

# Ecological Enhancement Works in River Channels

Smart, Green and Resilient Stormwater Management

Ms. Julia W. Y. CHAN

14 November 2017



Drainage Services Department –  
Research & Development Forum 2017

# Agenda

1. Background of the Eco-hydraulics Study
2. Ecological Enhancement Works
3. Initial Observations
4. Way Forwards



# Background of the Eco-hydraulics Study

## Stage 1

1 Select representative green channels for ecological and water quality field surveys.

---

2 Develop stream evaluation system to review the ecological value of green channels.

---

3 Provide ranking of selected channels by Rapid Stream Evaluation (RSE) as reference in prioritization of channel enhancement works.

---

4 Updating Practice Note 1/2015: *Guidelines on Environmental and Ecological Considerations for River Channel Design*

---

## Stage 2

1 Enhancement of RSE and select sites for ecological enhancement site trials.

---

2 Detail design of ecological enhancement works and construction.

---

3 Water quality and ecological monitoring, including pre-enhancement monitoring (completed) and post enhancement monitoring (on-going).

---

4 Conduct post-enhancement review, recommendations of operation and maintenance requirements for upkeeping the ecological value.

---

# Background of the Eco-hydraulics Study

## Rapid Stream Evaluation for Green Channels

Physical and chemical factors of importance to the biota

# 1

### Water quality

indicates the state of health of the river channel in supporting the aquatic life



# 2

### Instream habitat

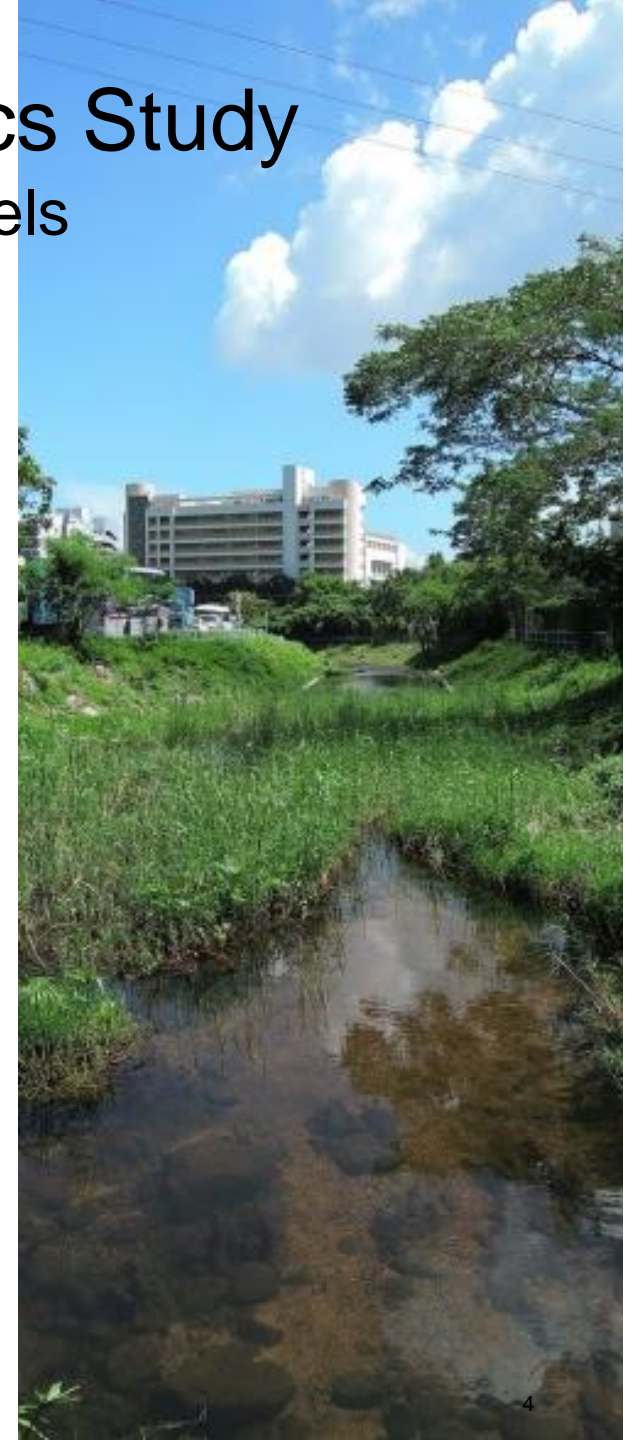
the naturalness and complexity of channel bed substrates for support of aquatic community



# 3

### Embankment profile

the ecological connectivity to adjacent habitats



# Background of the Eco-hydraulics Study

## Rapid Stream Evaluation for Green Channels

Biological factors of importance to the biota

1

Species richness

for native and wetland dependent species

2

Species of conservation concern



3

Freshwater/estuarine fish



4

Aquatic invertebrates

Biological indicator species



5

Riparian habitat conditions

Habitat diversity and ecological linkage

6

Riparian vegetation at water margin & embankment



# Background of the Eco-hydraulics Study

## Rapid Stream Evaluation for Green Channels

### Stage 2 – RSE Criteria

#### (1) Physical and chemical factors (Total 32%)

(a) Water quality (8%)

(i) pH (2%)

(ii) DO (% saturation) (2%)

(iii) BOD<sub>5</sub> (2%)

(iv) NH<sub>3</sub>-N (2%)

(b) Instream habitat – Substrate (6%)

(c) Embankment profile (6%)

(d) Aquatic habitat quality - Aquatic habitat diversity and longitudinal connectivity (6%)

(e) Stream-riparian Ecosystem – Lateral inundation of stream-riparian zone (6%)

#### (2) Biological factors (Total 68%)

(a) Species richness (12%)

(b) Species of conservation concern (12%)

(c) Freshwater/estuarine fish species (12%)

(d) Freshwater invertebrates (12%)

(e) Riparian habitat conditions (10%)

(f) Riparian vegetation at water margin & channel embankment (10%)

# Background of the Eco-hydraulics Study

## Rapid Stream Evaluation for Green Channels

### Categorization of Physical and Chemical Factors for Channels

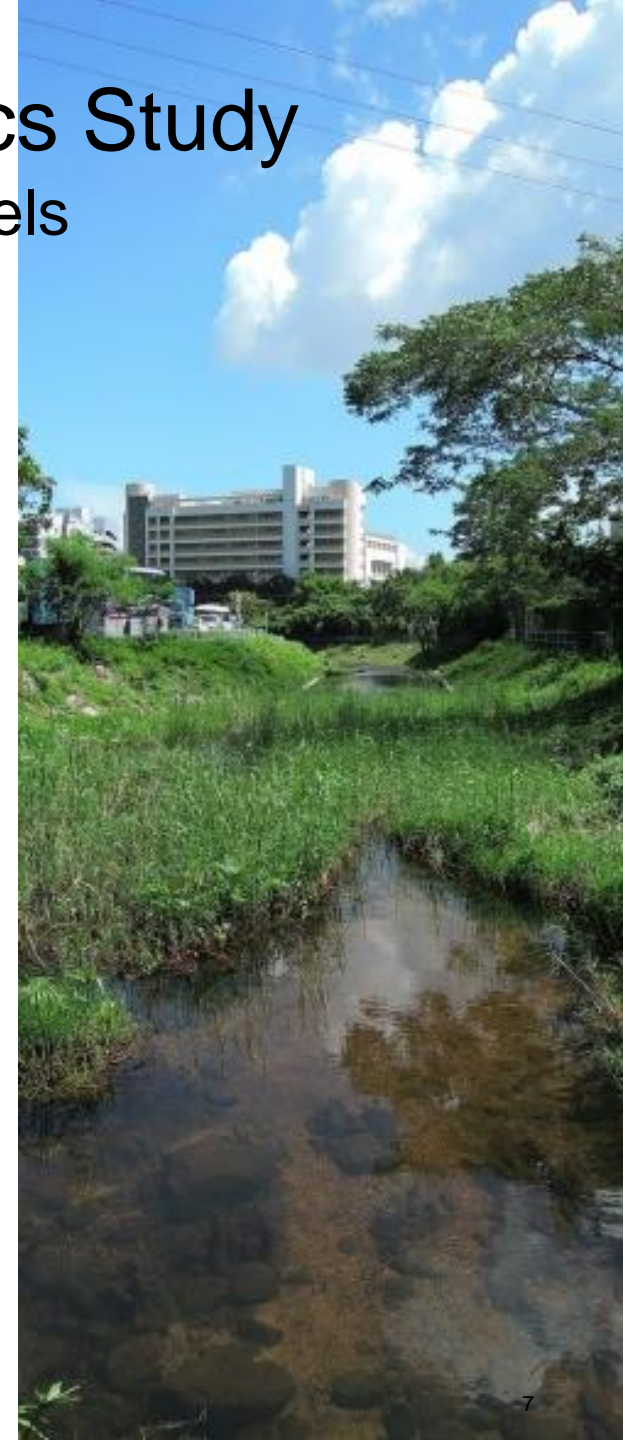
Categories	Overall Score
Excellent	27 – 32
Good	22 – 27
Average	16 – 22
Fair	8 – 16
Poor	0 – 8

### Categorization of Biological Factors for Channels

Categories	Overall Score
Excellent	57 – 68
Good	47 – 57
Average	34 – 47
Fair	17 – 34
Poor	0 – 17

### Overall Categorization of Ecological Value and Habitat Quality for Channels

Categories	Overall Score
Excellent	85 – 100
Good	70 – 85
Average	50 – 70
Fair	25 – 50
Poor	0 – 25

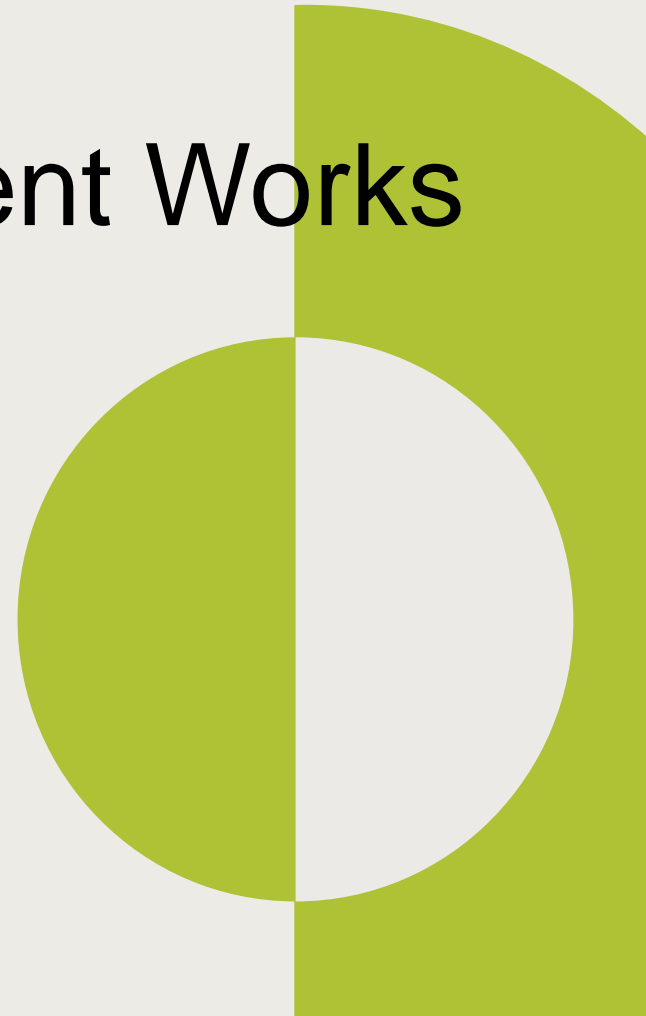


# Background of the Eco-hydraulics Study

## Rapid Stream Evaluation for Green Channels – RSE Ranking

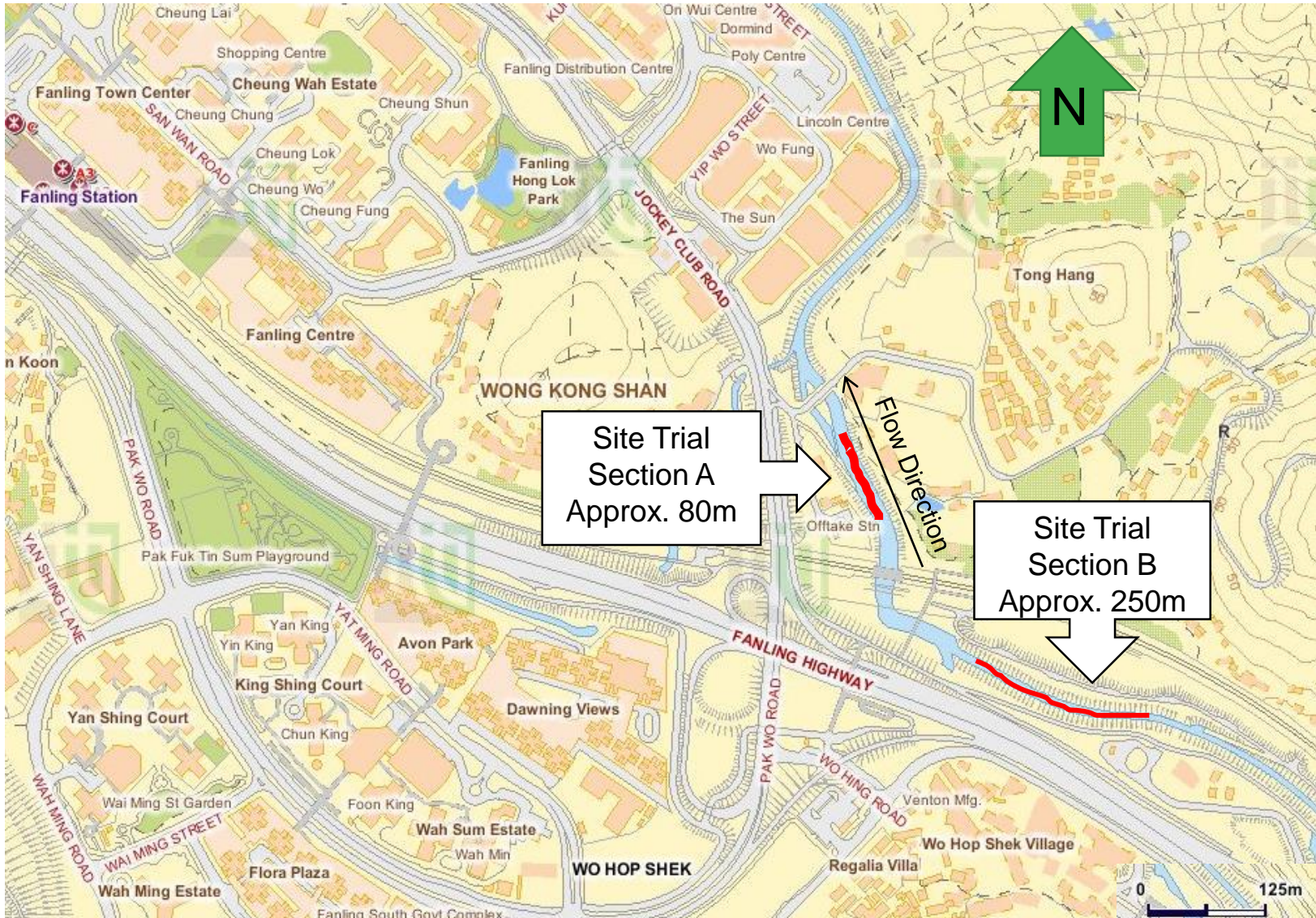


# Ecological Enhancement Works



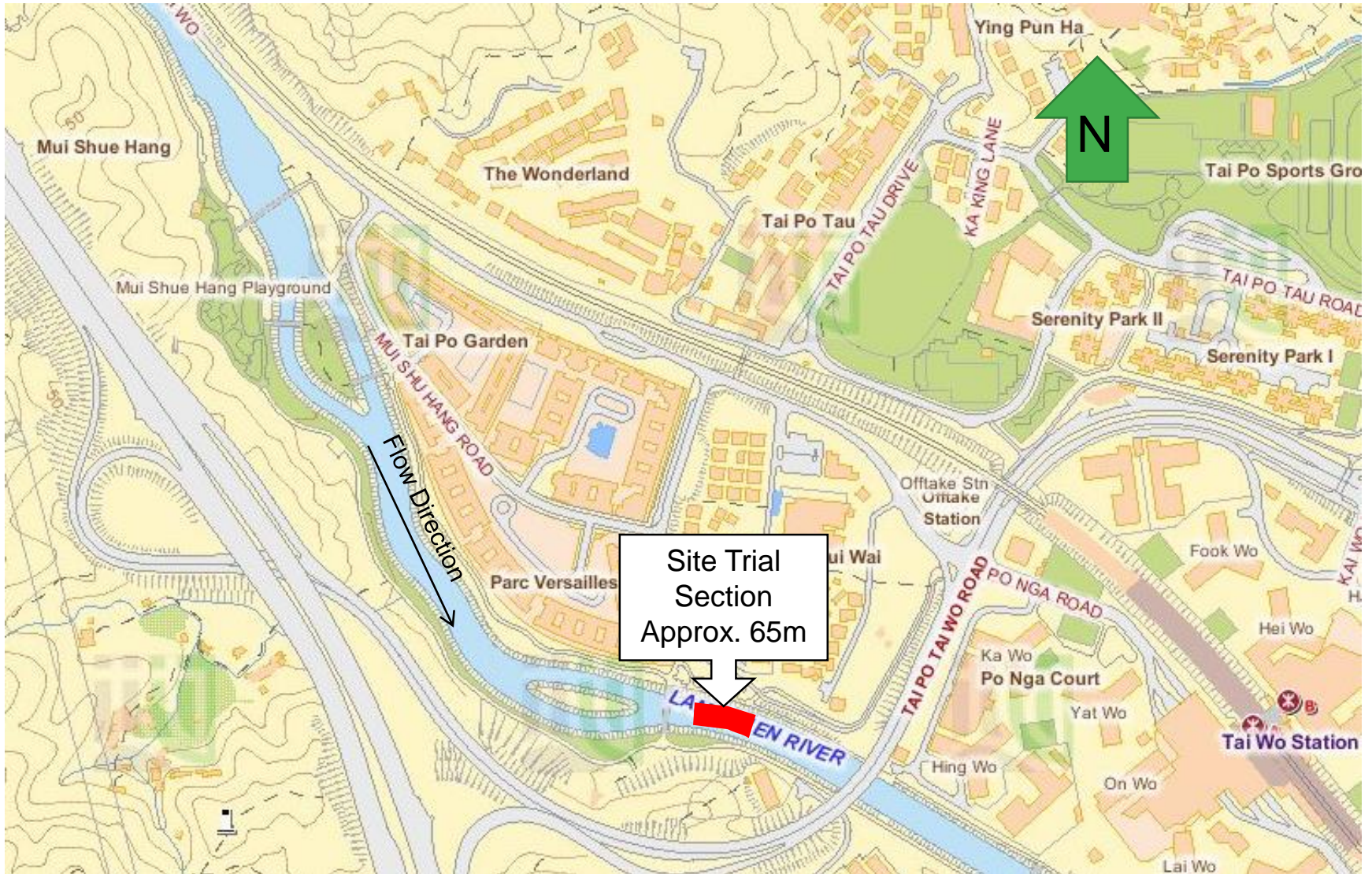
# Ecological Enhancement Works

## Site Trial at Ma Wat River



# Ecological Enhancement Works

## Site Trial at Lower Lam Tsuen River



# Ecological Enhancement Works

## Site Trial at Ma Wat River – Baseline Condition (2015)

### Geography

- Fanling
- Receive waters from Kau Lung Hang, Tai Wo Stream, Yuen Leng Stream, Nam Wa Po Stream and Ma Wat Stream
- Drain into Ng Tung River
- KLHS & TWS are EISs and concern species

### River Characteristic

- Trapezoidal
- Grasscrete embankment
- Rip-rap channel bed
- Water pools
- Meanders



### Ecology

- 96 flora & 54 faunal spp.
- 4 native & wetland dependent spp. of conservation concern



# Ecological Enhancement Works

## Site Trial at Ma Wat River – Baseline RSE Score (2015)

Criteria		Findings	
<b>(1) Physical and chemical factors of importance to the biota</b>			
(a) Water quality	(i) pH		8.5
	(ii) DO (% saturation)		106.9
	(iii) BOD <sub>5</sub> (mg/L)		2.9
	(iv) NH <sub>3</sub> -N		1.32
(b) Instream habitat	Substrate (Left - Naturalness; Right - Heterogeneity)	<b>36% Concrete</b>	15% of Mud and Sand; 20% Boulder; 29% Pebbles.
(c) Embankment profile	Sloping embankment at both sides with gradient within 35° to 55°		
(d) Total no. of aquatic habitat	2		
	Longitudinal connectivity	Water flow blocked by artificial structures	
(e) Stream-riparian Ecosystem Ranking	2		
<b>Categories for physical and chemical factors</b>		<b>Average</b>	
<b>(2) Biological factors</b>			
(a) Species richness			15
(b) Species of conservation concern			4
(c) Freshwater/estuarine fish species (Left – No. of fish species; Right – Percentage of native species)	11		18%
(d) Freshwater invertebrates (Left – No. of aquatic invertebrate species; Right – Number of biological indicators for poor water quality)	10		2
(e) Riparian habitat conditions			0
(f) Riparian vegetation at water margin & channel embankment (Left – No. of wetland plant species; Right: Number of native plant species)	33		60
<b>Categories for biological factors</b>		<b>Fair</b>	
<b>Overall Categories</b>		<b>Average</b>	



**Areas need improvement**

In-stream habitat

Limited aquatic fauna and poor riparian habitat conditions



---

**Project**  
**Ma Wat River**  
**Ecological**  
**Enhancement Site**  
**Trial**

Enhancement works  
& vegetation planting  
period  
2015 Q4 – 2017 Q1

---

## Opportunity

- Enhancement of instream habitat to increase the heterogeneity
- Enhance the riparian zone to promote ecological connectivity
- Provision of microhabitats to facilitate colonisation of aquatic flora and fauna

## Solution

- Replacement of concrete bed with natural bed materials
- Riparian planting
- Provision of bio-engineering features
- Low-flow channel enhancement

## Expected outcome

- Enhance the physical environment and ecological connectivity for facilitating the colonisation of aquatic flora and fauna

# Ecological Enhancement Works

## Site Trial at Ma Wat River – Ecological Enhancement Elements



Eco-Friendly Substrates



Pools & Riffles Creation



Fish Ladder



Sinuosity Configuration



Riparian Tree Planting



Palm Roll with Planting

# Ecological Enhancement Works

## Site Trial at Ma Wat River – Hard Engineering Features



Palm Fibre Concrete Block



Current Deflector Installation



Reinforced Concrete Grid with Grass Planting



Climbers Mesh



Gabion Baskets

# Ecological Enhancement Works

## Site Trial at Lower Lam Tsuen River – Baseline Condition (2015)

### Geography

- Tai Po
- Receive waters from Upper Lam Tsuen River, Pak Ngau Shek Stream and She Shan River
- Drain into Tolo Harbour
- Upper LTR & PNSS are EISs with concern species

### River Characteristic

- Trapezoidal
- Grasscrete & masonry embankment
- Concrete channel bed
- Dry weather flow channel



Little Egret

### Ecology

- 69 flora & 68 faunal spp.
- 7 native & wetland dependent spp. of conservation concern



Little Egret



# Ecological Enhancement Works

## Site Trial at Lower Lam Tsuen River – Baseline RSE Score (2015)

Criteria		Findings
<b>(1) Physical and chemical factors of importance to the biota</b>		
(a) Water quality	(i) pH	7.8
	(ii) DO (% saturation)	83.3
	(iii) BOD5 (mg/L)	6.4
	(iv) NH3-N	1.32
(b) Instream habitat	Substrate (Left - Naturalness; Right - Heterogeneity)	100% concrete
(c) Embankment profile	Sloping embankment at both sides with gradient within 35° to 55°	
(d) Total no. of aquatic habitat	1	
Longitudinal connectivity		Water flow blocked by artificial structures
(e) Stream-riparian Ecosystem Ranking	0	
<b>Categories for physical and chemical factors</b>		<b>Fair</b>
<b>(2) Biological factors</b>		
(a) Species richness	22	
(b) Species of conservation concern	7	
(c) Freshwater/estuarine fish species (Left – No. of fish species; Right – Percentage of native species)	17	35%
(d) Freshwater invertebrates (Left – No. of aquatic invertebrate species; Right – Number of biological indicators for poor water quality)	4	3
(e) Riparian habitat conditions	0	
(f) Riparian vegetation at water margin & channel embankment (Left – No. of wetland plant species; Right: Number of native plant species)	29	47
<b>Categories for biological factors</b>		<b>Average</b>
<b>Overall Categories</b>		<b>Fair</b>



### Areas need improvement

- In-stream habitat
- Limited aquatic fauna and poor riparian habitat conditions



---

## Project

### Lower Lam Tsuen River Ecological Enhancement Site Trial

#### Enhancement works & vegetation planting period

2016 Q1 – 2017 Q1

---

## Opportunity

- Enhancement of instream habitat to increase the heterogeneity
- Enhance the riparian zone to promote ecological connectivity
- Provision of microhabitats
- Slowing down of water flow to support aquatic fauna

## Solution

- Replacement of concrete bed with natural bed materials
- Riparian planting
- Provision of bio-engineering features
- Low-flow channel enhancement

## Expected outcome

- Enhance the physical environment and ecological connectivity for facilitating the colonisation of aquatic flora and fauna

# Ecological Enhancement Works

## Site Trial at Lower Lam Tsuen River – Ecological Enhancement Elements



Eco-Friendly Substrates



Shallow Pools



Riparian Vegetation Planting



Sinuosity Configuration



Wooden Poles Installation

# Ecological Enhancement Works

## Site Trial at Lower Lam Tsuen River – Hard Engineering Features



Palm Fibre Concrete Block to Prevent Erosion



Reinforced Concrete Grid with Grass Planting

Climbers Mesh



Current Deflector Installation



# Initial Observations



# Initial Observations - Ma Wat River



After enhancement @ 2017 Q2

# Initial Observations - Lower Lam Tsuen River



# Initial Observations - Ma Wat River

28 April 2017 – 4 months after establishment



15 May 2017 - During flood



1 Jun 2017 - Two weeks after flood



28 Sep 2017 – Late wet season snapshot



# Initial Observations - Ma Wat River

28 April 2017 – 4 months after establishment



4 May 2017 - During flood



18 May 2017 - Two weeks after flood



28 Sep 2017 – Late wet season snapshot



# Initial Observations - Lower Lam Tsuen River

1 June 2017 – 4 months after establishment



13 June 2017 – During flood



27 June 2017 – Two weeks after flood



12 Sep 2017 – Late wet season snapshot



# Initial Observations

## Ma Wat River Survey Area

### Preliminary Findings from Pre-enhancement and Post-enhancement Monitoring

Ecological Attributes	No. of Species	
	Pre-enhancement Monitoring (2015)	*Post-enhancement Monitoring (2017)
Avifauna species (Wetland-dependent species)	19 (5)	<b>24</b> (3)
Dragonflies species	6	<b>7</b>
Herpetofauna species (Wetland-dependent and native species)	8 (4)	5 (4)
Fauna species	54	53
Species Richness (Native and wetland-dependent fauna species, excl. fish and freshwater invertebrates)	15	14
Species of conservation importance which are both native and wetland-dependent	4	4
Freshwater fish species (native species)	11 (2)	8 (0)
Freshwater invertebrate species (bio-indicator of poor water quality)	10 (2)	9 (2)
Flora species	96	<b>98</b>
Wetland-associated plant species	33	<b>40</b>
Native plant species	60	<b>62</b>
RSE Score (out of 100)	52	<b>56</b>
<b>RSE Ranking</b>	Average	Average

Note: \*Data in **bold** indicated an increase in number of species recorded.

# Initial Observations

## Ma Wat River Enhanced Sections



Common Red Skimmer resting on riparian vegetation



Natural colonization of native wetland vegetation



Tree establishment



Riparian vegetation establishment



Palm roll vegetation establishment

# Initial Observations

## Ma Wat River Enhanced Sections

Enhanced ecological connectivity, enhanced in-stream habitat complexity, enhanced greenery



# Initial Observations

## Lower Lam Tsuen River Survey Area

### Preliminary Findings from Pre-enhancement and Post-enhancement Monitoring

Ecological Attributes	No. of Species	
	Pre-enhancement Monitoring (2015)	*Post-enhancement Monitoring (2017)
Avifauna species (Wetland-dependent species)	28 (6)	<b>39 (8)</b>
Dragonflies species	12	7
Herpetofauna species (Wetland-dependent and native species)	7 (4)	<b>7 (5)</b>
Fauna species	68	<b>84</b>
Species Richness (Native and wetland-dependent fauna species, excl. fish and freshwater invertebrates)	22	20
Species of conservation importance which are both native and wetland-dependent	7	<b>11</b>
Freshwater fish species (native species)	17 (6)	<b>20 (6)</b>
Freshwater invertebrate species (bio-indicator of poor water quality)	4 (3)	<b>11 (3)</b>
Flora species	69	<b>87</b>
Wetland-associated plant species	29	<b>34</b>
Native plant species	47	<b>62</b>
RSE Score (out of 100)	48	<b>60.5</b>
<b>RSE Ranking</b>	Fair	<b>Average</b>

Note: \*Data in **bold** indicated an increase in number of species recorded.

# Initial Observations

## Lower Lam Tsuen River Enhanced Section

### Wetland-dependent avifauna species



Night Herons (left: juvenile; right: adult) observed resting on the wooden poles and shallow pool



Common Kingfisher observed resting on the wooden pole



Little Egret observed feeding and resting at the shallow pool



Great Egret observed feeding and resting at the riparian zone

# Initial Observations

Lower Lam Tsuen River Enhanced Section

Enhanced ecological connectivity, reduced flow velocity at pool areas, enhanced in-stream habitat complexity



# Initial Observations

## Lower Lam Tsuen River Enhanced Section



# Way Forward



# Way Forward

Establishment Period  
Maintenance – Active removal  
of invasive species



*Bidens alba* 白花鬼針草



*Pomacea canaliculata* 福寿螺



*Sesbania cannabina* 田菁



*Brachiaria mutica* 巴拉草

# Way Forward



Post-Enhancement Monitoring



Knowledge Sharing



Operation and Maintenance Requirements



Raise Public Awareness of River Conservation



Thank you



---

# Q & A

---

