土木工程拓展署
CEDD Civil Engineering and Development Department

Agreement No. CE 63/2016 (EP)

Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau (2017-2020) – Investigation

Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – July to September 2020

Revision 0

April 2021

Environmental Resources Management
2507, 25/F
One Harbourfront
18 Tak Fung Street
Hunghom, Kowloon
Hong Kong
Telephone (852) 2271 3000
Facsimile (852) 2723 5660

www.erm.com

The business of sustainability

ERM

Agreement No. CE 63/2016 (EP) Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau (2017-2020) – Investigation

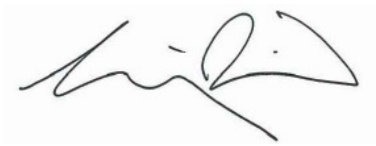
Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – July to September 2020

Revision 0

Document Code: 0400720_CMP Quarterly Jul-Sep 2020_v0.doc

Environmental Resources Management

2507, 25/F
One Harbourfront
18 Tak Fung Street
Hunghom, Kowloon
Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

Client: Civil Engineering and Development Department (CEDD)	Project No: 0400720
Summary: This document presents the Quarterly EM&A Report for *Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau*.	Date: 9 April 2021 Approved by:  Craig A. Reid *Partner*

v0	Quarterly EM&A Report for ESC CMPs	GS	RC	CAR	9/4/21
Revision	Description	By	Checked	Approved	Date

Distribution

☐ Internal

☒ Public

☐ Confidential

OHSAS 18001:2007
Certificate No. OHS 515956

ISO 9001 : 2008
Certificate No. FS 32515

土木工程拓展署
Civil Engineering and Development Department

ERM

Dredging, Management and Capping of Contaminated Sediment Disposal Facility at Sha Chau

Environmental Certification Sheet
EP-312/2008/A

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – July to September 2020
Date of Report:	9 April 2021
Date prepared by ET:	9 April 2021
Date received by IA:	9 April 2021

Reference EP Condition

Environmental Permit Condition:

Condition 3.1 of EP-312/2008/A
The EM&A programme shall be implemented in accordance with the procedures and requirements in the EM&A Manual. Any changes to the monitoring and audit requirements shall be justified by the ET leader and verified by the Independent Auditor as conforming to the requirements set out in the EM&A Manual, and shall seek the prior approval from the Director before implementation.

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-312/2008/A.

Craig A. Reid,
Environmental Team Leader:

Date: 9/4/2021

IA Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-312/2008/A.

Dr Wang Wen Xiong,
Independent Auditor:

Date: 9/4/2021

CONTENTS

	EXECUTIVE SUMMARY	*I*
1	*INTRODUCTION*	*1*
1.1	*PROJECT DESCRIPTION*	*1*
1.2	*ACTIVITIES CONDUCTED DURING THE REPORTING PERIOD*	*2*
1.3	*OBJECTIVES OF THE MONITORING AND AUDIT PROGRAMME*	*2*
2	*ENVIRONMENTAL MONITORING & AUDITING PROGRAMME*	*4*
2.1	*ENVIRONMENTAL MONITORING & AUDITING TASKS*	*4*
2.2	*EM&A SAMPLING AND ANALYSES*	*4*
3	*MONITORING & AUDITING RESULTS*	*5*
3.1	*OVERVIEW OF THE MONITORING & AUDITING ACTIVITIES*	*5*
3.2	*SUMMARY OF MONITORING RESULTS AND STATISTICAL ANALYSES FOR ESC CMPS*	*6*
4	*FINDINGS OF THE FIELD EVENTS AND LABORATORY TESTS AND ANALYSES BY THE INDEPENDENT AUDITOR*	*17*
5	*ACTIVITIES SCHEDULED FOR THE NEXT REPORTING PERIOD*	*18*

ANNEXES

ANNEX A SAMPLING SCHEDULE

ANNEX B DISPOSAL RECORDS

ANNEX C STATISTICAL ANALYSIS

Agreement No. CE 63/2016 (EP)
Environmental Monitoring and Audit
for Disposal Facility to the East of Sha Chau (2017-2020) - Investigation

Quarterly Environmental Monitoring and Audit (EM&A) Report for July to September 2020

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Water Quality Monitoring during Capping Operation of ESC CMPs, Pit Specific Sediment Chemistry, Cumulative Impact Sediment Chemistry, Sediment Toxicity Test and *Demersal Trawling* were carried out for the Contaminated Mud Pits (CMPs) to the East of Sha Chau (ESC) during the quarterly period of July to September 2020. This report presents the results of these monitoring activities to identify whether the disposal and capping operations at ESC CMP V are causing any unacceptable impact(s) to the surrounding aquatic environment or to those marine organisms that utilize these habitats.

Water Quality Monitoring for ESC CMPs

Water Column Profiling of ESC CMP Vb – July to September 2020

Results indicated that levels of Salinity, pH and Dissolved Oxygen (DO) complied with the Water Quality Objectives (WQOs) at both Upstream and Downstream stations. Levels of DO, Turbidity and Suspended Solids (SS) complied with the Action and Limit Levels at all stations. Overall, the results indicated that the mud disposal operation at ESC CMP Vb did not appear to cause any unacceptable impact in water quality during this quarterly period.

Routine Water Quality Monitoring of ESC CMPs – July and August 2020

Results of Routine Water Quality Monitoring conducted in July and August 2020 showed that the levels of DO, Turbidity and SS complied with the Action and Limit Levels at all stations. From the monitoring results and statistical analysis, there were no trends indicating any increase in the concentrations of contaminants with proximity to the pit or with time. Thus, it appears that mud disposal operations at ESC CMPs have not caused any unacceptable impact in water quality during the reporting period.

Water Quality Monitoring during Capping Operation of ESC CMPs – August 2020

Concentrations of DO, Turbidity and SS complied with the Action and Limit Levels at all stations in August 2020. From the statistical analysis, there were no trends indicating any increase in the concentrations of contaminants with proximity to the pit or with time. Overall, the results indicated that capping operations at ESC CMPs did not appear to cause any unacceptable water quality impact during the reporting period.

Sediment Quality Monitoring for ESC CMPs

Pit Specific Sediment Chemistry of ESC CMP Vb – July to September 2020

Monitoring results showed that the concentrations of inorganic contaminants were generally below the Lower Chemical Exceedance Levels (LCELs) at most monitoring stations. Statistical analysis indicated that there did not appear any trend of increasing sediment contaminants' concentrations with proximity to the pit or with time. Thus, it appears that mud disposal operation at ESC CMP Vb have not caused any unacceptable impact in sediment quality during the reporting period.

Cumulative Impact Sediment Chemistry of ESC CMPs – August 2020

Monitoring results showed that the concentrations of inorganic contaminants were generally below the LCELs at all monitoring stations. Statistical analysis indicated that there did not appear to be any significant trend of increasing concentrations of contaminants with proximity to the pit or with time. Thus, it appears that mud disposal operation at ESC CMP Vb have not caused any unacceptable impact in sediment quality during the reporting period.

Sediment Chemistry after a Major Storm of ESC CMPs – August 2020

Sampling for *Sediment Chemistry after a Major Storm Event* was conducted for ESC CMPs on 21 August 2020 after the visit of tropical cyclone Higos, which led to the issue of No. 9 Gale or Storm Signal on 19 August 2020.

Monitoring results showed that the concentrations of most inorganic contaminants were below the LCELs at most monitoring stations. Statistical analysis indicated that there did not appear to be any significant trend of increasing concentrations of contaminants with proximity to the pit. 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 2020.

Sediment Toxicity Test of ESC CMPs – August 2020

Statistical analysis showed that there were no significant differences between Impact and Reference stations in the toxicity tests of most tested marine benthos. There did not appear to be any evidence of unacceptable impacts to sediment toxicity due to the mud disposal operations at ESC CMPs.

Demersal Trawling for ESC CMPs – July and August 2020

During the sampling period in July and August 2020, the mean number of faunal species caught was generally lower at Impact stations in July and August 2020. Biotic abundance, biomass, Catch per Unit Effort (CPUE) and Yield per Unit Effort (YPUE) were generally lower at Impact stations ESC-INA and ESC-INB.

合約編號 第CE 63/2016（EP）號

沙洲以東海泥卸置設施的環境監察及審核（2017–2020）–勘查研究

環境監察及審核季度報告（二零二零年七月至九月）

行政摘要

在2020年7月至9月的季度報告期內，環境小組在沙洲以東海泥卸置設施進行了水層質量監察、例行水質監察、泥坑覆蓋過程之水質監察、指定污泥坑沉積物化學監察、沉積物化學累積性影響監察、沉積物毒性測試及底棲漁業資源監察。本報告詳述以上的環境監察結果，從而分析在沙洲以東海泥卸置設施CMP V的卸置及覆蓋作業有否對鄰近水體環境及利用這水體為棲身地的海洋生物造成不可接受的環境影響。

沙洲以東海泥卸置設施 (ESC CMPs)之水質監察

水層質量監察–2020年7月至9月

監察結果顯示上游及下游監測站的鹽度、酸鹼值及溶解氧含量均符合海水水質指標。上游及下游監測站的溶解氧含量、混濁度及懸浮固體含量也符合行動及極限水平。總體而言，水層質量監察結果表明報告期內沙洲以東海泥卸置設施CMP Vb 的污泥卸置活動沒有引致任何不可接受的水質影響。

例行水質監察–2020年7月和8月

2020年7月和8月的例行水質監察結果顯示所有監測站的溶解氧含量、混濁度及懸浮固體含量也符合行動及極限水平。從監察數據和統計結果顯示，海水的污染物濃度沒有因越接近泥坑而趨向增加，亦沒有隨著時間而增加。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對周邊水體環境產生任何不可接受的水質影響。

泥坑覆蓋過程之水質監察–2020年8月

在2020年8月，所有監測站的溶解氧濃度、渾濁度及懸浮固體含量均符合行動及極限水平。從統計結果顯示，海水的污染物濃度並沒有因越接近污泥坑而趨向增加，亦沒有隨著時間而增加。總括而言，結果顯示在報告期內泥坑的覆蓋運作並沒有引致任何不可接受的水質影響。

沙洲以東海泥卸置設施 (ESC CMPs)之沉積物監察

指定污泥坑沉積物化學監察–2020年7月至9月

監察結果顯示，大部分監測站的無機污染物含量均大致低於化學物質低量值。從統計結果顯示，沉積物的污染物濃度沒有因越接近泥坑而趨向增加，亦沒有隨著時間而增加。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對沉積物質素造成任何不可接受的影響。

沉積物化學累積性影響監察–2020年8月

監察結果顯示，所有監測站的無機污染物含量均大致低於化學物質低量值。從統計結果顯示，沉積物的污染物濃度沒有因越接近泥坑而趨向增加，亦沒有隨著時間而增加。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對沉積物質素造成任何不可接受的影響。

強颱風後的沉積物質素監察– 2020年8月

強烈熱帶風暴海高斯在2020年8月19日吹襲香港，並在同日發出九號烈風或暴風風力增強信號。在強颱風過後，環境小組在2020年8月21日在沙洲以東海泥卸置設施附近範圍採集沉積物樣本作分析。監察結果顯示大部分的無機污染物含量在所有監測站均低於化學物質低量值。從統計結果顯示，沉積物的污染物濃度沒有因越接近泥坑而趨向增加。總體而言，沒有證據顯示2020年8月的強颱風導致污泥從泥坑擴散或引起沉積物污染。

沙洲以東污泥坑之沉積物毒性測試–2020年8月

從統計結果顯示，大部份已測試的海洋底棲生物在受影響監測站及參考監測站的沉積物毒性測試沒有明顯分別。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對沉積物毒性造成任何不可接受的影響。

沙洲以東污泥坑之底棲漁業資源監察–2020年7月和8月

監察結果顯示，2020年7月和8月的底棲漁業資源在受影響監測站普遍錄得較低的品種數量。而在2020年7月及8月受影響監測站ESC-INA及ESC-INB的生物量、生物重量、單位努力漁獲量及單位努力生產量普遍錄得較低的數值。

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

1.1.1 The Civil Engineering and Development Department (CEDD) is managing a number of marine disposal facilities in Hong Kong waters, including the Contaminated Mud Pits (CMPs) to the South of The Brothers (SB) and to the East of Sha Chau (ESC) for the disposal of contaminated sediment, and open-sea disposal grounds located to the South of Cheung Chau (SCC), East of Tung Lung Chau (ETLC) and East of Ninepins (ENP) for the disposal of uncontaminated sediment. Two Environmental Permits (EPs), EP-312/2008/A and EP-427/2011/A, were issued by the Environmental Protection Department (EPD) to the CEDD, the Permit Holder, on 28 November 2008 and 23 December 2011 for the Dredging, Management and Capping of Contaminated Sediment Disposal Facilities at ESC CMP V and SB CMPs, respectively.

1.1.2 Under the requirements of the two EPs for ESC CMP V and SB CMPs, Environmental Monitoring and Audit (EM&A) programmes which encompass water and sediment chemistry, fisheries assessment, tissue and whole body analysis, sediment toxicity and benthic recolonisation studies as set out in the EM&A Manuals are required to be implemented. EM&A programmes have been continuously carried out during the operation of the CMPs at ESC and SB. A review of the collection and analysis of such environmental data from the monitoring programme demonstrated that there had not been any adverse environmental impacts resulting from disposal activities (1)(2). The current programme will assess the impacts resulting from dredging, disposal and capping operations of CMP V as well as capping operations of SB CMPs.

1.1.3 The present EM&A programme under *Agreement No. CE 63/2016 (EP)* ("the Study") covers the dredging, disposal and capping operations of the ESC CMP V as well as the capping operations of the SB CMPs (see *Annex A* for the EM&A programme). The scheduled EM&A programme for SB CMPs was completed in December 2018.

(1) ERM (2013). Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau. Final Report. For CEDD.

(2) ERM (2017). Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final Report. For CEDD.

1.2 *ACTIVITIES CONDUCTED DURING THE REPORTING PERIOD*

1.2.1 Detailed works schedule for ESC CMP V and SB CMPs is shown in *Figure 1.1*. During the reporting period of July to September 2020, the following works were being undertaken at the CMPs:

- Disposal of contaminated mud at ESC CMP Vb; and
- Capping operations at ESC CMP Vd.

Figure 1.1 Works Schedule for ESC CMPs

Pit	Operation	2017									2018												2019												2020												2021		
		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	M	A	M	J	J	A	S	O	N	D	J	F	M
ESC CMP V	Dredging				■	■	■																										■	■															
	Disposal	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Capping																																		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

1.2.2 The record for contaminated mud disposal at ESC CMP Vb during the reporting period are presented in *Annex B1*, and the record for capping operation at ESC CMP Vd during the reporting period is presented in *Annex B2*.

1.3 *OBJECTIVES OF THE MONITORING AND AUDIT PROGRAMME*

1.3.1 The objectives of the EM&A programme are as follows:

1) To monitor and report on the environmental impacts of the dredging operations associated with the construction of the disposal pits;

2) To monitor and report on the environmental impacts due to capping operations of the exhausted pits;

3) To monitor and report on the environmental impacts of the disposal of contaminated marine sediments in the active pits and specifically to determine:

   a. changes/trends caused by disposal activities in the concentrations of contaminants in sediments adjacent to the pits;

   b. changes/trends caused by disposal activities in the toxicity of sediment adjacent to the pits;

   c. changes/trends caused by disposal activities in the concentrations of contaminants in tissues of demersal marine life adjacent to and remote from the pits;

   d. impacts on water quality and benthic ecology caused by the disposal activities; and

   e. the risks to human health and dolphin of eating seafood taken in the marine area around the active pits.

4) To monitor and report on the environmental impacts of the disposal operation and specifically to determine whether the methods of disposal are effective in reducing the risks of unacceptable environmental impacts.

5) To monitor and report on the benthic recolonisation of the capped pits and specifically to determine the difference in infauna between the capped pits and adjacent sites.

6) To assess the impact of a major storm (Typhoon Signal No. 8 or above) on the containment of any uncapped or partially capped pits.

7) To design and continually review the operation and monitoring programme and:

    a. to make recommendations for changes to the operation that will rectify any unacceptable environmental impacts; and

    b. to make recommendations for changes to the monitoring programme that will improve the ability to cost effectively detect environmental changes caused by the disposal activities.

8) To establish numerical decision criteria for defining impacts for each monitoring component.

9) To provide supervision on the field works and laboratory works to be carried out by contractors/laboratories.

1.3.2 The purpose of this *Quarterly EM&A Report for July to September 2020* is to provide information regarding the findings in the quarterly reporting period of July to September 2020 on the environmental impacts resulting from backfilling operation at ESC CMP Vb and capping operation at ESC CMP Vd. Although the EM&A programme has been conducted since 1997, this report presents the analytical and statistical results of the quarterly reporting period. Results from previous monitoring will be presented and discussed in the Annual Review Report. Readers are referred to the *Monthly EM&A Reports* for this Study for graphical and tabular presentations of the monitoring results.

1.3.3 The objectives of this report are to:

- Confirm that all activities, tests, analyses, assessments etc. have been carried out as stated in the *EM&A Manual*; and,

- Report on any trend resulting from dredging, backfilling and capping operations at the CMPs.

2 *ENVIRONMENTAL MONITORING & AUDITING PROGRAMME*

2.1 ***ENVIRONMENTAL MONITORING & AUDITING TASKS***

2.1.1 Six key elements were designed for the EM&A Programme for assessing whether key environmental parameters are being affected by dredging, backfilling and capping operations at the CMPs. Key tasks are as follows:

- Sediment Quality Monitoring;
- Sediment Toxicity Testing;
- Trawling & Tissue/ Whole Body Contaminant Testing;
- Water Quality Monitoring;
- Human Health and Ecological Risk Assessment; and
- Benthic Recolonisation.

2.2 ***EM&A SAMPLING AND ANALYSES***

2.2.1 Details regarding the methodologies for the field sampling and laboratory analyses of the monitoring tasks listed in *Section 2.1* are presented in the *EM&A Manual* (1) as well as in *Contract No. CV/2017/04 (Sediment Disposal Facilities to the East of Sha Chau and East of Tung Lung Chau – Sampling (2018-2022))* and *Contract No. CV/2017/05 (Sediment Disposal Facilities to the East of Sha Chau and East of Tung Lung Chau – Testing (2018-2022))*. Lam Geotechnics Limited and Wellab Limited were responsible for sampling under *Contract No. CV/2017/04* and laboratory analyses under *Contract No. CV/2017/05*, respectively, during the quarterly period.

(1) ERM (2017). Updated EM&A Manual for ESC CMP V. Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau (2017-2020) – Investigation. Agreement No. CE 63/2016 (EP).

3 MONITORING & AUDITING RESULTS

3.1 OVERVIEW OF THE MONITORING & AUDITING ACTIVITIES

3.1.1 *Sampling & Laboratory Analysis*

3.1.2 Schedules of the EM&A programme are presented in *Annex A.* The samplings, *in-situ* measurements and analyses of samples were conducted in accordance with the *EM&A Manual* during this reporting period. The samplings conducted as well as the monitoring results received from the Contractors for this reporting period are shown in *Table 3.1*.

Table 3.1 Samplings Conducted and Monitoring Results Received from the Contractors for the Reporting Period of July to September 2020

Key Task	Date of Sampling & *in-situ* Measurement	Date of Results Received from the Contractors
ESC CMPs		
Water Column Profiling of ESC CMP Vb	8 July 2020 11 August 2020 3 September 2020	3 August 2020 4 September 2020 9 October 2020
Routine Water Quality Monitoring of ESC CMPs	10 July 2020 4 August 2020	3 August 2020 4 September 2020
Water Quality Monitoring during Capping Operation of ESC CMPs	10 August 2020	4 September 2020
Pit Specific Sediment Chemistry of ESC CMP Vb	7 July 2020 12 August 2020 2 September 2020	3 August 2020 4 September 2020 9 October 2020
Cumulative Impact Sediment Chemistry of ESC CMPs	5 & 6 August 2020	4 September 2020
Sediment Chemistry After a Major Storm	21 August 2020	4 September 2020
Sediment Toxicity Test of ESC CMPs	5 & 6 August 2020	9 September 2020
Demersal Trawling of ESC CMPs	8 & 9 July 2020 27 & 28 August 2020	9 September 2020 6 October 2020

3.1.3 The monitoring results of the above environmental monitoring components for ESC CMPs have been presented in the respective *Monthly EM&A Reports* for this Study. The statistical analyses of these environmental monitoring components, where applicable, are presented in the following sections to report any trends caused by disposal activities at ESC CMPs during the reporting period. It should be noted that statistical analysis was not conducted for *Water Column Profiling for ESC CMP Vb* as the monitoring stations were mobile depending on the location of backfilling operation during the monitoring event.

3.2 *SUMMARY OF MONITORING RESULTS AND STATISTICAL ANALYSES FOR ESC CMPS*

3.2.1 *Water Column Profiling of ESC CMP Vb*

3.2.2 *Water Column Profiling* for ESC CMP Vb was conducted once every month from July to September 2020 as presented in *Table 3.1*. A total of two (2) stations were sampled, one located 100 m Upstream and one located 100 m Downstream of the disposal area. The monitoring results indicated that levels of Salinity, pH and Dissolved Oxygen (DO) complied with the Water Quality Objectives (WQOs) at both Upstream and Downstream stations in July, August and September 2020. Levels of DO, Turbidity and Suspended Solids (SS) also complied with the Action and Limit Levels at all stations during the quarterly period.

3.2.3 Overall, the results indicated that the mud disposal operation at ESC CMP Vb did not appear to cause any unacceptable deterioration in water quality during this quarterly period.

3.2.4 *Routine Water Quality Monitoring of ESC CMPs*

Background

3.2.5 *Routine Water Quality Monitoring* for ESC CMPs was conducted in July and August 2020 as presented in *Table 3.1*. A total of ten (10) and sixteen (16) stations were sampled in July and August 2020 with locations of the monitoring stations presented in *Figures 3.1* and *3.2*, respectively. The disposal volume during the reporting period is detailed in *Annex B1*. The monitoring results showed that levels of DO, Salinity and pH complied with the WQOs at most stations, except the Salinity in Ma Wan was higher than WQO in July 2020. 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 wet season, when compared to the Reference stations. The levels of DO, Turbidity and SS complied with the Action and Limit Levels at all stations in July and August 2020.

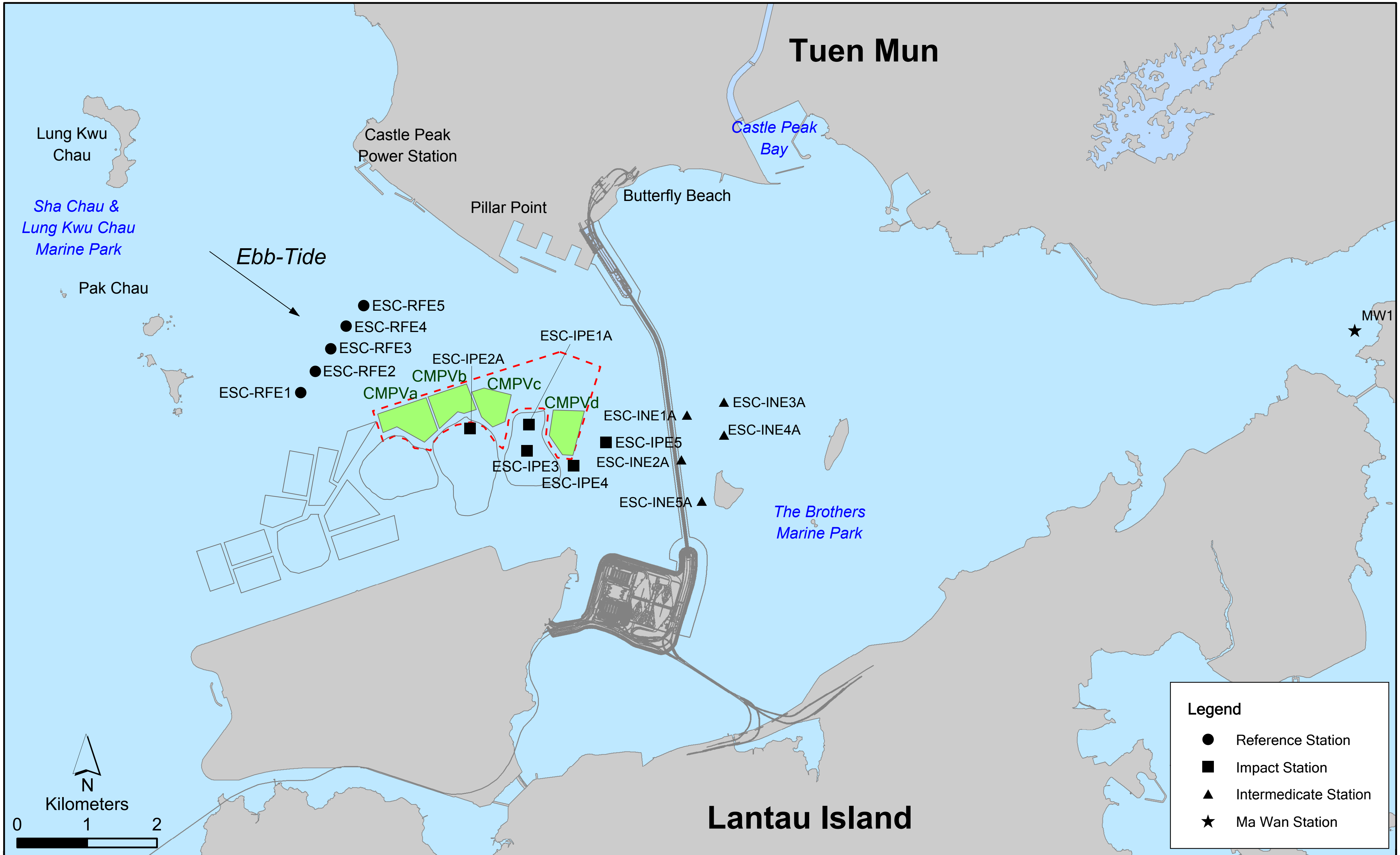


Figure 3.1

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

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_R_C_WQMS_ebb.mxd
Date: 19/4/2017

Environmental Resources Management

ERM

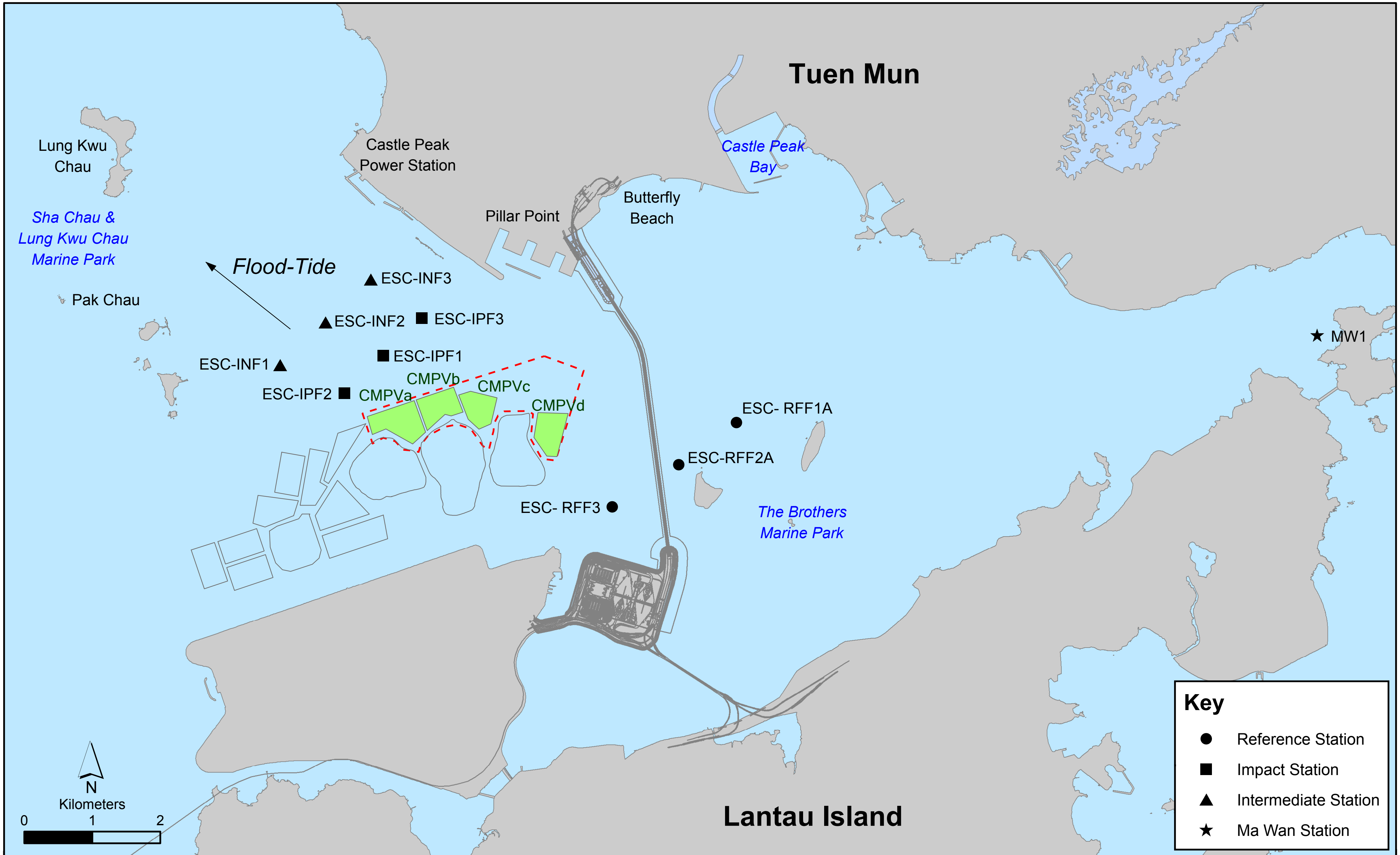


Figure 3.2

Routine & Capping Water Quality Sampling Stations (Flood-Tide) for ESC CMPs

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_R_C_WQMS_flood.mxd
Date: 25/4/2017

Environmental Resources Management

ERM

Summary of Statistical Analyses

3.2.6 The aim of the statistical analysis is to reveal any trends of increasing concentration of contaminants with proximity to the pit or with time. Data obtained during this reporting period were statistically compared with data obtained since monitoring began at CMP V in February 2012. For most parameters, only low concentrations were measured from February 2012 to August 2020 and some parameters have majority of their recorded values below the limit of reporting. Statistical analysis was performed on parameters for which at least 60% of data were above the limit of reporting since monitoring of CMP V began in February 2012. Spatio-temporal differences in *in-situ* parameters, dissolved metal, inorganic and organic contaminant contents were then tested by three-factor partially-nested Analysis of Variance (ANOVA). Area, Period and Station were treated as fixed factors under investigation with Station nested within Area.

3.2.7 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. Linear regression analysis makes assumptions of equal variance and normal distribution of data. Therefore, the significance level of the test was set at 1 % (i.e. $p = 0.01$) to reduce the chance of committing a Type 1 error. If a significant regression relationship was found between contaminant concentration and time (i.e. $p < 0.01$), r^2 value from the analysis would be further assessed. This value represents the proportion of the total variation in the dependent variable (i.e. contaminant concentration) that is accounted for by the fitted regression line and is referred to as the coefficient of determination. An r^2 value of 1 indicates a perfect relationship (or fit) whereas a value of 0 indicates that there is no relationship (or no fit) between the dependent and independent variables.

3.2.8 As there are no specific criteria to indicate how meaningful an r^2 value is, for the purposes of this EM&A programme a value of 0.60 was adopted to indicate a meaningful regression. If $r^2 < 0.60$ then it was considered that there was a weak relationship between contaminant concentration and time or proximity to the pit, or none at all. If the regression analysis indicated $r^2 > 0.60$ then it had been interpreted that there was in fact a strong relationship between the dependent and independent variables (i.e. a strong temporal trend of increasing contaminant concentration with time or strong spatial trend of increasing contaminant concentration with proximity to the pit). Details regarding the statistical analyses results are presented in *Annex C*.

In-situ Measurement

Dissolved Oxygen (DO)

3.2.9 DO levels varied significantly with sampling periods and areas. There was no consistent spatial trend of decreasing concentrations of DO with proximity to the pit or consistent temporal trend of decreasing concentrations of DO over time. DO levels were the highest in February 2017 and were the lowest in July 2013, August 2016 and July 2019. DO levels were the highest at Intermediate and Impact stations.

Turbidity

3.2.10 Turbidity levels varied significantly with sampling periods and areas. There was no consistent spatial trend of increasing concentrations of Turbidity with proximity to the pit or consistent temporal trend of increasing concentrations of Turbidity over time. Turbidity levels were the highest in April 2020 and November 2017 and were the lowest in February 2017. Turbidity was the highest at Impact and Reference stations.

Metals and Metalloid

3.2.11 The majority of dissolved metals had high percentage of their values below the limit of reporting (i.e. > 60% of values were below the limit of reporting during February 2012 to August 2020). Copper, Nickel and Zinc were the exceptions, and all varied significantly over area and time as indicated by results of the ANOVA tests (*Annex C*), but without any consistent spatial or temporal trends. The concentration of Copper was the highest in August 2013 when compared to all other sampling periods. The concentration of Nickel was significantly higher in April 2012, August 2013 and May 2013. The concentration of Zinc was the highest in November 2017 when compared to all other sampling periods. The concentrations of Copper were the highest at Reference stations. The concentrations of Nickel were the highest at Reference stations. The concentrations of Zinc were the highest at Ma Wan station.

Inorganic Contaminants

Ammonia Nitrogen (NH_3-N)

3.2.12 NH_3-N concentrations varied significantly with sampling periods and areas. There was no consistent spatial trend of increasing concentrations of NH_3-N with proximity to the pit or consistent temporal trend of increasing concentrations of NH_3-N over time. Concentrations of NH_3-N were the highest in April 2012. Concentrations of NH_3-N were the highest at Reference and Ma Wan station.

Total Inorganic Nitrogen (TIN)

3.2.13 TIN concentrations varied significantly with sampling periods and stations. There was no consistent spatial trend of increasing concentrations of TIN with proximity to the pit or consistent temporal trend of increasing concentrations of TIN over time. Concentrations of TIN were the highest in April 2012 and May 2018. Concentrations of TIN were the highest at Reference and Impact stations.

5-Day Biochemical Oxygen Demand (BOD_5)

3.2.14 Levels of BOD_5 varied significantly with sampling area and periods. There was no consistent spatial trend of increasing concentrations of BOD_5 with proximity to the pit or consistent temporal trend of increasing concentrations of BOD_5 over time. Levels of BOD_5 were the highest in August 2016. Levels of BOD_5 were the highest at Ma Wan and Reference stations.

Suspended Solids (SS)

3.2.15 SS levels varied significantly with sampling areas and periods. There was no consistent temporal trend of increasing concentrations of SS over time. SS levels were the highest in April 2020 and November 2017. SS levels were the highest at Impact stations, then at Intermediate stations and in turn higher than at Reference stations. Subsequent regression analysis between SS levels and proximity to the pit (i.e. Area) indicated that there was significant spatial trend of increasing SS level with proximity to the pit ($p < 0.01$), but there was a weak relationship between SS level and proximity to the pit ($r^2 < 0.60$).

3.2.16 Overall, results of statistical analyses for the water quality data did not appear to provide any evidence of unacceptable water quality impacts caused by the mud disposal operations at CMP Vb of the ESC area.

3.2.17 ***Water Quality Monitoring during Capping of ESC CMPs – August 2020***

Background

3.2.18 Water Quality Monitoring during Capping of ESC CMPs was conducted in August 2020 as presented in *Table 3.1*. A total of ten (10) stations were sampled in August 2020, and locations of the monitoring stations are presented in *Figure 3.2*. The capping volume during the reporting period is detailed in *Annex B2*. The monitoring results showed that levels of DO, Turbidity and SS complied with the WQO, Action and Limit Levels at all stations in August 2020 while the Levels of Salinity were higher than WQO at Ma Wan Station. 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 wet season, when compared to the Reference stations, so it is unlikely to be caused by the capping operations at ESC CMPs.

Summary of Statistical Analyses

3.2.19 The aim of the statistical analysis is to reveal any trends of increasing concentration of contaminants with proximity to the pit or with time. Data obtained during this reporting period were statistically compared with data obtained since monitoring began at ESC CMPs in December 2013. Spatio-temporal differences in DO, Turbidity and SS were tested by two-factor partially-nested ANOVA. Area and Period were treated as fixed factors under investigation with Station nested within Area.

3.2.20 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

Dissolved Oxygen (DO)

3.2.21 DO levels varied significantly with sampling areas and periods. However, there was no consistent spatial trend of decreasing concentrations of DO with proximity to the pit or consistent temporal trend of decreasing concentrations of DO over time.

Turbidity

3.2.22 Turbidity levels varied significantly with sampling areas and periods. However, there was no consistent spatial trend of increasing concentrations of Turbidity with proximity to the pit or consistent temporal trend of increasing concentrations of Turbidity over time.

Suspended Solids (SS)

3.2.23 SS levels varied significantly with sampling areas and periods. However, there was no consistent spatial trend of increasing concentrations of SS with proximity to the pit or consistent temporal trend of increasing concentrations of SS over time.

3.2.24 Overall, results of statistical analyses for the water quality data did not appear to provide any evidence of unacceptable water quality impacts caused by the capping operations at ESC CMPs.

3.2.25 ***Pit Specific Sediment Chemistry of ESC CMP Vb***

Background

3.2.26 *Pit Specific Sediment Chemistry of ESC CMP Vb* was conducted once every month from July to September 2020 as presented in *Table 3.1*. A total of six (6) monitoring stations for ESC CMP Vb were sampled in each monitoring event and the monitoring locations are shown in *Figure 3.3*. The monitoring results showed that the concentrations of most inorganic contaminants were below the Lower Chemical Exceedance Levels (LCELs) at most stations from July to September 2020, except the concentrations of Arsenic were higher than LCELs at Active Pit stations, Pit-Edge stations and Near-Pit stations.

Summary of Statistical Analyses

3.2.27 Statistical analyses were performed for data obtained from *Pit Specific Sediment Chemistry of ESC CMP Vb* since February 2020. Statistical tests were run to examine the difference in contaminant concentrations amongst Active-Pit, Pit-Edge and Near-Pit stations and amongst sampling periods. ANOVA was employed as the statistical test, with Area, Period and Station as fixed factors and Station nested within Area.

3.2.28 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

Metals and Metalloids

3.2.29 There were significant spatial and temporal variations in the concentrations of all metal and metalloid contaminants (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Mercury, Silver and Zinc). The concentrations of all measured metals and metalloids did not appear to increase over time. Subsequent linear regression analysis for Cadmium, Chromium, Lead, and Mercury levels and proximity to the pit (i.e. Area) indicated that there were significant spatial trends ($p < 0.01$), but there was a weak relationship between Cadmium, Chromium, Lead, and Mercury levels and proximity to the pit ($r^2 < 0.60$).

Organic Contaminants

3.2.30 Concentrations of majority of organic contaminants were below their limits of reporting. Statistical analyses were only performed for contaminants for which 60% of data were over their limits of reporting.

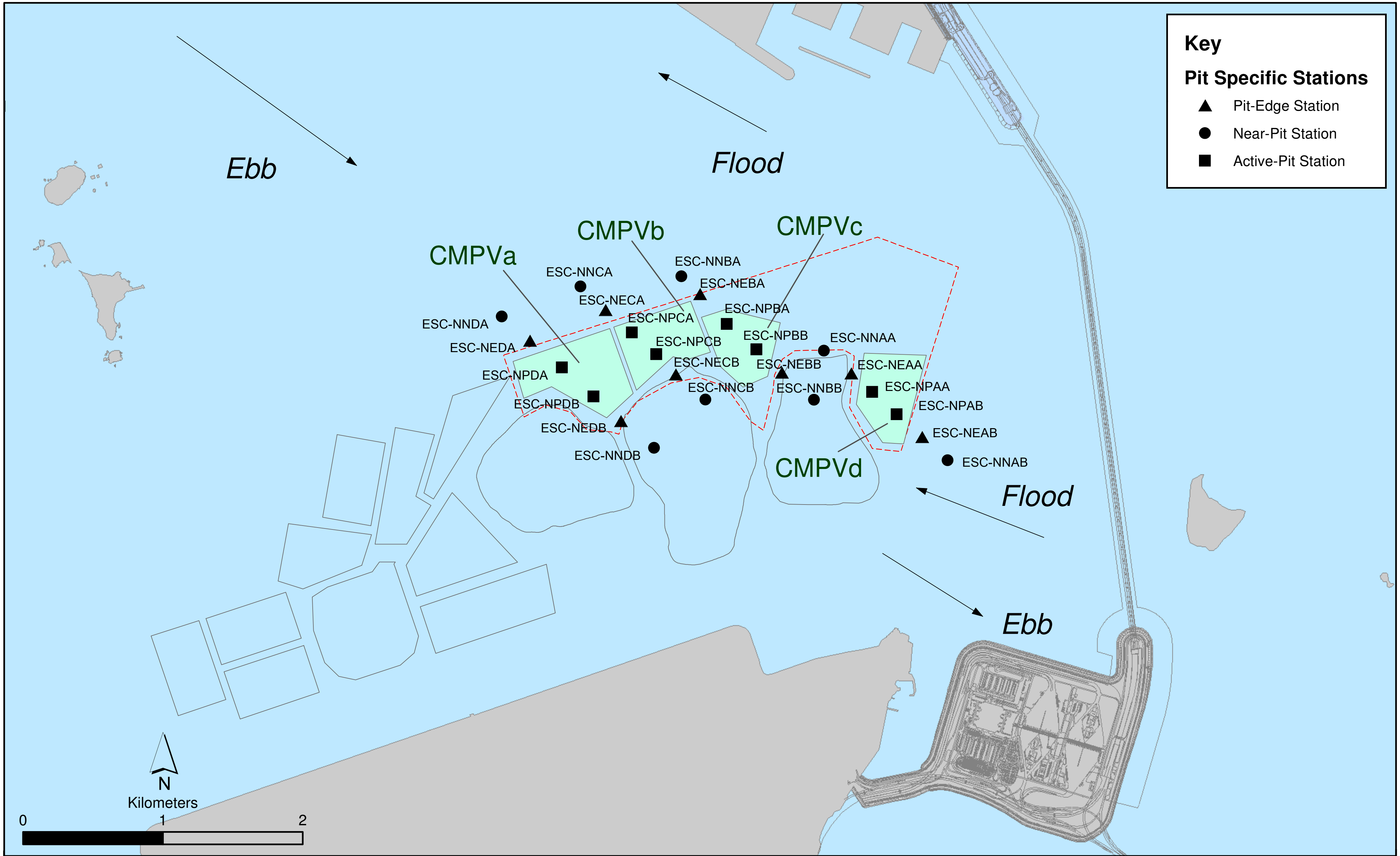


Figure 3.3

Pit Specific Sediment Quality Monitoring Stations for CMPV

File: T:\GIS\CONTRACT\0400720\Mxd\0400720_SQMS_pit specific.mxd
Date: 9/5/2017

Environmental
Resources
Management
ERM

3.2.31 In this reporting period, only Total Organic Carbon (TOC) concentrations were statistically analysed. Levels of TOC varied significantly with sampling area and time, but the concentrations of TOC did not appear to increase over time or increase with proximity to the pit.

3.2.32 From the results of the above statistical analyses, there did not appear to be any significant trend of increasing sediment contaminants' concentrations with proximity to the pit or with time. Therefore, there is no evidence indicating any unacceptable environmental impacts to sediment quality as a result of the contaminated mud disposal operations at ESC CMP Vb.

3.2.33 ***Cumulative Impact Sediment Chemistry of ESC CMPs***

Background

3.2.34 *Cumulative Impact Sediment Chemistry of ESC CMPs* was conducted in August 2020 as presented in *Table 3.1*. A total of nine (9) monitoring stations were sampled and the monitoring locations are shown in *Figure 3.4*. The monitoring results showed that the concentrations of all inorganic contaminants were generally below the LCELs at all monitoring stations in August 2020, except concentrations of Arsenic were higher than the LCEL at Mid-field stations ESC-RMA, ESC-RMB and Capped Pit station ESC-RCB1.

Summary of Statistical Analysis

3.2.35 Data obtained during this reporting period were statistically compared with previous data obtained since monitoring began for ESC CMPs in June 2016. Statistical tests were run to examine the difference in contaminant concentrations amongst Near-Field, Mid-Field, Far-Field stations. ANOVA was employed as the statistical test, with Area and Station as fixed factors and Station nested within Area.

3.2.36 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

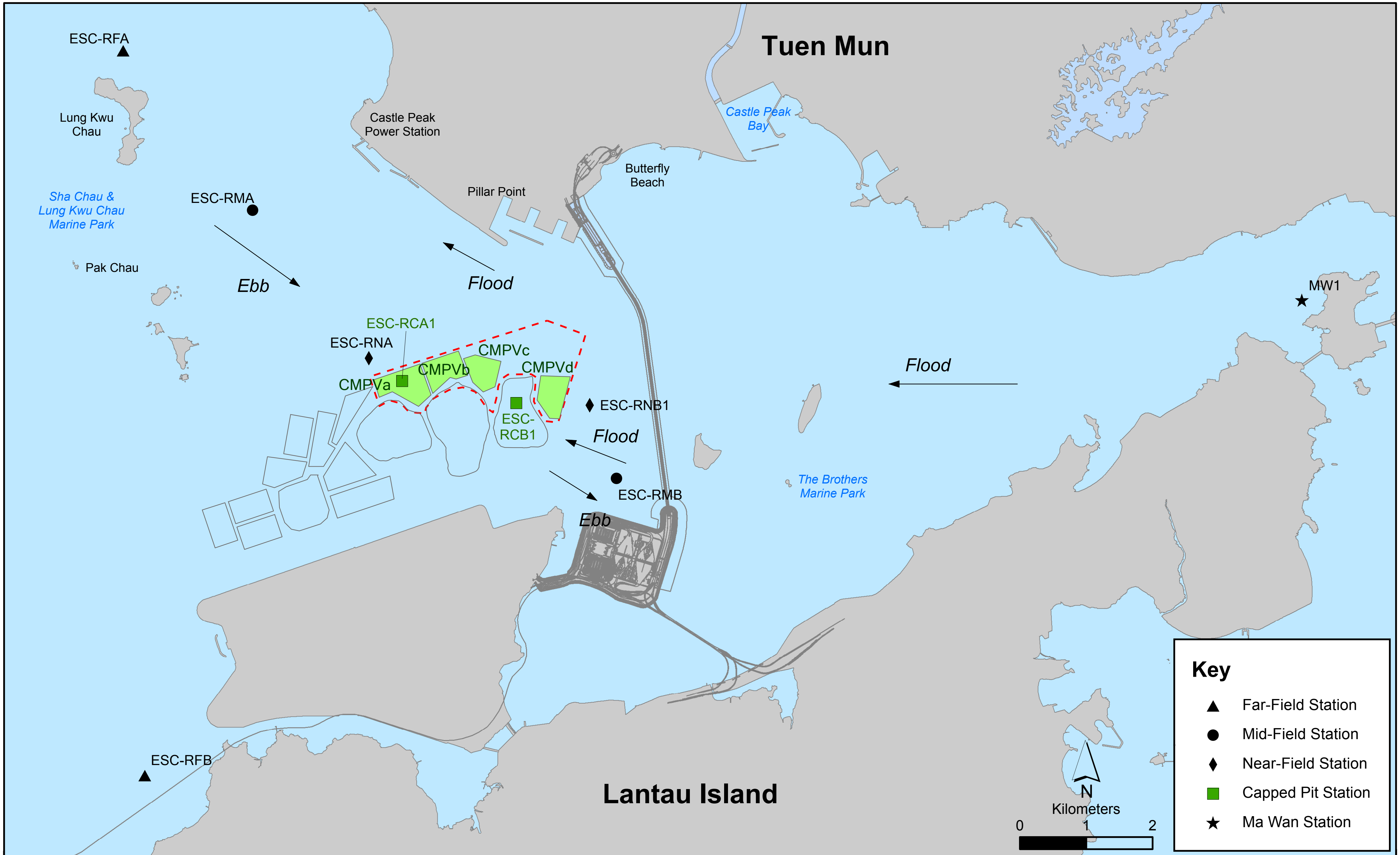


Figure 3.4

Cumulative Impacts Sediment Quality Monitoring Stations for ESC CMPs

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_SQMS_cum_impact.mxd
Date: 19/4/2017

Environmental Resources Management

ERM

Metals and Metalloid

3.2.37 There were significant spatial variations in the concentrations of all metal and metalloid contaminants (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Mercury, Silver and Zinc), but no consistent trend (i.e. Near-Field > Mid-Field > Far-Field) was observed. In most cases, metal concentrations were highest at Mid-Field or Ma Wan stations. The concentrations of all measured metals and metalloids varied significantly with sampling time, but did not appear to increase over time.

Organic Contaminants

3.2.38 Concentrations of majority of organic contaminants were below their limits of reporting. Statistical analyses were only performed for contaminants for which 60% of data were over their limits of reporting.

3.2.39 In this reporting period, only TOC and Tributyltin (TBT) concentrations were statistically analysed. Levels of TOC and TBT varied significantly with sampling area and time and were the highest at Ma Wan station. There was no consistent spatial trend of increasing concentrations of TOC/TBT with proximity to the pit or consistent temporal trend of increasing concentrations of TOC/TBT over time.

3.2.40 From the results of the above statistical analyses, there did not appear to be any significant trend of increasing sediment contaminants' concentrations with proximity to the pit or over time. Therefore, there is no evidence indicating any unacceptable environmental impacts to sediment quality as a result of the contaminated mud disposal operations at ESC CMP Vb during the quarterly period.

3.2.41 ***Sediment Chemistry after a Major Storm of ESC CMPs – August 2020***

Background

3.2.42 Samplings for *Sediment Chemistry after a Major Storm of ESC CMPs* were conducted at nine (9) monitoring stations (see *Figure 3.4* for the monitoring locations) on 21 August 2020 after the visit of tropical cyclone Higos, which led to the issue of No. 9 Gale or Storm Signal on 19 August 2020. The tracks of Higos are shown in *Figure 3.5*. The monitoring results showed that the concentrations of most inorganic contaminants were below the LCEL, except Arsenic at Near-field station ESC-RNB1, Mid-field stations ESC-RMA and ESC-RMB, Far-field stations ESC-RFA and ESC-RFB and Ma Wan Station in August 2020.

Figure 3.5 *Track of Tropical Cyclone Higos* *(Source: Hong Kong Observatory)*

Summary of Statistical Analyses

3.2.43 The data obtained were examined using statistical analyses. Statistical tests were run on inorganic contaminants, including Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Mercury, Silver and Zinc to examine differences in their sediment concentrations between Near-Field, Mid-Field, Far-Field, Capped-Pit and Ma Wan stations. A Two Factor Nested Analyses of Variance was employed as the statistical test, with Area as fixed factor and Station nested within Area.

3.2.44 Should spatial trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

3.2.45 Results of the statistical analyses indicated that concentrations of all contaminants showed significant differences amongst sampling areas. However, there did not appear to be any trend of increasing contaminant's concentrations with proximity to the pit (i.e. Near-field > Mid-field > Far-field). Therefore, results of statistical analyses do not provide any evidence of the failure of ESC CMP Vb in retaining disposed mud or causing contamination of sediments after the major storm event in August 2020.

3.2.46 ***Sediment Toxicity Test – August 2020***

3.2.47 Sediment Toxicity Tests were undertaken for sediments collected from the Impact (Near Pit), Reference and Ma Wan stations (see *Figure 3.6* for the sampling locations) in August 2020 using three international species (burrowing amphipod *Leptocheirus plumulosus*, marine benthic polychaete *Neanthes arenaceodentata* and marine bivalve *Crassostrea gigas*) and two local species (barnacles *Balanus amphitrite* and shrimp *Penaeus vannaamei*).

3.2.48 Appropriate statistical test, i.e. ANOVA, was applied for comparing and determining the level of significance in the results in August 2020. For all of the ANOVA techniques, initial analyses were performed to ensure that the data are independent of each other, normally distributed and homogeneous. Should the data not comply with these assumptions then the appropriate transformation would be applied to the data. Data transformation (e.g. natural logarithm of chemical concentrations, square-root of a count and arcsine square-root of a proportion or percentage) would be used to reduce the within class heterogeneity of variance. If, after transformation, the data are still non-compliant (i.e. the residual errors are not normally distributed or variances are still heterogeneous) then rank transformed data would be applied to parametric or non-parametric equivalents to ANOVA such as Kruskal-Wallis tests. When significant difference are detected then multiple comparison procedures would be used (e.g. Student Newman Keuls Test or Turkey's HSD or Dunn's Test) to isolate where the differences is occurring.

3.2.49 Results of the Sediment Toxicity Tests in August 2020 showed that there were no significant differences between Impact and Reference stations in the toxicity tests of most marine benthos, except for the growth rate of benthic polychaete. However, clear spatial patterns were not observed (i.e. all Reference stations > all Impact stations). Therefore, there did not appear to be any evidence of unacceptable impacts to sediment toxicity due to the mud disposal operations at ESC CMPs.

3.2.50 ***Demersal Trawling – July and August 2020***

3.2.51 Fishery resources monitoring by demersal trawling was carried out at two (2) impact and four (4) reference stations (see *Figure 3.7* for locations) in July and August 2020. Monitoring results are presented in the following sections.

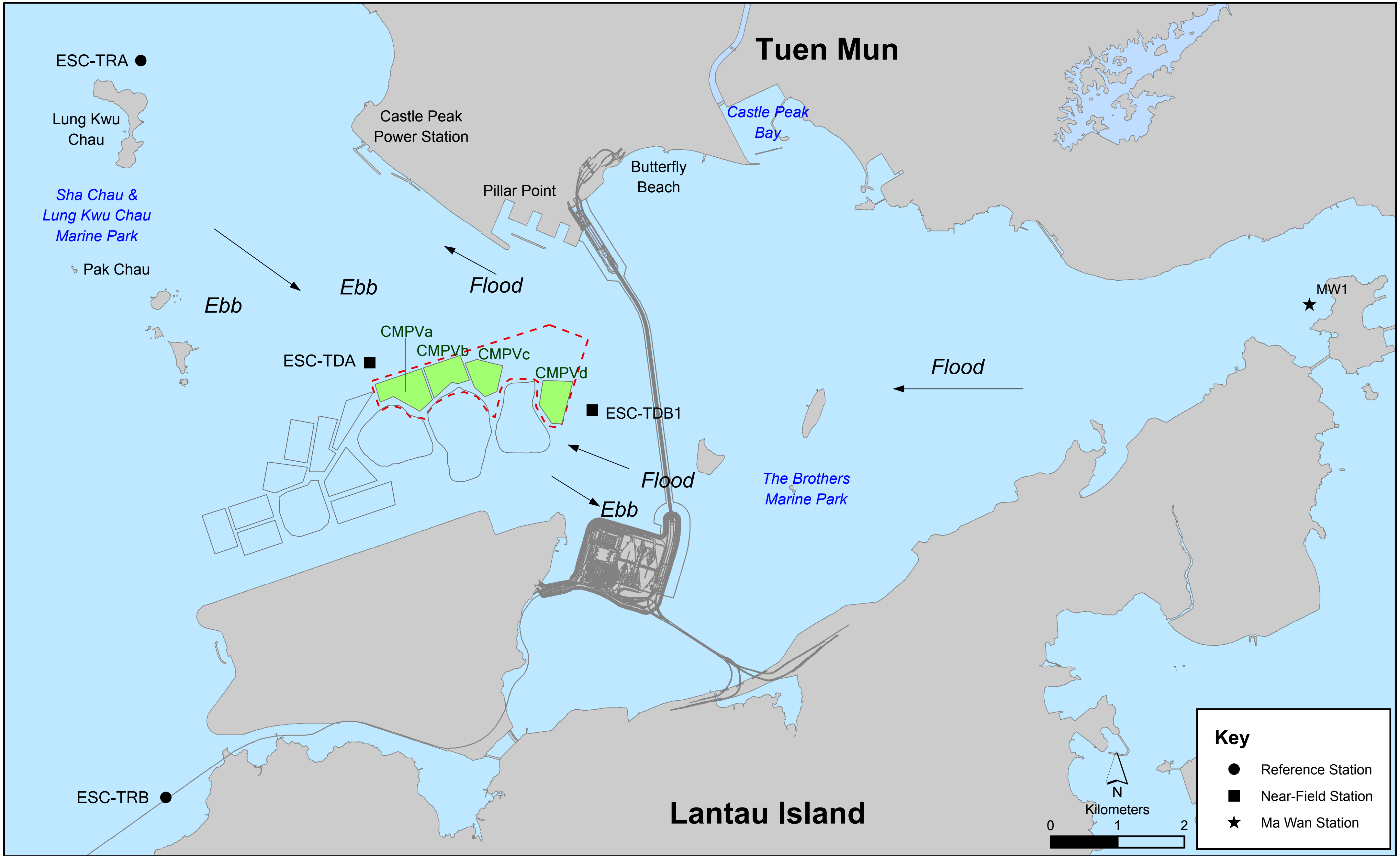


Figure 3.6

Sediment Toxicity Monitoring Stations for ESC CMPs

Environmental Resources Management
ERM

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_sed_toxicity.mxd
Date: 19/4/2017

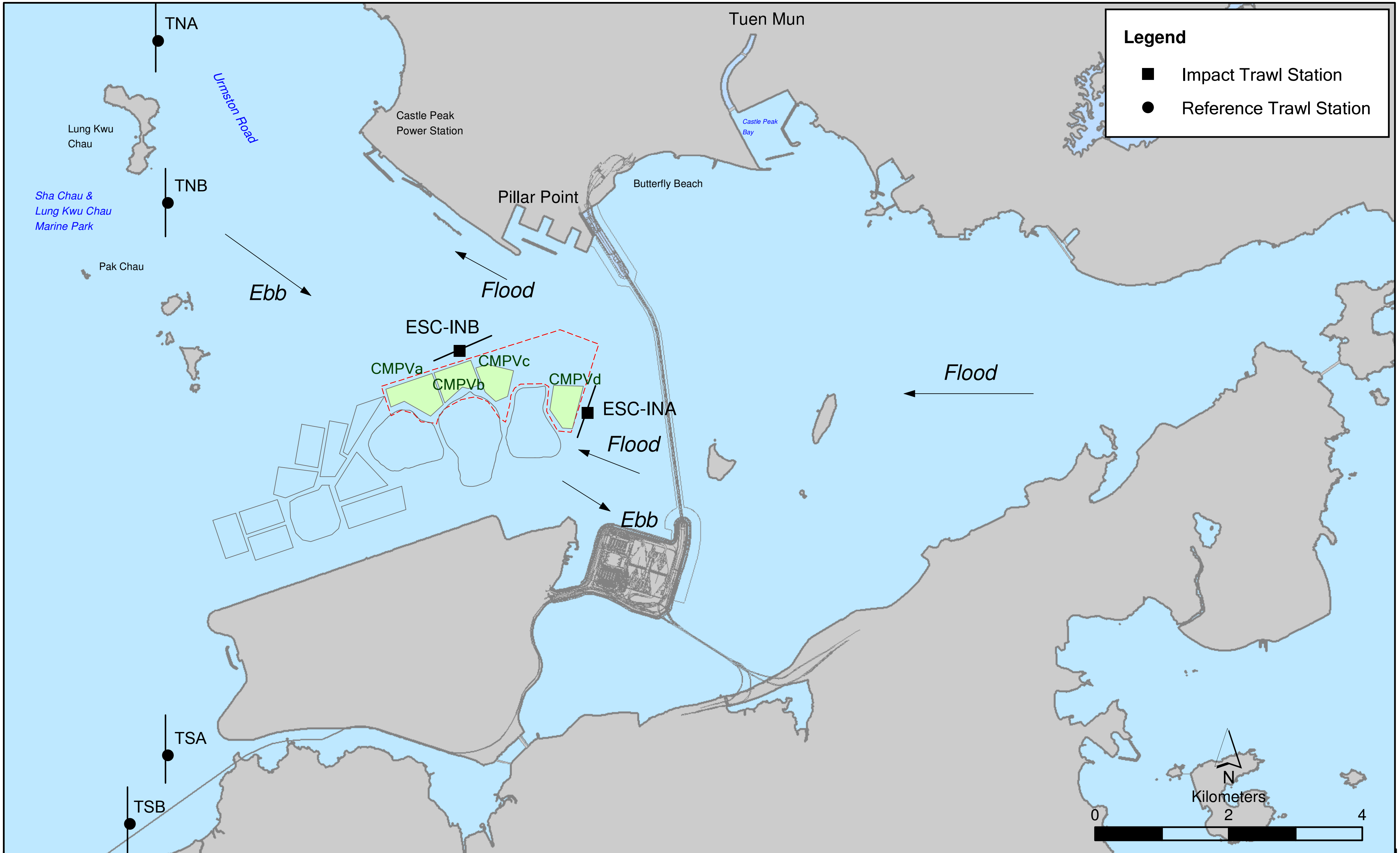


Figure 3.7

Marine Biota Monitoring Stations for CMPV

File: T:\GIS\CONTRACT\0400720\Mxd\0400720_Marine_Biota_2017.mxd
Date: 2/6/2017

Environmental Resources Management

ERM

Abundance and Biomass

3.2.52 The average number of species collected in the period of July and August 2020 is presented in *Table 3.2*. Mean number of faunal species caught at Impact stations was generally lower than at Reference stations in July and August 2020.

3.2.53 Biotic abundance, Biomass, Catch per Unit Effort (CPUE) and Yield per Unit Effort (YPUE) were generally lower at Impact stations ESC-INA and ESC-INB in July and August 2020 (*Table 3.3*). Annual trend and statistical analyses will be conducted in the Annual EM&A Review Report to determine whether there is any evidence of unacceptable impact to fishery resources caused by the mud disposal operations at ESC CMP Vb.

Table 3.2 ***Summary of the Mean Number of Faunal Species Caught during July and August 2020 Monitoring***

Mean Number of Faunal Species	Impact Stations		Reference Stations			
	ESC-INA	ESC-INB	TNA	TNB	TSA	TSB
July 2020	36.2	34	36.4	45.4	55.6	41.4
August 2020	34.2	20.4	37.4	38.2	58.8	44.4

Table 3.3 **Summary of CPUE and YPUE during July and August 2020 Monitoring**

Date	Stations	Stations	No. of Individuals per Station	Total Biomass per Station (g)	Mean CPUE#1 per Tow (No. / hr / net)	Mean YPUE#2 per Tow (g / hr / net)
Jul 2020	ESC-INA	Impact	3115	24188.8	623.0	483.76
Jul 2020	ESC-INB	Impact	2503	16559.0	500.6	3311.80
Jul 2020	TNA	Reference	3658	44677.9	731.6	8935.58
Jul 2020	TNB	Reference	2896	45644.0	558.3	9128.80
Jul 2020	TSA	Reference	6104	81171.8	1227.5	16234.36
Jul 2020	TSB	Reference	2220	41225.1	444.0	6870.85
Aug 2020	ESC-INA	Impact	2746	40145.9	549.2	8029.18
Aug 2020	ESC-INB	Impact	1267	25107.2	253.4	5021.44
Aug 2020	TNA	Reference	3454	77798.2	690.8	15559.64
Aug 2020	TNB	Reference	4471	74576.4	894.2	14915.28
Aug 2020	TSA	Reference	7281	134967.8	1456.2	26993.56
Aug 2020	TSB	Reference	4682	86051.1	936.4	17210.22

Notes:

#1 CPUE is calculated by dividing the number of individuals with the trawling time and number of nets (in hour and number of nets)

#2 YPUE is calculated by dividing the weight (g) of fish with trawling effort (in hour and number of nets)

4 *FINDINGS OF THE FIELD EVENTS AND LABORATORY TESTS AND ANALYSES BY THE INDEPENDENT AUDITOR*

4.1.1 During the reporting period of July to September 2020, there was no scheduled inspection conducted by the Independent Auditor (IA).

5 *ACTIVITIES SCHEDULED FOR THE NEXT REPORTING PERIOD*

5.1.1 The monitoring activities to be conducted in the next quarterly period of October to December 2020 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vb* in October, November and December 2020;
- *Routine Water Quality Monitoring of ESC CMPs* in October and November 2020;
- *Pit Specific Sediment Chemistry of ESC CMP Vb* in October, November and December 2020; and
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in December 2020.

5.1.2 The sampling schedule for ESC CMPs is presented in *Annex A*.

Annex A

Sampling Schedule

Annex A1 - East of Sha Chau Environmental Monitoring and Audit Sampling Schedule for CMP (April 2017 - March 2021)

			2017									2018												2019												2020												2021		
Pit Specific Sediment Chemistry	**Code**	**Frequency**	**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Active-Pit																																																			
	ESC-NPAA	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	ESC-NPAB	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Pit-Edge																																																			
	ESC-NEAA	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	ESC-NEAB	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Near-Pit																																																			
	ESC-NNAA	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	ESC-NNAB	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

Cumulative Impact Sediment Chemistry			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Near-field Stations																																																			
	ESC-RNA	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RNB1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Mid-field Stations																																																			
	ESC-RMA	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RMB	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Capped Pit Stations																																																			
	ESC-RCA1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RCB1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Far-Field Stations																																																			
	ESC-RFA	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RFB	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Ma Wan Station																																																			
	MW1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	

Sediment Toxicity Tests			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Near-Pit Stations																																																			
	ESC-TDA	2 times per year					5						5						5						5						5						5						5						5	
	ESC-TDB1	2 times per year					5						5						5						5						5						5						5						5	
Reference Stations																																																			
	ESC-TRA	2 times per year					5						5						5						5						5						5						5						5	
	ESC-TRB	2 times per year					5						5						5						5						5						5						5						5	
Ma Wan Station																																																			
	MW1	2 times per year					5						5						5						5						5						5						5						5	

Tissue/ Whole Body Sampling			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Near-Pit Stations																																																			
	ESC-INA	2 times per year					*						*						*						*						*						*						*						*	
	ESC-INB	2 times per year					*						*						*						*						*						*						*						*	
Reference North																																																			
	TNA	2 times per year					*						*						*						*						*						*						*						*	
	TNB	2 times per year					*						*						*						*						*						*						*						*	
Reference South																																																			
	TSA	2 times per year					*						*						*						*						*						*						*						*	
	TSB	2 times per year					*						*						*						*						*						*						*						*	

Demersal Trawling			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Near Pit Stations																																																			
	ESC-INA	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
	ESC-INB	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
Reference North																																																			
	TNA	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
	TNB	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
Reference South																																																			
	TSA	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
	TSB	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	

Capping			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Ebb Tide																																																			
Impact Station Downcurrent																																																			
	ESC-IPE1A	4 times per year																																			3				3		3				3		3	
	ESC-IPE2A	4 times per year																																			3				3		3				3		3	
	ESC-IPE3	4 times per year																																			3				3		3				3		3	
	ESC-IPE4	4 times per year																																			3				3		3				3		3	
	ESC-IPE5	4 times per year																																			3				3		3				3		3	
Intermediate Station Downcurrent																																																			
	ESC-INE1A	4 times per year																																			3				3		3				3		3	
	ESC-INE2A	4 times per year																																			3				3		3				3		3	
	ESC-INE3A	4 times per year																																			3				3		3				3		3	
	ESC-INE4A	4 times per year																																			3				3		3				3		3	
	ESC-INE5A	4 times per year																																			3				3		3				3		3	
Reference Station Upcurrent																																																			
	ESC-RFE1	4 times per year																																			3				3		3				3		3	
	ESC-RFE2	4 times per year																																			3				3		3				3		3	
	ESC-RFE3	4 times per year																																			3				3		3				3		3	
	ESC-RFE4	4 times per year																																			3				3		3				3		3	
	ESC-RFE5	4 times per year																																			3				3		3				3		3	
Ma Wan Station																																																			
	MW1	4 times per year																																			3				3		3				3		3	
Flood Tide																																																			
Impact Station Downcurrent																																																			
	ESC-IPF1	4 times per year																																			3				3		3				3		3	
	ESC-IPF2	4 times per year																																			3				3		3				3		3	
	ESC-IPF3	4 times per year																																			3				3		3				3		3	
Intermediate Station Downcurrent																																																			
	ESC-INF1	4 times per year																																			3				3		3				3		3	
	ESC-INF2	4 times per year																																			3				3		3				3		3	
	ESC-INF3	4 times per year																																			3				3		3				3		3	
Reference Station Upcurrent																																																			
	ESC-RFF1A	4 times per year																																			3				3		3				3		3	
	ESC-RFF2A	4 times per year																																			3				3		3				3		3	
	ESC-RFF3	4 times per year																																			3				3		3				3		3	
Ma Wan Station																																																			
	MW1	4 times per year																																			3				3		3				3		3	

Routine Water Quality Monitoring			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Ebb Tide																																																			
Impact Station Downcurrent																																																			
	ESC-IPE1A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE2A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE3	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE4	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE5	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Intermediate Station Downcurrent																																																			
	ESC-INE1A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE2A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE3A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE4A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE5A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Reference Station Upcurrent																																																			
	ESC-RFE1	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE2	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE3	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE4	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE5	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Ma Wan Station																																																			
	MW1	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Flood Tide																																																			
Impact Station Downcurrent																																																			
	ESC-IPF1	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPF2	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPF3	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Intermediate Station Downcurrent																																																			
	ESC-INF1	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INF2	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INF3	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Reference Station Upcurrent																																																			
	ESC-RFF1A	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFF2A	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFF3	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Ma Wan Station																																																			
	MW1	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	

Water Column Profiling			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Plume Stations	WCP1	Monthly	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	WCP2	Monthly	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Benthic Recolonisation Studies			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Capped Stations at CMPV																																																			
	ESCV-CPA	2 times per year																																																	
	ESCV-CPB	2 times per year																																																	
	ESCV-CPC	2 times per year																																																	
	ESCV-CPD	2 times per year																																																	
Reference Stations																																																			
	RBA	2 times per year																																																	
	RBB	2 times per year																																																	
	RBC1	2 times per year																																																	

Impact Monitoring for Dredging			**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**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Upstream Stations																																																			
	US1	3 times per week				2	2	2																										2	2															
	US2	3 times per week				2	2	2																										2	2															
Downstream Stations																																																			
	DS1	3 times per week				2	2	2																										2	2															
	DS2	3 times per week				2	2	2																										2	2															
	DS3	3 times per week				2	2	2																										2	2															
	DS4	3 times per week				2	2	2																										2	2															
	DS5	3 times per week				2	2	2																										2	2															
Ma Wan Station																																																			
	MW1	3 times per week				2	2	2																										2	2															

Notes:
The number shown in each cell represents the numbers of replicates per monitoring station
Impact Monitoring for Dredging will be scheduled when dredging operations commence.
Benthic Recolonisation Studies for CMP V will be scheduled when capping operation for CMP V is completed.

Annex B

Disposal & Capping Records

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Jul-2020	480	190253
2-Jul-2020	0	190253
3-Jul-2020	0	190253
4-Jul-2020	0	190253
5-Jul-2020	450	190703
6-Jul-2020	0	190703
7-Jul-2020	100	190803
8-Jul-2020	500	191303
9-Jul-2020	0	191303
10-Jul-2020	1030	192333
11-Jul-2020	550	192883
12-Jul-2020	0	192883
13-Jul-2020	500	193383
14-Jul-2020	460	193843
15-Jul-2020	0	193843
16-Jul-2020	0	193843
17-Jul-2020	445	194288
18-Jul-2020	500	194788
19-Jul-2020	0	194788
20-Jul-2020	500	195288
21-Jul-2020	0	195288
22-Jul-2020	460	195748
23-Jul-2020	0	195748
24-Jul-2020	0	195748
25-Jul-2020	0	195748
26-Jul-2020	0	195748
27-Jul-2020	0	195748
28-Jul-2020	475	196223
29-Jul-2020	0	196223
30-Jul-2020	0	196223
31-Jul-2020	100	196323
1-Aug-2020	0	196323
2-Aug-2020	425	196748
3-Aug-2020	0	196748
4-Aug-2020	0	196748
5-Aug-2020	425	197173
6-Aug-2020	0	197173
7-Aug-2020	0	197173
8-Aug-2020	445	197618
9-Aug-2020	0	197618
10-Aug-2020	0	197618
11-Aug-2020	0	197618
12-Aug-2020	425	198043
13-Aug-2020	500	198543
14-Aug-2020	500	199043
15-Aug-2020	500	199543
16-Aug-2020	500	200043
17-Aug-2020	840	200883
18-Aug-2020	0	200883
19-Aug-2020	0	200883
20-Aug-2020	0	200883
21-Aug-2020	1000	201883
22-Aug-2020	500	202383

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
23-Aug-2020	500	202883
24-Aug-2020	500	203383
25-Aug-2020	500	203883
26-Aug-2020	400	204283
27-Aug-2020	0	204283
28-Aug-2020	0	204283
29-Aug-2020	0	204283
30-Aug-2020	0	204283
31-Aug-2020	0	204283
1-Sep-2020	0	204283
2-Sep-2020	0	204283
3-Sep-2020	0	204283
4-Sep-2020	400	204683
5-Sep-2020	400	205083
6-Sep-2020	0	205083
7-Sep-2020	0	205083
8-Sep-2020	0	205083
9-Sep-2020	0	205083
10-Sep-2020	0	205083
11-Sep-2020	0	205083
12-Sep-2020	0	205083
13-Sep-2020	0	205083
14-Sep-2020	622	205705
15-Sep-2020	0	205705
16-Sep-2020	0	205705
17-Sep-2020	500	206205
18-Sep-2020	500	206705
19-Sep-2020	475	207180
20-Sep-2020	1000	208180
21-Sep-2020	0	208180
22-Sep-2020	500	208680
23-Sep-2020	500	209180
24-Sep-2020	1500	210680
25-Sep-2020	1941	212621
26-Sep-2020	1954	214575
27-Sep-2020	0	214575
28-Sep-2020	1962	216537
29-Sep-2020	1993	218530
30-Sep-2020	1966	220496

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Jul-2020	0	122800
2-Jul-2020	0	122800
3-Jul-2020	0	122800
4-Jul-2020	0	122800
5-Jul-2020	0	122800
6-Jul-2020	0	122800
7-Jul-2020	500	123300
8-Jul-2020	1200	124500
9-Jul-2020	600	125100
10-Jul-2020	1200	126300
11-Jul-2020	1800	128100
12-Jul-2020	1200	129300
13-Jul-2020	2400	131700
14-Jul-2020	1200	132900
15-Jul-2020	600	133500
16-Jul-2020	1200	134700
17-Jul-2020	600	135300
18-Jul-2020	1200	136500
19-Jul-2020	1200	137700
20-Jul-2020	0	137700
21-Jul-2020	600	138300
22-Jul-2020	1200	139500
23-Jul-2020	600	140100
24-Jul-2020	1200	141300
25-Jul-2020	0	141300
26-Jul-2020	600	141900
27-Jul-2020	1200	143100
28-Jul-2020	0	143100
29-Jul-2020	1200	144300
30-Jul-2020	1200	145500
31-Jul-2020	1200	146700
1-Aug-2020	1800	148500
2-Aug-2020	1800	150300
3-Aug-2020	1200	151500
4-Aug-2020	1200	152700
5-Aug-2020	600	153300
6-Aug-2020	1200	154500
7-Aug-2020	600	155100
8-Aug-2020	0	155100
9-Aug-2020	0	155100
10-Aug-2020	600	155700
11-Aug-2020	0	155700
12-Aug-2020	0	155700
13-Aug-2020	0	155700
14-Aug-2020	0	155700
15-Aug-2020	0	155700
16-Aug-2020	0	155700
17-Aug-2020	0	155700
18-Aug-2020	0	155700
19-Aug-2020	600	156300
20-Aug-2020	0	156300
21-Aug-2020	0	156300
22-Aug-2020	0	156300

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
23-Aug-2020	0	156300
24-Aug-2020	0	156300
25-Aug-2020	0	156300
26-Aug-2020	0	156300
27-Aug-2020	0	156300
28-Aug-2020	0	156300
29-Aug-2020	0	156300
30-Aug-2020	0	156300
31-Aug-2020	0	156300
1-Sep-2020	0	156300
2-Sep-2020	0	156300
3-Sep-2020	0	156300
4-Sep-2020	0	156300
5-Sep-2020	0	156300
6-Sep-2020	0	156300
7-Sep-2020	0	156300
8-Sep-2020	0	156300
9-Sep-2020	600	156900
10-Sep-2020	1800	158700
11-Sep-2020	1800	160500
12-Sep-2020	1800	162300
13-Sep-2020	0	162300
14-Sep-2020	1200	163500
15-Sep-2020	1200	164700
16-Sep-2020	600	165300
17-Sep-2020	0	165300
18-Sep-2020	0	165300
19-Sep-2020	0	165300
20-Sep-2020	0	165300
21-Sep-2020	0	165300
22-Sep-2020	0	165300
23-Sep-2020	0	165300
24-Sep-2020	0	165300
25-Sep-2020	0	165300
26-Sep-2020	0	165300
27-Sep-2020	0	165300
28-Sep-2020	0	165300
29-Sep-2020	0	165300
30-Sep-2020	0	165300

Annex C

Statistical Analysis

Routine Water Quality Monitoring for ESC CMPs – Analysis of Variance and Linear Regression Analysis up to August 2020

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	9102646.471	3	3034215.5	39.649	**
Period	3806829049	48	79308939	1036.351	**
Area * Period	202593885.2	144	1406902	18.384	**
Error	303506465.4	3966	76527.097		
Total	24040318543	4162			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Feb 17 ≥ Feb 13 ≥ Apr 16 = Jan 17 > Feb 18 = Jan 13 > Jan 18 ≥ Feb 12 = Feb 19 ≥ Nov 18 ≥ Feb 20 > Jan 19 > Apr 13 > Apr 17 = Jan 20 > Apr 18 = Nov 16 = Apr 19 > Apr 20 > Nov 17 = Nov 19 > Apr 12 = May 13 ≥ May 20 ≥ Nov 12 ≥ May 19 = May 18 = May 16 > Oct 16 ≥ Oct 12 ≥ Jul 12 > **Jul 20** ≥ **Aug 20** ≥ May 12 = May 17 ≥ Jul 18 > Oct 19 > Jul 16 = Aug 17 = Oct 18 = Oct 17 > Aug 12 > Aug 13 ≥ Aug 18 = Aug 19 = Jul 17 ≥ Aug 16 = Jul 19 = Jul 13
- Impact = Intermediate > Reference > Ma Wan Station

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	161842900.3	3	53947633	179.726	**
Period	2655176929	48	55316186	184.285	**
Area * Period	540567178.9	144	3753939	12.506	**
Error	1190458693	3966	300166.1		
Total	24040138799	4162			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 20 = Nov 17 > May 20 > Oct 17 = Aug 13 ≥ Jan 19 ≥ Apr 17 = Apr 12 = Aug 12 = May 19 = Aug 18 = Nov 18 = Nov 16 ≥ Oct 16 ≥ Jul 18 ≥ Nov 12 ≥ Jul 16 ≥ Jul 17 ≥ May 16 = Oct 18 = Aug 19 ≥ Apr 13 ≥ Feb 12 ≥ Oct 19 ≥ Apr 16 > Jul 19 = Jan 17 = May 18 ≥ **Aug 20** ≥ Oct 12 ≥ Apr 19 = Jul 12 ≥ Aug 17 = Jan 18 ≥ **Jul 20** ≥ Aug 16 ≥ Feb 13 ≥ Feb 18 = May 12 ≥ Jan 13 = Jan 20 ≥ Feb 19 = Apr 18 ≥ Jul 13 ≥ Nov 19 = Feb 20 = May 17 = May 13 > Feb 17
- Impact ≥ Reference ≥ Intermediate > Ma Wan Station

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6225326432	47	132453753.9	665.889	**
Area	25079175.72	3	8359725.238	42.027	**
Station(Area)	82257857.4	24	3427410.725	17.231	**
Period * Area	959366241.5	138	6951929.286	34.95	**
Period * Station(Area)	1314473602	420	3129699.053	15.734	**
Error	890730650.1	4478	198912.606		
Total	44656451703	5118			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Aug 13 > **Aug 20** = May 18 > Feb 12 = **Jul 20** > Nov 18 = Jul 18 = Aug 19 = May 20 ≥ Nov 19 ≥ Jul 13 ≥ Apr 12 = Feb 20 ≥ Oct 19 > Feb 19 = Oct 18 = Aug 18 = Jan 13 > Jan 19 = Jan 20 = Apr 13 = May 16 ≥ Apr 18 = May 19 = Nov 12 ≥ Apr 17 > May 12 > Apr 16 = Oct 12 > Jan 18 = May 13 = Jul 16 = May 17 ≥ Apr 19 ≥ Apr 20 = Aug 16 > Aug 12 = Jul 19 = Jul 12 = Nov 17 ≥ Feb 13 ≥ Feb 18 ≥ Aug 17 = Oct 17 > Oct 16 = Jul 17 = Jan 17 ≥ Feb 17 ≥ Nov 16
- Reference > Ma Wan Station = Impact > Intermediate

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5975072111	47	127129193.8	396.391	**
Area	49158061.86	3	16386020.62	51.092	**
Station(Area)	145683297.5	24	6070137.395	18.927	**
Period * Area	1113024730	138	8065396.592	25.148	**
Period * Station(Area)	798217114.9	420	1900516.94	5.926	**
Error	1436170731	4478	320717.001		
Total	44551889167	5118			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 12 = Aug 13 = May 13 > May 12 ≥ Apr 13 = Aug 16 = Jul 13 ≥ Oct 12 = Jan 13 ≥ May 20 = Aug 12 = Feb 12 = Nov 12 > Jul 17 = Jul 12 = Apr 18 > Aug 17 = Feb 17 > Apr 20 = Apr 17 = May 18 = Jan 20 = Feb 18 = Nov 18 = Jul 18 > Oct 18 ≥ Aug 18 = Jan 18 = May 19 = Oct 19 = Feb 13 ≥ Apr 19 ≥ **Aug 20** ≥ Oct 17 = Aug 19 > May 17 = Oct 16 ≥ Jul 16 ≥ Nov 17 = Feb 20 ≥ Nov 19 > Jul 19 = Jan 17 > Apr 16 ≥ Jan 19 = Nov 16 = Feb 19 = **Jul 20** ≥ May 16
- Reference > Impact > Intermediate > Ma Wan Station

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6437232580	47	136962395.3	415.62	**
Area	115230106.5	3	38410035.5	116.557	**
Station(Area)	111531427.9	24	4647142.828	14.102	**
Period * Area	769129275.2	138	5573400.545	16.913	**
Period * Station(Area)	1139597678	420	2713327.804	8.234	**
Error	1473363856	4471	329537.879		
Total	44515216244	5111			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Nov 17 ≥ Jul 17 = Oct 17 ≥ Feb 17 = Apr 17 = Feb 18 = Aug 17 ≥ Jan 18 = May 17 = Nov 18 = Jul 18 ≥ **Aug 20** = Apr 18 > Aug 19 > Nov 19 ≥ May 18 = May 20 > Apr 12 = Feb 12 = Aug 13 > Oct 19 ≥ Oct 18 = Aug 18 ≥ **Jul 20** ≥ Apr 20 = Jul 12 ≥ Nov 12 ≥ Apr 19 ≥ Jul 13 = Feb 20 = Jan 20 = Feb 19 ≥ May 16 ≥ May 12 = Jan 19 ≥ Jan 17 = Jan 13 ≥ Apr 13 = Apr 16 = Oct 16 = Oct 12 = May 19 > Jul 16 = Nov 16 > Jul 19 > May 13 = Aug 12 > Aug 16 = Feb 13
- Ma Wan Station > Reference > Impact > Intermediate

Ammonia Nitrogen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	7371834574	47	156847544.1	600.733	**
Area	6749514.147	3	2249838.049	8.617	**
Station(Area)	37443514.52	24	1560146.438	5.975	**
Period * Area	482494763.1	138	3496338.863	13.391	**
Period * Station(Area)	408260753.3	420	972049.413	3.723	**
Error	1169699179	4480	261093.567		
Total	44730984904	5120			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 12 > Apr 13 = Jan 20 = Apr 16 > May 13 = May 20 = Feb 19 = Jan 18 = Apr 17 > Apr 20 = May 19 ≥ Feb 17 = May 17 ≥ Feb 12 = Apr 19 ≥ Apr 18 > Feb 18 = **Aug 20** = May 16 ≥ Jan 13 ≥ Jan 17 ≥ Nov 17 = Jul 16 > **Jul 20** = Jul 18 = May 18 > Oct 17 = Jan 19 > Oct 19 ≥ Jul 13 ≥ Nov 16 ≥ Aug 19 = Feb 20 = Nov 19 = Aug 16 ≥ Jul 19 ≥ Aug 12 ≥ Aug 17 ≥ May 12 > Oct 16 = Jul 17 = Aug 18 > Oct 12 = Oct 18 ≥ Aug 13 ≥ Nov 12 > Jul 12 = Feb 13 > Nov 18
- Ma Wan Station = Reference > Impact > Intermediate

Total Inorganic Nitrogen

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	7290241695	47	155111525.4	1105.043	**
Area	132265595.1	3	44088531.7	314.095	**
Station(Area)	183621444.5	24	7650893.521	54.506	**
Period * Area	629393591.3	138	4560823.125	32.492	**
Period * Station(Area)	610215288.5	420	1452893.544	10.351	**
Error	628843967.6	4480	140366.957		
Total	44750281859	5120			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 12 = May 18 > Aug 13 > Apr 17 > Jul 16 = Aug 19 = May 13 > Jul 12 ≥ Nov 18 ≥ Aug 17 ≥ Jul 17 > May 12 = Aug 16 > **Jul 20** > May 17 =Jul 19 = Aug 12 = Apr 18 = Jul 18 > Jul 13 = May 16 = Jan 20 > Apr 20 = May 19 > Aug 18 = May 20 = Oct 17 > Apr 13 > Feb 17 = Apr 16 = Jan 18 > Oct 12 = Apr 19 ≥ Feb 19 ≥ Feb 12 = **Aug 20** > Nov 16 > Jan 17 = Oct 18 = Oct 16 = Oct 19 > Nov 12 > Feb 18 > Jan 19 = Nov 19 > Nov 17 = Jan 13 > Feb 13 = Feb 20
- Reference = Impact > Intermediate > Ma Wan Station

BOD_5

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	4433481924	47	94329402.63	223.861	**
Area	128363772.9	3	42787924.31	101.544	**
Station(Area)	82758211.72	24	3448258.822	8.183	**
Period * Area	1727976333	138	12521567.63	29.716	**
Period * Station(Area)	1476746646	420	3516063.443	8.344	**
Error	1887336126	4479	421374.442		
Total	44693615958	5119			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Aug 16 > **Jul 20** = Aug 19 = Nov 16 = Apr 16 > Jan 17 ≥ Apr 19 = May 12 ≥ Oct 19 ≥ Jan 20 ≥ Jan 13 = Aug 18 ≥ May 20 ≥ May 18 ≥ Jul 17 = Nov 17 ≥ May 17 = May 16 ≥ Feb 20 > Apr 18 = Jul 19 = Oct 18 = Feb 12 = Nov 18 = Jul 18 = May 19 = Feb 18 = Apr 17 = Oct 16 > Nov 19 ≥ Oct 17 = Feb 19 ≥ **Aug 20** = Apr 13 ≥ Nov 12 ≥ Jan 19 = Apr 12 ≥ Jul 12 ≥ Feb 13 = Oct 12 > Feb 17 > May 13 = Jul 16 = Aug 17 > Aug 12 = Jan 18 > Aug 13 = Apr 20 > Jul 13
- Reference = Ma Wan Station > Impact > Intermediate

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5987277829	47	127388890	1453.721	**
Area	46364316	3	15454772	176.365	**
Station(Area)	294332351.8	24	12263847.99	139.951	**
Period * Area	1099288654	138	7965859.814	90.904	**
Period * Station(Area)	2093124141	420	4983628.907	56.872	**
Error	392580278.3	4480	87629.526		
Total	44749898425	5120			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 20 = Nov 17 > May 20 > Jul 12 > Nov 12 = Jan 19 > Nov 16 = Jul 16 = Oct 16 = Aug 12 > Apr 12 ≥ Apr 17 = Oct 17 ≥ May 16 ≥ Oct 12 = May 19 > Aug 13 > **Aug 20** ≥ Nov 18 = Jan 17 = Jul 18 = Apr 16 = Aug 18 ≥ Jul 17 = Oct 18 ≥ Apr 13 > Aug 19 = Feb 12 > Jan 18 > Oct 19 = Aug 16 > **Jul 20** > May 18 = Feb 13 > Jan 20 > Apr 19 = Feb 18 = Feb 20 = Apr 18 = Jan 13 > Aug 17 > Feb 19 = Nov 19 ≥ May 13 = Jul 19 ≥ Jul 13 ≥ May 12 > May 17 > Feb 17
- Impact > Intermediate > Reference > Ma Wan Station

Linear Regression Analysis

Source	df	Slope	r	r^2	P
Area	1	-189.612	0.122	0.015	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Water Quality Monitoring during Capping of ESC CMPs – Analysis of Variance up to August 2020

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	3053413.123	3	1017804	37.652	**
Period	177446078	12	14787173	547.026	**
Area * Period	8085977.627	36	224610.5	8.309	**
Error	38196121.1	1413	27031.93		
Total	1049141077	1465			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Feb 16 > Feb 15 = Feb 14 > Feb 20 > Dec 14 = Dec 15 = **Aug 20** > Dec 13 > Jun 15 > Jun 14 = Aug 15 > Aug 14 > Jun 20
- Impact = Reference > Intermediate > Ma Wan Station

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	10269685.17	3	3423228	79.659	**
Period	157649681.1	12	13137473	305.711	**
Area * Period	10080928.18	36	280025.8	6.516	**
Error	60721644.9	1413	42973.56		
Total	1049123853	1465			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Dec 13 > Feb 20 ≥ Jun 15 ≥ Dec 15 > Dec 14 = Aug 14 = Aug 15 > Jun 20 > Feb 15 > Feb 14 > Jun 14 ≥ **Aug 20** ≥ Feb 16
- Impact = Reference > Intermediate > Ma Wan Station

Suspended Solids

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	6536164.763	12	544680.4	278.604	**
Area	270815.797	3	90271.93	46.174	**
Station(Area)	505105.824	18	28061.44	14.353	**
Period * Area	855599.377	33	25927.25	13.262	**
Period * Station(Area)	1569118.31	102	15383.51	7.869	**
Error	672533	344	1955.038		
Total	45927033	516			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Dec 13 > Jun 15 ≥ Feb 20 ≥ Dec 15 > Ag 14 = Feb 15 > Aug 15 = Dec 14 > Jun 20 > **Aug 20** = Feb 14 > Jun 14 = Feb 16
- Impact > Intermediate = Reference > Ma Wan Station

Pit Specific Sediment Chemistry for ESC CMP Vb – Analysis of Variance up to September 2020

Arsenic

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	486228.9	7	69461.27	10.394	**
Area	1912215	2	956107.6	143.075	**
Station(Area)	5422374	3	1807458	270.474	**
Period * Area	2355880	14	168277.1	25.182	**
Period * Station(Area)	2216909	21	105567.1	15.797	**
Error	3528385	528	6682.548		
Total	63863769	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 ≥ **Jul 20** ≥ Feb 20 ≥ **Sep 20** = Apr 20 ≥ **Aug 20** = May 20 = Jun 20
- Pit Edge > Active Pit > Near Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	2342365	7	334623.6	42.237	**
Area	4768443	2	2384221	300.941	**
Station(Area)	1340474	3	446824.8	56.399	**
Period * Area	1624606	14	116043.3	14.647	**
Period * Station(Area)	1572848	21	74897.54	9.454	**
Error	4183104	528	7922.545		
Total	63773617	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 > Apr 20 ≥ **Sep 20** = Feb 20 ≥ Jun 20 > **Aug 20** = May 20 = **Jul 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-109.513	0.539	0.291	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1082772	7	154681.7	26.547	**
Area	3999978	2	1999989	343.242	**
Station(Area)	6315241	3	2105080	361.278	**
Period * Area	564055.4	14	40289.67	6.915	**
Period * Station(Area)	886575.3	21	42217.87	7.246	**
Error	3076526	528	5826.754		
Total	63866925	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **Sep 20** = May 20 ≥ **Aug 20** = Jun 20 = Apr 20 ≥ **Jul 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-92.461	0.454	0.206	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1062454.243	7	151779.178	56.249	**
Area	6727543.414	2	3363771.707	1246.598	**
Station(Area)	4221564.758	3	1407188.253	521.497	**
Period * Area	848698.155	14	60621.297	22.466	**
Period * Station(Area)	1640175.305	21	78103.586	28.945	**
Error	1424734.625	528	2698.361		
Total	63866946.5	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 = Mar 20 > **Sep 20** ≥ **Aug 20** ≥ Jun20 = **Jul 20** ≥ Apr 20 > May 20
- Active Pit > Near Pit > Pit Edge

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	855165.882	7	122166.6	19.446	**
Area	5530298.284	2	2765149	440.156	**
Station(Area)	3357994.878	3	1119332	178.175	**
Period * Area	1791362.668	14	127954.5	20.368	**
Period * Station(Area)	1073340.914	21	51111.47	8.136	**
Error	3317001.875	528	6282.201		
Total	63866940.5	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 = **Sep 20** = Jun 20 > Apr 20 ≥ **Jul 20** = **Aug 20** > May 20
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-113.206	0.556	0.309	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	849042.646	7	121291.807	13.886	**
Area	3787094.773	2	1893547.387	216.786	**
Station(Area)	3731421.201	3	1243807.067	142.399	**
Period * Area	1300652.81	14	92903.772	10.636	**
Period * Station(Area)	1585675.779	21	75508.37	8.645	**
Error	4611894.792	528	8734.649		
Total	63807558	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 = Aug 20 = Jul 20 ≥ Sep 20 ≥ Mar 20 = Apr 20 > May 20 = Jun 20
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-93.871	0.462	0.213	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1513222.778	7	216174.7	51.194	**
Area	3681951.612	2	1840976	435.972	**
Station(Area)	6702427.102	3	2234142	529.08	**
Period * Area	831261.839	14	59375.85	14.061	**
Period * Station(Area)	966672.169	21	46032.01	10.901	**
Error	2229583	528	4222.695		
Total	63866894.5	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **Sep 20** = **Aug 20** = Jun 20 = May 20 = **Jul 20** > Apr 20
- Active Pit > Pit Edge = Near Pit

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	389769.715	7	55681.388	13.033	**
Area	7660263.539	2	3830131.77	896.506	**
Station(Area)	2470087.591	3	823362.53	192.722	**
Period * Area	1232191.871	14	88013.705	20.601	**
Period * Station(Area)	1889240.492	21	89963.833	21.058	**
Error	2255768.792	528	4272.289		
Total	63839098	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- **Sep 20** = Mar 20 = **Aug 20** = **Jul 20** > Feb 20 = May 20 = Apr 20 =Jun 20
- Active Pit > Near Pit > Pit Edge

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1523762.306	7	217680.3	37.942	**
Area	6402225.971	2	3201113	557.965	**
Station(Area)	2306872.982	3	768957.7	134.032	**
Period * Area	1610973.202	14	115069.5	20.057	**
Period * Station(Area)	1051940.664	21	50092.41	8.731	**
Error	3029201.875	528	5737.125		
Total	63866753	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **Sep 20** = Jun 20 > **Aug 20** = **Jul 20** = May 20 = Apr 20
- Active Pit > Near Pit > Pit Edge

Total Organic Carbon

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	3384970.792	7	483567.3	107.459	**
Area	5962555.32	2	2981278	662.505	**
Station(Area)	2172967.987	3	724322.7	160.96	**
Period * Area	705950.326	14	50425.02	11.206	**
Period * Station(Area)	1317871.492	21	62755.79	13.946	**
Error	2376005.583	528	4500.011		
Total	63862097.5	576			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 > **Sep 20** > Feb 20 = May 20 ≥ **Jul 20** ≥ **Aug 20** > Apr 20 > Jun 20
- Active Pit > Near Pit > Pit Edge

Cumulative Impact Sediment Chemistry for ESC CMPs – Analysis of Variance up to August 2020

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	153004287.7	17	9000252	454.1	**
Area	98205066.36	4	24551267	1238.714	**
Area * Station	11945957.17	4	2986489	150.681	**
Period * Area	275504152.7	67	4112002	207.468	**
Period * Area * Station	26912046.48	68	395765.4	19.968	**
Error	35319188.29	1782	19819.97		
Total	2450723292	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Dec 19 ≥ Jun 19 = Aug 19 ≥ Jun 20 > Jun 18 > **Aug 20** = Feb 20 > Dec 18 = Feb 19 = Dec 17 = Feb 18 > Aug 18 = Jun 17 > Jun 16 = Aug 17 > Dec 16 > Feb 17 = Aug 16
- Mid-Field > Ma Wan > Near-Field > Far-Field > Capped-Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	69957297.5	17	4115135	40.265	**
Area	51053054.74	4	12763264	124.884	**
Area * Station	89087092.33	4	22271773	217.921	**
Period * Area	131130592.2	67	1957173	19.15	**
Period * Area * Station	78415451.67	68	1153168	11.283	**
Error	181815597.5	1779	102201		
Total	2433543064	1941			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 ≥ Aug 16 ≥ Feb 20 = Aug 19 = Aug 17 = Jun 18 = Feb 18 ≥ Dec 17 ≥ Dec 19 = Dec 18 > Jun 17 = Aug 18 ≥ Feb 19 ≥ **Aug 20** ≥ Jun 20 = Feb 17 = Jun 19 > Dec 16
- Mid-Field > Ma Wan > Far-Field ≥ Capped-Pit ≥ Near-Field

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	25562670.76	17	1503687	57.884	**
Area	261224957.2	4	65306239	2513.964	**
Area * Station	38606965.99	4	9651741	371.544	**
Period * Area	177872884.5	67	2654819	102.197	**
Period * Area * Station	55347053.17	68	813927.3	31.332	**
Error	46291711.58	1782	25977.39		
Total	2450769609	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Aug 16 = Feb 20 = Dec 19 = Aug 19 = Aug 17 ≥ Dec 17 ≥ Jun 18 = Jun 17 ≥ Jun 19 ≥ **Aug 20** = Feb 19 = Feb 18 ≥ Dec 16 ≥ Jun 20 > Dec 18 = Feb 17 > Aug 18
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	25202555.34	17	1482503	51.034	**
Area	203271005.8	4	50817751	1749.35	**
Area * Station	158335836.3	4	39583959	1362.638	**
Period * Area	134917016.3	67	2013687	69.319	**
Period * Area * Station	30912591.79	68	454596.9	15.649	**
Error	51766226.29	1782	29049.51		
Total	2450769684	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 = Dec 17 > Dec 19 > Aug 17 = Jun 18 ≥ Feb 19 = Jun 16 = Jun 19 = Aug 16 = Aug 19 = Jun 17 ≥ Jun 20 ≥ Dec 18 > **Aug 20** ≥ Aug 18 = Dec 16 = Feb 18 ≥ Feb 17
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	132552462.2	17	7797204	240.91	**
Area	176886288.8	4	44221572	1366.311	**
Area * Station	29875538.53	4	7468885	230.766	**
Period * Area	168317370.9	67	2512200	77.619	**
Period * Area * Station	45914569.57	68	675214.3	20.862	**
Error	57675606.13	1782	32365.66		
Total	2450769585	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Aug 18 > Dec 18 > Aug 16 > Aug 19 = Dec 19 = Feb 19 = Aug 17 = Jun 18 > Jun 16 = Jun 19 = Feb 20 = Jun 20 ≥ Feb 18 ≥ **Aug 20** = Dec 17 > Dec 16 > Jun 17 > Feb 17
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

Mercury

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	224677444.9	17	13216320	133.873	**
Area	37030120.71	4	9257530	93.773	**
Area * Station	20586318.52	4	5146580	52.131	**
Period * Area	88253915.75	67	1317223	13.343	**
Period * Area * Station	32680702.47	68	480598.6	4.868	**
Error	175430864.5	1777	98723.05		
Total	2424735374	1939			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Aug 16 > Feb 20 ≥ **Aug 20** > Dec 18 = Aug 18 ≥ Dec 19 = Dec 16 > Feb 19 ≥ Feb 17 = Jun 20 ≥ Aug 17 = Jun 19 = Jun 17 ≥ Dec 17 ≥ Jun 18 = Aug 19 > Feb 18
- Ma Wan ≥ Capped-Pit ≥ Far-Field = Mid-Field ≥ Near-Field

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	26190653.26	17	1540627	59.804	**
Area	229609134.8	4	57402284	2228.237	**
Area * Station	46977354.5	4	11744339	455.891	**
Period * Area	198486643.7	67	2962487	114.998	**
Period * Area * Station	60987634.4	68	896877	34.815	**
Error	45906632.75	1782	25761.3		
Total	2450769238	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Aug 18 > Dec 18 ≥ Dec 19 = Aug 17 = Feb 20 = Dec 17 ≥ Aug 19 ≥ Dec 16 ≥ Jun 18 ≥ Jun 19 **= Aug 20** = Jun 17 = Feb 18 ≥ Jun 20 = Feb 19 > Aug 16 > Feb 17
- Ma Wan > Mid-Field > Far-Field = Near-Field > Capped-Pit

Silver

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	74925467.04	17	4407380	103.855	**
Area	197168484.2	4	49292121	1161.514	**
Area * Station	153193516	4	38298379	902.459	**
Period * Area	52728489.44	67	786992.4	18.545	**
Period * Area * Station	53026910.03	68	779807.5	18.375	**
Error	75624204.17	1782	42437.83		
Total	2450022762	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Aug 18 > Dec 18 > Dec 17 = Aug 16 = Feb 18 = Aug 17 > Feb 19 = Feb 17 = Feb 20 = Aug 19 = Dec 16 = Dec 19 = Jun 17 > Jun 19 = Jun 20 = **Aug 20** > Jun 16 > Jun 18
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	36311616.44	17	2135977	89.393	**
Area	200164933.8	4	50041233	2094.273	**
Area * Station	101117287.1	4	25279322	1057.963	**
Period * Area	185937499.2	67	2775187	116.144	**
Period * Area * Station	35162549.49	68	517096.3	21.641	**
Error	42579684.88	1782	23894.32		
Total	2450767352	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 = Dec 19 > Aug 16 ≥ Aug 19 ≥ Jun 19 = Jun 18 ≥ Jun 16 = Aug 17 ≥ Dec 17 ≥ Jun 17 = Feb 19 ≥ Feb 18 = Dec 16 > **Aug 20** = Jun 20 = Feb 17 > Dec 18 > Aug 18
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

TOC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	101497723.9	17	5970454	133.911	**
Area	149707085.4	4	37426771	839.445	**
Area * Station	20298014.24	4	5074504	113.816	**
Period * Area	176591864.5	67	2635699	59.116	**
Period * Area * Station	74641624.11	68	1097671	24.62	**
Error	79450752.96	1782	44585.16		
Total	2450585858	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Dec 19 = Feb 20 > Dec 16 = Aug 19 = Aug 16 > Dec 17 ≥ Feb 19 ≥ Jun 18 = Jun 17 ≥ Jun 19 ≥ Feb 18 = Dec 18 > Aug 17 ≥ Aug 18 ≥ Jun 20 = Feb 17 > **Aug 20**
- Ma Wan > Mid-Field > Far-Field > Capped-Pit > Near-Field

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	143955548.8	17	8467973	94.908	**
Area	115365631.9	4	28841408	323.252	**
Area * Station	7349737.3	4	1837434	20.594	**
Period * Area	56532240.62	67	843764.8	9.457	**
Period * Area * Station	31691331.01	68	466049	5.223	**
Error	158994611.8	1782	89222.57		
Total	2365291414	1944			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 17 = Dec 16 = Aug 17 = Jun 17 = Aug 18 > Jun 16 ≥ Feb 18 ≥ Dec 18 ≥ **Aug 20** ≥ Feb 19 = Aug 16 = Dec 19 ≥ Dec 17 ≥ Aug 19 = Jun 19 ≥ Jun 20 > Jun 18 = Feb 20
- Ma Wan > Capped-Pit = Far-Field = Near-Field > Mid Field

Sediment Chemistry after a Major Storm Event (21 August 2020) of ESC CMPs – Analysis of Variance

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	83966.25	4	20991.56	214.713	**
Station(Area)	11298.958	4	2824.74	28.893	**
Error	9678.792	99	97.766		
Total	425731	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Mid-field = Far-field > Ma Wan > Near-field > Capped Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	46454.604	4	11613.65	30.761	**
Station(Area)	19332.896	4	4833.224	12.802	**
Error	37376.5	99	377.54		
Total	423951	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Mid-field = Ma Wan = Far-field > Near-field > Capped Pit

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	84961.458	4	21240.37	171.493	**
Station(Area)	7743.875	4	1935.969	15.631	**
Error	12261.667	99	123.855		
Total	425754	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Ma Wan > Mid-field > Far-field > Near-field > Capped Pit

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	64961.896	4	16240.47	90.481	**
Station(Area)	22234.979	4	5558.745	30.969	**
Error	17769.625	99	179.491		
Total	425753.5	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Ma Wan > Far-field = Mid-field > Near-field > Capped Pit

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	82514.781	4	20628.7	152.506	**
Station(Area)	9056.51	4	2264.128	16.738	**
Error	13391.208	99	135.265		
Total	425749.5	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Ma Wan = Mid-field > Far-field > Near-field > Capped Pit

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	75514.271	4	18878.57	170.847	**
Station(Area)	18512.771	4	4628.193	41.884	**
Error	10939.458	99	110.5		
Total	425753.5	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Ma Wan > Far-field = Mid-field > Near-field > Capped Pit

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	37033.396	4	9258.349	17.225	**
Station(Area)	11768.979	4	2942.245	5.474	**
Error	53212.625	99	537.501		
Total	422802	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Ma Wan > Far-field = Mid-field > Near-field > Capped Pit

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	47492.813	4	11873.2	79.798	**
Station(Area)	42325.854	4	10581.46	71.116	**
Error	14730.333	99	148.791		
Total	425336	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:
- Ma Wan > Far-field = Mid-field > Near-field > Capped Pit

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	80523.208	4	20130.8	185.947	**
Station(Area)	13721.458	4	3430.365	31.686	**
Error	10717.833	99	108.261		
Total	425749.5	108			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:
- Ma Wan > Far-field = Mid-field > Near-field > Capped Pit

Sediment Toxicity for ESC CMP Vb – August 2020

Survival rate for burrowing amphipod Leptochirus plumulosus

	Survival
Chi-Square Df Asymp. Sig.	1.135 2 NS

Note:
1. NS: No significant difference;
2. **: Significant difference

Growth rate for benthic polychaete Neanthes arenaceodentata

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.185	4	0.046	3.644	**
Within Groups	1.523	120	0.013		
Total	1.708	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

SNK Results:

- ESC-TDB1 > ESC-TDA = MW1= ESC-TRA = ESC-TRB

Survival rate for marine bivalve Crassostrea gigas

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	35.567	4	8.892	0.627	NS
Within Groups	1701.568	120	14.18		
Total	1737.135	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

Mortality rate for barnacles Balanus Amphitrite

Source	Mortality
Chi-Square Df Asymp. Sig.	2.781 2 NS

Note:
1. NS: No significant difference;
2. **: Significant difference

Mortality rate for shrimp Penaeus vannaamei

Source	Mortality
Chi-Square df Asymp. Sig.	4.551 2 NS

Note:
1. NS: No significant difference;
2. **: Significant difference