figure 6. Avifauna Disturbance Monitoring Zones.



APPENDIX C

ENVIRONMENTAL NGO SUPPORTING LETTERS

Appendix C1: HKBWS Letter of Support

香 港 觀 鳥 會
THE HONG KONG BIRD WATCHING SOCIETY
認可公共性質慈善機構 Approved Charitable Institution of Public Character
電話 Tel. No.: 2377 4387 傳真 Fax. No.: 2314 3687

Dr Lew Young
Reserve Manager
Mai Po Marshes Nature Reserve
WWF (Hong Kong)

3rd October, 2005

Dear Dr Young

I am writing on behalf of the Hong Kong Bird Watching Society to offer our warmest support for the new boardwalk and hide that are planned for Mai Po.

The new hide will play an important role in increasing the time and physical area of the Ramsar site which can be viewed. This will add to the quality of information which can be gathered by the systematic surveys, (in particular the Waterbird Monitoring programme conducted under contract from the Agriculture, Fisheries and Conservation Department) conducted by HKBWS and WWF(HK). This is especially important as the progressive rate of siltation in the bay has reduced the time during which birds can be seen at close range from the two current hides, making accurate counting of the birds increasingly difficult.

In addition, we are delighted that the hides will provide greater opportunities for education, and for birdwatchers and other visitors to Mai Po to enjoy close views of the birds using the mudflats at times when views from the other hides are either distant or blocked by mangroves.

Finally it gives us great pleasure to see the funds from the Big Bird Race allocated for improving opportunities for bird watching being used so effectively, further strengthening the close relationship between WWF (HK), and HKBWS.

Yours sincerely,

p.p. Mike Kilburn
HKBWS Representative, Mai Po Management Committee
Vice Chairman, Hong Kong Bird Watching Society

Cc.
Chairman, Advisory Council on the Environment
Director, Agriculture, Fisheries and Conservation Department
Eric Bohm, Executive Director, WWF (HK)
Dr Cheung Ho Fai, Chairman, Hong Kong Bird Watching Society

Appendix C2: Green Power Letter of Support

綠色力量
GREEN
POWER

Dr. Lew Young
Manager
Mai Po Marshes Nature Reserve
WWF Hong Kong
Fax: 2482 0369

1 March 2006

Proposed extension to the existing boardwalk and new floating mudflat bird-watching hide at Mai Po nature reserve for education and conservation purposes

Dear Lew,

I am writing on behalf of Green Power to offer our great support for the captioned proposed new boardwalk and hide at Mai Po nature reserve for education and conservation purposes.

We understand that the new bird-watching hide will provide views of the waterbirds on the mudflats over a greater range of tidal levels. This would help overcome the current problems due to increasing sedimentation in Deep Bay area, which limits the time and space to see birds by existing bird hides.

We believe that the proposed new hide and the associated boardwalk extension with environmentally-friendly design and construction methods will have minimal impacts, if any, to the Mai Po environment. Moreover, the proposed mitigation measures during both construction and operation should be effective to address any possible minor impacts to the wetland habitats and wildlife.

Finally, Green Power welcomes the above proposed project which will enhance the biodiversity conservation of the Ramsar Site, strengthen the management of the Mai Po nature reserve, further help scientific research and raising the environmental awareness of the public.

Thank you for your attention.

Yours sincerely,

Dr. Cheng Luk-ki
Division Head – Scientific Research and Conservation
Green Power

Appendix C3: Kadoorie Farm and Botanical Garden Letter of Support

K F & B G

嘉道理農場暨植物園公司
Kadoorie Farm & Botanic Garden Corporation

Mai Po Nature Reserve
(Attn: Dr Lew Young / Mr Bena Smith)
WWFHK
Yuen Long
Hong Kong
(Fax: 2482 0369)

7 March, 2006 **By fax only**

Dear Dr Young / Mr Smith,

Re: Project Profile - Extension to the Existing Boardwalk and New Mudflat Bird-watching Hide at Mai Po Nature Reserve for Education and Conservation Purposes – letter of support

We refer to the your email dated 28 February from Mr Bena Smith of WWFHK to our Captain Wong concerning the captioned issue.

Based on the information provided in the project profile attached to the abovementioned email, we would like to support the proposal, which will involve extension of the board walk and construction of a bird hide in Inner Deep Bay for education and conservation purposes.

We wish every success in bringing this project to completion.

Thank you for your attention.

Yours faithfully,

Dr. Gary Ades
Senior Manager,
Fauna Conservation Department

Appendix C4: Conservancy Association Letter of Support

長春社 Since 1968
The Conservancy Association
會址：香港九龍吳松街 191-197 號突破中心 9 樓
Add.: 9/F, Breakthrough Ctr,191-197, Woosung St., Kln., Hong Kong.
網址 Website: www.conservancy.org.hk
電話 Tel.: (852)2728 6781 傳真 Fax.: (852)2728 5538
電子郵件 E-mail address: cahk@conservancy.org.hk

Dr Lew Young
Reserve Manager
Mai Po Marshes Nature Reserve
WWF (Hong Kong)

7 March 2006

Dear Dr Young

I am writing on behalf of The Conservancy Association to lend our strong support to the planned boardwalk and hide in Mai Po.

The new hide can provide a broader view of the mudflat as well as increasing the duration that the visitors can appreciate the birds. This can mitigate the current situation that intensified sedimentation has limited the space and time visitors can see the birds at close range.

We believe that WWF(HK), with their expertise and experience in managing wetlands with high ecological value, can minimize the impacts of the new hide and the associated boardwalk extension on Mai Po.

The Conservancy Association has been involved in the Ramsar Wetland Conservation Programme since 1997, and is delighted to see project such as this for facilitating the education on wetland conservation.

Thank you for your attention.

Yours sincerely

Lister Cheung
Chief Executive

APPENDIX D

FLORA AND FAUNA SPECIES LISTS

Table D1.1 : List of Flora Species within Mai Po Nature Reserve.

FERNS

Leather Fern	*Acrostichum aureum*
Oriental Blechnum	*Blechnum orientale*
Water Fern	*Ceratopteris thalictroides*
Hairy Wood-fern	*Cyclosorus acuminatus*
Interrupted Tri-vein Fern	*Cyclosorus interruptus*
Linear Forked Fern	*Dicranopteris linearis*
Climbing Fern	*Lygodium japonicum*
Scansorial Climbing Fern	*Lygodium scandens*
Rough Sword Fern	*Nephrolepis hirsutata*
-	*Nephrolepis* sp.
Nodding Clubmoss	*Palhinhaea cernua*
Silver Fern	*Pityrogramma calomelanos*

HERBS

Common Achyranthes	*Achyranthes aspera*
Billygoat-weed	*Ageratum conyzoides*
Alligator-weed	*Alternanthera philoxeroides*
Sessile Alternanthera	*Alternanthera sessilis*
Alyce Clover	*Alysicarpus vaginalis*
Green Amaranth	*Amaranthus viridis*
Water hyssop	*Bacopa monnieri*
Malabar-Nightshade	*Basella alba*
-	*Bidens alba*
Hairy Bur-marigold	*Bidens pilosa*
Malay Blumea	*Blumea lacera*
Canna Lily	*Canna* Hybride
Indian Canna	*Canna indica*
Sickle Senna	*Cassia tora*
Moneywort	*Centella asiatica*
Lamb's Quarters	*Chenopodium album*
Taro	*Colocasia esculenta*
-	*Conyza bonariensis*
Mock Jute	*Corchorus aestuans*
-	*Crassocephalum crepidioides*
-	*Crinum* spp.
Smooth Crotalaria	*Crotalaria pallida*
Dianella	*Dianella ensifolia*
Eclipta	*Eclipta prostrata*
Tassel-Flower	*Emilia sonchifolia*
-	*Eupatorium odoratum*
Red-involure Euphorbia	*Euphorbia cyathophora*
Garden spurge	*Euphorbia hirta*
Wild Globe Amaranth	*Gomphrena celosioides*
-	*Gynura bicolor*
-	*Gynura divaricata*
Water Spinach	*Ipomoea aquatica*
Sweet Potato	*Ipomoea batatas*
Beach Morning-glory	*Ipomoea pes-caprae*
-	*Ipomoea triloba*
Lesser Duck-weed	*Lemna minor*
Brittle False Pimpernel	*Lindernia crustacea*
Lily Turf	*Liriope spicata*
Water-dragon	*Ludwigia adscendens*
Jute-leaved Melochia	*Melochia corchorifolia*
Sensitive Plant	*Mimosa pudica*
Naked Flower Murdannia	*Murdannia nudiflora*
Common Banana	*Musa paradisiaca*
India Poberry	*Phytolacca acinosa*
Chinese Knotweed	*Polygonum chinense*
Spiny Knotweed	*Polygonum perfoliatum*
Purslane	*Portulaca oleracea*
-	*Ruellia brittoniana*
Toothed-fruited Dock	*Rumex dentatus*
-	*Senecio scandens*
Java Sesbania	*Sesbania javanica*
Sida Hemp	*Sida rhombifolia*
Black Nightshade	*Solanum nigrum*
Tetrongan	*Solanum torvum*
Sow-Thistle	*Sonchus oleraceus*
Gold Button	*Spilanthes paniculata*
South Sea-Blite	*Suaeda australis*
African Evergreen	*Syngonium podophyllum*
Rose Mallow	*Urena lobata*
Procumbent Indian Mallow	*Urena procumbens*
Iron Weed	*Vernonia cinerea*
-	*Wedelia triloba*
Common Zeuxine	*Zeuxine strateumatica*

GRASSES / SEDGES

Glutene-rice Grass	*Apluda mutica*
Australian Bluestem	*Bothriochloa bladhii*
Blunt Signal-grass	*Brachiaria mutica*
Couch Grass	*Cynodon dactylon*
Imbricate Galingale	*Cyperus imbricatus*
Rice Galingale	*Cyperus iria*
Malacca Galingale	*Cyperus malaccensis*
Nut-grass Galingale	*Cyperus rotundus*
-	*Crytococcum patens*
Two-flowered Golden-beard	*Dichanthium annulatum*

GRASSES / SEDGES (cont.)

Hispid Crabgrass	*Digitaria microbachne*	Hilo Grass	*Paspalum conjugatum*
Common Crabgrass	*Digitaria sanguinalis*	Knot Grass	*Paspalum paspaloides*
Barn-yard Grass	*Echinochloa crusgalli*	Ditch Millet	*Paspalum orbiculare*
Needle Spikesedge	*Eleocharis acicularis*	India Paspalum	*Paspalum scrobiculatum*
Water Chestnut	*Eleocharis dulcis*	Mission Grass	*Pennisetum polystachyum*
Goose Grass	*Eleusine indica*	Napier Grass	*Pennisetum purpureum*
Elongated Lovegrass	*Eragrostis zeylanica*	Common Reedgrass	*Phragmites australis*
Dichotomous Fimbristylis	*Fimbristylis dichotoma*	Reed	*Phragmites karka*
Lalang Grass	*Imperata koenigii*	Golden-hair Grass	*Pogonatherum crinitum*
Duck-beak Grass	*Ischaemum aristatum* var. *glaucum*	Branch Pycreus	*Pycerus polystachyus*
India Duck-beak	*Ischaemum indicum*	Redtop	*Rhynchelytrum repens*
Aromatic Kyllinga	*Kyllinga aromatica*	Reed-like Sugarcane	*Saccharum arundinaceum*
Rice Grass	*Leersia hexandra*	Coastal Bulrush	*Scirpus littoralis*
Chinese Sprangletop	*Leptochloa chinensis*	Australian Smut-grass	*Sporobolus fertilis*
Burma-reed	*Neyraudia reynaudiana*	Seashore Dropgrass	*Sporobolus virginicus*
Guinea Grass	*Panicum maximum*	Chinese Lawn Grass	*Zoysia sinica*
Panic Grass	*Panicum repens*		

CLIMBERS

Two-flowered Aniseia	*Aniseia biflora*	Oblong Gymnanthera	*Gymnanthera oblonga*
White Gourd	*Benincasa hispida*	Cairo Morning Glory	*Ipomoea cairica*
Hairy Gourd	*Benincasa hispida* var. *chieh qua*	Ivy-like Merremia	*Merremia hederacea*
Brazil Bougainvillea	*Bougainvillea spectabilis*	Mile-a-minuted Weed	*Mikania micrantha*
Sea Sword Bean	*Canavalia maritima*	Common Indian-mulberry	*Morinda umbellata*
Balloon Vine	*Cardiospermum halicacabum*	Chinese Feverine	*Paederia scandens*
Cassytha	*Cassytha filiformis*	Passion Flower	*Passiflora foetida*
Snail Seed	*Cocculus orbiculatus*	-	*Philodendron* spp.
White-flowered Derris	*Derris alborubra*	Goat Horns	*Strophanthus divaricatus*
Derris	*Derris trifoliata*	Wight's Toxocarpus	*Toxocarpus wightianus*
Creeping Fig	*Ficus pumila*	Indian Zehneria	*Zehneria indica*

SHRUBS

Spiny Bears Breech	*Acanthus ilicifolius*	Small Persimmon	*Diospyros vaccinioides*
		Chinese Eurya	*Eurya chinensis*
-	*Aegiceras corniculatum*	Oval Kumquat	*Fortunella margarita*
Mock Lime	*Aglaia odorata*	Cape Jasmine	*Gardenia jasminoides*
Allamanda	*Allamanda cathartica*	Chinese Hibiscus	*Hibiscus rosa-sinensis*
-	*Ardisia elliptica*	-	*Kandelia obovata*
Chinese Aucuba	*Aucuba chinensis*	Lantana	*Lantana camara*
Black Mangrove	*Avicennia marina*	White Popinac	*Leucaena leucocephala*
Waxy Leaf	*Breynia fruticosa*	Chinese Privet	*Ligustrum sinense*
Many-petaled Mangrove	*Bruguiera gymnorhiza*	Round-leaved Litsea	*Litsea rotundifolia*
Pink Power Puff	*Calliandra haematocephala*	Matrimony Vine	*Lycium chinense*
-	*Cansjera rheedii*	Turk's Cap	*Malvaviscus arboreus* var. *penduliflorus*
Double-fruited Cassia	*Cassia bicapsularis*	Common Melastoma	*Melastoma candidum*
-	Clerodendrum inerme	Blood-red Melastoma	*Melastoma sanguineum*
Garden Croton	Codiaeum variegatum	Orange-jessamine	*Murraya paniculata*
Thick-leaved Croton	*Croton crassifolius*	Thorny Wingnut	*Paliurus ramosissimus*
Demos	*Demos chinensis*	Marsh Fleabane	*Pluchea indica*

SHURBS (cont.)

Wild Coffee	*Psychotria asiatica*
Hong Kong Hawthorn	*Rhaphiolepis indica*
Red Azalea	*Rhododendron simsii*
Sumac	*Rhus chinensis*
Rough-leaved Holly	*Ilex asprella*
Chinese Ixora	*Ixora chinensis*
Hedge Sageretia	*Sageretia thea*
Chinese Scolopia	*Scolopia chinensis*
Box-leaved Atalantia	*Severinia buxifolia*
Yellow Oleander	*Thevetia peruviana*
Triumfetta	*Triumfetta rhomboidea*
Indian Wikstroemia	*Wikstroemia indica*

TREES

Ear-leaved Acacia	*Acacia auriculiformis*
Taiwan Acacia	*Acacia confusa*
Lebbeck Tree	*Albizia lebbeck*
Formosan Alder	*Alnus japonica*
Sugar-apple	*Annona squamosa*
Bamboo	*Bambusa* sp.
Purple Camel's Foot	*Bauhinia purpurea*
Autumn Maple	*Bischofia javanica*
Tree Cotton	*Bombax ceiba*
Pop-gun Seed	*Bridelia tomentosa*
Fishtail Palm	*Caryota ochlandra*
Horsetail Tree	*Casuarina equisetifolia*
Chinese Hackberry	*Celtis sinensis*
Cerbera	*Cerbera manghas*
Camphor Tree	*Cinnamomum camphora*
-	*Citrus* sp.
Lidded Cleistocalyx	*Cleistocalyx operculatus*
Obtuse-leaved Crateva	*Crateva trifoliata*
Flame Tree	*Delonix regia*
Ivory Coral Tree	*Erythrina speciosa*
Swamp Mahogany	*Eucalyptus robusta*
Milky Mangrove	*Excoecaria agallocha*
Chinese Banyan	*Ficus microcarpa*
Big-leaved Fig	*Ficus virens* var. *sublanceolata*
Water Pine	*Glyptostrobus pensilis*
Coastal Heritiera	*Heritiera littoralis*
Cuban Bast	*Hibiscus tiliaceus*
Chinese Holly	*Ilex rotunda*
Sweet Gum	*Liquidambar formosana*
Pond Spice	*Litsea glutinosa*
Elephant's Ear	*Macaranga tanarius*
Turn-in-the-wind	*Mallotus paniculatus*
China-berry	*Melia azedarach*
Microcos	*Microcos paniculata*
White Mulberry	*Morus alba*
Guava	*Psidium guajava*
Weeping Willow	*Salix babylonica*
Mountain Tallow Tree	*Sapium discolor*
Chinese Tallow Tree	*Sapium sebiferum*
Ivy Tree	*Schefflera heptaphylla*
Lance-leaved Sterculia	*Sterculia lanceolata*
Box-leaved Syzygium	*Syzygium buxifolium*
Rose Apple	*Syzygium jambos*

Table D1.2 : List of Avifauna Species within Deep Bay (Category A Birds Only).

GREBES			
Little Grebe	*Tachybaptus ruficollis*	Black-necked Grebe	*Podiceps nigricollis*
Great Crested Grebe	*Podiceps cristatus*	Horned Grebe	*Podiceps auritus*
PELICANS		**CORMORANTS**	
Dalmatian Pelican	*Pelecanus crispus*	Great Cormorant	*Phalacrocorax carbo*
FRIGATEBIRDS			
Christmas Island Frigatebird	*Fregata andrewsi*	Lesser Frigatebird	*Fregata ariel*
BITTERNS, HERONS AND EGRETS			
Grey Heron	*Ardea cinerea*	Chinese Pond Heron	*Ardeola bacchus*
Purple Heron	*Ardea purpurea*	Striated Heron	*Butorides striatus*
Great Egret	*Egretta alba*	Black-crowned Night Heron	*Nycticorax nycticorax*
Intermediate Egret	*Egretta intermedia*	Yellow Bittern	*Ixobrychus sinensis*
Little Egret	*Egretta garzetta*	Schrenck's Bittern	*Ixobrychus eurythmus*
Swinhoe's Egret	*Egretta eulophotes*	Cinnamon Bittern	*Ixobrychus cinnamomeus*
Pacific Reef Egret	*Egretta sacra*	Black Bittern	*Ixobrychus flavicollis*
Cattle Egret	*Bubulcus ibis*	Great Bittern	*Botaurus stellaris*
STORKS			
Black Stork	*Ciconia nigra*	Oriental Stork	*Ciconia boyciana*
IBISES AND SPOONBILLS			
Black-headed Ibis	*Threskiornis melanocephalus*	Eurasian Spoonbill	*Platalea leucorodia*
Glossy Ibis	*Plegadis falcinellus*	Black-faced Spoonbill	*Platalea minor*
DUCKS AND GEESE			
Whooper Swan	*Cygnus Cygnus*	Mallard	*Anas platyrhynchos*
Lesser Whistling Duck	*Dendrocygna javanica*	Spot-billed Duck	*Anas poecilorhyncha*
Greylag Goose	*Anser anser*	Northern Pintail	*Anas acuta*
Greater White-fronted Goose	*Anser albifrons*	Garganey	*Anas querquedula*
Ruddy Shelduck	*Tadorna ferruginea*	Northern Shoveler	*Anas clypeata*
Common Shelduck	*Tadorna tadorna*	Common Pochard	*Aythya ferina*
Cotton Pygmy-goose	*Nettapus coromandelianus*	Baer's Pochard	*Aythya baeri*
Mandarin Duck	*Aix galericulata*	Ferruginous Duck	*Aythya nyroca*
Eurasian Wigeon	*Anas penelope*	Tufted Duck	*Aythya fuligula*
Falcated Duck	*Anas falcata*	Greater Scaup	*Aythya marila*
Gadwall	*Anas strepera*	Velvet Scoter	*Melanitta fusca*
Baikal Teal	*Anas formosa*	Common Goldeneye	*Bucephala clangula*
Common Teal	*Anas crecca*	Smew	*Mergus albellus*
Green-winged Teal	*Anas carolinensis*	Red-breasted Merganser	*Mergus serrator*
EAGLES AND HAWKS			
Osprey	*Pandion haliaetus*	Eastern Marsh Harrier	*Circus spilonotus*
Black Baza	*Aviceda leuphotes*	Crested Goshawk	*Accipiter trivirgatus*
Crested Honey Buzzard	*Pernis ptilorhynchus*	Chinese Goshawk	*Accipiter soloensis*

EAGLES AND HAWKS (cont.)

Black-winged Kite	*Elanus caeruleus*	Japanese Sparrowhawk	*Accipiter gularis*
Black Kite	*Milvus migrans*	Besra	*Accipiter virgatus*
Brahminy Kite	*Haliastur indus*	Eurasian Sparrowhawk	*Accipiter nisus*
White-bellied Sea Eagle	*Haliaeetus leucogaster*	Common Buzzard	*Buteo buteo*
Eurasian Black Vulture	*Aegypius monachus*	Greater Spotted Eagle	*Aquila clanga*
Crested Serpent Eagle	*Spilornis cheela*	Imperial Eagle	*Aquila heliaca*
Grey-faced Buzzard	*Butastur indicus*	Bonelli's Eagle	*Hieraaetus fasciatus*
Pied Harrier	*Circus melanoleucos*		

FALCONS

Common Kestrel	*Falco tinnunculus*	Eurasian Hobby	*Falco subbuteo*
Amur Falcon	*Falco amurensis*	Peregrine Falcon	*Falco peregrinus*

FRANCOLINS AND QUAILS

Japanese Quail	*Coturnix japonica*

BUTTONQUAILS

Yellow-legged Button-quail	*Turnix tanki*	Barred Button-quail	*Turnix suscitator*

CRANES

Siberian Crane	*Grus leucogeranus*	Common Crane	*Grus grus*

RAILS, CRAKES AND COOTS

Slaty-breasted Rail	*Rallus striatus*	White-breasted Waterhen	*Amaurornis phoenicurus*
Water Rail	*Rallus aquaticus*	Watercock	*Gallicrex cinerea*
White-browed Crake	*Porzana cinerea*	Common Moorhen	*Gallinula chloropus*
Baillon's Crake	*Porzana pusilla*	Eurasian Coot	*Fulica atra*
Ruddy-breasted Crake	*Porzana fusca*		

JACANAS

Pheasant-tailed Jacana	*Hydrophasianus chirurgus*

PAINTED SNIPE

Greater Painted-snipe	*Rostratula benghalensis*

AVOCETS AND STILTS

Black-winged Stilt	*Himantopus himantopus*	Pied Avocet	*Recurvirostra avosetta*

PRANTINCOLES

Oriental Pratincole	*Glareola maldivarum*

PLOVERS

Northern Lapwing	*Vanellus vanellus*	Little Ringed Plover	*Charadrius dubius*
Grey-headed Lapwing	*Vanellus cinereus*	Kentish Plover	*Charadrius alexandrinus*
Pacific Golden Plover	*Pluvialis fulva*	Lesser Sand Plover	*Charadrius mongolus*
Grey Plover	*Pluvialis squatarola*	Greater Sand Plover	*Charadrius leschenaultii*
Common Ringed Plover	*Charadrius hiaticula*	Oriental Plover	*Charadrius veredus*

SANDPIPERS, SNIPES, CURLEWS AND ALLIES

Black-tailed Godwit	*Limosa limosa*	Eurasian Woodcock	*Scolopax rusticola*
Bar-tailed Godwit	*Limosa lapponica*	Pintail Snipe	*Gallinago stenura*
Little Curlew	*Numenius minutus*	Swinhoe's Snipe	*Gallinago megala*
Whimbrel	*Numenius phaeopus*	Common Snipe	*Gallinago gallinago*
Eurasian Curlew	*Numenius arquatus*	Long-billed Dowticher	*Limnodromus scolopaceus*
Far Eastern Curlew	*Numenius madagascariensis*	Asian Dowitcher	*Limnodromus semipalmatus*
Spotted Redshank	*Tringa erythropus*	Red Knot	*Calidris canutus*
Common Redshank	*Tringa totanus*	Great Knot	*Calidris tenuirostris*
Marsh Sandpiper	*Tringa stagnatilis*	Sanderling	*Calidris alba*
Common Greenshank	*Tringa nebularia*	Red-necked Stint	*Calidris ruficollis*
Nordmann's Greenshank	*Tringa guttifer*	Little Stint	*Calidris minuta*
Lesser Yellowlegs	*Tringa flavipes*	Temminck's Stint	*Calidris temminckii*
Green Sandpiper	*Tringa ochropus*	Long-toed Stint	*Calidris subminuta*
Wood Sandpiper	*Tringa glareola*	Pectoral Sandpiper	*Calidris melanotos*
Terek Sandpiper	*Xenus cinereus*	Sharp-tailed Sandpiper	*Calidris acuminata*
Common Sandpiper	*Actitis hypoleucos*	Dunlin	*Calidris alpina*
Grey-tailed Tattler	*Heteroscelus brevipes*	Curlew Sandpiper	*Calidris ferruginea*
Ruddy Turnstone	*Arenaria interpres*	Spoon-billed Sandpiper	*Eurynorhynchus pygmaeus*
Red-necked Phalarope	*Phalaropus lobatus*	Broad-billed Sandpiper	*Limicola falcinellus*
Red Phalarope	*Phalaropus fulicarius*	Ruff	*Philomachus pugnax*

SKUAS

Long-tailed Jaeger	*Stercorarius longicaudus*

GULLS AND TERNS

Black-tailed Gull	*Larus crassirostris*	Slender-billed Gull	*Larus genei*
Mew Gull	*Larus canus*	Little Gull	*Larus minutus*
Heuglin's Gull	*Larus heuglini*	Saunders' Gull	*Larus saundersi*
Brown-headed Gull	*Larus brunnicephalus*	Black-legged Kittiwake	*Rissa tridactyla*
Yellow-legged Gull	*Larus cachinnans*	Whiskered Tern	*Chlidonias hybridus*
Slaty-backed Gull	*Larus schistisagus*	White-winged Tern	*Chlidonias leucopterus*
Glaucous Gull	*Larus hyperboreus*	Gull-billed Tern	*Gelochelidon nilotica*
Glaucous-winged Gull	*Larus glaucescens*	Caspian Tern	*Sterna caspia*
Pallas's Gull	*Larus icthyaetus*	Common Tern	*Sterna hirundo*
Relict Gull	*Larus relictus*	Little Tern	*Sterna albifrons*
Black-headed Gull	*Larus ridibundus*	Greater Crested Tern	*Sterna bergii*

DOVES

Oriental Turtle Dove	*Streptopelia orientalis*	Spotted Dove	*Streptopelia chinensis*
Red Turtle Dove	*Streptopelia tranquebarica*	Emerald Dove	*Chalcophaps indica*

CUCKOOS

Chestnut-winged Cuckoo	*Clamator coromardelianas*	Horsfield's Cuckoo	*Cuculus Horsfieldi*
Large Hawk Cuckoo	*Hierococcyx sparverioides*	Plaintive Cuckoo	*Cacomantis merulinus*
Indian Cuckoo	*Cuculus micropterus*	Common Koel	*Eudynamis scolopacea*

COUCALS			
Greater Coucal	*Centropus sinensis*	Lesser Coucal	*Centropus bengalensis*
OWLS			
Eastern Grass Owl	*Tyto longinembris*	Asian Barred Owlet	*Glaucidium cuculiodes*
Oriental Scops Owl	*Otus sunia*	Short-eared Owl	*Asio flammeus*
NIGHTJARS			
Grey Nightjar	*Caprimulgus indicus*	Savanna Nightjar	*Caprimulgus affinis*
SWIFTS			
Himalayan Swiftlet	*Collocalia brevirostris*	Common Swift	*Apus apus*
White-throated Needletail	*Hirundapus caudacutus*	Pacific Swift	*Apus pacificus*
Silver-backed Needletail	*Hirundapus cochinchinesis*	Little Swift	*Apus affinis*
KINGFISHERS			
Pied Kingfisher	*Ceryle rudis*	Black-capped Kingfisher	*Halcyon pileata*
Common Kingfisher	*Alcedo atthis*	Collared Kingfisher	*Halcyon chloris*
White-throated Kingfisher	*Halcyon smyrnensis*		
BEE-EATERS			
Blue-throated Bee-eater	*Merops viridis*	Blue-tailed Bee-eater	*Merops philippinus*
ROLLERS		**HOOPOES**	
Dollarbird	*Eurystomus orientalis*	Eurasian Hoopoe	*Upupa epops*
WOODPECKER			
Eurasian Wryneck	*Jynx torquilla*		
LARKS			
Eurasian Skylark	*Alauda arvensis*	Oriental Skylark	*Alauda gulgula*
SWALLOWS AND MARTINS			
Sand Martin	*Riparia riparia*	Red-rumped Swallow	*Hirundo daurica*
Barn Swallow	*Hirundo rustica*	Asian House Martin	*Delichon dasypus*
PIPITS AND WAGTAILS			
Forest Wagtail	*Dendronanthus indicus*	Richard's Pipit	*Anthus novaeseelandiae*
Yellow Wagtail	*Motacilla flava*	Olive-backed Pipit	*Anthus hodgsoni*
Citrine Wagtail	*Motacilla citreola*	Red-throated Pipit	*Anthus cervinus*
Grey Wagtail	*Motacilla cinerea*	Pechora Pipit	*Anthus gustavi*
White Wagtail	*Motacilla alba*	Buff-bellied Pipit	*Anthus rubescens*
CUCKOO-SHRIKES AND MINIVETS			
Black-winged Cuckoo-shrike	*Coracina melaschistos*	Ashy Minivet	*Pericrocotus divaricatus*
Swinhoe's Minivet	*Pericrocotus cantonensis*		
BULBULS			
Red-whiskered Bulbul	*Pycnonotus jocosus*	Chinese Bulbul	*Pycnonotus sinensis*

BULBULS (cont.)

Sooty-headed Bulbul	*Pycnonotus aurigaster*	Chestnut Bulbul	*Hemixos castanonotus*

SHRIKES

Tiger Shrike	*Lanius tigrinus*	Brown Shrike	*Lanius cristatus*
Bull-headed Shrike	*Lanius bucephalus*	Long-tailed Shrike	*Lanius schach*

CHATS AND THRUSHES

Rufous-tailed Robin	*Luscinia sibilans*	White-throated Rock Thrush	*Monticola gularis*
Siberian Rubythroat	*Luscinia calliope*	Blue Rock Thrush	*Monticola solitarius*
Siberian Blue Robin	*Luscinia cyane*	Scaly Thrush	*Zoothera dauma*
Bluethroat	*Luscinia svecica*	Orange-headed Thrush	*Zoothera citrine*
Red-flanked Bluetail	*Tarsiger cyanurus*	Japanese Thrush	*Turdus cardis*
Oriental Magpie Robin	*Copsychus saularis*	Common Blackbird	*Turdus merula*
Daurian Redstart	*Phoenicurus auroreus*	Grey-backed Thrush	*Turdus hortulorum*
Plumbeous Redstart	*Rhyacornis fuliginosus*	Pale Thrush	*Turdus pallidus*
Common Stonechat	*Saxicola torquata*	Eyebrowed Thrush	*Turdus obscurus*
Grey Bushchat	*Savicola ferrea*	Dusky Thrush	*Turdus naumanni*

BABBLERS

Masked Laughing-thrush	*Garrulax perspicillatus*	Striated Yuhina	*Yuhina castaniceps*
Hwamei	*Garrulax canorus*		

OLD WORLD WARBLERS, CISTICOLAS AND PRINIAS

Asian Stubtail Warbler	*Urosphena squameiceps*	Yellow-bellied Prinia	*Prinia flaviventris*
Pale-footed Bush Warbler	*Cettia pallidipes*	Plain Prinia	*Prinia inornata*
Japanese Bush Warbler	*Cettia diphone*	Common Tailorbird	*Orthotomus sutorius*
Brownish-flanked Bush Warbler	*Cettia fortipes*	Mountain Tailorbird	*Orthotomus cuculatus*
Russet Bush Warbler	*Bradypterus seebohmi*	Chiffchaff	*Phylloscopus collybita*
Lanceolated Warbler	*Locustella lanceolata*	Dusky Warbler	*Phylloscopus fuscatus*
Pallas's Grasshopper Warbler	*Locustella certhiola*	Yellow-streaked Warbler	*Phylloscopus armandii*
Middendorff's Grasshopper Warbler	*Locustella ochotensis*	Radde's Warbler	*Phylloscopus schwarzi*
Styan's Grasshopper Warbler	*Locustella pleskei*	Pallas's Leaf Warbler	*Phylloscopus proregulus*
Black-browed Reed Warbler	*Acrocephalus bistrigiceps*	Yellow-browed Warbler	*Phylloscopus inornatus*
Manchurian Reed Warbler	*Acrocephalus tangorum*	Arctic Warbler	*Phylloscopus borealis*
Paddyfield Warbler	*Acrocephalus agricola*	Greenish Warbler	*Phylloscopus trochiloides*
Blunt-winged Warbler	*Acrocephalus concinens*	Pale-legged Leaf Warbler	*Phylloscopus tenellipes*
Blyth's Reed Warbler	*Acrocephalus dumetorum*	Sakhalin Leaf Warbler	*Phylloscopus borealoides*
Oriental Reed Warbler	*Acrocephalus orientalis*	Eastern Crowned Warbler	*Phylloscopus coronatus*
Thick-billed Warbler	*Acrocephalus aedon*	Blyth's Leaf Warbler	*Phylloscopus reguloides*
Zitting Cisticola	*Cisticola juncidis*		

FLYCATCHERS

Grey-streaked Flycatcher	*Muscicapa griseisticta*	Narcissus Flycatcher	*Ficedula narcissina*
Dark-sided Flycatcher	*Muscicapa sibirica*	Mugimaki Flycatcher	*Ficedula mugimaki*
Asian Brown Flycatcher	*Muscicapa dauurica*	Red-throated Flycatcher	*Ficedula albicilla*
Ferruginous Flycatcher	*Muscicapa ferruginea*	Blue-and-white Flycatcher	*Cyanoptila cyanomelana*
Verditer Flycatcher	*Eumyias thalasina*	Hainan Blue Flycatcher	*Cyornis hainana*
Yellow-rumped Flycatcher	*Ficedula zanthopygia*	Grey-headed Flycatcher	*Culicicapa ceylonensis*

MONARCHS			
Black-naped Monarch	*Hypothymis azurea*	Japanese Paradise Flycatcher	*Terpsiphone atrocaudata*
Asian Paradise Flycatcher	*Terpsiphone paradisi*		
WHITE-EYES		**PENDULINE TITS**	
Chestnut-flanked White-eye	*Zosterops erythropleurus*	Chinese Penduline Tit	*Remiz consobrinus*
Japanese White-eye	*Zosterops japonica*		
TITS			
Yellow-bellied Tit	*Parus venustulus*	Great Tit	*Parus major*
SUNBIRDS		**FLOWERPECKER**	
Fork-tailed Sunbird	*Aethopyga christinae*	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*
BUNTINGS			
Crested Bunting	*Melophus lathami*	Yellow-breasted Bunting	*Emberiza aureola*
Grey-necked Bunting	*Emberiza buchanani*	Black-headed Bunting	*Emberiza melanocephala*
Tristram's Bunting	*Emberiza tristrami*	Chestnut Bunting	*Emberiza rutila*
Chestnut-eared Bunting	*Emberiza fucata*	Japanese Yellow Bunting	*Emberiza sulphurata*
Little Bunting	*Emberiza pusilla*	Black-faced Bunting	*Emberiza spodocephala*
Yellow-browed Bunting	*Emberiza chrysophrys*	Common Reed Bunting	*Emberiza schoeniclus*
FINCHES			
Brambling	*Fringilla montifringilla*	Common Rosefinch	*Carpodacus erythrinus*
Grey-capped Greenfinch	*Carduelis sinica*	Yellow-billed Grosbeak	*Eophona migratorius*
Eurasian Siskin	*Carduelis spinus*		
MUNIAS		**SPARROWS**	
White-rumped Munia	*Lonchura striata*	Russet Sparrow	*Passer rutilans*
Scaly-breasted Munia	*Lonchura punctulata*	Eurasian Tree Sparrow	*Passer montanus*
STARLINGS AND MYNAS			
Red-billed Starling	*Sturnus sericeus*	White-cheeked Starling	*Sturnus cineraceus*
Chestnut-cheeked Starling	*Sturnus philippensis*	Black-collared Starling	*Sturnus nigricollis*
Purple-backed Starling	*Sturnus sturninus*	White-shouldered Starling	*Sturnus sinensis*
Rose-coloured Starling	*Srurnus roseus*	Crested Myna	*Acridotheres tristis*
Common Starling	*Sturnus vulgaris*		
DRONGOS		**ORIOLES**	
Ashy Drongo	*Dicrurus leucophaeus*	Black-naped Oriole	*Oriolus chinensis*
Black Drongo	*Dicrurus macrocercus*		
Hair-crested Drongo	*Dicrurus hottentottus*		
CROWS			
Eurasian Jay	*Garrulus glandarius*	Carrion Crow	*Corvus corone*
Blue Magpie	*Urocissa erythrorhyncha*	Large-billed Crow	*Corvus macrorhynchus*
Common Magpie	*Pica pica*	Collared Crow	*Corvus torquatus*
Daurian Jackdaw	*Corvus dauricus*		

Table D1.3 : List of Mammal Species within Mai Po Nature Reserve.

Wild boar	*Sus scrofa*	House Mouse	*Mus musculus*
Chinese Leopard Cat	*Felis bengalensis*	Ryuku Mouse	*Mus caroli*
Feral Dog	*Canis familiaris*	Chestnut Spiny Rat	*Niviventer fulvescens*
Chinese Otter	*Lutra lutra chinensis*	Musk Shrew	*Suncus murinus*
Small Asian Mongoose	*Herpestes javanicus*	Grey Shew	*Crocidura attenuata*
Crab-eating Mongoose	*Herpestes urva*	Japanese Pipistrelle	*Pipistrellus abramus*
Small Indian Civet	*Viverricula indica*	Noctule Bat	*Nycatalus noctula*
Large Bandicoot Rat	*Bandicota indica*	Lesser Yellow House Bat	*Scotophilus khuli*
Brown Rat	*Rattus norvegicus*	Greater Short-nosed Fruit	*Cynopterus sphinx*
Buff-bellied Rat	*Rattus rattus flavipectus*	Leschnault's Rousette Bat	*Rousettus leschnaulti*
Ship or Roof Rat	*Rattus rattus rattus*		

Table D1.4 : List of Fish Species within Mai Po Nature Reserve.

Small Snakehead	*Channa asiatica*	Gobiid Fish	*Mugilogobius abei*
Snakehead	*Channa maculata*	Chameleon goby	*Tridentiger trigonocephalus*
Jarbua Terapon	*Terapon jarbua*	Tilapia	*Sarotherodon mossambicus*
Gold silk seabream	*Acanthopagrus berda*	-	*Ochetobius elongatus*
Bald glassy	*Ambassis gymnocephalus*	Mud carp	*Cirrhinus molitorella*
Spotted Silver Scat	*Scatophagus argus*	Mosquito fish	*Gambusia affinis*
Giant Perch	*Lates calcarifer*	Catfish	*Clarias fuscus*
Bigmouth sleeper	*Gobiomorus dormitor*	Ladyfish	*Elops saurus*
Broadhead sleeper	*Eleotris melanosoma*	Grey Mullet	*Mugil cephalus*
Mud-skipper	*Periophthalmus cantonensis*	Flat-tail Mullet	*Liza dussumieri*
Blue-spotted Mud Hopper	*Boleopthalmus pectinirostris*	Japanese Eel	*Anguilla japonica*
Bearded goby	*Scartelaos viridis*	-	*Ophichthys celebicus*
Flathead	*Platycephalus indicus*		

Table D1.5 : List of Lepidoptera (*Rhopalocera*) Species within Mai Po Nature Reserve.

Common mime	*Chilasa clytia clytia*	Large Faun	*Faunis eumeus*
Common Mormon	*Papilio polytes polytes*	Indian Cabbage White	*Pieris canidia canidia*
Great Mormon	*Papilio memnon agenor*	Great Orange Tip	*Hebomoia glaucippe*
Paris Peacock	*Papilio paris paris*	Common Tiger	*Danus genutia genutia*
Red Helen	*Papilio helenus helenus*	Blue Tiger	*Tirumala limniace limniace*
Common Bluebottle	*Graphium sarpedon sarpedon*	Ceylon Blue Glassy Tiger	*Ideopsis similis similis*
Common Jay	*Graphium doson axion*	Common Indian Crow	*Euploea core amymone*
Tailed Jay	*Graphium agamemnon agamemnon*	Blue-spotted Crow	*Euploea midamus midamus*
Lemon Emigrant	*Catopsilia pomona pomona*	Common Evening Brown	M*elanitis leda leda*
Mottled Emigrant	*Cataopsilia pyranthe pyranthe*	Dark Evening Brown	*Melanitis phedima muskata*
Common Grass Yellow	*Eurema hecabe hecabe*	Banded Tree Brown	*Lethe confusa confusa*
Painted Jezebell	*Delias hyparete hierte*	Dark Brand Bush Brown	*Mycalesis mineus mineus*
Red-base Jezebell	*Delias pasithoe pasithoe*		

Table D1.5 (cont.)

Red Ring Skirt	*Hestina assimilis assimilis*
Rustic	*Cupha erymanthis erymanthis*
Blue Admiral	*Kaniska canace canace*
Grey Pansy	*Junonia atlites atlites*
Common Sailer	*Neptis hylas hylas*
Short-banded Sailor	*Phaedyma columella columella*
Great Egg-fly	*Hypolimnas bolina kezia*
Lemon Pansy	*Junonia lemonias lemonias*
Peacock Pansy	*Junonia almana almana*
Plum Judy	*Abisara echerius echerius*
Purple Sapphire	*Heliophorus epicles phoenicoparphus*
Silver Streak Blue	*Iraota timoleon timoleon*
Long-banded Silverline	*Spindasis lohita formosana*
Long-tailed Blue / Pea Blue	*Lampides boeticus*
Dark Grass Blue	*Zizeeria karsandra*
Pale Grass Blue	*Zizeeria maha* serica
Tailed Cupid	*Everes lacturnus rileyi*
Common Hedge Blue	*Acytolepis puspa gisca*
Gram Blue	*Euchryspos cnejus cnejus*
Banana Skipper	*Erionota torus*
Common Redeye	*Matapa aria*
Chinese Dart	*Potanthus confucius confucius*
Common Straight Swift	*Parnara guttata*
Little Branded Swift	*Pelopidas agna agna*
Contiguous Swift	*Polytremis lubricans lubricans*

Table D1.6 : List of Odonata Species within Mai Po Nature Reserve.

Orange-tailed Midget	*Agriocenemis femina oryzae*
Wandering Midget	*Agriocenemis pygmaea*
Four-spot Midget	*Mortonagrion hirosei*
Marsh Dancer	*Onychargia atrocyana*
Asian Bluetail	*Ischnura asiatica*
Common Bluetail	*Ischnura senegalensis*
Orange-tailed Sprite	*Ceriagrion aurantiacum ryukyuanum*
Orange-faced Sprite	*Pseudagrion rubriceps rubriceps*
Blue Sprite	*Pseudagrion microcephalum*
Eastern Lilysquatter	*Cercion melanotum*
Black-kneed Featherlegs	*Copera ciliata*
Yellow Featherlegs	*Copera marginipes*
Common Evening Hawer	*Anaciaeschna jaspidea*
Pale-spotted Emperor	*Anax guttatus*
Lesser Emperor	*Anax parthenope julius*
Little Dusk-hawker	*Gynacantha saltatrix*
Blue-spotted Dusk-hawker	*Gynacantha japonica*
Dingy Dusk-hawker	*Gynacantha subinterrupta*
Common Flangetail	*Ictinogomphus pertinax*
Golden Flangetail	*Sinictogomphus clavatus*
Tawny Hooktail	*Paragomphus capricornis*
Regal Pond Cruiser	*Epopthalmia elegans*
Blue Dasher	*Brachydiplax chalybea flavovittata*
Forest Chaser	*Lyriothemis elegantissima*
Coastal Glider	*Macrodiplax cora*
Blue Chaser	*Potamarcha congener*
Red-faced Skimmer	*Orthetrum chrysis*
Common Blue Skimmer	*Orthetrum. glaucum*
Marsh Skimmer	*Orthetrum luzonicum*
Common Red Skimmer	*Orthetrum pruinosum neglectum*
Green Skimmer	*Orthetrum sabina sabina*
Greater Blue Skimmer	*Orthetrum melania*
Asian Pintail	*Acisoma panorpoides panorpoides*
Asian Amberwing	*Brachythemis contaminata*
Crimson Darter	*Crocothemis servilia servilia*
Black-tipped Percher	*Diplacodes nebulosa*
Blue Percher	*Diplacodes trivalis*
Pied Percher	*Neurothemis tullia tullia*
Russet Percher	*Neurothemis fulvia*
Pied Skimmer	*Pseudothemis zonata*
Crimson Dropwing	*Trithemis aurora*
Indigo Dropwing	*Trithemis festiva*
Asian Widow	*Palpopleura sexmaculata sexmaculata*
Variegated Flutterer	*Rhyothemis variegata arria*
Amber-winged Glider	*Hydrobasileus croceus*
Wandering Glider	*Pantala flavescens*
Saddlebag Glider	*Tramea virginia*
Evening Skimmer	*Tholymis tillarga*
Dingy Dusk-darter	*Zyxomma petiolatum*

Table D1.7 : List of Marine Invertebrates within Deep Bay.

NERMETEA: Anopla
Dendrorhynchus sinensis
Procephalothrix orientalis

ANNELIDA : Oligochaeta
Limnodriloides biforis
Limnodriloides fraternus
Tectidrilus achaetus
Doliodrilus tener
Rhizodrilus russus

ANNELIDA : Polychaeta
Dendronereis pinnaticirrus
Laonome sp.
Ceratonereis sp.
Ceratonereies burmensis
Aglaophamus sp.
Polydora sp.
Neanthes sp.
Namalycastis aibiuma
Capitellis indet
Notomastus sp.

MOLLUSCA : Gastropoda
Sermyla tornatella
Dostia violacea
Haminoea yamagutii
Cerithideopsilla cingulata
Cerithideopsilla djadjariensis
Assiminea nitida
Assiminea sculpta
Assiminea brevicula
Assiminea sp.
Iravadia ornata
Iravadia bombayana
Stenothyra glabra
Stenothyra sp.
Clenchiella sp.
Salinator fragilis
Salinator sp.
Linopygrasp.
Pyramidellidsp.
Ellobium politum
Ellobium sp.
Melanoides tuberculata

MOLLUSCA : Gastropoda (cont.)
Mainwaringia rhizophila
Littorina melanostoma
Littoraria ardouiniana
Elysia leucolegnote
Tenellia adspersa

MOLLUSCA : Bivalvia
Pseudopythina maipoensis
Musculista senhausia
Glauconome chinesis
Placuna placenta
Crassostrea gigas
Mytilopsis sallei

ARTHROPODA : Arachnida (Acarina)
Dometorina rostrata
Amblysius sp.

ARTHROPODA : Crustacea (Decapoda)
Sesarmops sinensis
Chiromantes dehaani
Chiromantes tangi
Parasesarma affinis
Perisesarma bidens
Perisesarma maipoensis
Chasmagnathes convexus
Holometopus serenei
Helice tridens
Helice latimera
Helice sp.
Metaplax longipes
Metaplax elegans
Metaplax takahasii
Eriocheir sinensis
Varuna yui
Varuna litterata
Uca acuta
Uca arcuata
Uca paradussumieri
Uca chlorophthalmus crassipes
Uca lactea
Uca vocans vocans

ARTHROPODA : Crustacea (Decapoda) – (cont.)
Uca dusummieri
Paracleistosoma depressum
Paracleistostoma crassipilum
Cleistostoma dilatatum
Cleistocoeloma sinensis
Cleistocoeloma merguiensis
Ilyoplax dentimerosa
Ilyoplax tansuiensis
Ilyoplax pingi
Ilyoplax serrata
Ilyoplax ningpoensis
Macrophalmus tomentosus
Macrophalmus convexus
Macrophalmus definitus
Macrophalmus abbreviatus
Macrophalmus latreillei
Macrophalmus banzai
Scylla serrata
Metapenaeus ensis
Metapenaeus affinis
Penaeus monodon
Penaeus merguiensis
Penaeus penicillatus
Exopalaemon styliferus
Coutierella tonkinensis
Macrobrachium nipponense
Palaemon orientis
Caridina nilotica gracilipes
Alpheus euphrosyne

ARTHROPODA : Crustacea (Amphipoda)
Grandidierella sp.
Kamaka sp.
Melita sp.
Victoriopisa sp.
Talorchestia sp.

ARTHROPODA : Crustacea (Tanadacea)
Discapseudes sp.

Table D1.8 : List of Herpetofauna Species within Mai Po Nature Reserve.

Asian Common Toad	*Bufo melanostictus*
Asiatic Painted Frog	*Kaloula pulchra pulchra*
Ornate Narrow-mouthed Frog	*Microphla ornata*
Brown Tree Frog	*Polypedates megacephalus*
Paddy Frog	*Rana limnocharis*
Red and Black Frog	*Rana guentheri*
Chinese Bullfrog / Edible Frog	*Rana (tigrina) rugulosa*
Reeve's Turtle	*Chinemys reevesi*
Red-eared Slider	*Trachemys scripta elegans*
Chinese Softshell Turtle	*Pelodiscus sinensis*
Stump-toed Gecko	*Gehyra mutilata*
Browring's Gecko	*Hemidactylus bowringii*
Reeve's Smooth skink	*Scincella reevesii*
Chinese Skink	*Eumeces chinensis chinensis*
Striped Grass Lizard	*Takydromus sexlineatus ocellatus*
Common Blind Snake / Iron-wire Snake	*Ramphotyphlops braminus*
Burmese Python	*Python molurus bivittatus*
Copperhead Racer	*Elaphe radiata*
Common Rat Snake	*Ptyas mucosus*
Indo-chinese rat snake	*Ptyas korros*
Taiwan Kukri Snake	*Oligodon formosanus*
Checkered Keel-back	*Xenochrophis piscator*
Mangrove Water Snake	*Enhydris bennetti*
Common Water Snake	*Enhydris chinensis*
Many-banded Krait	*Bungarus multicinctus*
Chinese Cobra	*Naja atra*
King Cobra / Hamadryad	*Ophiophagus hannah*

APPENDIX E

ECOLOGICAL SURVEYS METHODOLOGY & RAW DATA

E1. ECOLOGICAL SURVEY METHODOLGY

Vegetation Survey

The structure and composition of mangrove trees/saplings along each boardwalk alignment route was assessed following a similar method to that of Duke & Khan (1999), which employed a 2m wide transect. However because the fixed boardwalk is only 1.0m wide, the width of the transect was reduced to 1.0m for both seedling and tree surveys. For the floating boardwalk alignments, the transect width remained at 1.0m for the mangrove seedling survey, but had to be increased to 3.1m (width of a floating boardwalk) to ensure that any overhanging mangrove branches were recorded.

For the mangrove seedling survey, a single $16m^2$ (1m x 16m) quadrat was placed at every 100m interval and the total number and species of seedlings recorded along all alignment options. Surveying was undertaken on 25th and 26th August 2005.

For the mangrove tree survey, a continuous belt transect (1.0m wide for fixed boardwalk, 3.1m wide for floating boardwalk) was used along all alignment options and all mangrove trees that would be affected (i.e. trimmed or pollarded) by the construction work recorded. For all trees recorded within each transect, the following parameters were measured; species, height (measured to the nearest 0.5m), circumference at breast height, and crown diameter (measured to the nearest 0.5m). In addition, a tree's health condition which would be trimmed[1] or pollarded[2] was recorded separately. Surveying was undertaken throughout August 2004.

[1] Trim: Only branches will be cut.

[2] Pollard: Trees will be cut at 1m above ground and no root portion will be affected, hence tree is expected to regrow.

Avifauna Survey

Field surveys were conducted to assess the species and abundance of birds associated with the mangrove (Options A, B and C) and creek (Option B) areas for each boardwalk alignment option and the new bird-watching hide location. For areas of mudflat within the Study Area no field surveying was necessary because data was obtained directly from the HKBWS monthly bird counts.

For each boardwalk alignment option, birds were recorded (using visual and sound identification) from within a 25m zone either side of the alignment route. Each route was walked on 5 separate occasions; 29 June, 5 July, 6 July, 7 July and 8 July 2004 between 07:00-11:00 as recommended in the EIAO. No data was collected for other seasons because the mangrove forests are typically used by resident birds similar to those recorded during the summer period.

For the bird-watching hide, data was collected from the mangrove areas within a 25m zone/radius from it's location (45% of the habitat) on 5 separate occasions; 30 June 2005, 1 July, 11 July, 12 July, 13 July 2005 between 07:00-11:00 as recommended in the EIAO. Data relating to bird usage of the inter tidal mudflat area during the period of construction work is obtained from the existing HKBWS Ramsar Site waterbird data. This data relates to the entire Ramsar Site inter tidal mudflat area and not specifically the area of mudflat within the Project Area.

During these surveys, observations were also made of any birds using the site for breeding/nesting.

Benthic Fauna Survey

The abundance and species of the main benthic fauna communities associated with each boardwalk alignment and new location of the bird-watching hide was assessed throughout September 2005.

Two epifauna surveys were undertaken. The first (survey A) included a count of both crab and mudskipper individuals inside a quadrat placed at 100m intervals along each alignment. For alignment options A and C, a 1m x 16m quadrat was used, and for alignment B, a 3.1m x 16m quadrat (a larger quadrat was necessary because most of the quadrat area along the creek was underwater even at low tide). For the hide location, the quadrat size was changed to 8.0m x 4.5m (45% of the footprint area). All benthic epifauna was counted using binoculars from a 10m distance. All observed mudskipper were further identified to species level for determination of composition.

The second epifauna survey (survey B) involved the collection of crabs for species identification purposes. For all three boardwalk alignments, three 1m x 1m quadrats were randomly positioned inside the larger sized quadrats used for survey A. For the bird-watching hide location, three 1m x 1m quadrats were randomly chosen within the footprint area. All crabs collected from within each quadrat were taken back to the laboratory for identification.

Benthic infauna associated with the sediment below each alignment shadow and the hide's footprint was determined by collecting core samples (8cm diameter x 20cm depth). Core samples were collected at 100m intervals along each alignment, by randomly selecting three locations along a 1m line perpendicular to the alignment. Infauna was sieved using a 5-micron mesh pan and classified to family level.

E2. ECOLOGICAL SURVEY RAW DATA

Table E2.1 : Mangrove Seedling Survey Results for Boardwalk Alignment Option A.

	Alignment A : Quadrat No.*					
Species	**Q1 (0m)**	**Q2 (100m)**	**Q3 (200m)**	**Q4 (300m)**	**Q5 (400m)**	**Total**
Kandelia obovata	13	22	11	10	9	65
Aegiceras corniculatum	3	6	3	4	2	18
Acanthus ilicifolius	-	1	3	-	-	4
Total	**16**	**29**	**17**	**14**	**11**	**87**
	Alignment B : Quadrat No.*					
Species	**Q1 (0m)**	**Q2 (100m)**	**Q3 (200m)**	**Q4 (300m)**	**Q5 (400m)**	**Total**
All	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
	Alignment C : Quadrat No.*					
Species	**Q1 (0m)**	**Q2 (100m)**	**Q3 (200m)**	**Q4 (300m)**	**Q5 (400m)**	**Total**
All	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**

* Each quadrat is 1m x 16m = 16m^2

Table E2.3 : Mangrove Seedling Survey Results for the New Bird-Watching Hide.

Species	**Total No.**
Kandelia obovata	39
Aegiceras corniculatum	15
Acanthus ilicifolius	6
Sonneratia apetala	1
Total	**61**

Table E2.4 : Results From the Mangrove Habitat Bird Survey.

Survey Date	**Option A**	**Option B**		**Option C**	**Bird-watching Hide**
Day*	**Inter tidal Mangrove Habitat**	**Inter tidal Mangrove Habitat**	**Inter tidal Creek Habitat**	**Inter tidal Mangrove Habitat**	**Inter tidal Mangrove Habitat**
Day 1	1 x *Egretta garzetta* 2 x Ardeola *bacchus*	2 x *Ardeola bacchus* 2 x *Zosterops erythropleurus*	1 x *Halcyon smyrnensis* 1 x *Egretta garzetta*	1 x *Centropus sinensis* 1 x *Copsychus saularis* 7 x *Zosterops erythropleurus*	1 x *Copsychus saularis* 1 x *Egretta garzetta* 2 x *Ardea alba*
Day 2	1 x *Halcyon smyrnensis* 4 x *Pycnonotus sinensis*	1 x *Ardea alba*	1 x *Alcedo atthis*	1 x *Copsychus saularis*	1 x *Alcedo atthis* 1 x *Ardea alba*
Day 3	No Birds	No Birds	1 x *Alcedo atthis*	2 x *Zosterops erythropleurus*	1 x *Copsychus saularis*
Day 4	No Birds	3 x *Zosterops erythropleurus*	8 x 1 x *Egretta garzetta*	1 x *Copsychus saularis* 3 x *Zosterops erythropleurus*	2 x *Pycnonotus sinensis* 1 x *Alcedo atthis*
Day 5	1 x *Egretta garzetta*	1 x *Copsychus saularis* 2 x *Pycnonotus sinensis*	No birds	1 x *Copsychus saularis*	1 x *Llanius schach*
TOTAL (Number)	**9**	**11**	**13**	**17**	**11**
TOTAL (Species)	**4**	**5**	**4**	**3**	**6**

* - For boardwalk Options A, B and C : Day 1 = 29 June 2004, Day 2 = 5 July 2004, Day 3 = 6 July 2004, Day 4 = 7 July 2004, Day 5 = 8 July 2004

* - For bird-watching hide : Day 1 = 30 June 2005, Day 2 = 1 July 2005, Day 3 = 11 July 2005, Day 4 = 12 July 2005, Day 5 = 13 July 2005

Table E2.2 : Inter tidal Mangrove Tree Survey Results for Boardwalk Alignment Option C.

Aegiceras corniculatum (*A. corniculatum*):桐花樹
Avicennia marina (*A. marina*):白骨壤
Kandelia obovata (*K. obovata*):秋茄

1. Trim = only side branches will be cut.
2. Pollard = trees will be cut at 1m above ground level and no root portion will be affected, hence each tree is expected to regrow.
3. Poor = Rotten/dead branches were observed
4. Fair = No rotten/dead branches, or flowers were observed
5. Good = Healthy with no dead or rotting branches

Interval & Distance (m)	Tree Code No.	Species	Circumference at Breast Height (cm)	Height (m)	Crown Diameter (m)	Health Condition	Tree Management
1.0	1	*K. obovata*	10.5	2	1.5	Fair[4]	Trim[1]
6.0	1A	*A. marina*	44.5	4.5	6	Poor[3]	Trim
9.0	2	*K. obovata*	15	2.3	2	Poor	Trim
10.0	3	*K. obovata*	31	4.5	3	Poor	Pollard[2]
12.5	4	*A. marina*	34	3	5	Poor	Trim
17.0	5	*A. marina*	54	5	6	Poor	Trim
18.5	6	*A. corniculatum*	10.5	2.5	0.5	Fair	Trim
20.5	7	*A. marina*	29	3	3	Fair	Trim
25.0	8	*A. marina*	22.5	5.5	6	Poor	Trim
32.8	9	*A. corniculatum*	13	2.5	1.5	Poor	Trim
33 to 36	10	*K. obovata*	20	3	1	Fair	Trim
39 to 42	11	*K. obovata*	30	3.5	2	Fair	Trim
42.5	12	*A. corniculatum*	16.5	3.5	1	Poor	Trim
42.5	13	*K. obovata*	27	6	1	Fair	Trim
42 to 45	14	*K. obovata*	25	6	0.5	Fair	Trim
42 to 45	15	*K. obovata*	31	4	2.5	Fair	Trim
60.0	16	*K. obovata*	17	6	1	Fair	Trim
63	17	*K. obovata*	24	6	1	Fair	Trim
66	18	*K. obovata*	27,28,34	5	4	Fair	Pollard
69 to 72	19	*A. corniculatum*	10.5	1.5	3	Fair	Trim
73	20	*A. corniculatum*	12	4	8	Fair	Trim
77.5	21	*K. obovata*	26.5	3.5	2	Fair	Trim
81	22	*K. obovata*	16.5	3	N.A.	Fair	Trim
82	23	*K. obovata*	6.5	1.2	N.A.	Fair	Trim

Interval & Distance (m)	Tree Code No.	Species	Circumference at Breast Height (cm)	Height (m)	Crown Diameter (m)	Health Condition	Tree Management
91	24	*A. marina*	13	1.5	2	Fair	Trim
93	25	*K. obovata*	19	3	5	Fair	Trim
98	26	*K. obovata*	24.5	3	3.5	Fair	Trim
102	28	*K. obovata*	7	2	1	Fair	Trim
103	29	*A. corniculatum*	14	3	1.5	Fair	Trim
103	30	*K. obovata*	9	2	1	Poor	Trim
107	31	*K. obovata*	19	3.5	5	Good[5]	Trim
109	32	*A. corniculatum*	10	2.5	N.A.	Good	Trim
110.5	33	*K. obovata*	16	3	1	Fair	Trim
111	34	*A. corniculatum*	10.5	1.5	4	Fair	Trim
111.5	35	*A. corniculatum*	22	4	3	Fair	Trim
116	36	*K. obovata*	23	3	3	Fair	Trim
116	37	*A. corniculatum*	22	3.5	3	Fair	Pollard
120	38	*A. corniculatum*	16.5	2.5	2	Fair	Trim
121.5	39	*A. corniculatum*	7	1.8	1	Fair	Pollard
122	40	*A. corniculatum*	11	2	1	Fair	Pollard
124.5	41	*A. corniculatum*	15	2	1	Fair	Pollard
124.5	42	*A. corniculatum*	17	2	1.5	Fair	Pollard
125	43	*A. corniculatum*	10	2	1	Fair	Trim
127	44	*A. corniculatum*	9	2.5	1	Fair	Trim
129	45	*A. corniculatum*	13	2.5	1	Fair	Trim
131.5	46	*A. corniculatum*	26	4	2	Fair	Trim
132	47	*A. corniculatum*	12	3	1	Fair	Trim
132.5	48	*A. corniculatum*	9	2.5	1	Fair	Trim
133	49	*A. corniculatum*	25	2.5	2	Fair	Trim
134	50	*A. corniculatum*	27.5	2.5	2.5	Fair	Trim
137	51	*A. corniculatum*	18.5	1.8	2	Fair	Trim
142	52	*K. obovata*	27	6	3	Fair	Trim
150	53	*K. obovata*	22	2.5	2	Fair	Trim
159	54	*A. corniculatum*	22.5	2.5	2.5	Fair	Trim
162	55	*A. corniculatum*	20	2.5	1.5	Fair	Pollard

Interval & Distance (m)	Tree Code No.	Species	Circumference at Breast Height (cm)	Height (m)	Crown Diameter (m)	Health Condition	Tree Management
165	56	*K. obovata*	24.5,22	2.5	2.5,4	Fair	Pollard
171	57	*K. obovata*	33.5	5	4	Fair	Trim
174.5	58	*A. corniculatum*	14.5	3	2	Fair	Trim
175	59	*K. obovata*	25.5	5	1.5	Fair	Trim
184	60	*A. corniculatum*	21.5	2.5	2.5	Fair	Trim
192.5	61	*A. corniculatum*	12	2.5	1.5	Fair	Pollard
192.5	62	*A. corniculatum*	10.5	2.5	1.5	Fair	Trim
217.5	63	*A. corniculatum*	16	2	2.5	Fair	Pollard
223	64	*A. corniculatum*	12	1	2	Fair	Trim
227	65	*K. obovata*	16	6	3	Fair	Trim
227	66	*A. corniculatum*	15	4	1.5	Fair	Pollard
227.5	67	*A. corniculatum*	13	5	1	Fair	Trim
251	71	*K. obovata*	14	6	4	Fair	Trim
276	72	*A. corniculatum*	11.5,17.5	2	1.5	Fair	Pollard
276	73	*A. corniculatum*	13	2	1	Fair	Trim
292	77	*K. obovata*	11.5	4	1	Fair	Trim
293	78	*K. obovata*	12.5	4	0.5	Poor	Pollard
294	79	*K. obovata*	19.5	4	1.5	Fair	Pollard
296	80	*K. obovata*	19.5	4	1.5	Poor	Pollard
300	81	*K. obovata*	13.5	4.5	1.5	Fair	Trim
300	82	*K. obovata*	13.5	4.5	1.5	Fair	Trim
302	83	*K. obovata*	15	5	1	Fair	Pollard
302	84	*K. obovata*	10	5	0.5	Fair	Pollard
306	85	*K. obovata*	11	4	1	Fair	Pollard
306.5	86	*K. obovata*	11	5	0.5	Fair	Pollard
306.5	87	*K. obovata*	13	5	1	Fair	Pollard
307	88	*K. obovata*	12	5	1	Fair	Pollard
308	89	*K. obovata*	16	5	2	Fair	Pollard
311	91	*K. obovata*	12	4.5	5	Poor	Pollard
312	90	*K. obovata*	11	5	0.5	Poor	Trim

Interval & Distance (m)	Tree Code No.	Species	Circumference at Breast Height (cm)	Height (m)	Crown Diameter (m)	Health Condition	Tree Management
315	92	*K. obovata*	10	3.5	1	Fair	Trim
316.5	93	*K. obovata*	17	5	1.5	Fair	Trim
317	94	*K. obovata*	19	5	1.5	Fair	Trim
319	95	*K. obovata*	14,11.5,6	3.5	4	Fair	Trim
319.5	96	*K. obovata*	4	3.5	2	Fair	Trim
321	98	*K. obovata*	42	5.5	3	Fair	Trim
326	97	*A. corniculatum*	10	3.5	2	Fair	Pollard
326	99	*A. corniculatum*	15	3	1	Fair	Trim
326	100	*A. corniculatum*	10	2	2.5	Fair	Pollard
330	101	*K. obovata*	10,10,15,12	3	6	Fair	Pollard
336	102	*A. corniculatum*	13	3	2	Fair	Pollard
336	103	*A. corniculatum*	11	4	1.5	Fair	Pollard
336.5	104	*A. corniculatum*	14	4	1.5	Poor	Pollard
339	105	*K. obovata*	12,12	3.5	2	Fair	Pollard
341	106	*K. obovata*	11	4	3	Fair	Pollard
345	107	*K. obovata*	33	5	2.5	Fair	Pollard
349	108	*K. obovata*	23	6	4	Fair	Trim
352	109	*K. obovata*	11	6.5	2	Fair	Trim
366	113	*K. obovata*	17	7	3	Fair	Trim
370	114	*K. obovata*	26	7.5	2.5	Fair	Trim
375.5	115	*K. obovata*	22	7	3	Fair	Trim
378.5	116	*K. obovata*	25	7	4	Fair	Trim
390.5	118	*K. obovata*	21,16	7	5	Fair	Trim
394	120	*K. obovata*	21	7	2.5	Fair	Trim
410	126	*K. obovata*	22.5	7.5	1	Fair	Trim
410.5	127	*K. obovata*	14.5	7.5	1	Fair	Trim
412.5	128	*K. obovata*	17.5	7	1.5	Fair	Trim
413.5	129	*K. obovata*	23, 23.5	8	1.5	Fair	Trim
414	130	*K. obovata*	26.5	7.5	1.5	Fair	Trim
417	131	*K. obovata*	14.5	5.5	1	Fair	Trim
419.5	132	*K. obovata*	22.5	7.5	3	Fair	Trim

Interval & Distance (m)	Tree Code No.	Species	Circumference at Breast Height (cm)	Height (m)	Crown Diameter (m)	Health Condition	Tree Management
420.5	133	*K. obovata*	18	7	1	Fair	Trim
423	134	*K. obovata*	27	8	2.5	Fair	Trim
423	135	*K. obovata*	24.5	8	2	Fair	Trim
427.5	136	*K. obovata*	18.5,26.5	8	4	Fair	Trim
432	137	*K. obovata*	17.5	7	2.5	Fair	Trim
435	138	*K. obovata*	14.5	7	2.5	Fair	Trim
441	139	*K. obovata*	17.5	6	2.5	Fair	Trim
450	145	*K. obovata*	20.5,16.5,14.5	4	3	Fair	Pollard
454	149	*K. obovata*	12	6.5	2	Fair	Trim
457	150	*K. obovata*	11.5	6	1.5	Fair	Trim
459	151	*K. obovata*	18,8,9.5	5.5	1	Fair	Trim
459	152	*K. obovata*	14.5	6	2	Fair	Trim
462.5	153	*K. obovata*	14.5,16.5	6	2.5	Fair	Trim
468	154	*K. obovata*	18.5	7	4	Fair	Trim
473.5	155	*K. obovata*	15.5	5	5	Fair	Trim
483	156	*K. obovata*	14.5	5	2	Fair	Trim
483	157	*K. obovata*	19.5	5	2.5	Fair	Pollard
487.5	158	*A. corniculatum*	12.5	3.5	0.5	Fair	Pollard
491.5	159	*K. obovata*	13,13.5	4.5	2.5	Fair	Pollard
492	160	*K. obovata*	14.5	4	2	Fair	Pollard
516	161*	*K. obovata*	18.5	3.5	2	Fair	Pollard

*** - Note : The total number of affected trees is 137. 161 refers to the tree code along the alignment.**

Table E2.5 : Benthic Epifauna Survey (Crab Species).

Alignment	Distance (m)	Crab Species	No. of Individuals
A	0	*Uca (Deltuca) arcuata*	1
		Ilyoplax pingi	5
	100	Unidentifiable	1*
	200	*Ilyoplax pingi*	6
	300	*Uca (Deltuca) arcuata*	1
		Perisesarma bidens/affinis	1
		Ilyoplax pingi	6
	400	*Uca (Deltuca) arcuata*	4
		Ilyoplax pingi	57
B	0	*Ilyoplax pingi*	3
	100	*Ilyoplax pingi*	1
		Uca (Deltuca) arcuata	4
	200	*Ilyoplax pingi*	8
		Unidentifiable	2*
		Uca (Deltuca) arcuata	1
	300	*Ilyoplax pingi*	1
		Uca (Deltuca) arcuata	1
	400	*Uca (Deltuca) arcuata*	5
	500	*Perisesarma bidens/affinis*	1
		Ilyoplax pingi	28
C	0	*Uca (Deltuca) arcuata*	4
	100	*Ilyoplax pingi*	5
		Uca (Deltuca) arcuata	12
	200	*Ilyoplax pingi*	2
		Perisesarma bidens/affinis	1
		Uca (Deltuca) arcuata	2
	300	*Ilyoplax pingi*	29
		Uca (Deltuca) arcuata	1
	400	*Ilyoplax pingi*	1
		Perisesarma bidens/affinis	2
		Uca (Deltuca) arcuata	5
		Perisesarma bidens/affinis	1
	500	*Helice* sp.	1
		Ilyoplax pingi	2
		Perisesarma bidens/affinis	4
		Uca (Deltuca) arcuata	3
New Hide		*Ilyoplax pingi*	110
		Metaplax elegans	1
		Varuna litterata	1

* - Specimen still in big eye body stage or juvenile

Table E2.6 : Benthic Infauna Survey : Raw Data.

BOARDWALK ALIGNMENT A			
Distance (m)	**Class**	**Species / Group**	**Number of Individuals**
0	Gastropoda	*Linopygra* sp.	233
0	Gastropoda	*Pyramidellid* sp.	3
0	Gastropoda	*Salinator fragalis*	3
0	Gastropoda	*Stenothyra* sp.	35
0	Oligochaeta	Family Tubificidae	167
0	Oligochaeta	Family Naididae	1
100	Bivalva	-	1
100	Gastropoda	*Assiminea* sp.	2
100	Gastropoda	*Linopygra* sp.	255
100	Gastropoda	*Salinator fragalis*	1
100	Gastropoda	*Stenothyra* sp.	16
100	Insecta	-	1
100	Oligochaeta	Family Tubificidae	75
100	Polychaeta	Family Capitelldae	2
100	Polychaeta	Family Nereidae / Spionidae	2
200	Gastropoda	*Linopygra* sp.	171
200	Gastropoda	*Pyramidellid* sp.	1
200	Gastropoda	*Salinator fragalis*	1
200	Gastropoda	*Stenothyra* sp.	10
200	Oligochaeta	Family Tubificidae	202
200	Oligochaeta	Family Naididae	3
200	Polychaeta	Family Nereidae / Spionidae	1
200	Polychaeta	Unidentifiable	1
300	Bivalva	-	1
300	Gastropoda	*Linopygra* sp.	101
300	Gastropoda	*Stenothyra* sp.	14
300	Oligochaeta	Family Tubificidae	233
300	Oligochaeta	Family Naididae	2
300	Polychaeta	Family Nereidae / Spionidae	4
400	Gastropoda	*Assiminea* sp.	1
400	Gastropoda	*Linopygra* sp.	29
400	Gastropoda	*Salinator fragalis*	1
400	Gastropoda	*Stenothyra* sp.	7
400	Oligochaeta	Family Tubificidae	136
400	Oligochaeta	Unidentifiable	1

Table E2.6 (cont.)

BOARDWALK ALIGNMENT B			
Distance (m)	**Class**	**Species / Group**	**Number of Individuals**
0	Bivalva	-	1
0	Gastropoda	*Assiminea* sp.	7
0	Gastropoda	*Linopygra* sp.	1
0	Gastropoda	*Pyramidellid* sp.	2
0	Gastropoda	*Stenothyra* sp.	5
0	Oligochaeta	Family Tubificidae	12
0	Polychaeta	Family Sabellidae	1
100	Oligochaeta	Family Tubificidae	37
100	Polychaeta	Family Sabellidae	21
200	Oligochaeta	Family Tubificidae	12
200	Polychaeta	Family Sabellidae	5
300	Gastropoda	*Linopygra* sp.	3
300	Gastropoda	*Pyramidellid* sp.	1
300	Oligochaeta	Family Tubificidae	23
300	Polychaeta	Family Sabellidae	25
400	Crustacea	Crab	1
400	Gastropoda	*Linopygra* sp.	1
400	Oligochaeta	Family Tubificidae	19
400	Polychaeta	Family Sabellidae	37
400	Polychaeta	Family Sabellidae	37
500	Gastropoda	*Assiminea* sp.	32
500	Gastropoda	*Linopygra* sp.	16
500	Gastropoda	*Stenothyra* sp.	9
500	Oligochaeta	Family Tubificidae	3
500	Polychaeta	Family Sabellidae	45

Table E2.6 (cont.)

BOARDWALK ALIGNMENT C			
Distance (m)	**Class**	**Species / Group**	**Number of Individuals**
0	Gastropoda	*Assiminea* sp.	3
0	Gastropoda	*Stenothyra* sp.	28
0	Oligochaeta	Family Tubificidae	8
0	Polychaeta	Family Capitelldae	2
0	Polychaeta	Family Nereidae / Spionidae	10
0	Polychaeta	Unidentifiable	4
100	Gastropoda	*Stenothyra* sp.	2
100	Oligochaeta	Family Tubificidae	11
100	Oligochaeta	Family Naididae	1
100	Polychaeta	Family Capitelldae	24
100	Polychaeta	Family Nereidae / Spionidae	5
100	Unknown	Unidentifiable	1
200	Bivalva	-	1
200	Gastropoda	*Pyramidellid* sp.	6
200	Oligochaeta	Family Tubificidae	26
200	Oligochaeta	Family Naididae	8
200	Polychaeta	Family Capitelldae	25
200	Polychaeta	Family Nereidae / Spionidae	23
200	Polychaeta	Unidentifiable	5
300	Gastropoda	*Assiminea* sp.	3
300	Gastropoda	*Iravadia* sp.	6
300	Gastropoda	*Stenothyra* sp.	2
300	Oligochaeta	Family Tubificidae	14
300	Polychaeta	Family Capitelldae	10
300	Polychaeta	*Namalycastis abinma*	5
400	Gastropoda	*Assiminea* sp.	4
400	Gastropoda	*Pyramidellid* sp.	2
400	Gastropoda	*Stenothyra* sp.	3
400	Gastropoda	Unidentifiable	1
400	Oligochaeta	Family Tubificidae	73
400	Polychaeta	Family Capitelldae	25
400	Polychaeta	Family Nereidae / Spionidae	8
400	Polychaeta	Unidentifiable	1
500	Gastropoda	*Assiminea* sp.	4
500	Gastropoda	*Pyramidellid* sp.	5
500	Gastropoda	*Stenothyra* sp.	1
500	Oligochaeta	Family Tubificidae	23
500	Oligochaeta	Family Naididae	1
500	Polychaeta	Family Capitelldae	3
500	Polychaeta	Family Nereidae / Spionidae	12
500	Polychaeta	Unidentifiable	2

BIRD-WATCHING HIDE			
Under Footprint	**Class**	**Species / Group**	**Number of Individuals**
1	Gastropoda	*Assiminea* sp.	1
2	Gastropoda	*Iravadia* sp.	6
3	Gastropoda	*Stenothyra* sp.	3
4	Oligochaeta	Family Tubificidae	16

Table E2.7 : Benthic Fauna Summary.

OPTION A

	Benthic Infauna (No.)						Benthic Epifauna (No.)			
							Crab	Mudskipper		
Distance (m)	Gastropoda	Polychaeta	Arthropoda	Oligochaeta	Bivalvia	Crustacea		*P. catonensis*	*B. pectinirostris*	Unidentified
0	281	0	0	168	0	0	13	1	13	4 (juv)
100	274	4	1	75	1	0	5	10	8	6 (juv)
200	183	2	0	205	0	0	4	8	15	0
300	115	4	0	235	1	0	4	5	12	3
400	38	0	0	137	0	0	17	0	1	0
Total	**891**	**10**	**1**	**820**	**2**	**0**	**43**	**24**	**49**	**13** (juv)

OPTION B

0	15	1	0	12	1	0	7	0	0	0
100	0	21	0	37	0	0	3	1	0	0
200	0	5	0	12	0	0	10	1	0	0
300	4	25	0	23	0	0	11	0	1	1 (juv)
400	1	37	0	19	0	1	38	0	0	0
500	58	45	0	3	0	0	5	0	0	0
Total	**78**	**134**	**0**	**106**	**1**	**1**	**74**	**2**	**1**	**1** (juv)

OPTION C

0	31	16	0	8	0	0	14	0	0	0
100	2	29	0	12	0	0	24	0	0	0
200	6	53	0	34	1	0	6	0	0	1 (juv)
300	11	15	0	14	0	0	6	0	0	2 (juv)
400	10	34	0	73	0	0	4	1	0	0
500	10	17	0	24	0	0	3	0	0	0
Total	**70**	**164**	**0**	**165**	**1**	**0**	**57**	**1**	**0**	**3**

BIRD HIDE

-	10	0	0	16	0	0	14	4	4	0
Total	**10**	**0**	**0**	**16**	**0**	**0**	**14**	**4**	**4**	**0**

(Total Sample Area for Benthic Epifauna: Option A = 90m^2, Option B = 248m^2, Option C = 96m^2, Bird-watching Hide = 18m^2)

APPENDIX F

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