

**Independent Environmental Checker for
Contract No. YL/2009/01 – Hang Hau Tsuen Channel at
Lau Fau Shan**

Post-Construction Mangrove Monitoring

**8th Quarterly Mangrove Monitoring Report
(March 2015)**

Prepared for:
Civil Engineering and Development Department

Prepared by:
ENVIRON Hong Kong Limited

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8th Quarterly Mangrove Monitoring Report
(March 2015)**

Prepared by:



Shirley Lui
Environmental Consultant

Approved by:



David Yeung
Managing Director

ENVIRON Hong Kong Limited
Room 2403, Jubilee Centre
18 Fenwick Street, Wan Chai, Hong Kong
Tel: (852) 3465 2888
Fax: (852) 3465 2899
Email: hkinfo@environcorp.com

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Contents

	Page
1.0 INTRODUCTION	1
1.1 Project Background	1
2.0 MANGROVE MONITORING MEHTHODOLOGY.....	2
2.1 Monitoring Equipment.....	2
2.2 Quadrate	2
2.3 Measurement.....	2
2.4 Photo Record.....	3
3.0 MONITORING RESULTS.....	4
3.1 Visual Inspection	4
3.2 Measurement of selected plant individual.....	4
3.3 Photographic record	10
4.0 CONCLUSION.....	11

List of Tables

Table 1 Mangrove plant growth and health monitoring for each planted species.....	5
Table 2 Record sheet for mangrove plant density and survival rate monitoring	6
Table 3 Mean height of <i>Acanthus ilicifolius</i> and <i>Kandelia obovata</i>	9
Table 4 Mean diameter of <i>Acanthus ilicifolius</i> and <i>Kandelia obovata</i>	9

List of Figures

Figure 1 Mean height (cm) of *Acanthus ilicifolius* and *Kandelia obovata* monitored at Hang Hau Tsuen Channel from Jun 2013 to Mar 2015

Figure 2 Mean diameter (mm) of *Acanthus ilicifolius* and *Kandelia obovata* monitored at Hang Hau Tsuen Channel from Jun 2013 to Mar 2015

List of Annexes

Annex A Location of the mangrove zone and quadrate within Hang Hau Tsuen Channel
Annex B Overall view of mangrove compensation area

1.0 INTRODUCTION

1.1 Project Background

1.1.1 Hang Hau Tsuen is situated at the southern part of Lau Fau Shan bordering the Hang Hau Tsuen stream. A channel improvement project under an Environmental Permit (EP no: EP-343/2009) has been carried out to alleviate flooding occurred in the catchment by converting the existing Hang Hau Tsuen stream between Deep Bay and Deep Bay Road to an engineered channel that will meet the required flood protection standards. Habitat restoration will be performed after finished the construction work in the channel. In accordance with Clause 2.16 of the EP and Section 6.4 of the Environmental Monitoring and Audit (EM&A) Manual (the EM&A Manual) under the EP, to mitigate the loss of 0.07 ha of mangrove patches, a total of 0.07 ha (1:1 ratio) area at tidal zone on northern side of the constructed channel will be planted with various mangrove species. Monitoring was required to assess the growing condition of planted mangrove plants during the Operation Phase of the Project in accordance with Section 6.4 of the EM&A Manual.

1.1.2 The proposal and schedules for Operational Phase monitoring of compensatory mangrove planting had been submitted to AFCD on 14 May 2012. Comments on the proposal had been received from AFCD on 5 June 2012, and the revised proposal and schedules had been submitted to AFCD on 14 November 2012. No comment has been received from AFCD on 19 November 2012.

1.1.3 China-Hong Kong Ecology Consultants Co. (CHEC) has been appointed by ENVIRON Hong Kong Limited as ecologist to undertake the post-construction mangrove monitoring starting from June 2013 for 2 years.

1.1.4 Monitoring should be conducted once every quarter for two years after completion of the mangrove planting in accordance with Section 6.4 of the EM&A Manual.

1.1.5 This is the eighth and the last quarterly monitoring report presents the findings of the initial monitoring survey that was undertaken on 20th March 2015.

2.0 MANGROVE MONITORING MEHTHODOLOGY

2.1 Monitoring Equipment

2.1.1 Monitoring was involved physical measurement and photo record. Thus, tape/metallic ruler, vernier caliper and camera were used for the monitoring.

2.2 Quadrate

2.2.1 Locations of five quadrates of 5m x 5m in size were chosen at representative plantation area. The locations of quadrates were selected based on tidal level, species and ground characteristics as well as accessibility by foot. The location for each quadrate was marked by setting up bamboo or similar material at each corner of quadrates. The species and number of mangrove individual were counted within each quadrate. The location of mangrove zone and quadrates within the channel was shown in **Annex A**.

2.3 Measurement

2.3.1 In order to collect data consistent and comparable in temporal scale, for each planted plant species, 5 selected plants in each quadrate was marked by color rope or ribbon. Color rope or ribbon was tied on tree branch for marking only. No damage or any adverse effect was anticipated on the growth of mangrove trees. There was a maximum of 25 plants for each species will be selected for measurements if the species presented in all 5 quadrates. Every planted species was selected for monitoring. It is expected that at least two mangrove species was planted in the planting area. Maximum height of the selected individual plant was measured to a nearest centimeter based on growing form of plant.

2.3.2 Stem diameter for 5 selected plants of each species in each quadrate was measured by vernier caliper. A mark such as rope/ribbon was made on stem where diameter measurement will be carried out. Same orientation for the vernier caliper will be maintained for each measurement. Measurement will be taken to the nearest millimeter.

2.3.3 The overall health condition was assessed for each species within quadrate. The assessment in some inaccessible location was aided by binocular. The following was the health scheme for the assessment. The rate of survival of the mangroves after planting was estimated by visual observation.

2.3.4 Health scheme:

Good: Low mortality rate. Green foliage color. Dense foliage. No damage from floating rubbish or high water flow.

Fair: Low to medium mortality rate. Less dense foliage. Some yellowish foliage color recorded. Some leave or branches were damaged by floating rubbish, water flow or insect.

Poor: High mortality rate. Highly sparse crown and most foliage were drying up.

The plant may be seriously damaged.

2.4 Photo Record

- 2.4.1 Photos of overall view for mangrove compensation area and each quadrat was taken. For consistency, same photo location and angle for each measurement will try to be maintained but it may need adjustment due to site and plant change. Other site conditions and observations should also be recorded.

3.0 MONITORING RESULTS

3.1 Visual Inspection

- 3.1.1 The species and the total number of mangrove tree were counted within each quadrat. Two native species (*Acanthus ilicifolius*, *Kandelia obovata*) were planted on the compensatory mangrove planting area.
- 3.1.2 The overall health condition of each species within each quadrat was assessed and shown in **Table 1**. The total number, density and survival rate of mangrove tree within each quadrat were shown in **Table 2**. Overall survival rate of each mangrove species is higher than 75%, thus no replanting shall be implemented.
- 3.1.3 Generally, the overall health condition of *Acanthus ilicifolius* and *Kandelia obovata* was fair as green foliage color was observed during the monitoring survey. However, the health condition of *Kandelia obovata* in Quadrat 1 was assessed as “Poor to Fair” due to the mangrove tree on eastern side of Quadrat 1 was dead since the inspection on December 2013. As that side of Quadrat 1 was nearest to an outfall, it was believed that eastern side of Quadrat 1 was immersed by the discharge from outfall and lead to the death of mangrove tree on that area. However, the affected area was small compare to the whole compensatory site, and a total of 0.07 (1:1 ratio) compensation area is still complied as regeneration in other area was observed. Thus the loss of small proportion of trees is minor.
- 3.1.4 One of the selected *Kandelia obovate* was found dead in Quadrat 2. As the rest of the trees in the same quadrat were observed to have positive growth without significant change, it was believed that the tree was dead naturally and reason of the death is not related to any impacts raised from the compensatory site.

3.2 Measurement of selected plant individual

- 3.2.1 Maximum height and stem diameter of maximum 5 selected individual of each species in each quadrat was measured during the monitoring survey. Result of the measurement was shown in **Table 1**.
- 3.2.2 Mean height & diameter of *Acanthus ilicifolius* and *Kandelia obovata* was calculated and shown in **Tables 3 & 4**. The change of measurement parameters since June 2013 was shown in **Charts 1 & 2**.
- 3.2.3 By compare the measurement record for both last and current inspection, most mangrove trees were recorded in positive growth and increment in height or diameter was observed. The comparison for the measurement was shown on **Tables 1 to 4**.

Table 1 Mangrove plant growth and health monitoring for each planted species

Date: 20 March 2015

Temperature: 25°C

Quadrat	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
Acanthus ilicifolius	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Health (G/FP)	(Unchange/Better/Poor)
	Dead	Dead	63	18.1	91	10.85	107	11.8	59	18.6	Fair	Unchange
Kandelia obovata	Dead	Dead	63	18.1	Dead	Dead	Dead	Dead	59	18.6	Poor to Fair	Unchange
Quadrat 2	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
Acanthus ilicifolius	80	10.2	97	10.7	102	13.8	139	13.2	110	11.3	Health (G/FP)	(Unchange/Better/Poor)
Kandelia obovata	63	16.5	Dead	Dead	45	17.4	87	29.4	75	21	Fair	Unchange
Quadrat 3	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
Acanthus ilicifolius	118	14.8	127	13	135	13.8	70	15.7	57	10.4	Health (G/FP)	(Unchange/Better/Poor)
Kandelia obovata	70	18.6	117	26.4	73	24	68	17	79	19	Fair	Unchange
Quadrat 4	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
Acanthus ilicifolius	46	8.54	120	13.7	30	6.7	94	10.98	101	12	Health (G/FP)	(Unchange/Better/Poor)
Kandelia obovata	46	8.54	120	13.7	30	6.7	94	10.98	101	12	Fair	Unchange
Quadrat 5	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
Acanthus ilicifolius	73	12.4	84	11.58	67	10.5	40	12.5	113	13.3	Health (G/FP)	(Unchange/Better/Poor)
Kandelia obovata	80	19.93	112	20.6	50	12.5	111	16.9	54	15.5	Fair	Unchange

Table 2 Record sheet for mangrove plant density and survival rate monitoring

Date	Parameter	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Overall Survival rate in five Quadrates (%)
4 th Jun 2013	Initial total number of mangrove tree	18	24	31	20	18	N.A
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.72	0.96	1.24	0.8	0.72	N.A
12 th Sep 2013	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	86%	100%	89%	84%	100%	91.8%
		<i>Acanthus ilicifolius</i>					
	Survival rate (%)	88%	89%	94%	N/A	93%	91%
		<i>Kandelia obovata</i>					
03 rd Dec 2013	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	57%	94%	89%	84%	100%	85%
		<i>Acanthus ilicifolius</i>					
	Survival rate (%)	63%	78%	94%	N/A	93%	82%
		<i>Kandelia obovata</i>					

Date	Parameter	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Overall Survival rate in five Quadrats (%)	
04 th Mar 2014	Initial total number of mangrove tree	23	26	27	31	20	N.A	
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1.04	1.08	1.24	0.8	N.A	
	Survival rate (%)	<i>Acanthus ilicifolius</i>	55%	94%	89%	84%	100%	85%
		<i>Kandelia obovata</i>	60%	78%	94%	N.A	93%	82%
20 th Jun 2014	Initial total number of mangrove tree	23	26	27	31	20	N.A	
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1.04	1.08	1.24	0.8	N.A	
	Survival rate (%)	<i>Acanthus ilicifolius</i>	55%	94%	89%	84%	100%	85%
		<i>Kandelia obovata</i>	59%	78%	94%	N.A	93%	82%
26 th Sept 2014	Initial total number of mangrove tree	23	26	27	31	20	N.A	
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1.04	1.08	1.24	0.8	N.A	
	Survival rate (%)	<i>Acanthus ilicifolius</i>	55%	94%	89%	84%	100%	85%
		<i>Kandelia obovata</i>	59%	78%	94%	84%	100%	85%

8th Quarterly Mangrove Monitoring Report (March 2015)
 Contract No. YL/2009/01 – Hang Hau Tsuen at Lau Fau Shan

Date	Parameter	Quadratrate 1	Quadratrate 2	Quadratrate 3	Quadratrate 4	Quadratrate 5	Overall Survival rate in five Quadratrates (%)
23 rd Dec 2014	<i>Kandelia obovata</i>	59%	78%	94%	N/A	93%	82%
	Initial total number of mangrove tree	23	26	27	31	20	N/A
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1.04	1.08	1.24	0.8	N/A
	Survival rate (%)	55%	94%	89%	84%	100%	85%
	<i>Acanthus ilicifolius</i>						
	<i>Kandelia obovata</i>	59%	78%	94%	N/A	93%	82%
20 th Mar 2015	Initial total number of mangrove tree	23	25	27	31	20	N/A
	Initial density of mangrove tree (No. of mangrove tree / m ²)	0.92	1	1.08	1.24	0.8	N/A
	Survival rate (%)	55%	94%	89%	84%	100%	85%
	<i>Acanthus ilicifolius</i>						
	<i>Kandelia obovata</i>	59%	74%	94%	N/A	93%	80%
	Change of survival rate compared with last month (Unchanged/ better/poor)	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged
	Unchanged	Poor	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged

Table 3 Mean height of Acanthus ilicifolius and Kandelia obovata

Month	Mean Height (cm)							Change of mean height (Positive growth, negative)	
	Jun 2013	Sept 2013	Dec 2013	Mar 2014	June 2014	Sept 2014	Dec 2014		Mar 2015
Acanthus ilicifolius	92.81	93.2	94.85	97.18	85.54	88.64	90.05	90.95	Positive growth
Kandelia obovata	75.05	73.05	65	65.92	66.525	72.41	73.82	75.38	Positive growth

Table 4 Mean diameter of Acanthus ilicifolius and Kandelia obovata

Month	Mean Diameter (mm)							Change of mean height (Positive growth, negative)	
	Jun 2013	Sep 2013	Dec 2013	Mar 2014	June 2014	Sept 2014	Dec 2014		Mar 2015
Acanthus ilicifolius	11.05	10.94	10.83	11.13	10.5312	11.05	11.47	11.90	Positive growth
Kandelia obovata	14.26	14.96	15.39	15.59	16.0145	17.66	19.01	19.46	Positive growth

3.3 Photographic record

3.3.1 The overall view of the mangrove compensation area and each quadrat was presented by a number of photos taken at specific location along the channel. The photos will be useful to illustrate and compare the mangrove plant condition with future record. The overall view of the mangrove compensation area and each quadrat for both last and current inspection was presented in **Annex B, Photo 1-8** and **Photo 9-18** respectively.

3.3.2 By compare the photographic record for both last and current inspection, there was no significant change for the condition of mangrove trees in the monitoring site. The comparison for the photographic record was shown on **Photo 9-18**.

4.0 CONCLUSION

- 4.1.1 The post-construction mangrove monitoring survey was carried out on 20th March 2015. The species and the total number of mangrove tree were counted within each quadrat. The overall health condition of each species within each quadrat was assessed and shown in **Table 1**. The total number, density and survival rate of mangrove tree within each quadrat were shown in **Table 2**. Overall survival rate of each mangrove species is higher than 75%, thus no replanting shall be implemented.
- 4.1.2 The health condition of *Kandelia obovata* in Quadrat 1 was assessed as “Poor to Fair” due to the death of mangrove tree on eastern side. It was believed that eastern side of Quadrat 1 was immersed by discharge from nearest outfall and lead to the death of mangrove tree. However, the affected area was small compare to the whole compensatory site, and a total of 0.07 (1:1 ratio) compensation area is still complied as regeneration in other area was observed. Thus the loss of small proportion of trees is minor.
- 4.1.3 One of the selected *Kandelia obovate* was found dead in Quadrat 2. As the rest of the trees in the same quadrat were observed to have positive growth without significant change, it was believed that the tree was dead naturally and reason of the death is not related to any impacts raised from the compensatory site. Generally, the overall health condition of *Acanthus ilicifolius* and *Kandelia obovata* was fair.
- 4.1.4 Maximum height and stem diameter of maximum 5 selected individual of each species in each quadrat was measured, the result of the measurement was shown in **Table 1**. Mean height & diameter of *Acanthus ilicifolius* and *Kandelia obovata* was calculated and shown in **Tables 3 & 4**. The change of measurement parameters since June 2013 was shown in **Charts 1 & 2**. Generally, most mangrove trees were recorded in positive growth and increment in height or diameter was observed.
- 4.1.5 The overall view of the mangrove compensation area and each quadrat was presented in **Photos 1-4** and **Photos 5-9** respectively.
- 4.1.6 Monitoring should be conducted once every quarter for two years after completion of the mangrove planting in accordance with Section 6.4 of the EM&A Manual. Thus this is the eighth and the last post-construction quarterly mangrove monitoring report, and a final report summarizing the monitoring results over the entire operational monitoring period and its findings will be prepared separately.

Figures

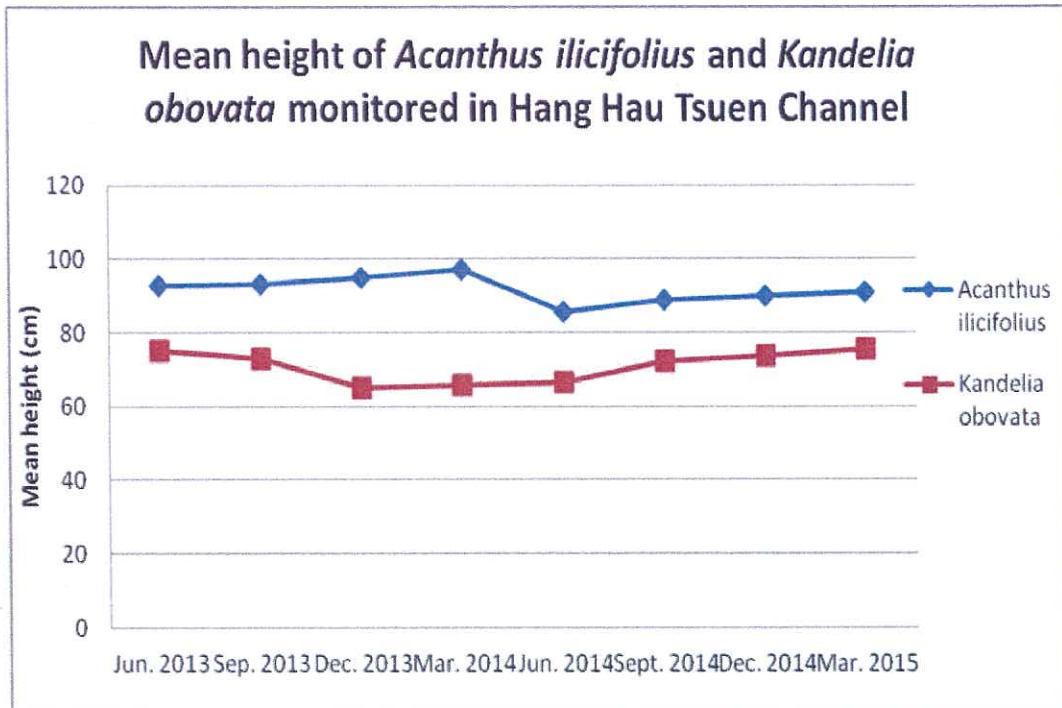


Figure 1 - Mean height (cm) of *Acanthus ilicifolius* and *Kandelia obovata* monitored at Hang Hau Tsuen Channel from Jun 2013 to Mar 2015

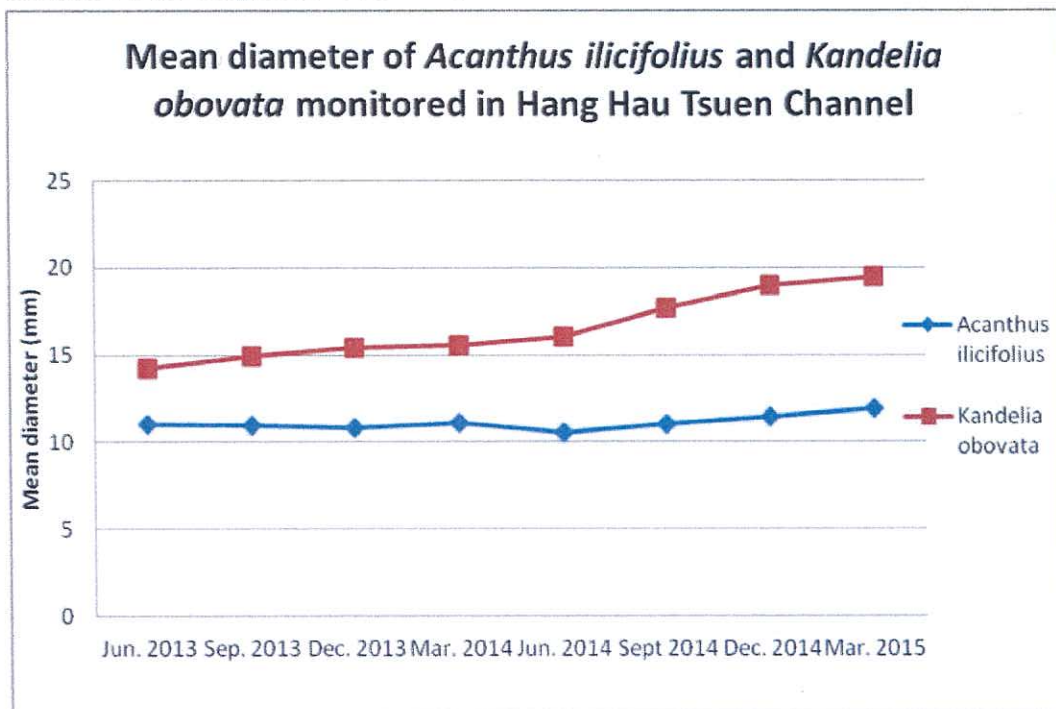
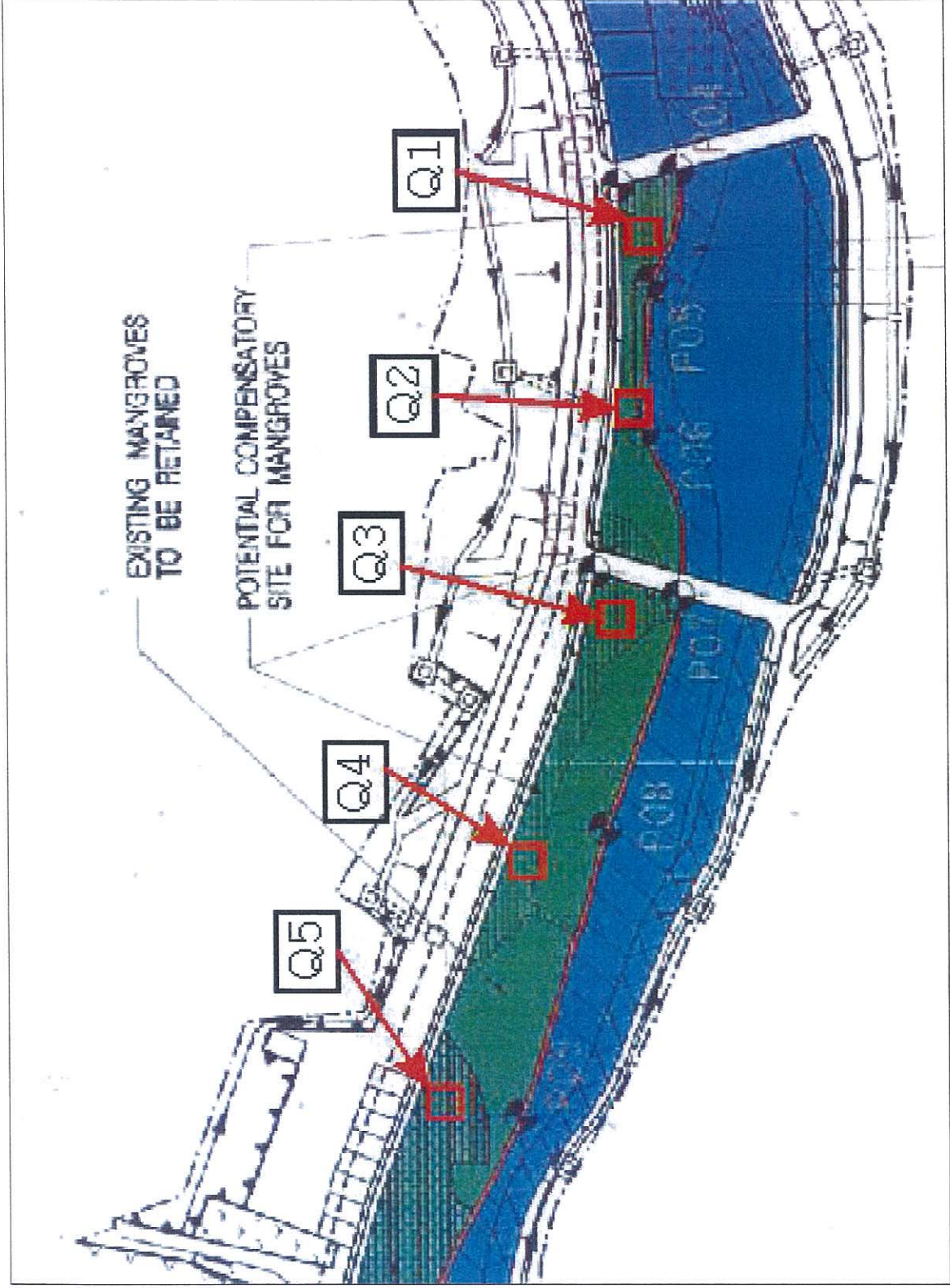


Figure 2 - Mean diameter (mm) of *Acanthus ilicifolius* and *Kandelia obovata* monitored at Hang Hau Tsuen Channel from Jun 2013 to Mar 2015

Annex A



Annex A: Location of mangrove zone and quadrates within Hang Hau Tsuen Channel

Annex B



1. Last inspection



2. Current inspection



3. Last inspection



4. Current inspection



5. Last inspection



6. Current inspection



7. Last inspection



8. Current inspection

Post-construction mangrove monitoring – Mar 2015

Overall view of mangrove compensation area for both last and current inspection

Photo 1 - 8

Date 20th Mar 2015

Quadrat 1



9. Last inspection



10. Current inspection: No significant change

Quadrat 2



11. Last inspection



12. Current inspection: No significant change

Quadrat 3



13. Last inspection



14. Current inspection: No significant change

Post-construction mangrove monitoring – Mar 2015

Overall view of Quadrat 1 – 3 for both last and current inspection

Photo 9 - 14

Date 20th Mar 2015

Quadrat 4



15. Last inspection



16. Current inspection: No significant change

Quadrat 5



17. Last inspection



18. Current inspection: No significant change

Post-construction mangrove monitoring – Mar 2015

Overall view of Quadrat 4-5 for both last and current inspection

Photo 15-18

Date 20th Mar 2015