Agreement No. DP 04/2012

Post-Construction Ecological Monitoring

of Drainage Improvement Works in Southern Lantau

Implemented under 4128CD in Contract DC/2006/11

Monthly EM&A Report – August 2014

September 2014

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Pursuant to Condition 4.3 of Environmental Permit No. EP-237/2005/B, this monthly EM&A Report for post-construction ecological monitoring and ecological water monitoring during August 2014 has been certified by the Environmental Team Leader (ETL) and verified by the Independent Environmental Checker (IEC)

Certified by:

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EXECUTIVE SUMMARY

This is the twelfth bi-monthly post-construction ecological monitoring and audit exercise for “Drainage Improvement in Southern Lantau” conducted by AECOM. This report concludes the post-construction phase ecological monitoring and audit requirement for the activities undertaken during the period of 1 August 2014 to 31 August 2014.

Ecological monitoring and ecological water quality monitoring were performed on 12 August 2014 and 21 August 2014, respectively. Results obtained are presented in this report.

The Environmental Team (ET) will continue to implement the environmental monitoring & audit (EM&A) programme in accordance with the EM&A Manual and Environmental Permit requirement. The report is available for public inspection and will be uploaded to the dedicated project website (http://www.envproject.com/sldiwema.htm).

1. INTRODUCTION

1.1. Background

1.1.1. The Drainage Services Department (DSD) has implemented Contract No. DC/2006/11 "Drainage Improvement in Southern Lantau and Construction of Mui Wo Village Sewerage Phase 1". The monitoring requirements of the drainage improvement works are subject to the conditions specified in Environmental Permit (EP) No. EP-237/2005/B issued by the Environmental Protection Department (25 January 2006). In compliance with the EP, an Environmental Monitoring and Audit (EM&A) programme was established during the construction and post-construction phases of the project. The operation of the project is subject to the conditions in EP No. EP-434/2012.

1.1.2. The Post-Construction Ecological Monitoring and Audit of Drainage Improvement Works in Southern Lantau under Agreement No. DP 04/2012, commenced in January 2012. AECOM Asia Co. Ltd. was appointed by DSD as the Environmental Team (ET) to conduct the above captioned monitoring project from October 2012 onwards. This is the twelfth bi-monthly post-construction ecological monitoring and audit report under that appointment.

1.2. Project Description

1.2.1. Under Contract No. DC/2006/11, the improvement works were undertaken at Pak Ngan Heung River (PNH), Luk Tei Tong River (LTT) and Tai Tei Tong River (TTT) in Southern Lantau, west of Mui Wo. The works for which the post-construction ecological monitoring required by EP No. EP-237/2005/B covered included:

- the drainage channel and a three-cell box culvert at PNH;
- the drainage channel at LTT; and
- the bypass channel at LTT.

1.2.2. No ecological monitoring and ecological water monitoring was required following the drainage improvement works at TTT and village sewerage works in Mui Wo.

1.2.3. Both PNH and LTT are part of the Mui Wo River (also named as Silver River) in Lantau Island. These two tributaries of Mui Wo River, together with Tai Tei Tong River, then joined and connected to Silver Mine Bay next to Mui Wo.

1.3. Report Objectives

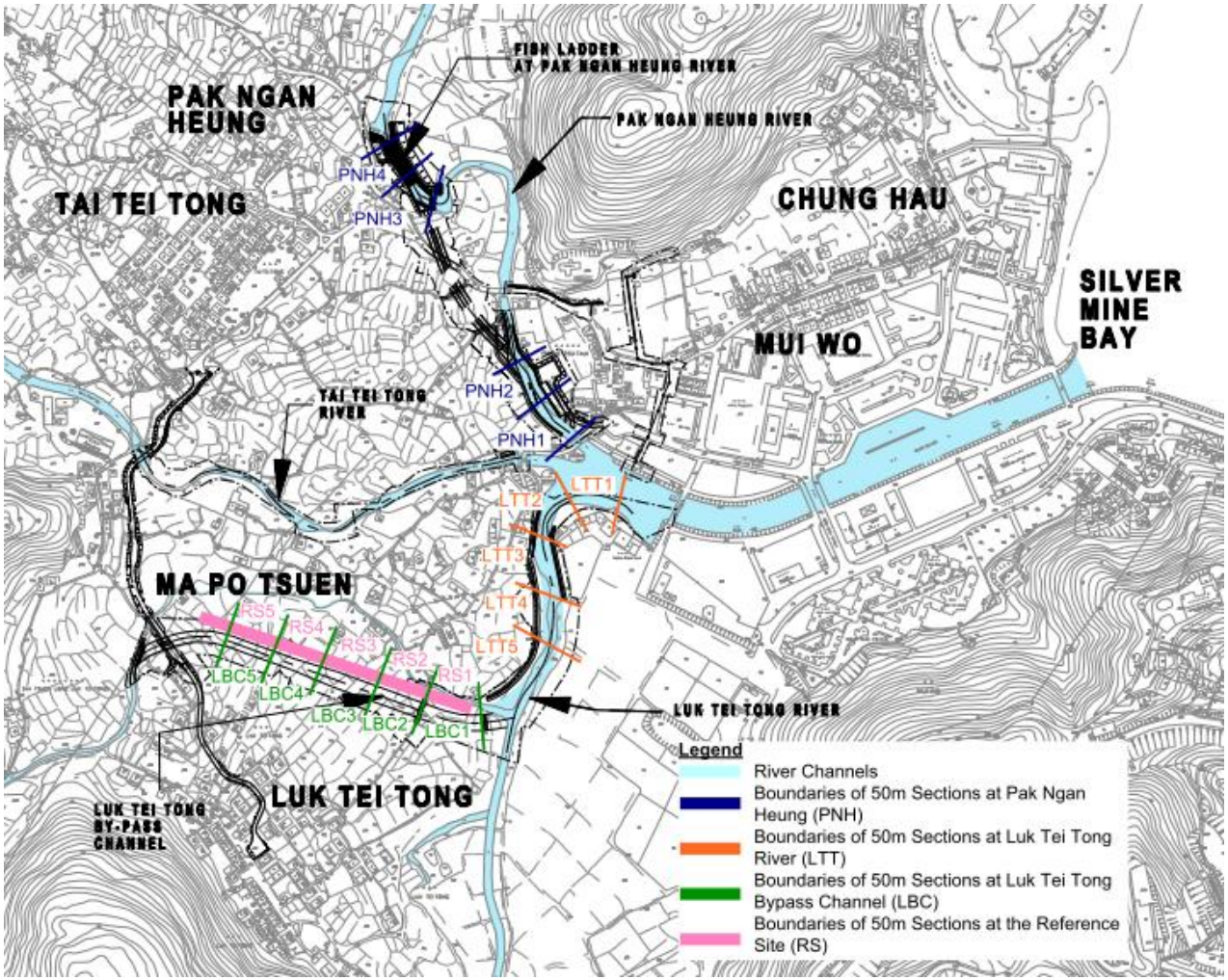
1.3.1. This report presents the findings of the ecological monitoring and the ecological water monitoring conducted in August 2014.

2. ECOLOGICAL MONITORING PARAMETERS

2.1. Ecological Surveys

2.1.1. Details of the monitoring parameters and survey methodology are described below. According to the Final EM&A Manual, a specific ecological monitoring programme of the improved section of PNH, LTT, LTT Bypass Channel (LBC) and its Reference Site (RS) is recommended.

Figure 1 Ecological Monitoring Locations at Pak Ngan Heung River, Luk Tei Tong River, Luk Tei Tong Bypass Channel and the Reference Site



Pak Ngan Heung River and Luk Tei Tong River

2.1.2. The ecological survey for these two rivers was divided into nine 50 m sections and comprised the following:

- Two sections for downstream of PNH (PNH1 and 2), two sections for upstream of PNH (PNH3 and 4);
- Five sections for LTT (LTT1 to 5).

2.1.3. The location plan is shown in **Figure 1** for reference.

2.1.4. The monitoring parameters and survey methodology for each section are described below:

(a) Bird species in each 50 m section were surveyed quantitatively using transect count method. Birds within the river channel and on the riverbank were identified to species and their abundance was recorded. Birds that flew over/across the river channel without landing were not considered to be utilising the area and thus excluded from the records. This does not apply to species that rarely land and are associated with specific habitats (e.g. Barn Swallow).

(b) Surveys on aquatic macroinvertebrate focused on determination of the diversity and abundance. Sampling methods included active searching, direct observation, hand netting and kick sampling. In each section, the macroinvertebrate species composition was identified and their relative abundance was recorded.

(c) Surveys on fish focused on determination of the diversity and abundance of fish communities. Sampling methods included active searching, direct observation, and hand netting, and were determined in accordance with site conditions. In each section, the fish species composition was identified and their relative abundance was recorded.

(d) Adult odonate community in each 50 m section were surveyed quantitatively by transect count method. Adult odonates within the river channel and on the riverbank were identified to species and their abundance was recorded. Species requiring close examination were netted.

(e) Aquatic, emergent and riparian vegetation community was recorded by walk-through survey. Plant species composition and their relative abundance were recorded.

Luk Tei Tong Bypass Channel

2.1.5. The ecological survey for the Luk Tei Tong Bypass Channel (LBC) and its Reference Sites (RS) were carried out in every 50 m section and comprised the following:

- Five sections for LBC (LBC1 to 5);
- Five sections for RS (RS1 to 5).

2.1.6. The location plan is shown in **Figure 1** for reference.

2.1.7. The monitoring parameters and survey methodology are described below:

(a) Bird species in each 50 m section were surveyed quantitatively using transect count method. Birds within the river channel and on the riverbank were identified to species and their abundance was recorded. Birds that flew over/across the river channel without landing were not considered to be utilising the area and thus excluded from the records. This does not apply to species that rarely land and are associated with specific habitats (e.g. Barn Swallow).

(b) Where/when water was present, surveys of aquatic macroinvertebrate focused on determination of their diversity and abundance of stream aquatic communities. Sampling

methods included active searching, direct observation, hand netting and kick sampling. In each section, macroinvertebrate species composition was identified and their relative abundance was recorded.

(c) Where/when water was present, surveys of fish focused on determination of their diversity and abundance. Sampling methods included active searching, direct observation, and hand netting, were determined in accordance with site conditions. In each section, fish species composition was identified and their relative abundance was recorded.

(d) Adult odonate community in each 50 m section were surveyed quantitatively by transect count method. Adult dragonflies within the river channel and on the riverbank were identified to species and their abundance was recorded. Species requiring close examination were netted.

(e) Line-intercept method was adopted to determine the relative plant cover of aquatic, emergent and riparian vegetation. One line transect of 10 m was set perpendicular to the stream channel at each section, and five 1 m x 1 m quadrats were placed along the transect. Relative coverage and plant species intercepting the transect line was recorded. Percentage cover of each species within the quadrat was recorded to the nearest 10% (except "1" = present but insignificant cover, normally 1 to 2 individuals, and 5% = up to 5%). The conditions of vegetation were described.

(f) Herpetofauna community within LBC and RS were surveyed by active searching in potential habitats. Reptiles were identified and their abundance was recorded. Amphibians were identified by their calls and the number of calling males in each section was recorded.

2.1.8. For all surveys, identification of plant species and distribution status in Hong Kong were made with reference to Corlett *et al.* (2000), Hu *et al*. (2003), Hong Kong Herbarium (2012), and Hong Kong Herbarium and South China Botanical Gardens (2007; 2008; 2009; 2011).

2.1.9. In terms of assessing geographical distribution, published references specializing in the distribution of specific faunal groups in Hong Kong have been utilized. For general status, these have included Fellowes *et al*. (2002) and the Hong Kong Biodiversity Database (AFCD, 2014), and for specific faunal groups, these have included: Avifauna – Carey *et al.* (2001), Viney *et al.* (2006); Dragonflies – Tam *et al.* (2011); Butterflies – Lo (2005); and Chan *et al*. (2011); Amphibians – Chan *et al.* (2005); Reptiles – Chan *et al.* (2006), Chan *et al*. (2009), and Karsen *et al.* (1998); Terrestrial Mammals – Shek (2006); Freshwater Fish – Lee *et al.* (2004); and Freshwater Community – Dudgeon (2003). The status and rarity of vascular plants has been based on Hu *et al*. (2003) and Corlett *et al*. (2000).

2.2. Ecological Water Quality Monitoring

2.2.1. Ecological water quality monitoring along PNH, LTT, LBC, and RS was carried out. Ten locations were selected and comprised the following:

- Three locations for existing PNH (WE1 to 3);
- Three locations for existing LTT (WE4 to 6);
- Two locations for RS (WE7 to 8);
- Two locations for existing LBC (WE9 to 10).

2.2.2. The location plan for ecological water quality monitoring is shown in **Figure 2**.

2.2.3. Water Quality Monitoring along PNH, LTT, LBC and RS included the monitoring parameters shown below:

- Biochemical Oxygen Demand (BOD_5)
- Nitrate
- Ammonia
- Reactive Phosphorus
- Total Suspended Solids (SS)
- Temperature
- Dissolved Oxygen (DO)
- Water Depth* and Water Flow Rate
- Conductivity
- pH
- Salinity
- Sediment Characteristics

Note:

*As referred to in the Final EM&A Manual, Water Depth is required only for LBC.

2.2.4. The DO, water depth and water flow rate, conductivity, pH, temperature, salinity and sediment characteristics were measured in-situ while the other water samples were analyzed in a HOKLAS accredited laboratory and the analyses followed the standard methods according to APHA Standard Methods for the Examination of Water and Wastewater, 20th Edition, or equivalent. The limit of reporting for the laboratory analysis is summarized in **Table 2.1**.

Table 2.1 Limit of Reporting for Water Quality Parameters

Parameters	Limit of Reporting (mg/L)
Total Suspended Solids	2
Biochemical Oxygen Demand (BOD_5)	2
Nitrate	0.01
Ammonia	0.01
Reactive Phosphorus	0.01

2.2.5. The instrument for in-situ measurement of pH, temperature, DO, salinity and conductivity is a portable and weather proof Sonde Environmental Monitoring System complete with cable and uses a DC power source. Calibration certificates are attached in **Appendix 1**. The instruments are capable of measuring:

- pH in the range of 0 to 14
- Temperature of -5 to $+65^0$C
- DO in the range of 0 to 20 mg/L and 0 to 200% saturation
- Salinity in the range of 0-80ppt
- Conductivity in the range of 0 to 4999 µS/cm

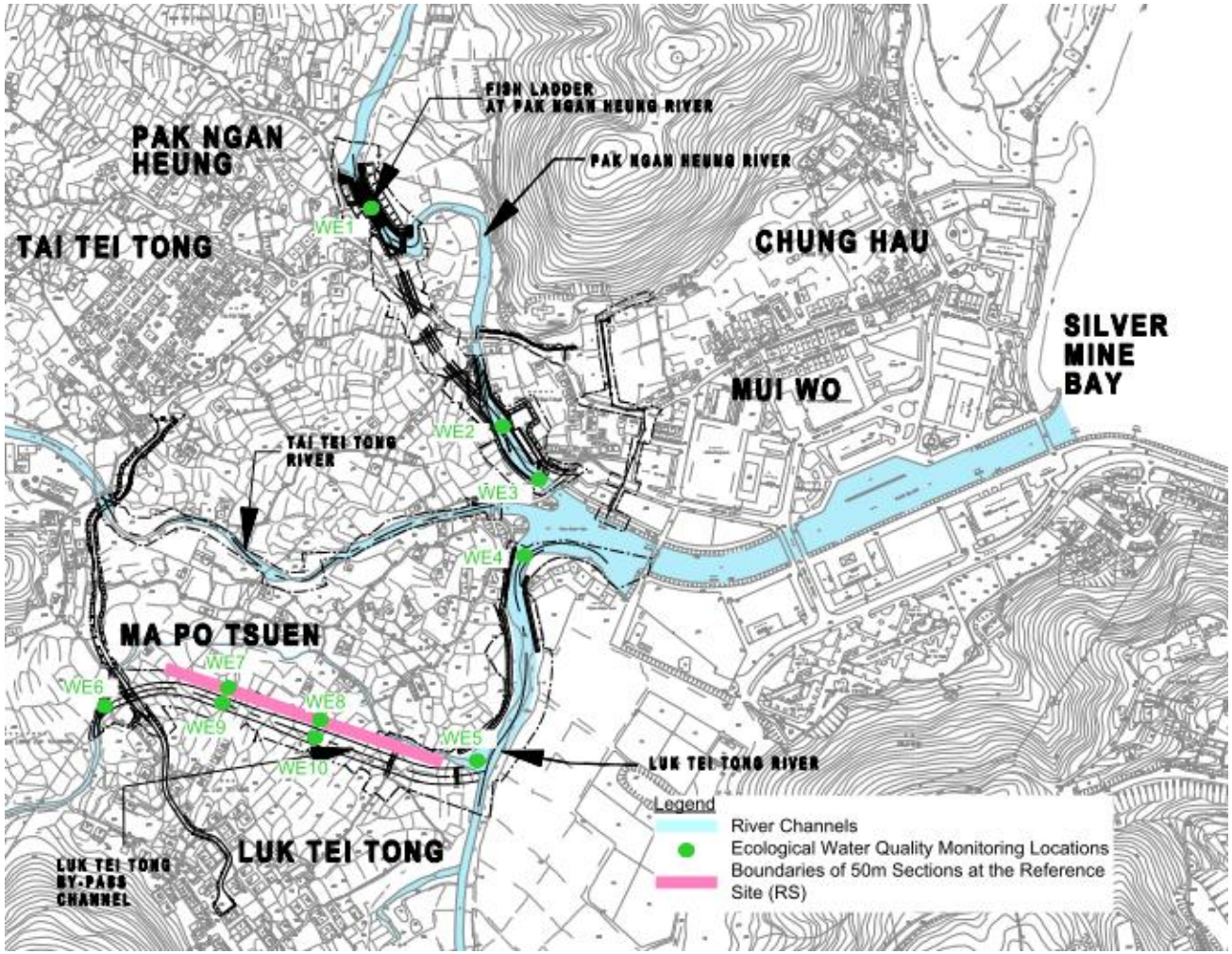
2.2.6. According to the requirement of the Final EM&A Manual, two consecutive measurements for parameters of DO concentration, and DO saturation are required to be taken at each monitoring location. When the difference in value between the first and second reading of DO is more than 25%, the reading was discarded and a further reading taken.

2.3. Limitations

2.3.1. No water was present at LBC2 to LBC5 at the time of survey, therefore aquatic fauna surveys were not undertaken in these locations.

2.3.2. No water was present at WE7 - WE10 at the time of survey, therefore water quality monitoring was not undertaken at these locations.

Figure 2 Ecological Water Quality Monitoring Locations at Pak Ngan Heung River, Luk Tei Tong River, Luk Tei Tong Bypass Channel and the Reference Site



3. MONITORING RESULTS

3.1. Ecological Survey Findings

Pak Ngan Heung River (PNH)

3.1.1. The lower stream of PNH (PNH1 and PNH2) is subject to tidal influence from Silver Mine Bay. Vertical concrete retaining wall formed the banks of the river channel. The two sections were located at the mouth of the PNH. PNH1 and PNH2 were adjacent to each other. The bridge formed the southern boundary of PNH1 whereas the box-culvert formed the northern boundary of PNH2. Small boulders and sandy substrate formed the main component of the streambed.

3.1.2. Rock-filled gabion formed the eastern bank and the gabion and a vertical concrete retaining wall formed the western bank of the upper stream (PNH3 and PNH4). PNH3 and PNH4 are adjacent to each other. PNH4 comprised a man-made cascade, including a fish ladder, while PNH3 comprised a pool below the cascade and was bounded by a bridge at its downstream end. Small boulders and sandy substrate were the main component in the middle streambed which allowed water flow and pool formation, whereas big boulders were scattered on both sides of the streambed and had an absence of water. The width of the fish ladder at PNH4 is approximately 7 m.

3.1.3. The cascade/fish ladder at PHN4 was designed to allow open water flow and should be free of vegetation in order to allow fish movement.

Vegetation

3.1.4. At PNH1, no plant species were recorded within the river channel. The vegetation recorded on the vertical wall included *Wedelia trilobata* and Opposite-leaved Fig (*Ficus hispida*) at PNH1. At PNH2, seedlings of *Kandelia obovata* were recorded. No significant changes to the plant species were observed compared with last monitoring in June 2014. During the monitoring, the water level at lower PNH was approximately 45 cm during ebbing tide.

3.1.5. At PNH3 and PNH4, a total of 20 plant species were recorded. The exotic species Mile-a-minute (*Mikania micrantha*) continued to dominate the upper PNH section, in August. Mile-a-minute grew on the banks of PNH3 pool, the gabion of the PNH3 and PNH4, and the two edges of the cascade/fish ladder; however, free water flow was still observed along the PNH cascade/fish ladder. Apart from Mile-a-minute, herb species such as Blunt Signal-grass (*Brachiaria mutica*), *Bidens alba* and Diffuse Day-flower (*Commelina diffusa*) were also scattered along the gabion of the PNH3 and PNH4 cascade.

3.1.6. The list of plant species is presented in **Appendix 2a**.

Terrestrial Fauna

3.1.7. Nine avifauna species were recorded at PNH, all of which are common or abundant in Hong Kong (AFCD, 2014) (**Table 3.1**). No avifauna species of conservation importance were recorded during the monitoring.

3.1.8. Five avifauna species were recorded at lower PNH (PNH1 and PNH2). All recorded avifauna were generalist species (e.g. Spotted Dove, *Streptopelia chinensis*), and they were recorded in low numbers. There was no evidence of breeding or nesting activities during the monitoring period.

3.1.9. Seven avifauna species were recorded at upper PNH (PNH3 and PNH4). The birds at PNH3 and PNH4 were observed along the banks of the river channel or in the trees near the channel, and were dominated by generalist species, such as Red-whiskered Bulbul (*Pycnonotus jocosus)*.

3.1.10. A total of eight odonate species were recorded at upper PNH (PNH3 and PNH4). All the recorded species are abundant or common in Hong Kong (AFCD, 2014) (**Table 3.2**). Wandering Glider (*Pantala flavescens*) was most abundant at PNH3 and PNH4. No odonate species of conservation importance were recorded during the monitoring.

3.1.11. No herpetofauna species were recorded at PNH during the monitoring.

Aquatic Macroinvertebrate and Fish

3.1.12. A total of 13 species were recorded within the PNH river, including three fish species, two crustacean species, and eight other aquatic macroinvertebrate species such as worms, snails and insects (**Table 3.3**). All the recorded fish species are commonly found in freshwater and estuarine habitats of Hong Kong (Williams, 2003; Chan *et al*., 2003; AFCD, 2014). No fish species of conservation importance were recorded during the monitoring.

Table 3.1 Number of Avifauna Recorded at Pak Ngan Heung River (PNH)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	PNH1	PNH2	PNH3	PNH4
Spotted Dove	*Streptopelia chinensis*	Abundant	R	-	-	-	-	2		1	
Red-whiskered Bulbul	*Pycnonotus jocosus*	Abundant	R	-	-	-	-			1	2
Chinese Bulbul	*Pycnonotus sinensis*	Abundant	R	-	-	-	-	2			1
Common Tailorbird	*Orthotomus sutorius*	Common	R	-	-	-	-	1			
Masked Laughingthrush	*Garrulax perspicillatus*	Abundant	R	-	-	-	-	2	2	1	
Japanese White-eye	*Zosterops japonicus*	Abundant	R,?W	-	-	-	-				1
Crested Myna	*Acridotheres cristatellus*	Common	R	-	-	-	-				2
Oriental Magpie Robin	*Copsychus saularis*	Abundant	R	-	-	-	-				1
White Wagtail	*Motacilla alba*	Common	W,R	-	-	-	-	1			

Note:
(1) All wild birds are protected under Wild Animals Protection Ordinance (Cap. 170).
(2) AFCD (2014). Hong Kong Biodiversity Database.
(3) R=resident; W=winter visitor; ?W=the extent of immigration in winter is unclear.
(4) Fellowes *et al*. (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
(8) Wetland-dependent species (including wetland-dependent species and waterbirds).

Table 3.2 Number of Odonates Recorded at Pak Ngan Heung River (PNH)

Common Name	Scientific Name	Distribution in Hong Kong [1]	Level of Concern [2]	Protection Status in China [3]	China Red Data Book [4]	IUCN Red List [5]	PNH1	PNH2	PNH3	PNH4
Common Blue Jewel	*Rhinocypha perforata perforata*	Abundant	-	-	-	-			1	2
Orange-tailed Midget	*Agriocnemis femina oryzae*	Abundant	-	-	-	-			1	
Orange-tailed Sprite	*Ceriagrion auranticum ryukyuanum*	Abundant	-	-	-	-			4	
Yellow Featherlegs	*Copera marginipes*	Abundant	-	-	-	-			1	1
Black Threadtail	*Prodasineura autumnalis*	Abundant	-	-	-	-			5	2
Red-faced Skimmer	*Orthetrum chrysis*	Common	-	-	-	-				1
Wandering Glider	*Pantala flavescens*	Abundant	-	-	-	-			15	15
Crimson Dropwing	*Trithemis aurora*	Abundant	-	-	-	-			1	

Note:
(1) AFCD (2014). Hong Kong Biodiversity Database.
(2) Fellowes *et al*. (2002).
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.

Table 3.3 Relative Abundance of Aquatic Macroinvertebrate and Fish Recorded at Pak Ngan Heung River (PNH)

Fauna Group	Common Name	Scientific Name	Distribution in Hong Kong (1)(2)(3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	PNH1	PNH2	PNH3	PNH4
Fish	Jarbua Terapon	*Terapon jarbua*	Common	-	-	-	-		+++		
Fish	Spotted Scat	*Scatophagus argus*	Common	-	-	-	-		+++		
Fish	Mudskipper	*Periophthalmus modestus*	Common	-	-	-	-	+			
Crustacean (Crabs)	-	*Sesarma* (*Perisesarma*) *bidens*	Very common	-	-	-	-	+	+		
Crustacean (Shrimps)	-	*Caridina cantonensis*	-	-	-	-	-		++		
Worms	-	Sigambra hanaokai	-	-	-	-	-	+	+		
Worms	-	*Capitella capitata*	-	-	-	-	-			+	
Snails	-	*Clithon* sp.	-	-	-	-	-	++	+++		
Snails	-	Thiaridae	-	-	-	-	-	+			
Insects	Non-Biting Midges	Chironomidae	-	-	-	-	-	+	+		
Insects	Mayfly	Baetidae	-	-	-	-	-			+++	+++
Insects	Mayfly	Caenidae	-	-	-	-	-				+
Insects	Mayfly	Ephemeroptera	-	-	-	-	-				+

Note:
(1) AFCD (2014). Hong Kong Biodiversity Database.
(2) Williams, G. (2003). Hong Kong Field Guides – Rocky Shores.
(3) Chan *et al.* (2003). Hong Kong Field Guides – Sandy Shores.
(4) Fellowes *et al.* (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
Relative abundance: + = occasional, less than 5 individuals were found; ++ = common, 5-20 individuals were found; +++ = abundant, more than 20 individuals were found.

Luk Tei Tong River (LTT)

3.1.13. The LTT is subject to tidal influence from Silver Mine Bay and is estuarine in nature. It is a north-south running river. A vertical concrete retaining wall formed the riverbank of the LTT1 whereas rock-filled gabion formed the riverbank of LTT2 to LTT5. LTT1 was located at the confluence with Pak Ngan Heung River, Tai Tei Tong River and Luk Tei Tong River. Since it is subject to tidal flow, water flowed from south to north during the survey when the tide was going out. LTT1 and LTT2 had sandy substrate whilst LTT3 to LTT5 had muddy substrate. Clusters of boulders occurred at both sides of the river channel. The width of the river channel was approximately 8-10 m.

3.1.14. No evidence of maintenance works (including those relevant to Conditions 2.1 to 2.4 of EP No. EP-434/2012) was observed during the monitoring period.

Vegetation

3.1.15. A total of 13 plant species were recorded in LTT. Seven out of 13 recorded species were exotic. The majority were herbs or climbers scattered along the gabion such as *Bidens alba*, *Wedelia trilobata* and Wild Kudzu Vine (*Pueraria phaseoloides*). In addition to the mangrove stand supporting Spiny Bears Breech (*Acanthus ilicifolius*) and *Kandelia obovata* that has colonized inside the river channel at LTT2 and LTT3, several seedlings of *Kandelia obovata* have naturally regenerated at LTT1, LTT2, LTT3 and LTT5.

3.1.16. The list of plant species is presented in **Appendix 2a**.

Terrestrial Fauna

3.1.17. A total of six avifauna species were recorded at LTT, all of them are common or abundant in Hong Kong (AFCD, 2014) (**Table 3.4**). Most recorded species were generalist (e.g. Crested Myna), and mostly recorded in low numbers. No avifauna species of conservation importance were recorded during the monitoring.

3.1.18. Two odonate species, Wandering Glider (*Pantala flavescens*) and Crimson Dropwing (*Trithemis aurora*), were recorded at LTT during the monitoring (**Table 3.5**). Both of the species were abundant in Hong Kong (AFCD, 2014). No odonate species of conservation importance was recorded during the monitoring.

3.1.19. No herpetofauna species were recorded at LTT during the monitoring.

Aquatic Macroinvertebrate and Fish

3.1.20. A total of 21 species, including seven fish species, seven crustacean species and seven species of other aquatic macroinvertebrates were recorded from LTT (**Table 3.6**). Most of the other recorded species are either common or very common in river mouth or estuarine habitats in Hong Kong (Williams, 2003; Chan *et al*., 2003; AFCD, 2014). Several individuals of Predaceous Chub (*Parazacco spilurus*), a fish species of conservation importance, were recorded at LTT5. Predaceous Chub is listed as “Vulnerable” in China Red Data Book and “Data Deficient” in IUCN Red List.

Table 3.4 Number of Avifauna Recorded at Luk Tei Tong River (LTT)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	LTT1	LTT2	LTT3	LTT4	LTT5
Spotted Dove	*Streptopelia chinensis*	Abundant	R	-	-	-	-	1				
Black Drongo	*Dicrurus macrocercus*	Common	M,Su	-	-	-	-		1			1
Crested Myna	*Acridotheres cristatellus*	Common	R	-	-	-	-	3				3
Black-collared Starling	*Gracupica nigricollis*	Common	R	-	-	-	-				1	
Oriental Magpie Robin	*Copsychus saularis*	Abundant	R	-	-	-	-	1	1			1
White Wagtail	*Motacilla alba*	Common	W,R	-	-	-	-					1

Note:
(1) All wild birds are protected under Wild Animals Protection Ordinance (Cap. 170).
(2) AFCD (2014). Hong Kong Biodiversity Database.
(3) R=resident; Su=summer visitor; W=winter visitor; M=migrant.
(4) Fellowes *et al.* (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
(8) Wetland-dependent species (including wetland-dependent species and waterbirds).

Table 3.5 Number of Odonate Recorded at Luk Tei Tong River (LTT)

Common Name	Scientific Name	Distribution in Hong Kong (1)	Level of Concern (2)	Protection Status in China (3)	China Red Data Book (4)	IUCN Red List (5)	LBC1	LBC2	LBC3	LBC4	LBC5
Wandering Glider	*Pantala flavescens*	Abundant	-	-	-	-	5	5		5	3
Crimson Dropwing	*Trithemis aurora*	Abundant	-	-	-	-					1

Note:
(1) AFCD (2014). Hong Kong Biodiversity Database.
(2) Fellowes *et al*. (2002).
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.

Table 3.6 Relative Abundance of Aquatic Macroinvertebrate and Fish Recorded at Luk Tei Tong River (LTT)

Fauna Groups	Common Name	Scientific Name	Distribution in Hong Kong [1][2][3]	Level of Concern [4]	Protection Status in China [5]	China Red Data Book [6]	IUCN Red List [7]	LTT1	LTT2	LTT3	LTT4	LTT5
Fish	Yellowfin seabream	*Acanthopagrus latus*	Common	-	-	-	-					++
Fish	**Predaceous Chub**	***Parazacco spilurus***	Common	-	-	Vulnerable	Data Deficient					++
Fish	Jarbua Terapon, Crescent-banded Grunter	*Terapon jarbua*	Common	-	-	-	-	++				+++
Fish	Spotted Scat	*Scatophagus argus*	Common	-	-	-	-					++
Fish	-	Gobiidae	-	-	-	-	-		++			
Fish	Mudskipper	*Periophthalmus modestus*	Common	-	-	-	-		+	+		++
Fish	Silver Moony	*Monodactylus argenteus*	Common	-	-	-	-			+		
Crustacean (Crabs)	-	*Varuna litterata*	-	-	-	-	-	+				
Crustacean (Crabs)	-	*Sesarma* (*Perisesarma*) *bidens*	Very common	-	-	-	-		++	+++		
Crustacean (Crabs)	-	*Uca* (*Deltuca*) *arcuata*	Common	-	-	-	-			++		
Crustacean (Crabs)	-	*Uca lactea*	Common	-	-	-	-			++		
Crustacean (Shrimps)	-	*Macrobrachium hainanense*	-	-	-	-	-					++
Crustacean (Shrimps)	-	*Caridina cantonensis*	-	-	-	-	-		+		+	
Crustacean (Barnacles)	-	*Chthamalus malayensis*	Very common	-	-	-	-		++			
True Slugs	-	*Onchidium* spp.	Common	-	-	-	-				+	
Limpets	-	Ancylidae	-					+++				
Snails	-	*Clithon* sp.	-	-	-	-	-					+
Snails	-	Thiaridae	-	-	-	-	-	+	+			

Fauna Groups	Common Name	Scientific Name	Distribution in Hong Kong [1][2][3]	Level of Concern [4]	Protection Status in China [5]	China Red Data Book [6]	IUCN Red List [7]	LTT1	LTT2	LTT3	LTT4	LTT5
Bivalves	Rock oyster	*Saccostrea cucullata*	Very common	-	-	-	-		+			
Insects	Non-Biting Midges	Chironomidae	-	-	-	-	-					+
Insects	Mayfly	Baetidae	-	-	-	-	-					++

Note:
(1) AFCD (2014). Hong Kong Biodiversity Database.
(2) Williams, G (2003). Hong Kong Field Guides – Rocky Shores.
(3) Chan *et al.* (2003). Hong Kong Field Guides – Sandy Shores.
(4) Fellowes *et al*. (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
(8) Relative abundance: + = occasional, less than 5 individuals were found; ++ = common, 5-20 individuals were found; +++ = abundant, more than 20 individuals were found.
Species of conservation importance is noted in bold type face.

Luk Tei Tong Bypass Channel (LBC) and Reference Site (RS)

3.1.21. The LBC links to the end of LTT5 and runs east to west but the connection with LTT5 is blocked by a layer of gabion wall approximately 1 m in height, which allows water flow between LBC and LTT when water level is higher than the height of the gabion. It is located in the Luk Tei Tong Marsh to the west of the original LTT. Gabion walls formed both sides of the channel bank. Generally, all sections were heavily vegetated except in LBC1 where a small pool of approximately 60 m^2 in size was located at the western end of LBC1. The pool was separated from the LTT by a weir constructed from a single layer of rock-filled gabion. The substrate comprised soil, which was translocated from the marsh area prior to construction of the bypass. The width of the bypass channel was approximately 15 m.

3.1.22. The RS was located parallel to the northern side of the LBC. Next to the RS was village housing. The site was vegetated and did not have any free-standing water at the time of survey.

Vegetation

3.1.23. A total of 37 plant species were recorded in LBC, of which 17 species were recorded in the quadrats sampled. The list of plant species is presented in **Appendix 2b**. Among all the recorded species, about 38% were exotic (**Table 3.7**). Same as the last monitoring survey in June, half of the LBC1 section included a patch of open water. Other sections were dry.

3.1.24. The habitat at LBC1 differed from the remaining LBC sections in terms of vegetation type. It adjoined LTT5 and had a pool of open water at the eastern tip. LBC1 may be subject to tidal influence during high tide because it is located immediately next to LTT. The sedge, Ferrugineous-scale Fimbristylis (*Fimbristylis sieboldii*) and *Ruellia coerulea*, dominated LBC1. Native Leather Fern (*Acrostichum aureum*), was recorded occasionally at the dry section west to the open water at LBC1.

3.1.25. The exotic species, *Wedelia trilobata*, continued to be the dominant vegetation species at LBC2 to LBC5. Other herbaceous species commonly encountered along the transects in LBC2 to LBC5 included native Couch Grass (*Cynodon dactylon*), native Panic Grass (*Panicum repens*) and exotic Gairo Morning Glory (*Ipomoea cairica*). Tree seedlings (e.g. Taiwan Acacia, *Acacia confusa*, and Chinese Tallow Tree, *Sapium sebiferum*) were occasionally recorded at the drier section near the bridge at LBC1, and near the gabion at LBC2 and LBC3. Wetland species such as Hairy Knotweed (*Polygonum barbatum*), Taro (*Colocasia esculenta*), and Ginger Lily (*Hedychium coronarium*) were occasionally recorded along LBC2 to LBC5.

3.1.26. A total of 43 plant species were recorded in the RS, of which 14 species were found in the quadrats (**Table 3.7**). Among all the recorded species, about 37% were exotic. The list of plant species is presented in **Appendix 2b**. All sections were dry and were located next to the village housing. The dominant species was exotic *Wedelia trilobata*. Exotic Sensitive Plant (*Mimosa pudica*), Hilo Grass (*Paspalum conjugatum*) and *Bidens alba* were commonly recorded along the RS sections. The majority of vegetation recorded at the RS could typically be found in disturbed land. Records of wetland species such as Taro and Ginger Lily were occasional.

Table 3.7 Vegetation Coverage at Luk Tei Tong Bypass Channel (LBC) and Reference Site (RS)

	LBC	RS
No. of species recorded in quadrats	17	14
Total No. of species	37	43
Total No. of exotic species	14	16
Average vegetation coverage	100%	100%
Bare ground coverage	0%	0%

Note:
(1) The transect was not laid along any open water, thus open water coverage was not provided in this table.

Terrestrial Fauna

3.1.27. Nine species of avifauna were recorded at the LBC (**Table 3.8**) and seven species of avifauna were recorded at the RS (**Table 3.9**). All recorded species are common or abundant in Hong Kong (AFCD, 2014). One individual of Greater Coucal, which is a species of conservation importance, was recorded roosting at a tree at RS4. This species was listed as "Class II" Protection Status in China and "Vulnerable" in China Red Data Book.

3.1.28. Most of other avifauna recorded at LBC and RS were generalists that have adapted to disturbed environments such as Red-whiskered Bulbul (*Pycnonotus jocosus*).

3.1.29. Two odonate species, Red-faced Skimmer (*Orthetrum chrysis*) and Wandering Glider (*Pantala flavescens*), which are abundant / common in Hong Kong (AFCD, 2014), were recorded at LBC (**Table 3.10**). No odonate species were recorded at RS during the monitoring.

3.1.30. No herpetofauna species were recorded at LBC and RS during the monitoring.

Aquatic Macroinvertebrate and Fish

3.1.31. One fish, one crustacean, and five other macroinvertebrates species were recorded at LBC1 (**Table 3.11**). Most of the recorded species are either common or very common in river mouth or estuarine habitats in Hong Kong (Williams, 2003; Chan *et al*., 2003; AFCD, 2014). No aquatic macroinvetebrate or fish species of conservation importance were recorded.

3.1.32. No aquatic fauna was recorded at the RS or the remaining sections of the LBC2 to LBC5 as they were dry during the monitoring.

Table 3.8 Number of Avifauna Recorded at Luk Tei Tong Bypass Channel (LBC)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	LBC1	LBC2	LBC3	LBC4	LBC5
Spotted Dove	*Streptopelia chinensis*	Abundant	R	-	-	-	-	1				
White-throated Kingfisher	*Halcyon smyrnensis*	Common	AM,P	(LC)	-	-	-	1				
Large-billed Crow	*Corvus macrorhynchos*	Common	R	-	-	-	-	1				
Red-whiskered Bulbul	*Pycnonotus jocosus*	Abundant	R	-	-	-	-		2	2		
Yellow-bellied Prinia	*Prinia flaviventris*	Common	R	-	-	-	-					1
Common Tailorbird	*Orthotomus sutorius*	Common	R	-	-	-	-			1		
Masked Laughingthrush	*Garrulax perspicillatus*	Abundant	R	-	-	-	-			1		
Crested Myna	*Acridotheres cristatellus*	Common	R	-	-	-	-	1	2		5	2
Black-collared Starling	*Gracupica nigricollis*	Common	R	-	-	-	-					2

Note:
(1) All wild birds are protected under Wild Animals Protection Ordinance (Cap. 170).
(2) AFCD (2014). Hong Kong Biodiversity Database.
(3) R=resident; A=autumn; M=migrant.
(4) Fellowes *et al.* (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
(8) Wetland-dependent species (including wetland-dependent species and waterbirds).

Table 3.9 Number of Avifauna Recorded at Reference Site (RS)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	RS1	RS2	RS3	RS4	RS5
Greater Coucal	***Centropus sinensis***	Common	R	-	Class II	Vulnerable	-				1	
Large-billed Crow	*Corvus macrorhynchos*	Common	R	-	-	-	-					1
Yellow-bellied Prinia	*Prinia flaviventris*	Common	R	-	-	-	-					1
Common Tailorbird	*Orthotomus sutorius*	Common	R	-	-	-	-	1				
Crested Myna	*Acridotheres cristatellus*	Common	R	-	-	-	-		2			
Black-collared Starling	*Gracupica nigricollis*	Common	R	-	-	-	-			2		
Oriental Magpie Robin	*Copsychus saularis*	Abundant	R	-	-	-	-		1			

Note:
(1) All wild birds are protected under Wild Animals Protection Ordinance (Cap. 170).
(2) AFCD (2014). Hong Kong Biodiversity Database.
(3) R=resident.
(4) Fellowes *et al.* (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
Species of conservation importance is noted in bold type face.

Table 3.10 Number of Odonate Recorded at Luk Tei Tong Bypass Channel (LBC)

Common Name	Scientific Name	Distribution in Hong Kong (1)	Level of Concern (2)	Protection Status in China (3)	China Red Data Book (4)	IUCN Red List (5)	LBC1	LBC2	LBC3	LBC4	LBC5
Red-faced Skimmer	*Orthetrum chrysis*	Common	-	-	-	-	1				
Wandering Glider	*Pantala flavescens*	Abundant	-	-	-	-		10	10	3	

Note:
(1) AFCD (2014). Hong Kong Biodiversity Database.
(2) Fellowes *et al*. (2002).
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.

Table 3.11 Relative Abundance of Aquatic Macroinvertebrate and Fish Recorded at Luk Tei Tong Bypass Channel (LBC)

Fauna Groups	Common Name	Scientific Name	Distribution in Hong Kong (1)	Level of Concern (2)	Protection Status in China (3)	China Red Data Book (4)	IUCN Red List (5)	LBC1	LBC2	LBC3	LBC4	LBC5
Fish	Spotted Scat	*Scatophagus argus*	Common	-	-	-	-	+				
Crustacean (Crabs)	-	*Sesarma* (*Perisesarma*) *bidens*	Very common	-	-	-	-	+				
Snails	-	*Clithon* sp.	-	-	-	-	-	+++				
Snails	-	*Cerithidea* sp.	-	-	-	-	-	++				
Insects	Sea Slater	*Ligia exotica*	Common	-	-	-	-	++				
Insects	Non-Biting Midges	Chironomidae	-	-	-	-	-	+				
Insects	-	Rhagovelia sp.	-	-	-	-	-	+				

Note:
(1) AFCD (2014). Hong Kong Biodiversity Database.
(2) Fellowes *et al.* (2002).
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2.
Relative abundance: + = occasional, less than 5 individuals were found; ++ = common, 5-20 individuals were found; +++ = abundant, more than 20 individuals were found.

3.2. Ecological Water Quality Monitoring (EWQM)

3.2.1. The post-construction phase EWQM was conducted on 21 August 2014. The monitoring results are presented in **Appendix 3** and summarised in **Table 3.12**, which includes reference to the key Water Quality Objectives (WQOs). Baseline surveys were conducted in 2007 prior to the start of the drainage improvement works. The baseline survey results are presented in **Table 3.13**.

3.2.2. The water quality monitoring results are discussed in **Section 5**.

Table 3.12 Summarized Ecological Water Quality Monitoring Results (August 2014)

Parameters	Key Water Quality Objectives(1)	WE1	WE2	WE3	WE4	WE5	WE6
Suspended Solids (mg/L)	<20	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrogen (Ammonia) (mg/L)	-	0.01	<0.01	0.01	0.01	0.36	<0.01
Nitrogen (Nitrate) (mg/L)	-	0.58	0.14	0.14	0.14	0.26	0.58
Reactive Phosphorous (mg/L)	-	<0.01	0.03	0.02	0.02	0.12	<0.01
5-day Biochemical Oxygen Demand (BOD5) (mg/L)	<5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dissolved Oxygen (mg/L)	>4	7.1	7.5	7.2	7.4	7.3	6.9
Temperature (°C)	-	25.6	25.0	25.2	25.1	25.6	26.1
pH	6.5 – 8 5	7.6	7.2	7.4	7.1	7.1	7.5
Salinity (ppt)	-	<0.1	<0.1	<0.1	0.1	0.1	<0.1
Conductivity (µs/cm)	-	33.5	30.5	41.0	26.1	56.7	72.2
Water Flow (m/s)	-	0.3	0.2	0.2	0.2	<0.1	<0.1
Water Depth (cm)	-	56.0	14.0	10.0	21.0	18.0	31.0

Note:
(1) The available key Water Quality Objectives (WQOs) for River Monitoring Stations at Mui Wo River on Lantau Island (EPD, 2013).

Table 3.13 Baseline Results of Ecological Water Quality Monitoring Results (September 2007)

Parameters	WE1	WE2	WE3	WE4	WE5	WE6
Suspended Solids (mg/L)	1.0	2.0	3.0	3.0	<1.0	<1.0
Nitrogen (Ammonia) (mg/L)	0.07	0.12	0.11	0.23	0.03	0.02
Nitrogen (Nitrate) (mg/L)	0.12	0.13	0.13	0.31	0.04	0.05
Reactive Phosphorous (mg/L)	0.04	0.06	0.06	0.09	0.06	0.05
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dissolved Oxygen (mg/L)	6.58	6.82	6.37	7.61	6.87	5.70
pH	6.4	7.1	7.0	6.8	6.6	6.1
Salinity (ppt)	<0.1	0.1	0.3	7.6	0.1	<0.1

4. ECOLOGICAL MONITORING SCHEDULE

4.1. The next ecological surveys and ecological water quality monitoring are tentatively scheduled for mid-October 2014.

5. DISCUSSION AND RECOMMENDATIONS

5.1. The aim of the monitoring programme is to provide data on the re-establishment of aquatic/riparian communities in the PNH and LTT, and allow an assessment of the relative success of the mitigation measures to be made. In addition, monitoring of the LBC will assess whether the proposed channel design has provided suitable compensation for the impacts to the Luk Tei Tong Marsh.

5.2. Key observations made during the August 2014 monitoring period in relation to the implemented mitigation measures are presented in **Table 5.1**. Where applicable, recommendations for improving the functionality of the mitigation measures have been made for DSD's consideration.

5.3. The vegetation composition at LBC2 to LBC5 continues to be dominated by the exotic species, *Wedelia trilobata*. Marsh species including *Polygonum barbatum*, Taro and Ginger Lily were occasionally recorded at LBC2 to LBC5. The limited occurrence of these species suggested that the water levels/availability within the channel might not be adequate to sustain a marsh habitat.

5.4. Tree seedlings (such as Taiwan Acacia and Chinese Tallow Tree) were recorded near the bridge at LBC1, and near the gabion at LBC2 and LBC3. These trees may hinder the re-establishment of marsh habitat.

5.5. Mangrove stands of Spiny Bears Breech and *Kandelia obovata* were observed inside the river channel at LTT2 and LTT3. Several *Kandelia obovata* seedlings were observed at LTT1, LTT2, LTT3 and LTT5. This indicated a natural re-colonization of mangrove.

5.6. One fish species of conservation importance, Predaceous Chub, was recorded at LTT5. During the post-construction monitoring exercise, this species has been recorded intermittently at PNH and LTT.

5.7. Whilst some differences between the original 2007 baseline surveys and the August 2014 monitoring surveys are evident, findings from water monitoring could be attributed to a range of factors including seasonal variations, and climatic conditions and/or the influence of tidal status at the time of survey. Taking this into account, the key Water Quality Objectives (WQOs) for River Monitoring Stations at Mui Wo River (EPD, 2013) have been included to provide a comparison with standard water quality goals applicable to the area (refer to **Table 3.10**).

5.8. The Environmental Protection Department (EPD) analyses and presents data from its annual water monitoring programme to express the level of compliance with the statutory WQOs including pH, Suspended Solids (SS), 5-day Biochemical Oxygen Demand (BOD_5), and Dissolved Oxygen (DO). These WQOs specify the long-term water quality goals that the Government is to achieve and maintain for individual rivers in Hong Kong, including the Mui Wo River. As part of the programme five locations are sampled from the Mui Wo River, three of which are associated with the monitoring area for the drainage improvement works (MW1, MW2 and MW4). The objectives related to these sampling locations, have been used in this report. Water quality of the subject watercourses has met the WQOs during the survey.

5.9. No observable evidence of environmental changes such as odour, or discharge within the surveyed area, were recorded. When compared with the EPD key water quality objectives for river monitoring (2013), the parameters (SS, BOD_5, and DO complied with the statutory WQOs). Nitrogen (ammonia) concentration decreased slightly at all monitoring stations when compared to the last monitoring period. Suspended Solids concentration decreased significantly at all the monitoring stations. Nitrogen (nitrate) concentration decreased slightly at WE2, WE3, WE5, WE6 and significantly at WE4, while it increased significantly at WE1. Conductivity was observed to decrease slightly at WE1, WE2, WE3, WE4; decreased significantly at WE5; and increased significantly at WE6. The salinity level decreased significantly at WE4, while salinity level at WE1, WE2, WE3, WE5 and WE6 have demonstrated minimal change. The dissolved oxygen level at all the monitoring sites increased significantly compared to last monitoring. Other monitoring parameters such as reactive phosphorus, BOD_5 concentrations, flow rate and pH value at all locations have demonstrated minimal change compared to the last sampling record.

5.10. The water quality conditions have been monitored for the first 23 months of the 4-year monitoring programme. While fluctuations in water quality have been observed, no trend in water quality decline has been detected. The water quality will continue to be monitored and findings will be presented in subsequent reports as additional information becomes available.

Table 5.1 Key Observations/Comments and Recommendations Arising from the August 2014 Monitoring Period

Location	Mitigation Measure	Observations/Comments	Recommendations
PNH and LTT	Construction of a small fish ladder at the upstream end of the PNH	Some vegetation has re-established at upper PNH; however, the fish ladder is not currently overgrown or blocking water flow.	Continued retention of native species, particularly at the edges of the river channel, during any future maintenance activities is recommended, to maintain existing habitat and minimize the re-colonization of exotic species. Some pits have been incorporated into the gabion banks, but do not appear to have been planted up. Planting of riparian vegetation, preferably with native species suggested in the EIA report Section 7.8.17 and Table 2.6 (e.g. *Albizia lebbeck*, *Sterculia lanceolata, Cinnamomum camphora, Polyspora axillaris*, and *Rhaphiolepis indica*) is recommended. On-going, regular weed

Location	Mitigation Measure	Observations/Comments	Recommendations
			management is recommended, as required, to maintain the open nature of the fish ladder.
		The fish ladder does not meet the lip of the weir at the up-stream end of PNH4 due to a drop of approximately 30 cm. This could limit the overall function of the fish ladder for fish passage/movement up and downstream.	As per the current design of the fish ladder, the gap from the top of the fish ladder and the bottom of the weir is 30-40cm - presenting an obstacle to fish passage. Some improvement may be achieved by stacking additional boulders resembling that in PNH4 to form pools at the top of the fish ladder, which could facilitate fish movement.
	Re-establishment of aquatic / riparian communities	One species of conservation importance, Predaceous Chub (*Parazacco spilurus*), was recorded at LTT5 during current monitoring. This species was recorded at PNH3 during the last post-construction monitoring period. Another species of conservation importance Flagtail (*Kuhlia marginata*) was recorded in the 2003-2004 EIA surveys; however, this species was not recorded during the current monitoring in August 2014.	The presence of species of conservation importance in both PNH and LTT including relative abundance will continue to be monitored.
LBC	Provision of suitable habitat compensation	Native species Leather Fern was recorded occasionally at LBC1. Continued dominance by the exotic species, *Wedelia trilobata,* with limited marsh species were recorded from LBC2 to LBC5. Tree seedlings re-established at LBC1, LBC2 and LBC3 that may hinder the re-establishment of a marsh habitat.	The establishment and the coverage of this species will continue to be monitored. The regeneration of marsh species in the LBC is to be monitored. Removal of tree seedling (e.g. Taiwan Acacia and Chinese Tallow Tree) is suggested at LBC1, LBC2 and LBC 3.
		The limited occurrence of typical marsh plant species (although this was also limiting in the RS) suggests that the water levels/availability within the channel may not be adequate to sustain a marsh habitat.	On-going monitoring of water levels and species composition within the channel are required. Further assessment should take into account the timing of the surveys (wet/dry season).

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Appendix 1. Calibration Certificate of the Instrument (Sonde Environmental Monitoring System)

ALS Technichem (HK) Pty Ltd
11/F, Chung Shun Knitting Centre
1-3 Wing Yip Street
Kwai Chung, N.T., Hong Kong
T: +852 2610 1044
F: +852 2610 2021
www.alsglobal.com

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

CONTACT:	MR MIKE SHEK	**WORK ORDER:**	HK1425712
CLIENT:	AECOM ASIA COMPANY LIMITED	**LABORATORY:**	HONG KONG
ADDRESS:	1501-10, 15/F, TOWER 1, GRAND CENTRAL PLAZA, 138 SHATIN RURAL COMMITTEE ROAD, SHATIN, NEW TERRITORIES, HONG KONG	**DATE RECEIVED:**	12/08/2014
		DATE OF ISSUE:	13/08/2014

COMMENTS

The performance of the equipment stated in this report is checked with independent reference material and results compared against a calibrated secondary source.
The "Tolerance Limit" quoted is the acceptance criteria applicable for similar equipment used by the ALS Hong Kong laboratory or quoted from relevant international standards.
The "Next Calibration Date" is recommended according to best practice principals as practised by the ALS Hong Kong laboratory or quoted from relevant international standards.

Scope of Test:	pH, Salinity, Conductivity, Temperature, Dissolved Oxygen and Turbidity
Description:	Sonde Environmental Monitoring System
Brand Name:	YSI
Model No.:	6820 V2
Serial No.:	12A101545
Equipment No.:	W.026.35
Date of Calibration:	12 August 2014

NOTES

This is the Final Report and supersedes any preliminary report with this batch number.
Results apply to sample(s) as submitted. All pages of this report have been checked and approved for release.

Mr Fung Lim Chee, Richard
General Manager -
Greater China & Hong Kong

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

Work Order: HK1425712
Date of Issue: 13/08/2014
Client: AECOM ASIA COMPANY LIMITED

Description: Sonde Environmental Monitoring System
Brand Name: YSI
Model No.: 6820 V2
Serial No.: 12A101545
Equipment No.: W.026.35
Date of Calibration: 12 August 2014 Date of next Calibration: 12 November 2014

Parameters:

Conductivity **Method Ref: APHA (20th edition), 2510B**

Expected Reading (uS/cm)	Displayed Reading (uS/cm)	Tolerance (%)
146.9	145.5	-1.0
6667	6720	+0.8
12890	12745	-1.1
58670	58610	-0.1
	Tolerance Limit (%)	±10.0

Dissolved Oxygen **Method Ref: APHA (21st edition), 4500O: G**

Expected Reading (mg/L)	Displayed Reading (mg/L)	Tolerance (mg/L)
3.95	3.91	-0.04
5.80	5.83	+0.03
7.45	7.50	+0.05
	Tolerance Limit (mg/L)	±0.20

pH Value **Method Ref: APHA (21st edition), 4500H:B**

Expected Reading (pH Unit)	Displayed Reading (pH Unit)	Tolerance (pH unit)
4.0	3.99	-0.01
7.0	7.01	+0.01
10.0	9.99	-0.01
	Tolerance Limit (pH Unit)	±0.20

Remark: "Displayed Reading" presents the figures shown on item under calibration / checking regardless of equipment precision or significant figures.

Mr Fung Lim Chee, Richard
General Manager -
Greater China & Hong Kong

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

Work Order: HK1425712
Date of Issue: 13/08/2014
Client: AECOM ASIA COMPANY LIMITED

Description: Sonde Environmental Monitoring System
Brand Name: YSI
Model No.: 6820 V2
Serial No.: 12A101545
Equipment No.: W.026.35
Date of Calibration: 12 August 2014 Date of next Calibration: 12 November 2014

Parameters:

Salinity

Method Ref: APHA (21st edition), 2520B

Expected Reading (g/L)	Displayed Reading (g/L)	Tolerance (%)
0	0.00	--
10	9.98	-0.2
20	19.85	-0.7
30	29.86	-0.5
	Tolerance Limit (%)	±10.0

Temperature

Method Ref: Section 6 of International Accreditation New Zealand Technical Guide No. 3 Second edition March 2008: Working Thermometer Calibration Procedure.

Reading of Ref. thermometer (°C)	Displayed Reading (°C)	Tolerance (°C)
15.0	14.95	-0.1
25.5	25.40	-0.1
38.0	37.95	-0.0
	Tolerance Limit (°C)	±2.0

Turbidity

Method Ref: APHA (21st edition), 2130B

Expected Reading (NTU)	Displayed Reading (NTU)	Tolerance (%)
0	0.0	--
4	3.9	-2.5
10	9.9	-1.0
20	19.6	-2.0
50	49.4	-1.2
100	99.2	-0.8
	Tolerance Limit (%)	±10.0

Remark: "Displayed Reading" presents the figures shown on item under calibration / checking regardless of equipment precision or significant figures.

Mr Fung Lim Chee, Richard
General Manager -
Greater China & Hong Kong

Appendix 2a: Plant Species Recorded in Pak Ngan Heung River and Luk Tei Tong River

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	PNH1	PNH2	PNH3	PNH4	LTT1	LTT2	LTT3	LTT4	LTT5
Acanthus ilicifolius	shrub	native	common						+	+		
Bidens alba	herb	exotic	very common			++	++		+	+	+	+
Bidens pilosa	herb	exotic	very common									
Brachiaria mutica	herb	exotic	common			++	++					
Canavalia maritima	climber	native	common								+	+
Celosia argentea	herb	native	very common			+	+					
Colocasia esculenta	herb	native	-			+	+					
Commelina diffusa	herb	native	common			++	++					
Cyperus spp.	herb	-	-			+						
Emilia sonchifolia	herb	native	very common			+						
Ficus hispida	tree	native	very common	+		+	+					
Ficus variegata	shrub	native	common			+	+					
Hedychium coronarium	shrub	exotic	-				+					
Ipomoea cairica	climber	exotic	very common									+
Ipomoea pes-caprae	perennial herb	native	common			+	+					
Kandelia obovata	shrub or small tree	native	common		+			+	++	+		+
Lantana camara	shrub	exotic	very common						+		+	+
Macaranga tanarius	tree	native	common			+						
Mikania micrantha	climber	exotic	very common			+++	+++		+	+		
Mimosa pudica	herb	exotic	very common							+		
Miscanthus sinensis	perennial herb	native	very common			+	+		+		+	+
Neyraudia reynaudiana	herb	native	very common									+
Panicum maximum	herb	exotic	very common			+	+	+		+		+
Polygonum barbatum	herb	native	common			+	+					
Pueraria phaseoloides	climber	native	very common						+	+	+	+
Pycreus flavidus	herb	native	-			+						
Rhus hypoleuca	shrub	native	common			+						
Torenia fournieri	herb	exotic	-				+					
Wedelia trilobata	perennial herb	exotic	common	+		+	+		+	+		+

Note:
Code for Abundance: +++=abundant; ++=occasional; +=scarce

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

LTT Bypass Channel (LBC)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	LBC1	LBC2	LBC3	LBC4	LBC5	Average
Species recorded in the quadrats along the transects				**Average Percentage Cover**					
Acrostichum aureum	herb	native	restricted	0.01	0	0	0	0	0.00
Bidens alba	herb	exotic	very common	0	0.03	0.12	0.01	0.07	0.05
Crotalaria pallida	herb	exotic	common	0	0	0	0.04	0.01	0.01
Cyclosorus interruptus	herb	native	common	0	0	0.03	0	0	0.01
Cynodon dactylon	perennial herb	native	very common	0	0	0.2	0.06	0.23	0.10
Fimbristylis sieboldii	herb	native	common	0.46	0	0	0	0	0.09
Ipomoea cairica	climber	exotic	very common	0.25	0	0.02	0	0.05	0.06
Mikania micrantha	climber	exotic	very common	0	0	0.01	0	0	0.00
Mimosa pudica	herb	exotic	very common	0	0.03	0	0.07	0	0.02
Panicum repens	perennial herb	native	very common	0	0.32	0.02	0	0	0.07
Paspalum conjugatum	perennial herb	exotic	common	0	0.01	0.05	0.08	0.05	0.04
Paspalum orbiculare	herb	native	-	0.04	0	0.01	0	0.01	0.01
Polygonum barbatum	herb	native	common	0	0	0	0	0.02	0.00
Praxelis clematidea	perennial herb	exotic	very common	0	0	0	0.01	0	0.00
Pycreus polystachyus	herb	native	common	0.04	0	0	0	0	0.01
Ruellia coerulea	herb	exotic	-	0.22	0	0	0	0	0.04
Wedelia trilobata	perennial herb	exotic	common	0	0.61	0.54	0.72	0.56	0.49
Species recorded during the walk-through survey				**Occurrence of the Species**					
Acacia confusa	tree	exotic	-	+	+				
Acrostichum aureum	herb	native	restricted	+					
Apluda mutica	herb	native	very common		+	+	+	+	
Bidens alba	herb	exotic	very common		+	+	+	+	
Brachiaria mutica	herb	exotic	common			+		+	
Celosia argentea	herb	native	very common			+	+	+	
Celtis sinensis	tree	native	common				+	+	
Colocasia esculenta	herb	native	-		+	+			
Conyza canadensis	herb	exotic	very common		+	+		+	
Crotalaria pallida	herb	exotic	common		+	+	+	+	
Cyclosorus interruptus	herb	native	common			+	+		
Cynodon dactylon	perennial herb	native	very common		+	+	+	+	
Cyperus flabelliformis	herb	-	-	+					
Cyperus sp.	-	-	-		+	+	+	+	
Fimbristylis sieboldii	herb	native	common	+					
Hedychium coronarium	shrub	exotic	-			+	+		
Ipomoea cairica	climber	exotic	very common	+	+	+	+	+	
Kandelia obovata	shrub or small tree	native	common	+					

Note:
Code: +=occurrence of the species

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

LTT Bypass Channel (LBC)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	LBC1	LBC2	LBC3	LBC4	LBC5
Other species recorded during the walk-through survey (Continue)				**Occurrence of the Species**				
Kyllinga monocephala	herb	native	-			+	+	
Mikania micrantha	climber	exotic	very common		+	+	+	+
Mimosa pudica	herb	exotic	very common		+	+	+	+
Miscanthus sinensis	perennial herb	native	very common		+	+	+	+
Neyraudia reynaudiana	herb	native	very common	+		+	+	
Panicum maximum	herb	exotic	very common			+	+	+
Panicum repens	perennial herb	native	very common		+	+	+	+
Paspalum conjugatum	perennial herb	exotic	common		+	+	+	+
Paspalum orbiculare	herb	native	-	+	+	+	+	+
Phragmites vallatorius	herb	native	very common	+	+			
Polygonum barbatum	herb	native	common		+	+	+	+
Polygonum spp.	herb	-	-		+	+		
Praxelis clematidea	perennial herb	exotic	very common		+	+	+	+
Pueraria phaseoloides	climber	native	very common		+	+	+	+
Pycreus polystachyus	herb	native	common	+	+			
Ruellia coerulea	herb	exotic	-	+				
Sapium sebiferum	tree	native	common			+		
Urena lobata	shrub	native	common		+	+	+	+
Wedelia trilobata	perennial herb	exotic	common		+	+	+	+

Note:
Code: +=occurrence of the species

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

Reference Site (RS)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	RS1	RS2	RS3	RS4	RS5	Average
Species recorded in the quadrats along the transects				**Average Percentage Cover**					
Aeschynomene indica	shrubby herb	native	very common	0	0	0.01	0	0	0.00
Bidens alba	herb	exotic	very common	0.17	0.1	0	0.04	0.14	0.09
Crotalaria pallida	herb	exotic	common	0	0	0.02	0.04	0	0.01
Ficus hispida	tree	native	very common	0	0.03	0	0	0	0.01
Kyllinga monocephala	herb	native	-	0	0	0.01	0	0	0.00
Mimosa pudica	herb	exotic	very common	0.25	0.06	0.09	0.05	0.36	0.16
Miscanthus sinensis	perennial herb	native	very common	0	0.02	0	0	0	0.00
Panicum repens	perennial herb	native	very common	0	0.02	0	0	0	0.00
Paspalum conjugatum	perennial herb	exotic	common	0.03	0.09	0.07	0.05	0.05	0.06
Paspalum orbiculare	herb	native	-	0.02	0	0	0	0	0.00
Pueraria phaseoloides	climber	native	very common	0.03	0.04	0	0.02	0.04	0.03
Sapium sebiferum	tree	native	common	0	0.01	0	0	0	0.00
Urena lobata	shrub	native	common	0	0	0.06	0	0	0.01
Wedelia trilobata	perennial herb	exotic	common	0.5	0.63	0.74	0.79	0.41	0.61
Other species recorded during the walk-through survey				**Occurrence of the Species**					
Acacia confusa	tree	exotic	-	+	+				
Aeschynomene indica	shrubby herb	native	very common		+	+	+	+	
Allamanda cathartica	climbing shrub	exotic	-		+				
Alocasia odora	perennial herb	native	very common	+	+	+	+		
Bambusa ventricosa	bamboo	exotic	-					+	
Bauhinia blakeana	tree	native	common		+				
Bidens alba	herb	exotic	very common	+	+	+	+	+	
Bridelia tomentosa	tree	native	very common				+		
Canna indica	herb	exotic	-		+	+	+		
Celosia argentea	herb	native	very common		+	+	+	+	
Celtis sinensis	tree	native	common	+			+		
Colocasia esculenta	herb	native	-				+	+	
Conyza canadensis	herb	exotic	very common		+			+	

Note:
Code: + = the occurrence of the species

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

Reference Site (RS)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	RS1	RS2	RS3	RS4	RS5
Other species recorded during the walk-through survey (Continue)				**Occurrence of the Species**				
Crotalaria pallida	herb	exotic	common	+	+	+	+	+
Dactyloctenium aegyptium	herb	native	common		+	+	+	+
Diospyros kaki	shrub	native	-		+			
Emilia sonchifolia	herb	native	very common				+	
Ficus hispida	tree	native	very common		+	+	+	+
Ficus variegata	shrub	native	common			+		
Hedychium coronarium	shrub	exotic	-		+	+	+	
Ipomoea cairica	climber	exotic	very common	+	+	+	+	+
Ipomoea pes-caprae	perennial herb	native	common	+	+	+	+	+
Kyllinga monocephala	herb	native	-	+	+	+		+
Lantana camara	shrub	exotic	very common	+	+	+	+	+
Ludwigia octovalvis	perennial herb	native	common		+	+	+	+
Mallotus paniculatus	tree	native	very common					+
Melastoma sanguineum	shrub	native	common				+	
Microstegium ciliatum	perennial procumbent herb	native	very common			+		+
Mikania micrantha	climber	exotic	very common	+	+	+	+	+
Mimosa pudica	herb	exotic	very common	+	+	+	+	+
Miscanthus sinensis	perennial herb	native	very common	+				
Panicum maximum	herb	exotic	very common	+	+	+	+	+
Panicum repens	perennial herb	native	very common			+	+	+
Paspalum conjugatum	perennial herb	exotic	common	+	+	+	+	+
Paspalum orbiculare	herb	native	-	+	+			
Praxelis clematidea	perennial herb	exotic	very common	+				
Pueraria phaseoloides	climber	native	very common	+	+	+	+	+
Pycreus polystachyus	herb	native	common		+			
Sageretia thea	shrub	native	very common					+
Sapium sebiferum	tree	native	common		+	+	+	
Setaria sp.	herb	-	-		+	+		
Urena lobata	shrub	native	common	+	+	+	+	+
Wedelia trilobata	perennial herb	exotic	common	+	+	+	+	+

Note:
Code: +=occurrence of the species

Appendix 3: Ecological Water Quality Monitoring Raw Data (August 2014)

Date of Monitoring: 21 August 2014 **Weather : Sunny**

Monitoring Location	Suspended Solids (mg/L)	Nitrogen (Ammonia) (mg/L)	Nitrogen (Nitrate) (mg/L)	Reactive Phosphorous (mg/L)	5-day Biochemical Oxygen Demand (BOD^5) (mg/L)	Dissolved Oxygen (mg/L)	
						M1	M2
WE1	<2.0	0.01	0.58	<0.01	<2.0	7.06	7.07
WE2	<2.0	<0.01	0.14	0.03	<2.0	7.56	7.51
WE3	<2.0	0.01	0.14	0.02	<2.0	7.20	7.18
WE4	<2.0	0.01	0.14	0.02	<2.0	7.40	7.42
WE5	<2.0	0.36	0.26	0.12	<2.0	7.32	7.29
WE6	<2.0	<0.01	0.58	<0.01	<2.0	6.87	6.86
WE7	No water - Not sampled						
WE8	No water - Not sampled						
WE9	No water - Not sampled						
WE10	No water - Not sampled						

Monitoring Location	Temperature (^oC)		pH	Salinity (ppt)		Conductivity (µs/cm)		Water Flow (m/s)		Water Depth (cm)
	M1	M2		M1	M2	M1	M2	M1	M2	
WE1	25.6	25.5	7.6	0.01	0.01	33.4	33.6	0.333	0.338	56.0
WE2	25.0	25.0	7.2	0.00	0.00	30.5	30.4	0.196	0.189	14.0
WE3	25.2	25.2	7.4	0.01	0.01	40.8	41.2	0.156	0.161	10.0
WE4	25.0	25.1	7.1	0.10	0.11	26.0	26.2	0.214	0.218	21.0
WE5	25.5	25.6	7.1	0.13	0.13	56.8	56.6	0.055	0.051	18.0
WE6	26.0	26.1	7.5	0.00	0.00	72.3	72.0	0.072	0.075	31.0
WE7	No water - Not sampled									
WE8	No water - Not sampled									
WE9	No water - Not sampled									
WE10	No water - Not sampled									

Note:
Where more than one measurement was taken, the data is represented by Measurement M1 and M2.

PNH1 and PNH2

PNH3 and PNH4

LTT1

LTT2

LTT3 and LTT4

LTT5

LBC1

LBC2 and LBC3

AECOM	Post-Construction Ecological Monitoring of Drainage Improvement Works in Southern Lantau	SCALE	N.T.S.	DATE	Aug-14
	Representative Photographs taken during the Monitoring	CHECK	McmillanSE	DRAWN	CHIKYY
		JOB NO.	60278381	DRAWING NO.	Appendix 4

LBC4 and LBC5

RS1

RS2

RS3 and RS4

RS5

AECOM	Post-Construction Ecological Monitoring of Drainage Improvement Works in Southern Lantau	SCALE	N.T.S.	DATE	Aug-14
	Representative Photographs taken during the Monitoring	CHECK	McmillanSE	DRAWN	CHIKYY
		JOB NO.	60278381	DRAWING NO.	Appendix 4