

**Environmental Monitoring and Audit  
for Contaminated Mud Pits to the  
South of The Brothers and at East  
Sha Chau (2012-2017) – Investigation  
Agreement No. CE 23/2012(EP)**

**48<sup>th</sup> Monthly Progress Report for Contaminated  
Mud Pits to the South of The Brothers and at  
East Sha Chau – August 2016**

Final (Revision 1)

30 September 2016

**Environmental Resources Management**  
16/F Berkshire House  
25 Westlands Road  
Quarry Bay, Hong Kong  
Telephone (852) 2271 3000  
Facsimile (852) 2723 5660  
[www.erm.com](http://www.erm.com)



**Dredging, Management and Capping of Contaminated Sediment Disposal  
Facility to the South of The Brothers**

**Environmental Certification Sheet  
EP-427/2011/A**

**Reference Document/Plan**

Document/Plan to be Certified/ Verified:	48 <sup>th</sup> Monthly Progress Report for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau - August 2016
Date of Report:	12 September 2016
Date prepared by ET:	12 September 2016
Date received by IA:	12 September 2016

**Reference EP Condition**

Environmental Permit Condition:	Condition No.: 4.4
4 hard copies and 1 electronic copy of monthly EM&A Report shall be submitted to the Director within 2 weeks after the end of the reporting month. The EM&A Reports shall include a summary of all non-compliance (exceedances) of the environmental quality performance limits (Action and Limit Levels). The submissions shall be certified by the ET Leader and verified by the Independent Auditor. Additional copies of the submission shall be provided to the Director upon request by the Director.	

**ET Certification**

I hereby certify that the above referenced document/plan complies with the above referenced condition of EP-427/2011/A

Craig A. Reid,  
Environmental Team Leader:



Date: 12/9/2016

**IA Verification**

I hereby verify that the above referenced document/plan complies with the above referenced condition of EP-427/2011/A

Dr Wang Wen Xiong,  
Independent Auditor:



Date: 12/9/2016

# Environmental Monitoring and Audit for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau (2012-2017) – Investigation




## 48<sup>th</sup> Monthly Progress Report for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau – August 2016

Final (Revision 1)

### Environmental Resources Management

16/F  
 Berkshire House  
 25 Westlands Road  
 Quarry Bay  
 Hong Kong  
 Telephone: (852) 2271 3000  
 Facsimile: (852) 2723 5660  
 E-mail: post.hk@erm.com  
 http://www.erm.com

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Summary:  This document presents the 48 <sup>th</sup> monthly progress report for Contaminated Mud Pits at the South of The Brothers and at East Sha Chau.		Date: 30 September 2016			
		Approved by:   Craig A. Reid Partner			
v1	48 <sup>th</sup> Monthly Progress Report for ESC CMPs and SB CMPs	RC	JT	CAR	30/9/16
v0	48 <sup>th</sup> Monthly Progress Report for ESC CMPs and SB CMPs	RC	JT	CAR	12/9/16
Revision	Description	By	Checked	Approved	Date
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**Agreement No. CE 23/2012 (EP)**  
**Environmental Monitoring and Audit**  
**for Contaminated Mud Pits to the South of The Brothers and at East Sha**  
**Chau (2012-2017) - Investigation**

**48<sup>TH</sup> MONTHLY PROGRESS REPORT FOR AUGUST 2016**

**1.1 BACKGROUND**

1.1.1 Since early 1990s, contaminated sediment <sup>(1)</sup> arising from various construction works (e.g. dredging and reclamation projects) in Hong Kong has been disposed of at a series of seabed pits at East of Sha Chau (ESC). In late 2008, a review indicated that the existing and planned facilities at ESC would not be able to meet the disposal demand after 2012. In order to meet this demand, the Hong Kong Special Administrative Region Government (HKSARG) decided to implement a new contained aquatic disposal (CAD) <sup>(2)</sup> facility at the South of The Brothers (SB CMPs) which had been under consideration for a number of years.

1.1.2 The environmental acceptability of the construction and operation of the Project had been confirmed by findings of the associated Environmental Impact Assessment (EIA) study completed in 2005 under *Agreement No. CE 12/2002(EP)* <sup>(3)</sup>. The Director of Environmental Protection (DEP) approved this EIA report under the *Environmental Impact Assessment Ordinance (Cap. 499) (EIAO)* in September 2005 (*EIA Register No.: AEIAR-089/2005*).

1.1.3 In accordance with the EIA recommendation, prior to commencement of construction works for the SB CMPs, the Civil Engineering and Development Department (CEDD) undertook a detailed review and update of the EIA findings for the SB site <sup>(4)</sup>. Findings of the EIA review undertaken in 2009/2010 confirmed that the construction and operation of the SB site had been predicted to be environmentally acceptable.

(1) According to the Management Framework of Dredged/ Excavated Sediment of ETWB TC(W) No. 34/2002, contaminated sediment in general shall mean those sediment requiring Type 2 – Confined Marine Disposal as determined according to this TC(W).

(2) CAD options may involve use of excavated borrow pits, or may involve purpose-built excavated pits. CAD sites are those which involve filling a seabed pit with contaminated mud and capping it with uncontaminated material such that the original seabed level is restored and the contaminated material is isolated from the surrounding marine environment.<sup>7</sup>

(3) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/ East of Sha Chau Area (*Agreement No. CE 12/2002(EP)*)

(4) Under the CEDD study *Contaminated Sediment Disposal Facility to the South of The Brothers (Agreement No. FM 2/2009)*

1.1.4 *Environmental Permits (EPs) (EP-312/2008/A and EP-427/2011A)* were issued by the Environmental Protection Department (EPD) to the CEDD, the Permit Holder, on 28 November 2008 for ESC CMP V and on 23 December 2011 for SB CMPs, respectively. Under the requirements of the *EPs*, an Environmental Monitoring and Audit (EM&A) programme as set out in the EM&A Manuals <sup>(1)</sup> <sup>(2)</sup> is required to be implemented for the CMPs.

1.1.5 The present EM&A programme under *Agreement No. CE 23/2012 (EP)* covers the dredging, disposal and capping operations of the SB CMPs as well as ESC CMPs. Detailed works schedule for ESC CMPs and SB CMPs is shown in *Figure 1.1*. In August 2016, the following works were being undertaken:

- Disposal of contaminated mud at ESC CMP Vd; and
- Capping operation at SB CMP 2.

*Figure 1.1 Works Schedule for ESC CMPs and SB CMPs*

Pit	Operation	2012			2013					2014					2015					2016					2017						
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
ESC CMP	Dredging																														
	Backfilling																														
	Capping																														
SB CMP 1	Dredging																														
	Backfilling																														
	Capping																														
SB CMP 2	Dredging																														
	Backfilling																														
	Capping																														

**1.2 REPORTING PERIOD**

1.2.1 This 48<sup>th</sup> *Monthly Progress Report* covers the EM&A activities for the reporting month of August 2016.

**1.3 DETAILS OF SAMPLING AND LABORATORY TESTING ACTIVITIES**

1.3.1 The following monitoring activities have been undertaken for ESC CMPs in August 2016:

- *Benthic Recolonisation Studies of ESC CMP IV* was undertaken on 5 August 2016;
- *Sediment Chemistry after a Major Storm of ESC CMPs* was undertaken on 5 August 2016;

(1) ERM (2012) Environmental Monitoring and Audit (EM&A) Manual. Final First Review. Environmental Monitoring and Audit for Contaminated Mud Pits to the South of the Brothers and at East Sha Chau (2012-2017) – Investigation. Agreement No. CE 23/2012(EP). Submitted to EPD in November 2012.

(2) ERM (2010) Environmental Monitoring and Audit (EM&A) Manual. Final Second Review. Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau (2009-2013) – Investigation. Agreement No. CE 4/2009(EP). Submitted to EPD in November 2010.

- *Routine Water Quality Monitoring of ESC CMPs* was undertaken on 8 August 2016;
- *Pit Specific Sediment Chemistry of ESC CMP Vd* was undertaken on 9 August 2016;
- *Demersal Trawling of ESC CMPs* was undertaken on 10 and 11 August 2016.
- *Water Column Profiling of ESC CMP Vd* was undertaken on 15 August 2016;
- *Cumulative Impact Sediment Chemistry of ESC CMPs* was undertaken on 11 and 12 August 2016;
- *Sediment Toxicity Test of ESC CMPs* was undertaken on 11 and 12 August 2016; and

1.3.2 The following monitoring activities have been undertaken for SB CMPs in August 2016:

- *Water Quality Monitoring During Capping of SB CMPs* was undertaken on 20 August 2016; and
- *Benthic Recolonisation Studies of SB CMP 1* was undertaken on 23 August 2016.

#### **1.4 DETAILS OF OUTSTANDING SAMPLING AND/OR ANALYSIS**

1.4.1 No outstanding sampling remained for August 2016.

1.4.2 A summary of field activities conducted are presented in *Annex A*. The following analyses are in progress and will be presented in the corresponding quarterly report:

- Species identification of the biota samples collected from *Demersal Trawling for ESC CMPs* in July and August 2016;
- Laboratory analyses of sediment samples collected for *Benthic Recolonisation Studies of ESC CMPs and SB CMP 1* in August 2016; and
- Laboratory analyses for *Sediment Toxicity Test of ESC CMPs* in August 2016.

1.4.3 The following laboratory analyses are in progress during the preparation of this monthly report and will be presented in the next monthly report once the data are available:

- Laboratory analyses of sediment samples collected for *Pit Specific Sediment Chemistry of ESC CMP Vd* in August 2016; and

- Laboratory analyses of sediment samples collected for *Cumulative Impact Sediment Chemistry of ESC CMP Vd* in August 2016.

## 1.5 **BRIEF DISCUSSION OF THE MONITORING RESULTS FOR ESC CMPs**

1.5.1 Brief discussion of the monitoring results of the following activities for ESC CMPs is presented in this 48<sup>th</sup> *Monthly Progress Report*:

- *Routine Water Quality Monitoring of ESC CMPs* in August 2016;
- *Water Column Profiling of ESC CMP Vd* in August 2016; and
- *Sediment Chemistry after a Major Storm of ESC CMPs* in August 2016.

### 1.5.2 ***Routine Water Quality Monitoring of ESC CMPs – August 2016***

1.5.3 *Routine Water Quality Monitoring of ESC CMPs* was undertaken on 8 August 2016. The monitoring results have been assessed for compliance with the Water Quality Objectives (WQOs) set by Environmental Protection Department (EPD). This consists of a review of the EPD routine water quality monitoring data for the wet season period (April to October) of 2005 - 2014 from stations in the Northwestern Water Control Zone (WCZ), where the ESC CMPs are located <sup>(1)</sup>. For Salinity, the averaged value obtained from the Reference stations was used for the basis as the WQO. Levels of Dissolved Oxygen (DO) and Turbidity were also assessed for compliance with the Action and Limit Levels (see *Table B1 of Annex B* for details). The monitoring results are shown in *Tables B2 and B3 of Annex B* and *Figures 1 - 10 of Annex C*. A total of sixteen (16) monitoring stations were sampled in August 2016 as shown in *Figure 1.2*.

#### *In-situ Measurements*

- 1.5.4 Graphical presentation of the monitoring results (Temperature, DO, pH, Salinity and Turbidity) is shown in *Figures 1 - 6 of Annex C*. Analyses of results for August 2016 indicated that the levels of pH and DO complied with the WQOs at all stations (Impact, Intermediate, Reference and Ma Wan stations) in August 2016 (*Table B2 of Annex B*; *Figures 1 and 3 of Annex C*). Levels of Salinity at most stations complied with the WQOs, except for Ma Wan station (*Table B2 of Annex B*; *Figure 5 of Annex C*). The higher Salinities recorded at Ma Wan station are likely to be caused by the larger separation distance to Pearl River mouth, which release a large amount of freshwater runoff in the area during flooding, when compared to the Reference stations.
- 1.5.5 The levels of DO and Turbidity complied with the Action and Limit Levels at all stations (*Table B2 of Annex B*; *Figures 3 and 6 of Annex C*).

<sup>(1)</sup> <http://epic.epd.gov.hk/EPICRIVER/marine/?lang=en>





Figure 1.2

Routine & Capping Water Quality Sampling Stations (Ebb-Tide) for CMPV

File: CMPV\0103262\_R\_C\_WQMS\_ebb.mxd  
Date: 29/10/2009

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1.5.6 Overall, *in-situ* measurement results of the *Routine Water Quality Monitoring* indicated that the disposal operation at ESC CMP Vd did not appear to cause any unacceptable impacts in water quality in August 2016.

#### *Laboratory Measurements*

1.5.7 Laboratory analysis of August 2016 results indicated that concentrations of Cadmium, Lead, Silver and Mercury were below their limit of reporting at all stations. Arsenic, Chromium, Nickel, Copper and Zinc were detected in August 2016 samples and the concentrations of these metals and metalloid were similar amongst stations (*Table B3 of Annex B; Figure 7 of Annex C*).

1.5.8 For nutrients, concentrations of Total Inorganic Nitrogen (TIN) at all stations in August 2016 exceeded the WQO (0.5 mg/L) (*Table B3 of Annex B; Figure 8 of Annex C*). It should be noted that due to the effect of Pearl River, the North Western WCZ has historically experienced higher levels of TIN<sup>(1)</sup>. Since TIN concentrations were recorded to be similar amongst all stations, the exceedances of TIN WQO at all stations are unlikely to be caused by the disposal operation at ESC CMP Vd. Concentrations of Ammonia Nitrogen (NH<sub>3</sub>-N) were relatively similar amongst all stations (*Table B3 of Annex B; Figure 8 of Annex C*). Levels of 5-day Biochemical Oxygen Demand (BOD<sub>5</sub>) appear to be higher at Ma Wan station in August 2016 (*Table B3 of Annex B; Figure 9 of Annex C*).

1.5.9 Analyses of results for August 2016 indicated that the SS levels complied with the WQO (11.1 mg/L for wet season) and the Action and Limit Levels at all stations (*Table B3 of Annex B; Figure 10 of Annex C*).

1.5.10 Overall, results of the *Routine Water Quality Monitoring* indicated that the disposal operation at ESC CMP Vd did not appear to cause any unacceptable deterioration in water quality in August 2016. Detailed statistical analysis will be presented in the Quarterly Report to investigate any spatial and temporal trends of potential concern.

#### **1.5.11 *Water Column Profiling of ESC CMP Vd - August 2016***

1.5.12 *Water Column Profiling* was undertaken at a total of two sampling stations (Upstream and Downstream stations) on 15 August 2016. The monitoring results have been assessed for compliance with the WQOs (see *Section 1.5.3* for details). Levels of DO and Turbidity were also assessed for compliance with the Action and Limit Levels (see *Table B1 of Annex B* for details).

<sup>(1)</sup> [http://www.epd.gov.hk/epd/misc/marine\\_quality/1986-2005/textonly/eng/index.htm](http://www.epd.gov.hk/epd/misc/marine_quality/1986-2005/textonly/eng/index.htm)

*In-situ Measurements*

1.5.13 Analyses of results for August 2016 indicated that levels of Salinity and pH complied with the WQOs at both Downstream and Upstream stations (*Table B4 of Annex B*). Levels of DO at Upstream station was lower than the WQO (4 mg/L for wet season). However, DO and Turbidity at all stations complied with the Action and Limit Levels (*Table B4 of Annex B*).

*Laboratory Measurements for Suspended Solids (SS)*

1.5.14 Analyses of results for August 2016 indicated that the SS levels were higher than the WQO at Downstream station. However, both Upstream and Downstream stations complied with the Action and Limit Levels (*Table B4 of Annex B*).

1.5.15 Overall, the monitoring results indicated that the mud disposal operation at ESC CMP Vd did not appear to cause any deterioration in water quality during this reporting period.

1.5.16 *Sediment Chemistry after a Major Storm of ESC CMPs – August 2016*

1.5.17 Sampling for Sediment Chemistry after a Major Storm Event was conducted at nine (9) monitoring stations (*Figure 1.3*) on 5 August 2016 after the visit of Typhoon Nida, which led to the issue of Gale or Storm Wind Signal No.8 on 1 August 2016. The track of Nida is shown in *Figure 1.4*.

**Figure 1.4** *Track of Typhoon Nida from 29 July to 3 August 2016 (Source: Hong Kong Observatory)*

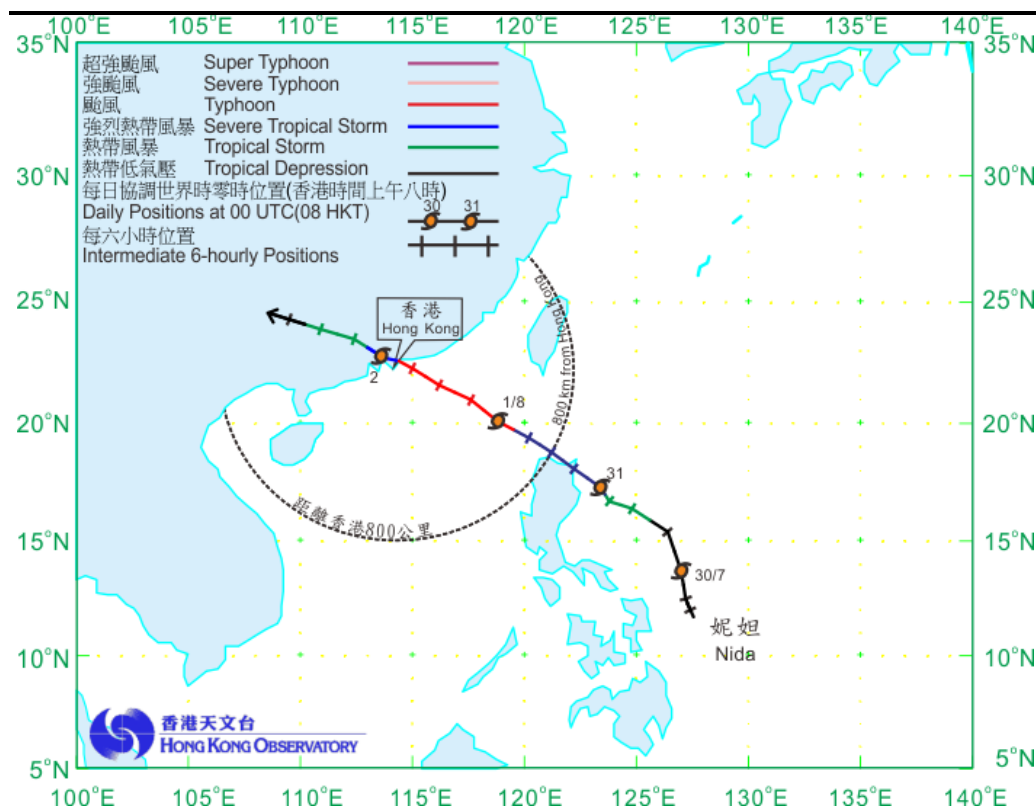




Figure 1.3

Cumulative Impacts Sediment Quality Monitoring Stations for CMPV

File: 0103262\_SQMS\_cum impact.mxd  
Date: 29/10/2009

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1.5.18 Analyses of results for the *Sediment Chemistry after a Major Storm* indicated that the concentrations of all inorganic contaminants were below the LCEL (*Figures 11 and 12 of Annex B*).

1.5.19 Overall, there appeared to be no evidence showing the failure of CMPs in retaining disposed mud or causing contamination of sediments after the major storm event in August 2016.

## **1.6 BRIEF DISCUSSION OF THE MONITORING RESULTS FOR SB CMPs**

1.6.1 Brief discussion of the monitoring results of the following activities for SB CMPs is presented in this 48<sup>th</sup> *Monthly Progress Report*:

- *Water Quality Monitoring during Capping Operations of SB CMPs in August 2016.*

### **1.6.2 *Water Quality Monitoring during Capping of SB CMPs – August 2016***

1.6.3 The monitoring results obtained during August 2016 sampling in the wet season have been assessed for compliance with the WQOs (see *Section 1.5.3* for details). Levels of DO and Turbidity were also assessed for compliance with the Action and Limit Levels (see *Table B5 of Annex B* for details). A total of twenty (20) monitoring stations were sampled in August 2016 as shown in *Figure 1.5*. Graphical presentation of the monitoring results is provided in *Annex C*.

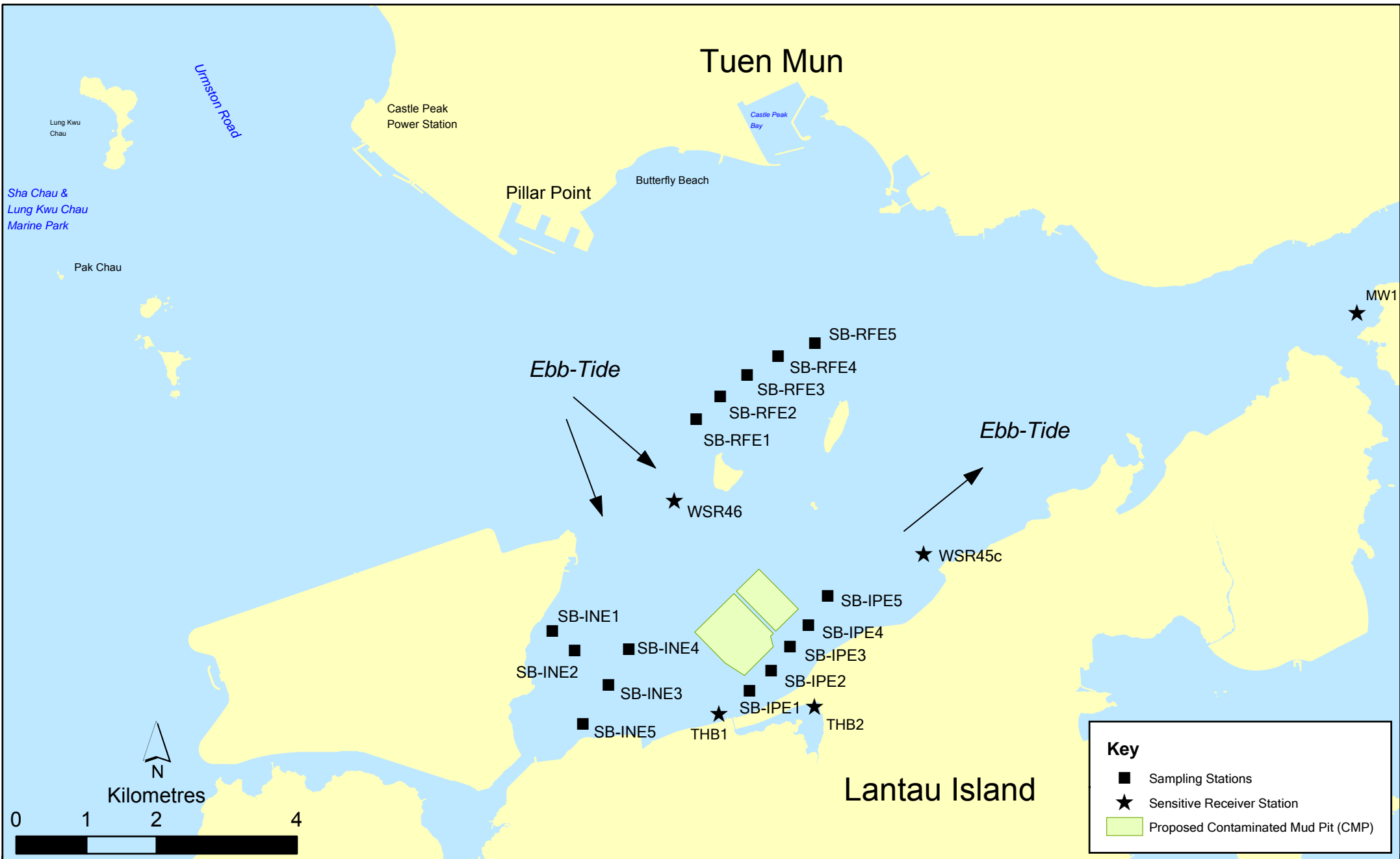


Figure 1.5

Routine Water Quality Sampling Stations (Ebb-Tide) for South Brothers Facility

### *In-situ Measurements*

- 1.6.4 Graphical presentation of the monitoring results (Temperature, DO, pH, Salinity and Turbidity) is shown in *Figures 13 - 18 of Annex C*. Levels of pH at all stations in August 2016 complied with the WQO (*Table B6 of Annex B; Figure 13 of Annex C*). The levels of Turbidity at all stations complied with the Action and Limit levels in August 2016 (*Table B6 of Annex B; Figure 14 of Annex C*). DO at all stations also complied with the WQO and the Action and Limit levels in August 2016 (*Table B6 of Annex B; Figure 16 of Annex C*).
- 1.6.5 Levels of Salinity at most stations complied with the WQO except at Tai Ho Bay 2 station (*Table B6 of Annex B; Figure 18 of Annex C*). The lower Salinities recorded at Tai Ho Bay 2 are likely due to the close proximity of the nearby streams, which release large amount of freshwater runoff in the area during flooding.

### *Laboratory Measurement*

- 1.6.6 Concentrations of SS were recorded higher than the WQO (11.1 mg/L for wet season) at Reference, Intermediate, Ma Wan and Tai Mo To stations in August 2016 (*Table B6 of Annex B; Figure 19 of Annex C*). However, levels of SS at all stations complied with the Action and Limit Levels (*Table B4 of Annex B*).
- 1.6.7 For nutrients, concentrations of NH<sub>3</sub> were relatively similar amongst all stations (*Table B6 of Annex B; Figure 20 of Annex C*). TIN at all stations exceeded the WQO of 0.5 mg/L (*Table B6 of Annex B; Figure 21 of Annex C*). As discussed in *Section 1.5.8*, the North Western WCZ has historically experienced higher levels of TIN and such exceedances of TIN WQO at all stations are unlikely to be caused by the disposal operation at CMP 2. Levels of BOD<sub>5</sub> appeared to be higher at Tai Ho Bay 1 station in August 2016 (*Table B6 of Annex B; Figure 22 of Annex C*).
- 1.6.8 Overall, the monitoring results indicated that the capping operation at CMP 2 did not appear to cause any unacceptable deterioration in water quality in August 2016. Statistical analysis will be undertaken and presented in the quarterly report to investigate whether the capping operations at CMP 2 is causing any unacceptable impacts in water quality of the area.

**1.7**                    **ACTIVITIES SCHEDULED FOR THE NEXT MONTH**

1.7.1                  The following monitoring activities will be conducted in the next monthly period of September 2016 for ESC CMPs:

- *Water Column Profiling of ESC CMP Vd; and*
- *Pit Specific Sediment Chemistry of ESC CMP Vd.*

1.7.2                  No monitoring activities will be scheduled in the next monthly period of September 2016 for SB CMPs.

1.7.3                  The sampling schedule is presented in *Annex A*.

**1.8**                    **STUDY PROGRAMME**

1.8.1                  A summary of the Study programme is presented in *Annex D*.



Annex A

## Sampling Schedule

Annex A1 - Environmental Monitoring and Audit Sampling Schedule for East of Sha Chau (September 2012 - February 2017)

		2012				2013				2014				2015				2016				2017																					
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
<b>Pit Specific Sediment Chemistry</b>																																											
Active-Pit	ESC-NPDA	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	ESC-NPDB	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Pit-Edge	ESC-NEDA	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	ESC-NEDB	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Near-Pit	ESC-NNDA	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	ESC-NNDB	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<b>Cumulative Impact Sediment Chemistry</b>																																											
Near-field Stations	ESC-RNA					*	*					*	*																				*	*							*	*	
	ESC-RNB					*	*					*	*																				*	*							*	*	
Mid-field Stations	ESC-RMA					*	*					*	*																				*	*							*	*	
	ESC-RMB					*	*					*	*																				*	*							*	*	
Capped Pit Stations	ESC-RCA					*	*					*	*																				*	*							*	*	
	ESC-RCB					*	*					*	*																				*	*							*	*	
Far-Field Stations	ESC-RFA					*	*					*	*																				*	*							*	*	
	ESC-RFB					*	*					*	*																				*	*							*	*	
Ma Wan Station	MW1					*	*					*	*																				*	*							*	*	
<b>Sediment Toxicity Tests</b>																																											
Near-Field Stations	ESC-TDA					*						*																					*	*							*	*	
	ESC-TDB					*						*																					*	*							*	*	
Reference Stations	ESC-TRA					*						*																					*	*							*	*	
	ESC-TRB					*						*																					*	*							*	*	
Ma Wan Station	MW1					*						*																					*	*							*	*	
<b>Tissue/ Whole Body Sampling</b>																																											
Impact Stations	ESC-INA					*						*																					*	*							*	*	
	ESC-INB					*						*																					*	*							*	*	
Reference	ESC-TNA					*						*																					*	*							*	*	
	ESC-TNB					*						*																					*	*							*	*	
	ESC-TSA					*						*																					*	*							*	*	
	ESC-TSB					*						*																					*	*							*	*	
<b>Demersal Trawling</b>																																											
Impact Stations	ESC-INA					*	*					*	*																				*	*							*	*	
	ESC-INB					*	*					*	*																				*	*							*	*	
Reference Stations	ESC-TNA					*	*					*	*																				*	*							*	*	
	ESC-TNB					*	*					*	*																				*	*							*	*	
	ESC-TSA					*	*					*	*																				*	*							*	*	
	ESC-TSB					*	*					*	*																				*	*							*	*	
<b>Water Column Profiling</b>																																											
Plume Stations	WCP1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	WCP2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	











Annex A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (July 2012 - February 2017)

			2012					2013					2014					2015					2016					2017																		
			J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
<b>Capping Water Quality Monitoring</b>																																														
<b>Ebb Tide</b>																																														
Impact Stations Downcurrent	SB-IP1	4 times per year																																												
	SB-IP2	4 times per year																																												
	SB-IP3	4 times per year																																												
	SB-IP4	4 times per year																																												
	SB-IP5	4 times per year																																												
	Intermediate Stations Downcurrent	SB-INE1	4 times per year																																											
		SB-INE2	4 times per year																																											
		SB-INE3	4 times per year																																											
		SB-INE4	4 times per year																																											
		SB-INE5	4 times per year																																											
Reference Stations Upcurrent	SB-RFE1	4 times per year																																												
	SB-RFE2	4 times per year																																												
	SB-RFE3	4 times per year																																												
	SB-RFE4	4 times per year																																												
	SB-RFE5	4 times per year																																												
Sensitive Receiver Stations	MW1	4 times per year																																												
	THB1	4 times per year																																												
	THB2	4 times per year																																												
	WSR45C	4 times per year																																												
	WSR46	4 times per year																																												
<b>Flood Tide</b>																																														
Impact Stations Downcurrent	SB-IPF1	4 times per year																																												
	SB-IPF2	4 times per year																																												
	SB-IPF3	4 times per year																																												
Intermediate Stations Downcurrent	SB-INF1	4 times per year																																												
	SB-INF2	4 times per year																																												
	SB-INF3	4 times per year																																												
Reference Stations Upcurrent	SB-RFF1	4 times per year																																												
	SB-RFF2	4 times per year																																												
	SB-RFF3	4 times per year																																												
Sensitive Receiver Stations	MW1	4 times per year																																												
	THB1	4 times per year																																												
	THB2	4 times per year																																												
	WSR45C	4 times per year																																												
	WSR46	4 times per year																																												
<b>Benthic Recolonisation Studies</b>																																														
Capped Contaminated Mud Pits	SB-CPA	2 times per year																																												
	SB-CPB	2 times per year																																												
Reference Stations	RBA	2 times per year																																												
	RBB	2 times per year																																												
	RBC	2 times per year																																												

Notes:  
 "n" = Number of replicates depends on parameters  
 Naming of stations are tentative only and will be subjected to changes



Annex B

## Water Quality Monitoring Results

**Table B1** *Action and Limit Levels of Water Quality for Dredging, Backfilling and Capping Activities at ESC CMPs*

<b>Parameter</b>	<b>Action Level</b>	<b>Limit Level</b>
Dissolved Oxygen (DO) <sup>(1)</sup>	<u>Surface and Mid-depth</u> <sup>(2)</sup> 5%-ile of baseline data for surface and middle layer = <b>3.76 mg L<sup>-1</sup></b>	<u>Surface and Mid-depth</u> <sup>(2)</sup> 1%-ile of baseline data for surface and middle layer = <b>3.11 mg L<sup>-1</sup></b> <sup>(3)</sup>
	and	and
	Significantly less than the reference stations mean DO (at the same tide of the same day)	Significantly less than the reference stations mean DO (at the same tide of the same day)
	<u>Bottom</u> 5%-ile of baseline data for bottom layers = <b>2.96 mg L<sup>-1</sup></b>	<u>Bottom</u> The average of the impact station readings are <b>&lt;2 mg/L<sup>-1</sup></b>
	and	and
	Significantly less than the reference stations mean DO (at the same tide of the same day)	Significantly less than the reference stations mean DO (at the same tide of the same day)
Depth-averaged Suspended Solids (SS) <sup>(4)(5)</sup>	95%-ile of baseline data for depth average = <b>37.88 mg L<sup>-1</sup></b>	99%-ile of baseline data for depth average = <b>61.92 mg L<sup>-1</sup></b>
	and	and
	120% of control station's SS at the same tide of the same day	130% of control station's SS at the same tide of the same day
Depth-averaged Turbidity (Tby) <sup>(4)(5)</sup>	95%-ile of baseline data = <b>28.14 NTU</b>	99%-ile of baseline data = <b>38.32 NTU</b>
	and	and
	120% of control station's Tby at the same tide of the same day	130% of control station's Tby at the same tide of the same day

**Notes:**

- (1) For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.
- (2) The Action and Limit Levels for DO for Surface & Middle layers were calculated from the combined pool of baseline surface layer data and baseline middle layer data.
- (3) Given the Action Level for DO for Surface & Middle layers has already been lower than 4 mg L<sup>-1</sup>, it is proposed to set the Limit Level at 3.11 mg L<sup>-1</sup> which is the first percentile of the baseline data.
- (4) "Depth-averaged" is calculated by taking the arithmetic means of reading of all three depths.
- (5) For turbidity and SS, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.

**Table B2 In-situ Monitoring Results for Routine Water Quality Monitoring of ESC CMPs in August 2016**

Sampling Period	Stations	Temp (°C)	Salinity (ppt)	Turbidity (NTU)	Dissolved Oxygen (%)	Dissolved Oxygen (mg L <sup>-1</sup> )	pH (mg L <sup>-1</sup> )
August 2016	RFE (Reference)	27.72	21.45	7.12	68.81	4.80	7.62
	IPE (Impact)	27.18	23.46	5.56	64.87	4.52	7.66
	INE (Intermediate)	27.45	22.45	3.47	64.28	4.48	7.62
	Ma Wan	25.93	27.49	2.10	59.32	4.13	7.61
	WQO	N/A	19.20 – 23.59 <sup>#</sup>	N/A	N/A	>4	6.5-8.5

**Notes:**

<sup>#</sup>Not exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

**Table B3 Laboratory Results for Routine Water Quality Monitoring of ESC CMPs in August 2016**

Sampling Period	Stations	As (µg/L)	Cd (µg/L)	Cr (µg/L)	Cu (µg/L)	Pb (µg/L)	Hg (µg/L)	Ni (µg/L)	Ag (µg/L)	Zn (µg/L)	NH <sub>3</sub> (mg/L)	TIN (mg/L)	BOD <sub>5</sub> (mg/L)	SS (mg/L)
August 2016	RFE	2.66	<LOR	0.70	3.43	<LOR	<LOR	3.37	<LOR	4.15	0.07	1.05	2.84	11.09
	IPE	2.77	<LOR	1.37	2.41	<LOR	<LOR	2.26	<LOR	3.51	0.08	0.94	2.70	10.75
	INE	2.86	<LOR	2.18	2.86	<LOR	<LOR	2.96	<LOR	4.13	0.08	0.99	2.51	6.23
	Ma Wan	2.49	<LOR	0.50	3.31	<LOR	<LOR	2.22	<LOR	4.58	0.08	0.74	3.45	3.98

WQO of TIN: 0.5 mg/L

Wet Season WQO of SS : 11.1 mg/L

**Notes:**

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

**Table B4 Water Column Profiling Results for ESC CMP Vd in August 2016**

Stations	Temp (°C)	Salinity (ppt)	Turbidity (NTU)	Dissolved Oxygen (%)	Dissolved Oxygen (mg L <sup>-1</sup> )	pH (mg L <sup>-1</sup> )	Suspended Solids (mg L <sup>-1</sup> )
WCP 1 (Downstream)	26.23	25.48	4.87	57.95	4.06	7.61	12.25
WCP 2 (Upstream)	25.33	28.57	7.93	48.12	3.36	7.59	10.25
WQO (Wet season)	N/A	24.32 – 31.43 <sup>#</sup>	N/A	N/A	>4	6.5-8.5	11.1

**Note:**

<sup>#</sup>Not exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

**Table B5 Action and Limit Levels of Water Quality for Dredging, Backfilling and Capping Activities for SB CMPs**

<b>Parameter</b>	<b>Action Level</b>	<b>Limit Level</b>
Dissolved Oxygen (DO) <sup>(1)</sup>	<u>Surface and Mid-depth</u> <sup>(2)</sup> The average of the impact, WSR 45C and WSR 46 station readings are < 5%-ile of baseline data for surface and middle layer = <b>4.32 mg L<sup>-1</sup></b>  and  Significantly less than the reference stations mean DO (at the same tide of the same day)	<u>Surface and Mid-depth</u> <sup>(2)</sup> The average of the impact, WSR 45C and WSR 46 station readings are < <b>4 mg L<sup>-1</sup></b>  and  Significantly less than the reference stations mean DO (at the same tide of the same day)
	<u>Bottom</u> The average of the impact, WSR 45C and WSR 46 station readings are < 5%-ile of baseline data for bottom layers = <b>3.12 mg L<sup>-1</sup></b>  and  Significantly less than the reference stations mean DO (at the same tide of the same day)	<u>Bottom</u> The average of the impact station, WSR 45C and WSR 46 readings are < <b>2 mg L<sup>-1</sup></b>  and  Significantly less than the reference stations mean DO (at the same tide of the same day)
Depth-averaged Suspended Solids (SS) <sup>(3)(4)</sup>	The average of the impact, WSR 45C and WSR 46 station readings are > 95%-ile of baseline data for depth average = <b>21.60 mg L<sup>-1</sup></b>  and  120% of control station's SS at the same tide of the same day	The average of the impact, WSR 45C and WSR 46 station readings are > 99%-ile of baseline data for depth average = <b>40.10 mg L<sup>-1</sup></b>  and  130% of control station's SS at the same tide of the same day
Depth-averaged Turbidity (Tby) <sup>(3)(4)</sup>	The average of the impact, WSR 45C and WSR 46 station readings are > 95%-ile of baseline data = <b>25.04 NTU</b>  and  120% of control station's Tby at the same tide of the same day	The average of the impact, WSR 45C and WSR 46 station readings are > 99%-ile of baseline data = <b>32.68 NTU</b>  and  130% of control station's Tby at the same tide of the same day

**Notes:**

- (1) For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.
- (2) The Action and Limit Levels for DO for Surface & Middle layers were calculated from the combined pool of baseline surface layer data and baseline middle layer data.
- (3) "Depth-averaged" is calculated by taking the arithmetic means of reading of all three depths.
- (4) For turbidity and SS, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.

**Table B6** *Monitoring Results for Water Quality Monitoring during Capping of SB CMP in August 2016*

Sampling Period	Stations	Temp (°C)	Salinity (ppt)	Turbidity (NTU)	Dissolved Oxygen (%)	pH (mg L <sup>-1</sup> )	SS (mg L <sup>-1</sup> )	NH3 (mg L <sup>-1</sup> )	TIN (mg L <sup>-1</sup> )	BOD <sub>5</sub> (mg L <sup>-1</sup> )	
August 2016	RFE (Reference)	26.54	26.13	29.24	63.87	4.43	7.57	25.80	0.15	0.97	1.05
	IPE (Impact)	27.05	24.34	7.45	72.05	5.00	7.60	10.81	0.20	1.10	1.37
	INE (Intermediate)	27.21	24.02	9.45	73.59	5.11	7.60	11.32	0.19	1.08	1.37
	Ma Wan	26.75	25.93	5.92	66.40	4.60	7.57	11.35	0.18	0.94	0.90
	Sham Shui Kok	27.14	24.28	5.30	71.67	4.97	7.59	10.22	0.18	1.04	1.17
	Tai Mo To	26.42	26.19	13.34	62.83	4.37	7.03	17.45	0.18	1.01	1.50
	Tai Ho Bay 1	26.96	24.33	4.49	77.98	5.43	7.59	9.93	0.12	0.92	1.73
	Tai Ho Bay 2	27.34	23.26	4.07	65.12	4.53	7.37	5.80	0.16	0.92	1.30
	WQO	N/A	23.52-28.74*	N/A	N/A	>4	6.5-8.5	11.1	N/A	0.50	N/A

**Notes:**

# Not exceeding 2°C of change of the results from the Reference Station.

#Not exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

Annex C

## Graphical Presentations

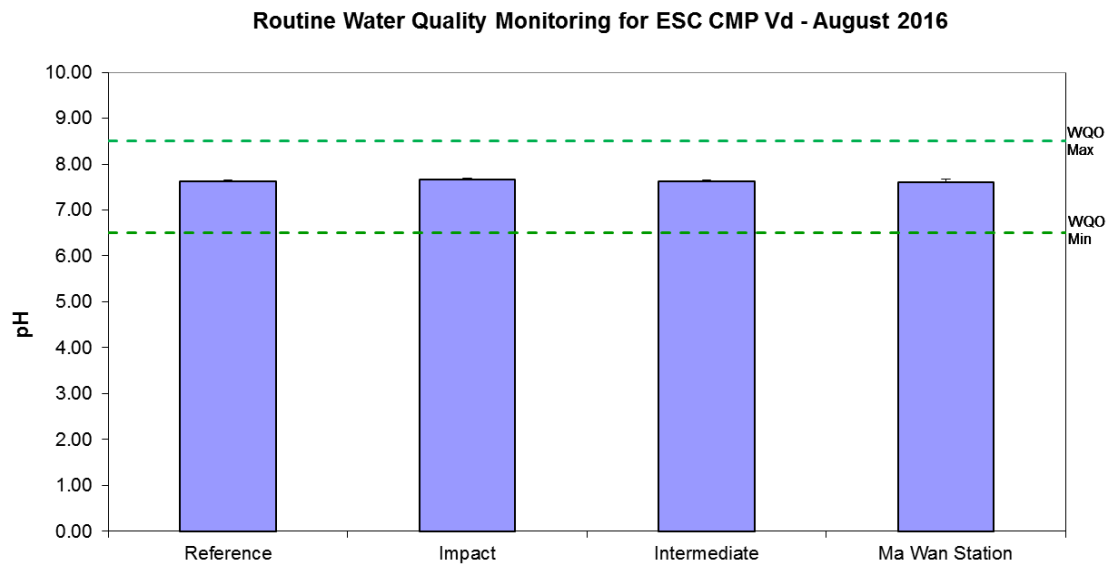


Figure 1: Level of pH recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

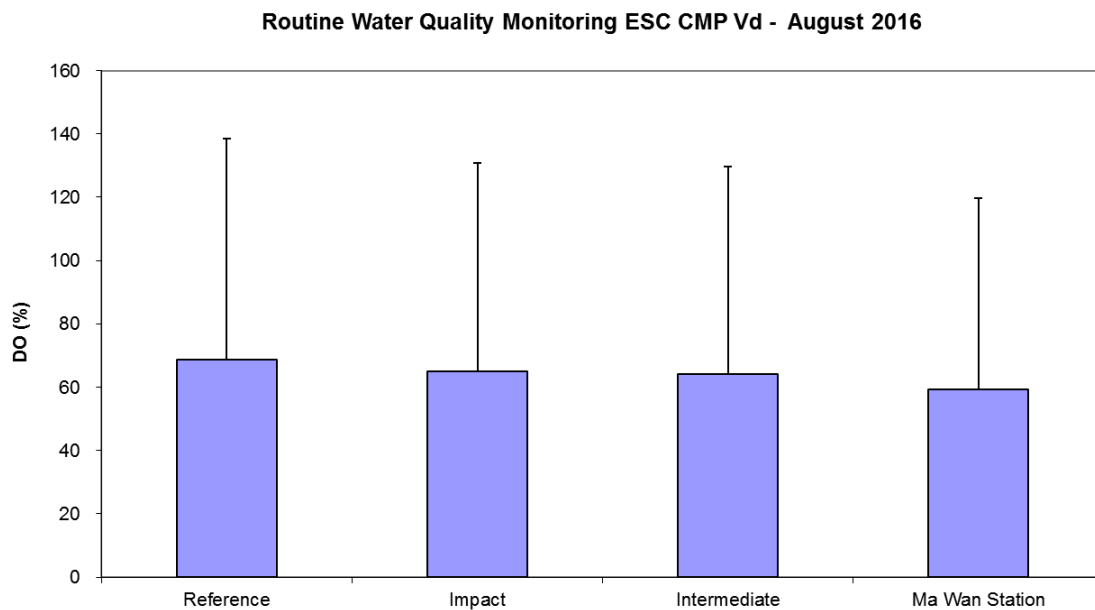


Figure 2: Level of Dissolved Oxygen (DO) (% saturation; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

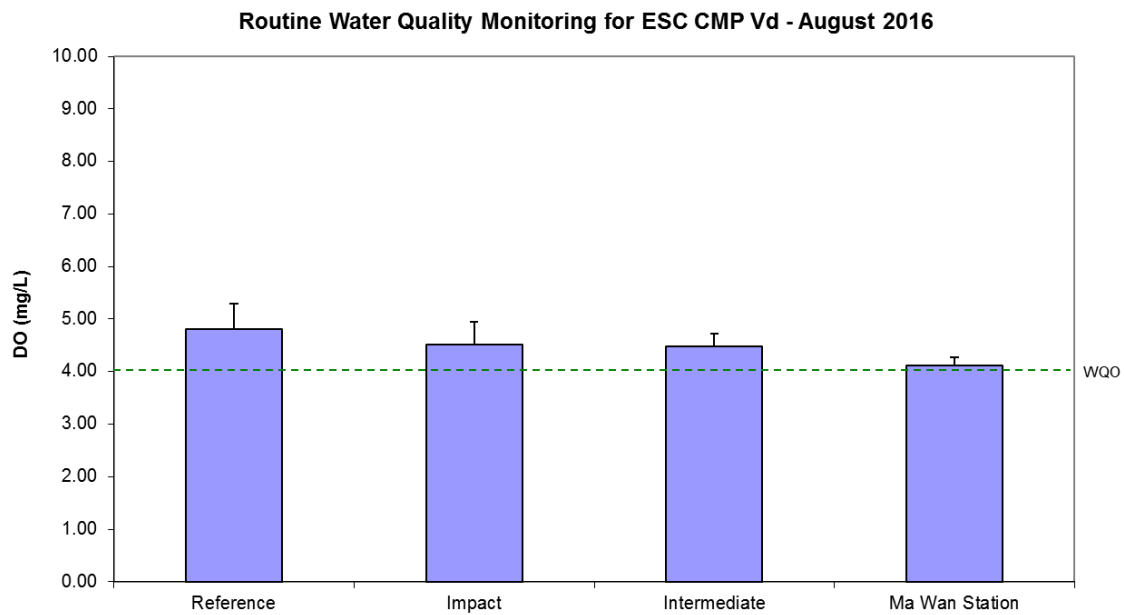


Figure 3: Concentration of Dissolved Oxygen (DO) (mg/L; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

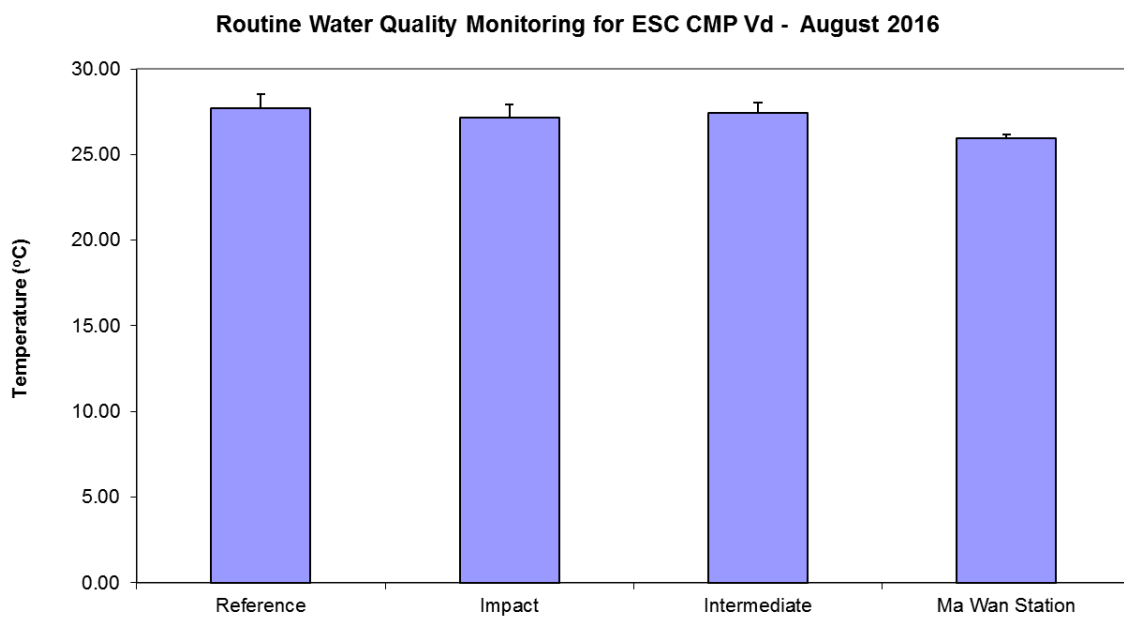


Figure 4: Level of Temperature (°C; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.



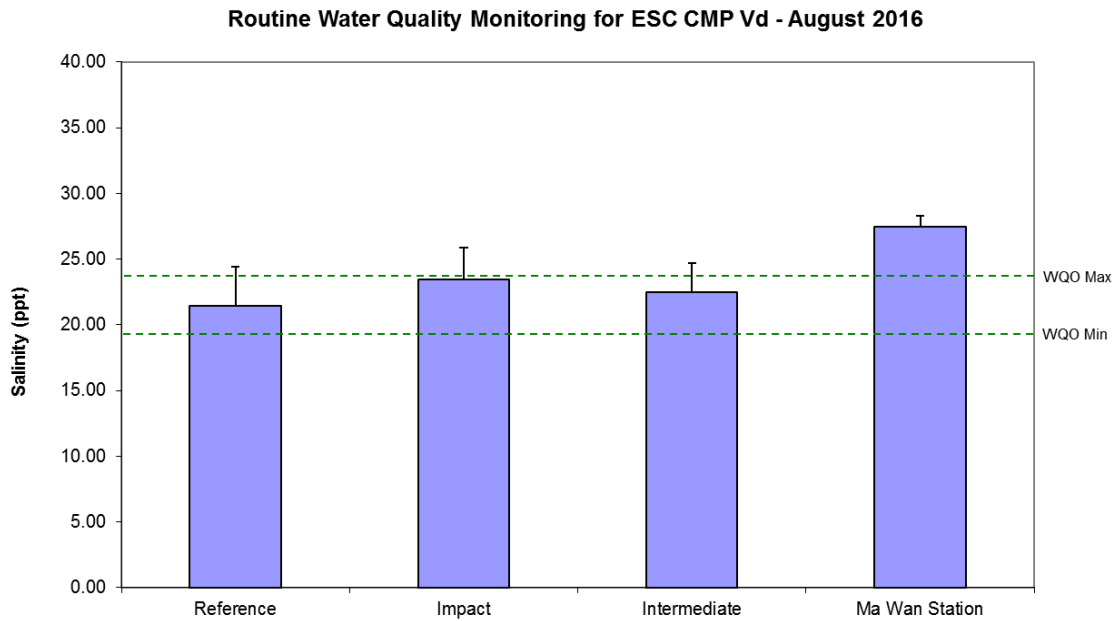


Figure 5: Level of Salinity (ppt; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

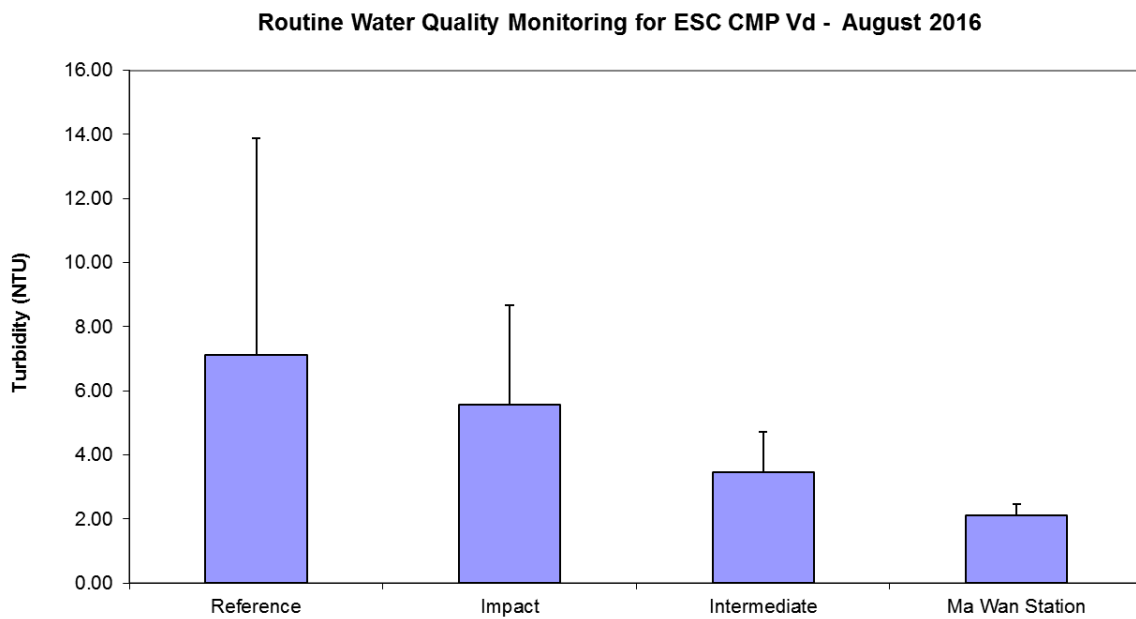


Figure 6: Levels of Turbidity (NTU; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

**Routine Water Quality Monitoring for Metals and Metalloid  
August 2016**

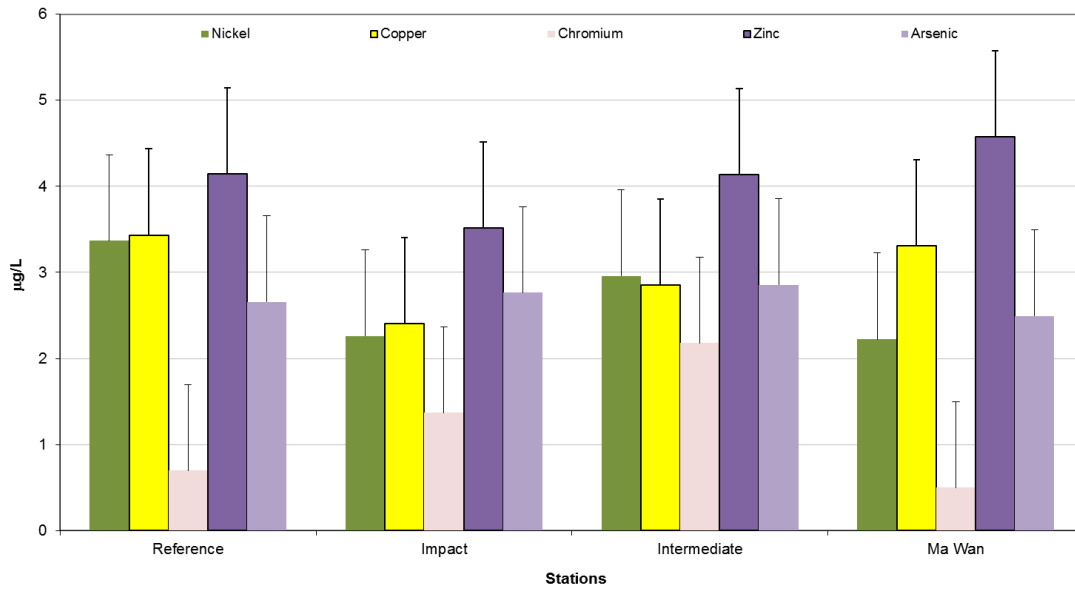


Figure 7: Concentration of Copper, Chromium, Zinc, Arsenic and Nickel ( $\mu\text{g/L}$ ; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

**Routine Water Quality Monitoring Results for Nutrients  
August 2016**

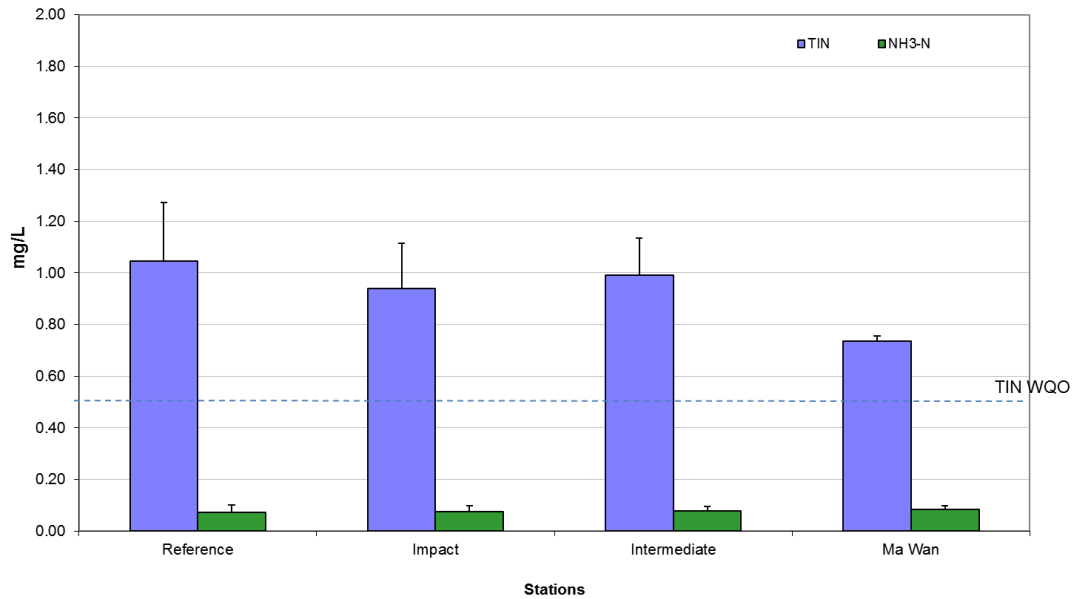


Figure 8: Concentration of Total Inorganic Nitrogen (TIN) and Ammonia Nitrogen (NH<sub>3</sub>-N) ( $\mu\text{g/L}$ ; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

**Routine Water Quality Monitoring Results for Biochemical Oxygen Demand (BOD<sub>5</sub>)  
August 2016**

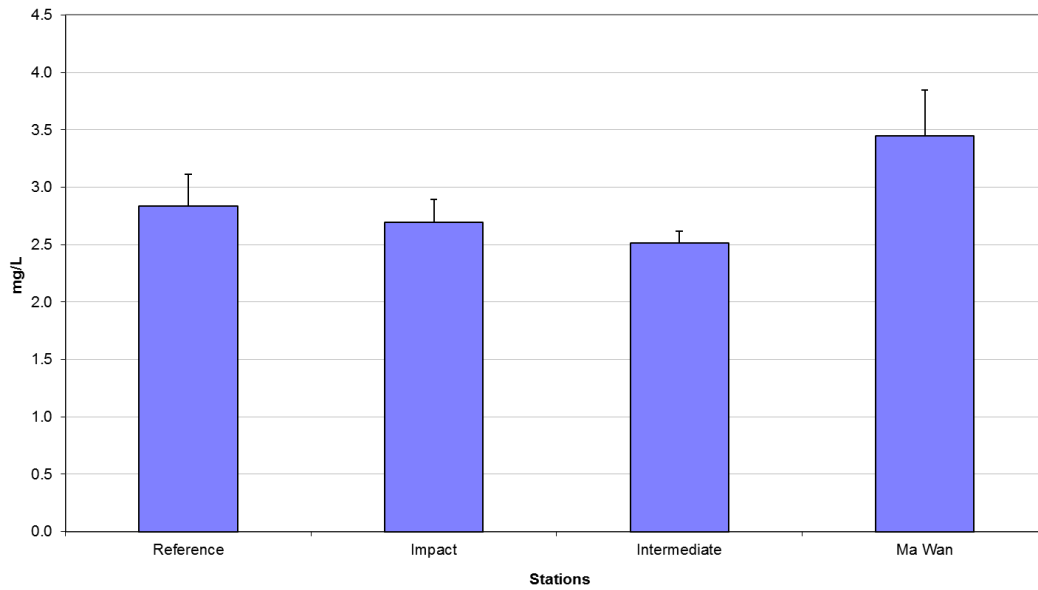


Figure 9: Level of Biochemical Oxygen Demand (BOD<sub>5</sub>) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

**Routine Water Quality Monitoring for Suspended Solids  
August 2016**

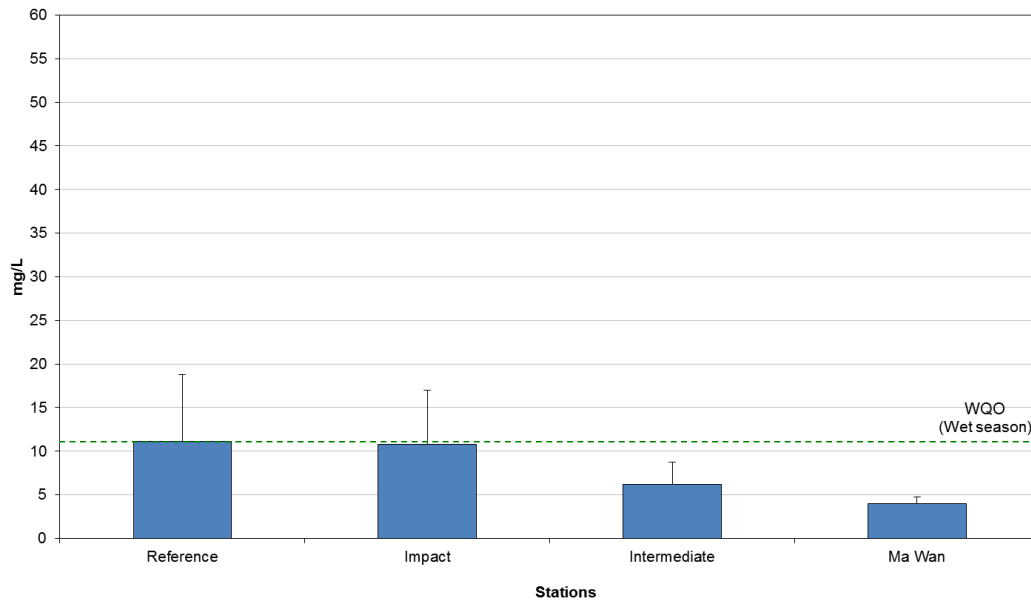


Figure 10: Concentration of Suspended Solids (SS) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

Source: H:\Team\EM\GMS Projects\0175086 CEDD EM&A for South Brothers\02 Deliverable\07 CMP Monthly Report\48th (August 2016)

Date: 10/9/2016

**Environmental  
Resources  
Management**



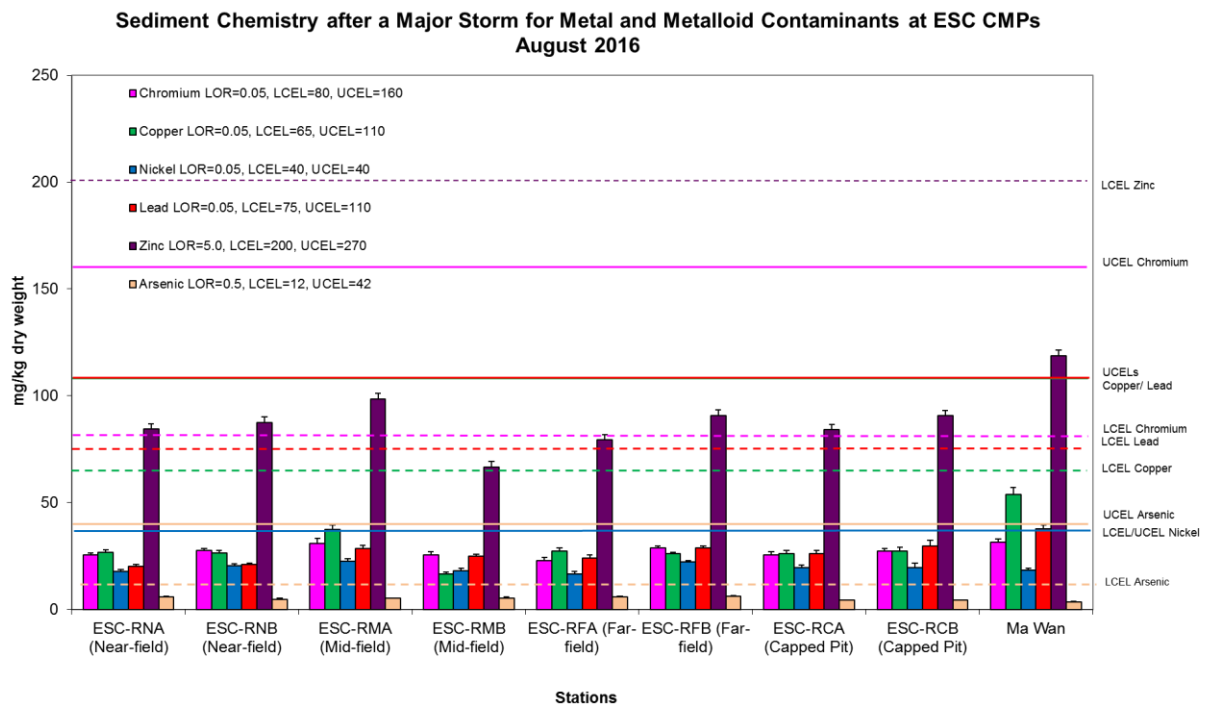


Figure 11: Concentration of Metals (Cr, Cu, Ni, Pb, Zn, As; mean +SD) in sediment samples collected from *Sediment Chemistry after a Major Storm* for SB CMPs in August 2016.

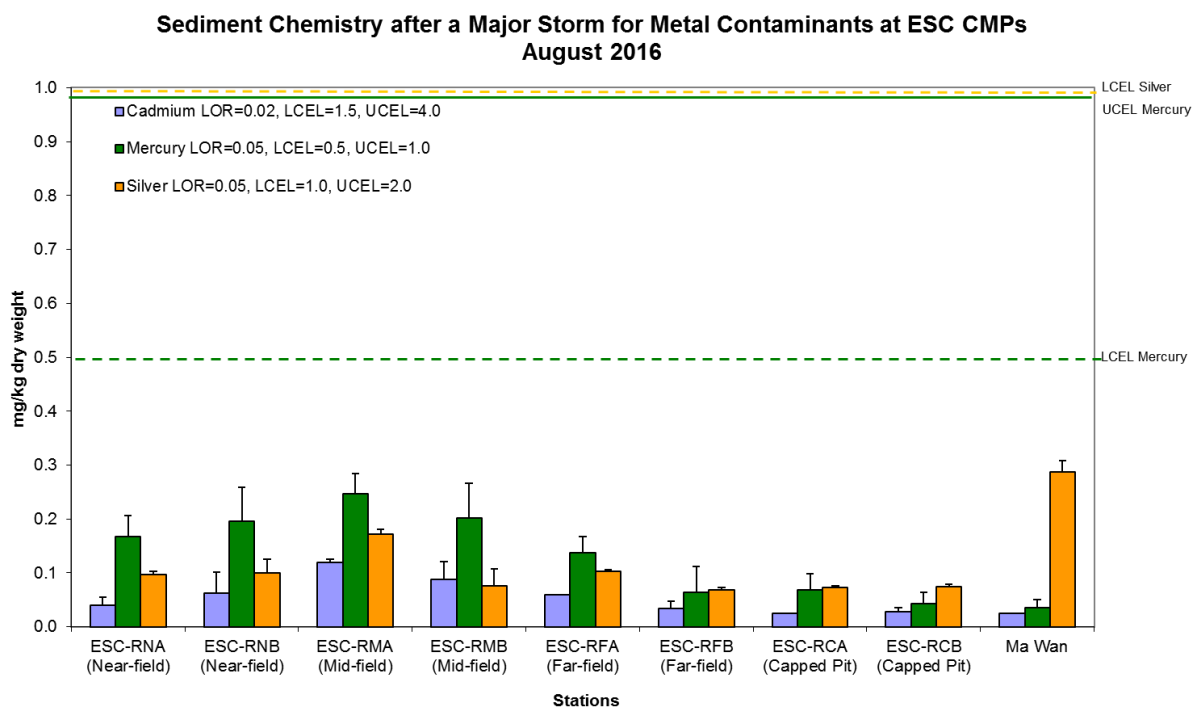


Figure 12: Concentration of Metals (Cd, Hg, Ag; mean +SD) in sediment samples collected from *Sediment Chemistry after a Major Storm* for SB CMPs in August 2016.

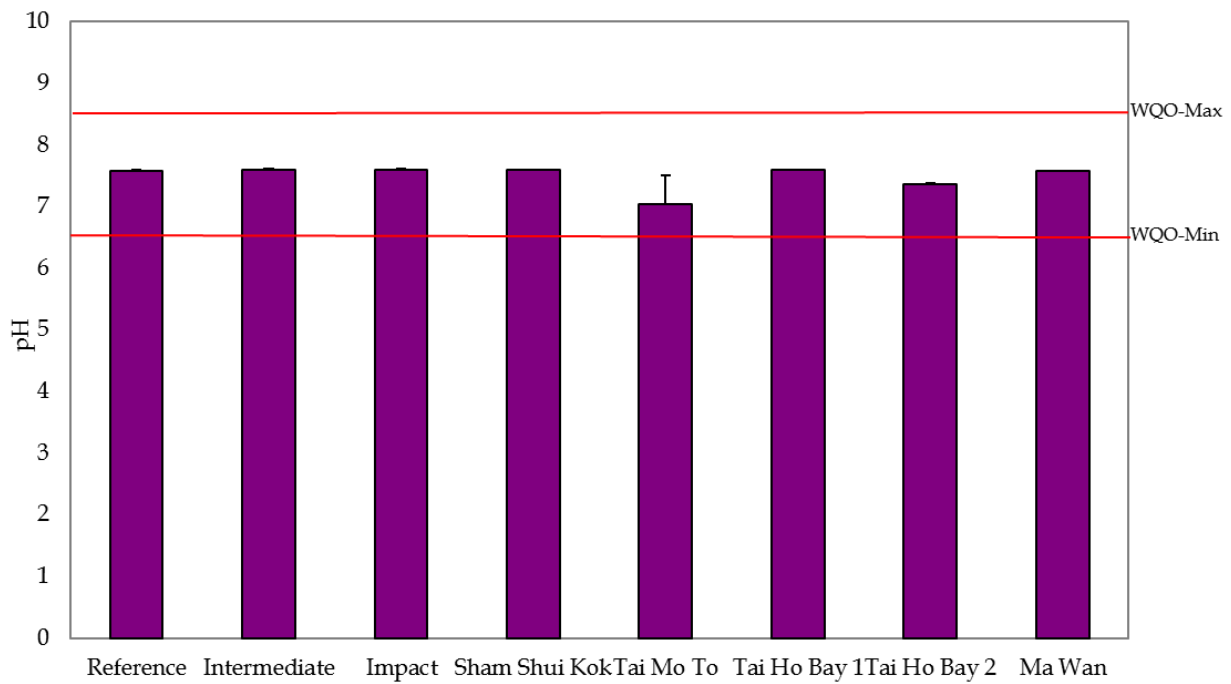


Figure 13: Levels of pH (mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016.

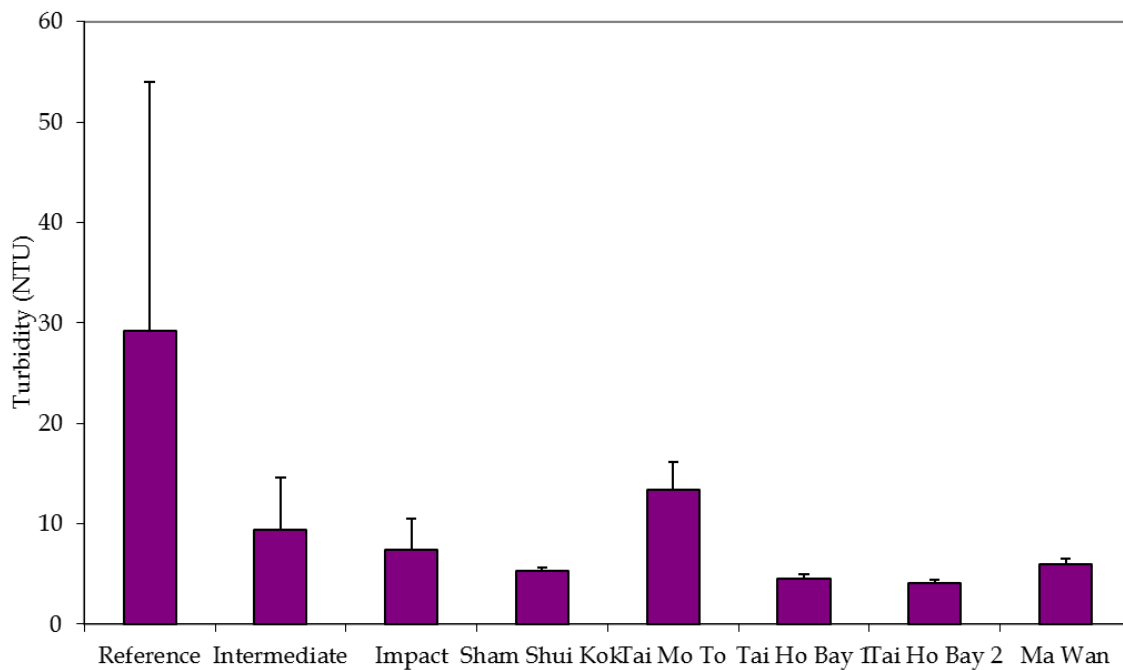


Figure 14: Levels of Turbidity (NTU; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

Source: H:\Team\EM\GMS Projects\0175086 CEDD EM&A for South Brothers\02 Deliverable\07 CMP Monthly Report\48th (August 2016)

Date: 10/9/2016

**Environmental  
Resources  
Management**



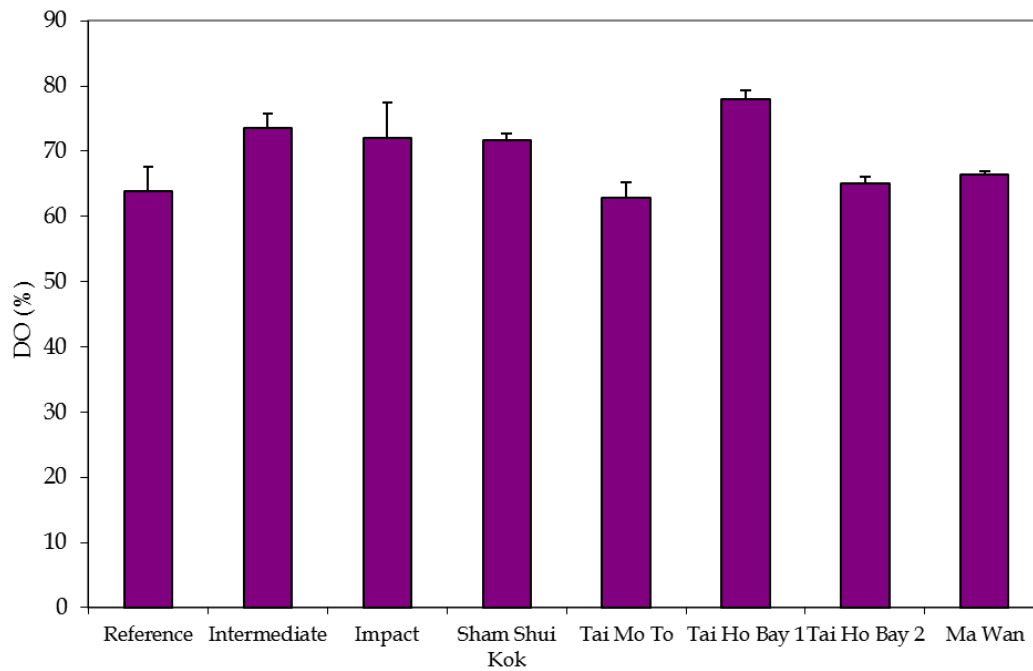


Figure 15: Levels of Dissolved Oxygen (% saturation; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

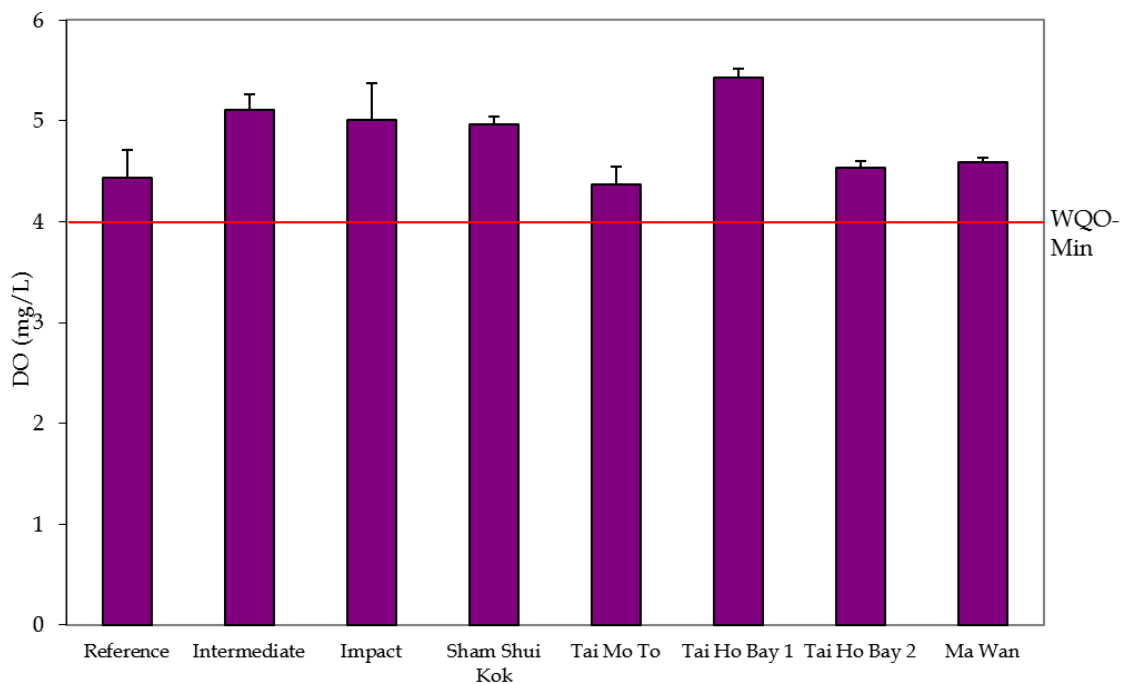


Figure 16: Levels of Dissolved Oxygen (mg/L; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

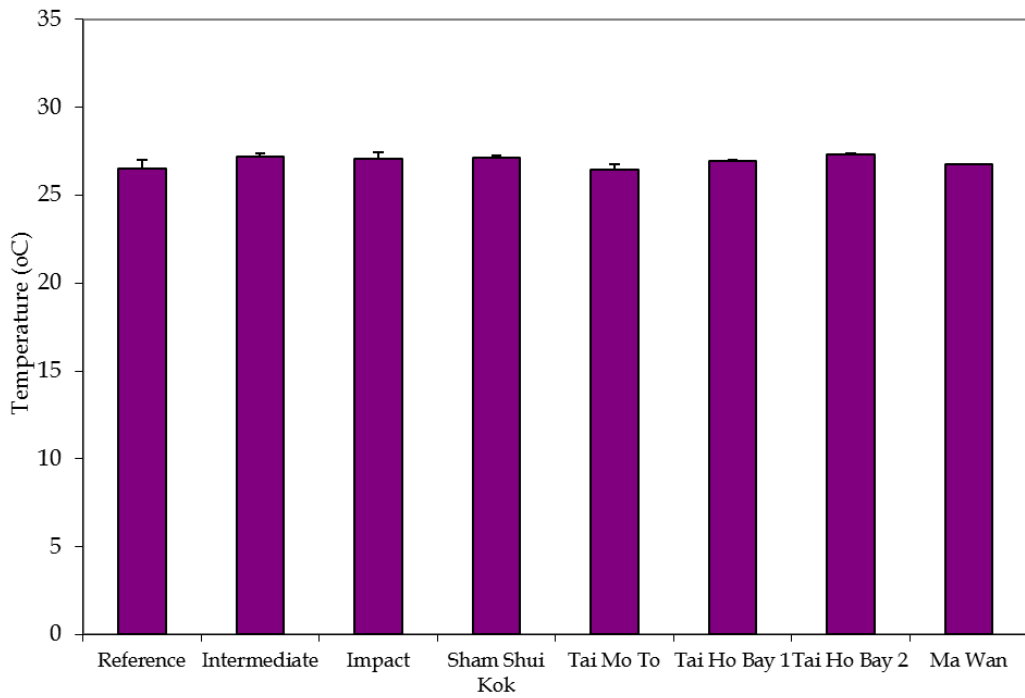


Figure 17: Levels of Temperature (°C; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016.

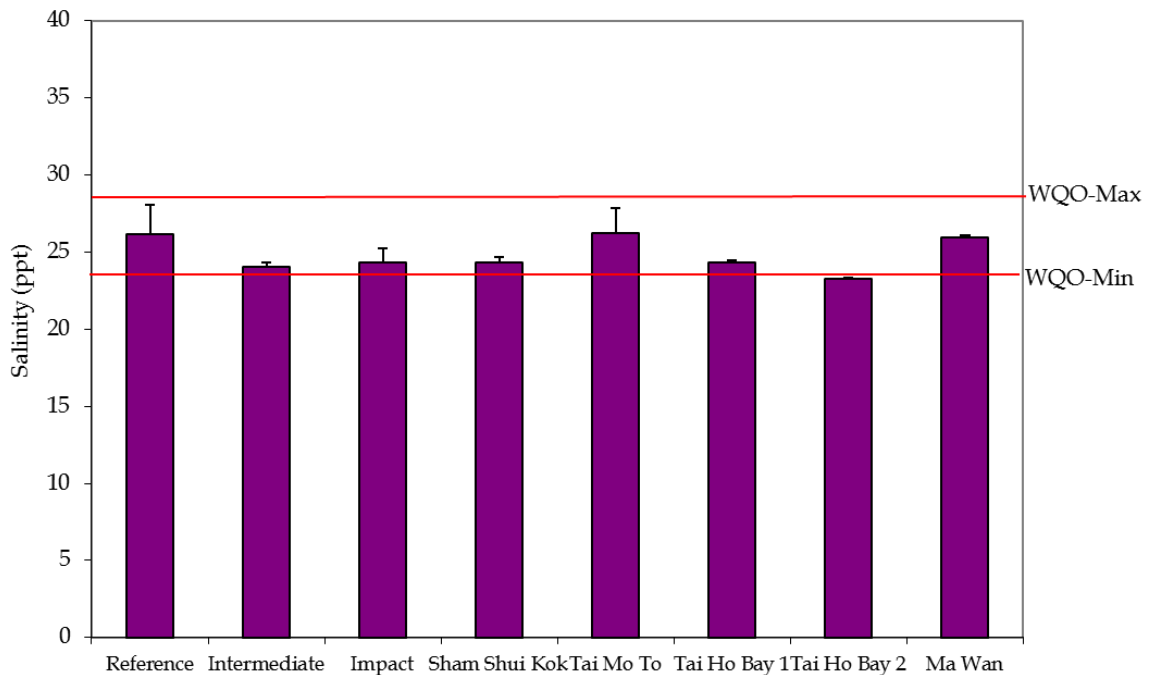


Figure 18: Levels of Salinity (ppt; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016.

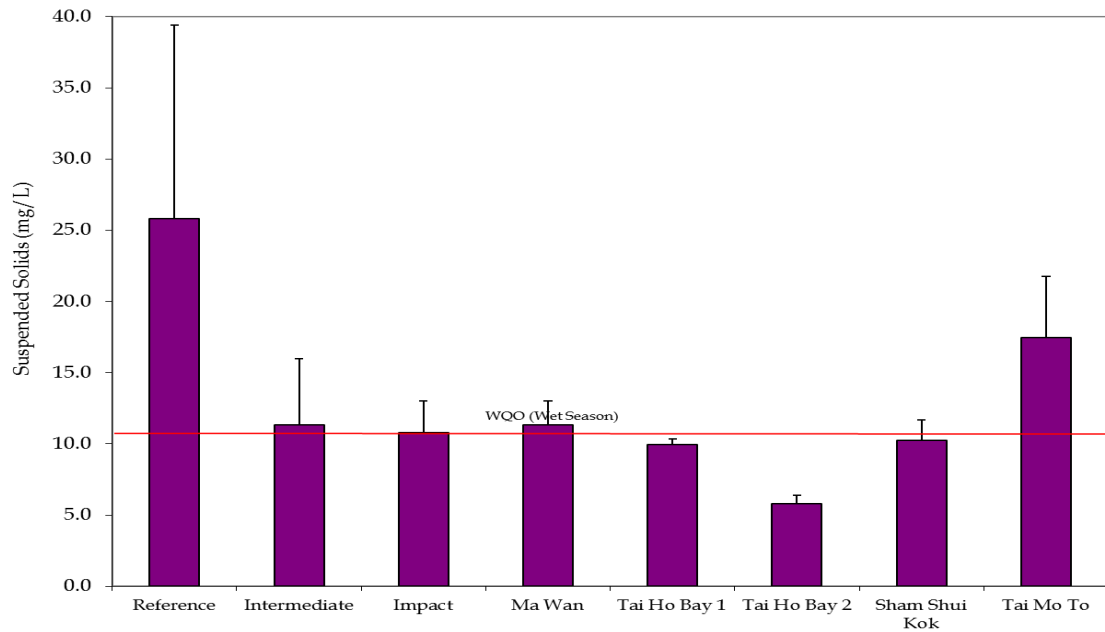


Figure 19: Levels of Suspended Solids (mg/L; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

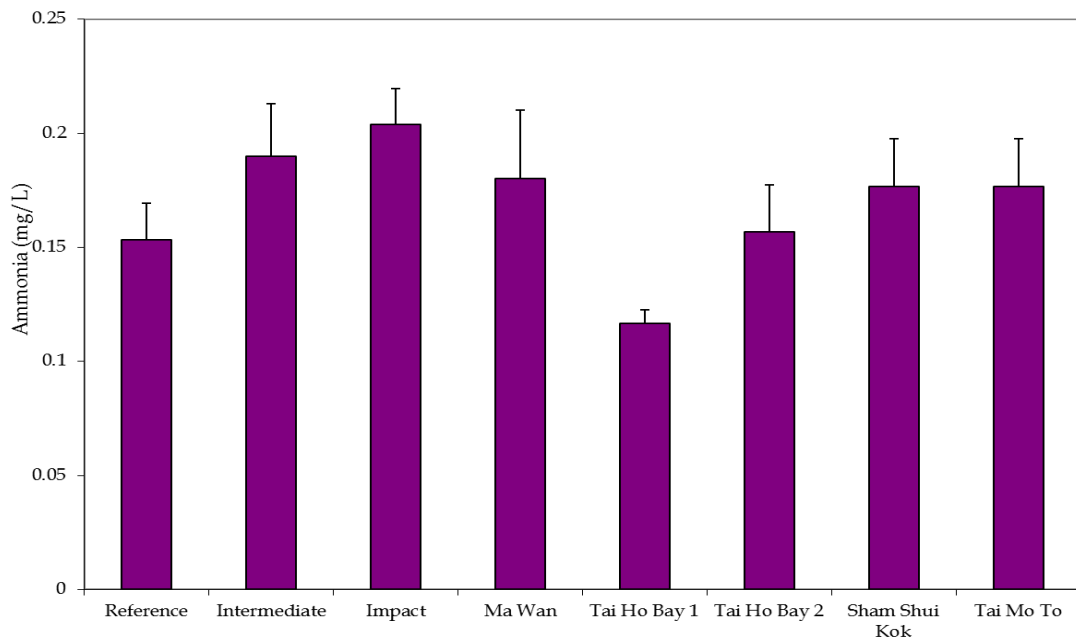


Figure 20: Level of Ammonia (mg/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMPs in August 2016.



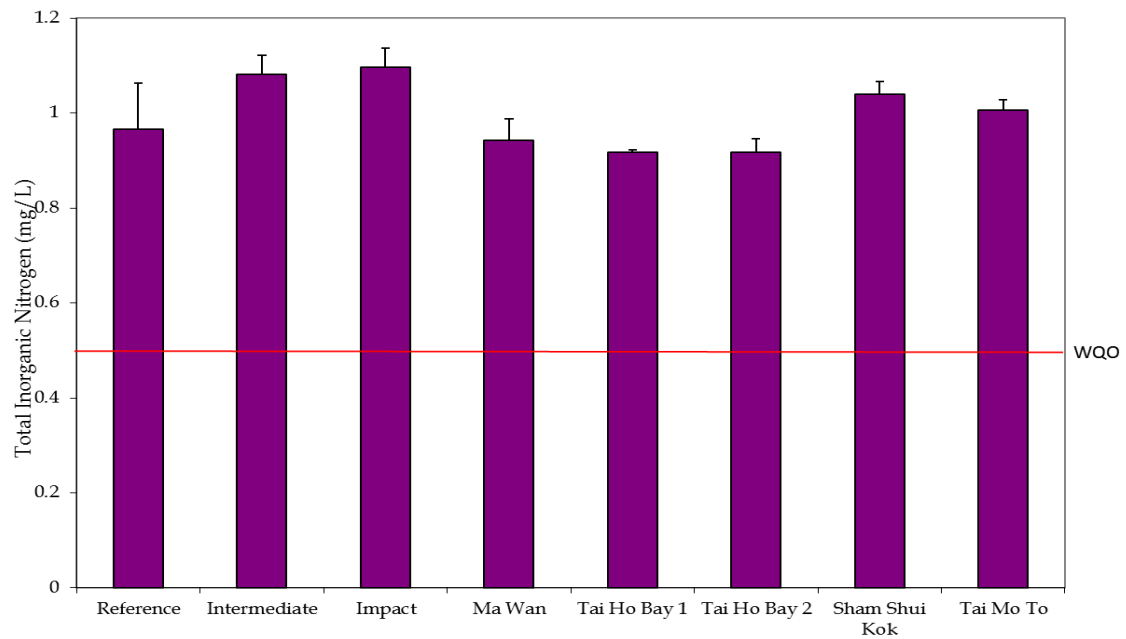


Figure 21: Level of TIN (mg/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMPs in August 2016

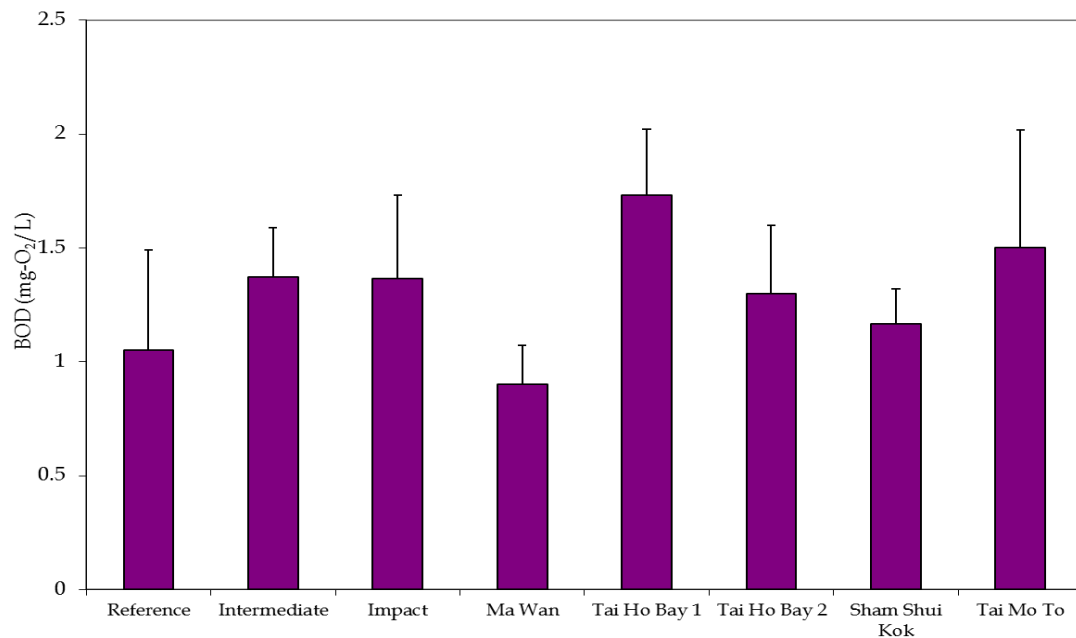
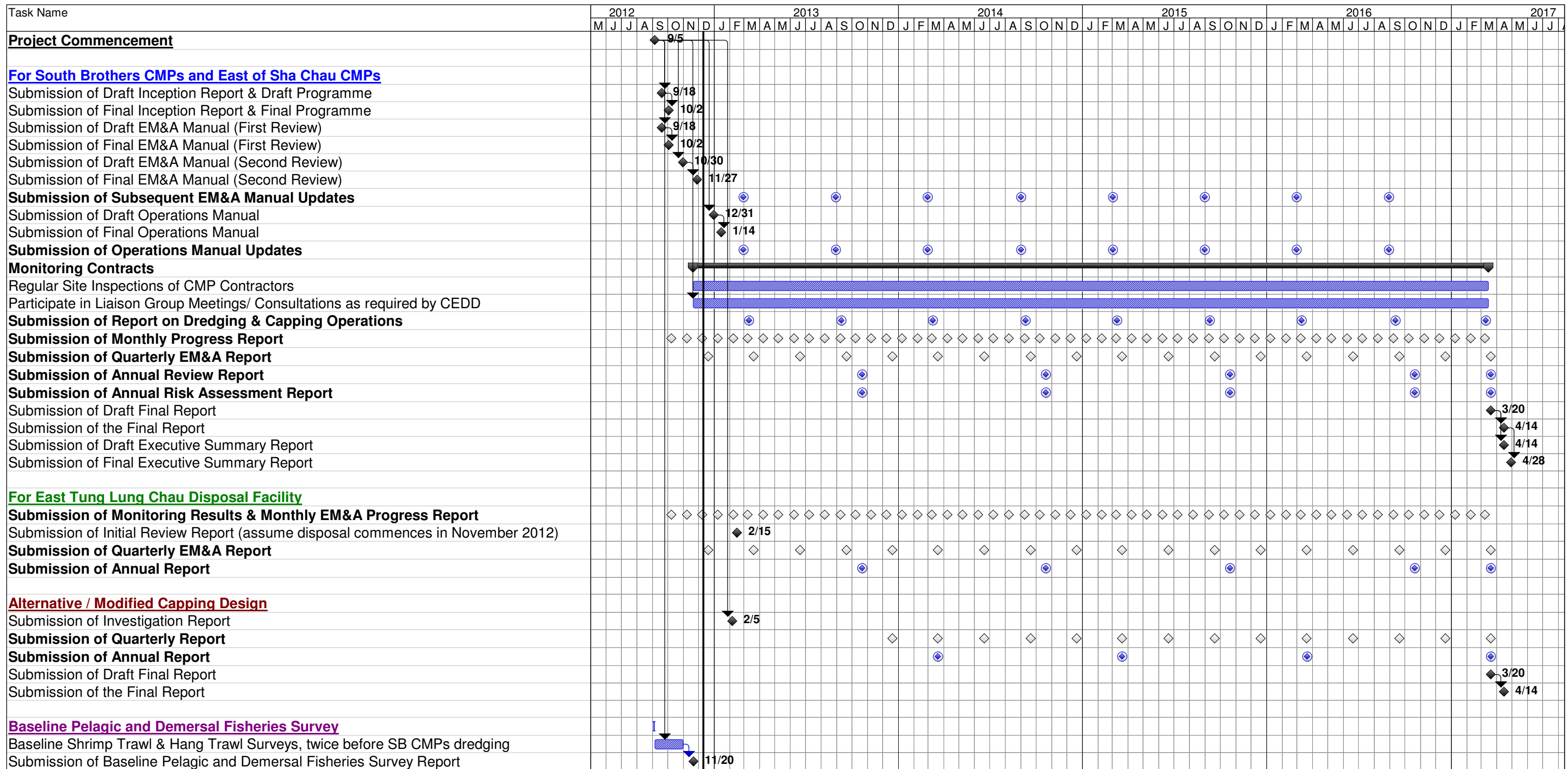


Figure 22: Level of BOD<sub>5</sub> (mg-O<sub>2</sub>/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMPs in August 2016.

Annex D

## Study Programme



<b>Study Programme</b>	Task		Milestone		Summary		Rolled Up Task		Rolled Up Milestone	
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