土木工程拓展署
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 and the South of The Brothers – July to September 2018

Revision 0

December 2018

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

ERM

The business of sustainability

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

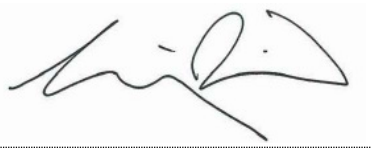
Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau and the South of The Brothers – July to September 2018

Revision 0

Document Code: 0400720_CMP Quarterly Jul-Sep 2018_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:	Project No:
Civil Engineering and Development Department (CEDD)	0400720
Summary: This document presents the Quarterly EM&A Report for *Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau and the South of The Brothers*.	Date: 19 December 2018 Approved by:  Craig A. Reid *Partner*

Revision	Description	By	Checked	Approved	Date
v0	Quarterly EM&A Report for ESC CMPs and SB CMPs	EL	RC	CAR	19/12/18

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
CEDD Civil Engineering and Development Department

ERM

Dredging, Management and Capping of Contaminated Sediment Disposal Facility at Sha Chau and to the South of The Brothers

Environmental Certification Sheet
EP-312/2008/A & EP-427/2011/A

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau and the South of The Brothers – July to September 2018
Date of Report:	19 December 2018
Date prepared by ET:	19 December 2018
Date received by IA:	19 December 2018

Reference EP Condition

Environmental Permit Condition:

Condition 3.1 of EP-312/2008/A and Condition 4.1 of EP-427/2011/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

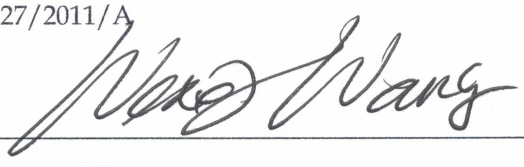
I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-312/2008/A and EP-427/2011/A

Craig A. Reid,
Environmental Team Leader: 

Date: 19/12/2018

IA Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-312/2008/A and EP-427/2011/A

Dr Wang Wen Xiong,
Independent Auditor: 

Date: 19/12/2018

CONTENTS

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 2018

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Pit Specific Sediment Chemistry, Cumulative Impact Sediment Chemistry, Sediment Chemistry after a Major Storm, Demersal Trawling and Sediment Toxicity Tests were carried out for the Contaminated Mud Pits (CMPs) to the East of Sha Chau (ESC). In addition, *Benthic Recolonisation Studies* were conducted for the CMPs to the South of The Brothers (SB) during the quarterly period of July to September 2018. This report presents the results of these monitoring activities to identify whether the disposal operations at ESC CMP V and the capping operations of the SB CMPs 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 Vd – July to September 2018

Results indicated that levels of Salinity, pH and Dissolved Oxygen (DO) generally 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 Vd 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 2018

Results of Routine Water Quality Monitoring conducted in July and August 2018 showed that levels of DO, Salinity and pH complied with the WQOs at all stations. 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 CMP Vd have not caused any unacceptable impact in water quality during the reporting period.

Sediment Quality Monitoring for ESC CMPs

Pit Specific Sediment Chemistry of ESC CMP Vd – July to September 2018

Monitoring results showed that the concentrations of inorganic contaminants were generally below the Lower Chemical Exceedance Levels (LCELs) at all 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 did not cause any unacceptable impact in sediment quality of ESC CMP Vd during the reporting period.

Cumulative Impact Sediment Chemistry of ESC CMPs – August 2018

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 is considered that mud disposal operations at ESC CMP Vd have not caused any unacceptable impact in sediment quality during the reporting period.

Sediment Chemistry after a Major Storm of ESC CMPs – September 2018

Sampling for *Sediment Chemistry after a Major Storm Event* was conducted for ESC CMPs on 20 September 2018 after the visit of tropical cyclone Mangkhut, which led to the issue of No. 10 Hurricane Signal on 16 September 2018.

Monitoring results showed that the concentrations of most inorganic contaminants were 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. 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 September 2018.

Demersal Trawling for ESC CMPs

During the sampling period in July and August 2018, mean number of faunal species caught at Impact stations was lower than at Reference stations in July and August 2018. Biotic abundance, biomass, Catch per Unit Effort (CPUE) and Yield per Unit Effort (YPUE) were lower at Impact stations ESC-INA and ESC-INB in July and August 2018.

Benthic Recolonisation Studies for SB CMPs

The average number of individuals, average biomass per area and diversity were lower at the Capped Pit station than at the Reference stations. Samples contained a variety of species, but each species was often in low abundance. The most dominant species recorded were mainly bivalve mollusks at the Capped Pit and Reference stations during the reporting period. Overall, the results indicated that recolonisation of macrobenthos infauna was observed at the Capped Pit stations of SB CMPs.

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（二零一八年七月至九月）

行政摘要

在2018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、指定污泥坑沉積物化學監察、沉積物化學累積性影響監察、強颱風後的沉積物質素監察、底棲漁業資源監察及沉積物毒性測試。此外，環境小組也在大小磨刀以南海泥卸置設施進行了底棲生物群落研究。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的卸置作業及大小磨刀以南海泥卸置設施的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－2018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大致符合海水水質指標。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 Vd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 － 2018年7月和8月

2018年7月和8月的例行水質監察結果顯示受影響監測站、中距離監測站及參考監測站的溶解氧含量、鹽度及酸鹼值均符合海水水質指標。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。

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－2018年7月至9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。

沉積物化學累積性影響監察－2018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。

超強颱風山竹在2018年9月16日吹襲香港，並在同日發出十號颶風信號。在強颱風過後，環境小組在2018年9月20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2018年9月的強颱風導致污泥從泥坑擴散或引起沉積物污染。

沙洲以東污泥坑之底棲漁業資源監察

監察結果顯示，2018年7月和8月的底棲漁業資源在受影響監測站錄得較低的品種數量。而在2018年7月及8月受影響監測站ESC-INA及ESC-INB的物種豐富度、生物量及漁獲數目均錄得較低的數值。

大小磨刀以南污泥坑之底棲生物群落研究

已覆蓋污泥坑監測站的平均個體數目、平均生物量、及多樣性均較參考站為低。每個樣本均記錄到不同的物種，但數量不多，而雙殼綱軟體動物在已覆蓋污泥坑監測站及參考站最為常見。總體而言，監察數據顯示底棲生物正在已覆蓋污泥坑監測站形成群落。

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).

1.2 ACTIVITIES CONDUCTED DURING THE REPORTING PERIOD

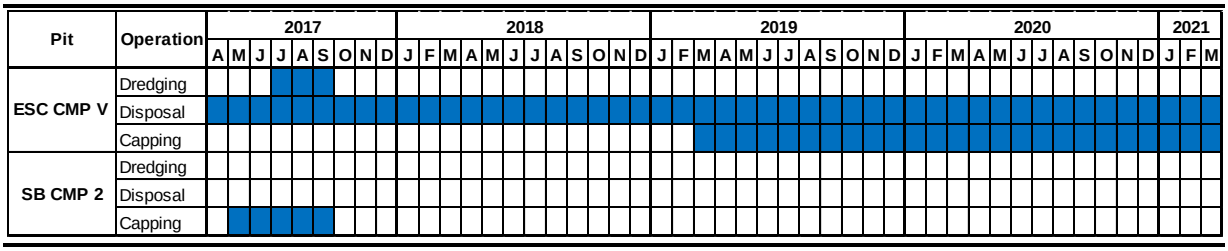
1.2.1 Detailed works schedule for ESC CMP V and SB CMPs is shown in *Figure 1.1*. During the reporting period of July to September 2018, the following works were being undertaken at the CMPs:

- Disposal of contaminated mud at ESC CMP Vd

(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.

Figure 1.1 Works Schedule for ESC CMPs



1.2.2 The records for contaminated mud disposal at ESC CMP Vd during the reporting period are presented in *Annex B* respectively.

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 2018* is to provide information regarding the findings in the quarterly reporting period of July to September 2018 on the environmental impacts resulting from backfilling operation at ESC CMP Vd and the capping operations of the SB CMPs. 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 disposal, 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 CMPs of ESC and SB. 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 Manuals* (1) (2) 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).

(2) ERM (2015). Final Second Review of the EM&A Manual for SB CMPs. Prepared for CEDD for EM&A for Contaminated Mud Pit to the South of The Brothers and at East Sha Chau (2012-2017) – Investigation. Agreement No. CE 23/2012 (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 2018

Key Task	Date of Sampling & *in-situ* Measurement	Date of Results Received from the Contractors
ESC CMPs		
Water Column Profiling of ESC CMP Vd	28 July 2018 16 August 2018 7 September 2018	21 August 2018 10 September 2018 13 October 2018
Routine Water Quality Monitoring of ESC CMPs	27 July 2018 17 August 2018	29 August 2018 10 September 2018
Pit Specific Sediment Chemistry of ESC CMP Vd	30 July 2018 13 August 2018 6 September 2018	10 September 2018 13 October 2018 12 November 2018
Cumulative Impact Sediment Chemistry of ESC CMPs	21 and 22 August 2018	13 October 2018
Sediment Chemistry after a Major Storm of ESC CMPs	20 September 2018	30 October 2018
Demersal Trawling for ESC CMPs	25 and 26 July 2018 16 and 17 August 2018	16 August 2018 13 September 2018
Sediment Toxicity Tests of ESC CMPs	21 and 22 August 2018	3 October 2018
SB CMPs		
Benthic Recolonisation Studies of SB CMPs	20 August 2018	20 September 2018

3.1.3 The monitoring results of the above environmental monitoring components for ESC and SB 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 and SB CMPs during the reporting period. It should be noted that statistical analysis was not conducted for *Water Column Profiling for ESC CMP Vd* 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 Vd

3.2.2 *Water Column Profiling* for ESC CMP Vd was conducted once every month from July to September 2018 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 2018, except for lower DO levels recorded at all stations in September 2018. 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 Vd 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 2018 as presented in *Table 3.1*. A total of sixteen (16) and ten (10) stations were sampled in July and August 2018 respectively, and locations of the monitoring stations are presented in *Figures 3.1* and *3.2*. The disposal volume during the reporting period is detailed in *Annex B*. The monitoring results showed that levels of DO, Salinity and pH complied with the WQOs and the Action and Limit Levels at all stations in July and August 2018.

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 2018 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.

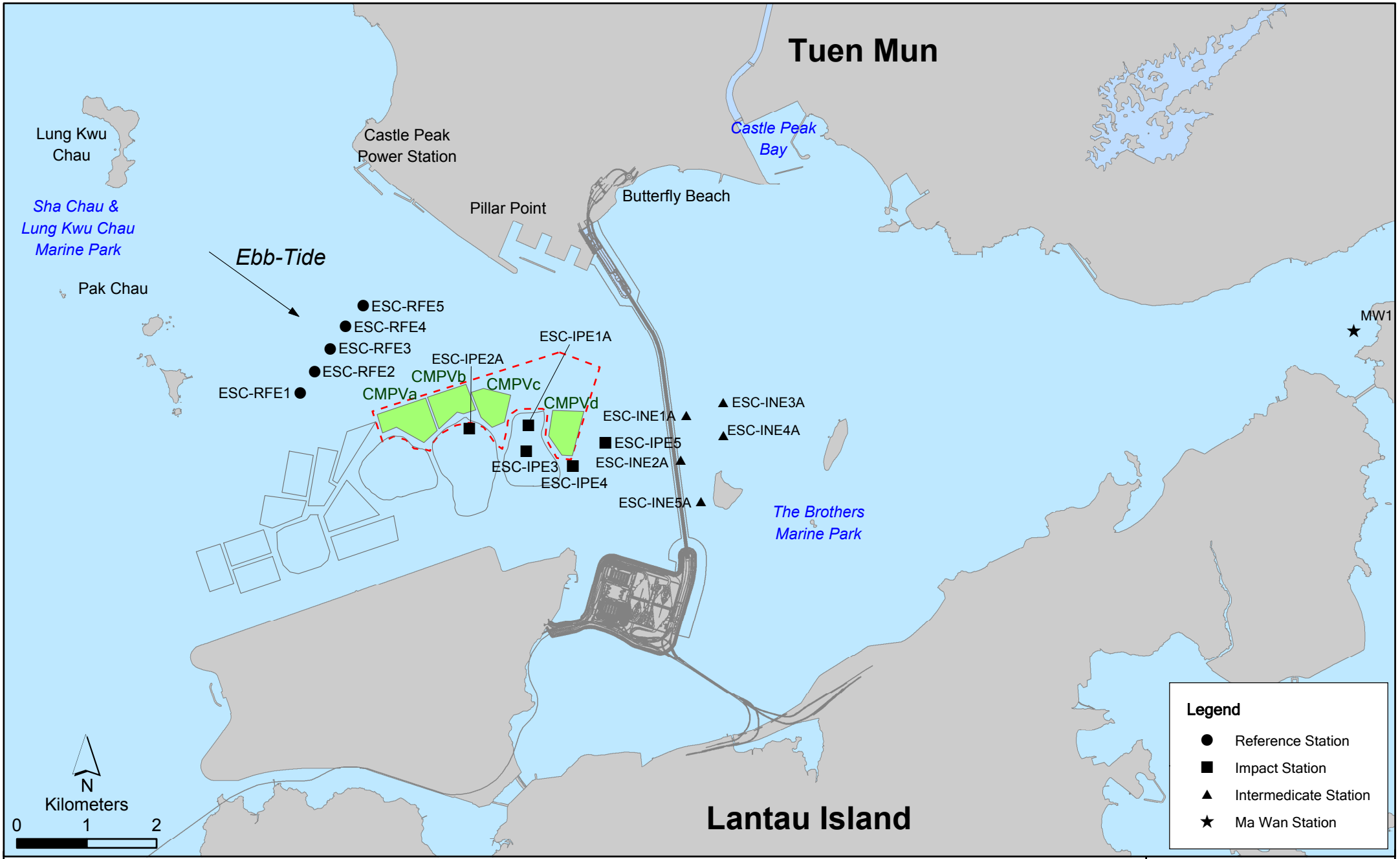


Figure 3.1

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

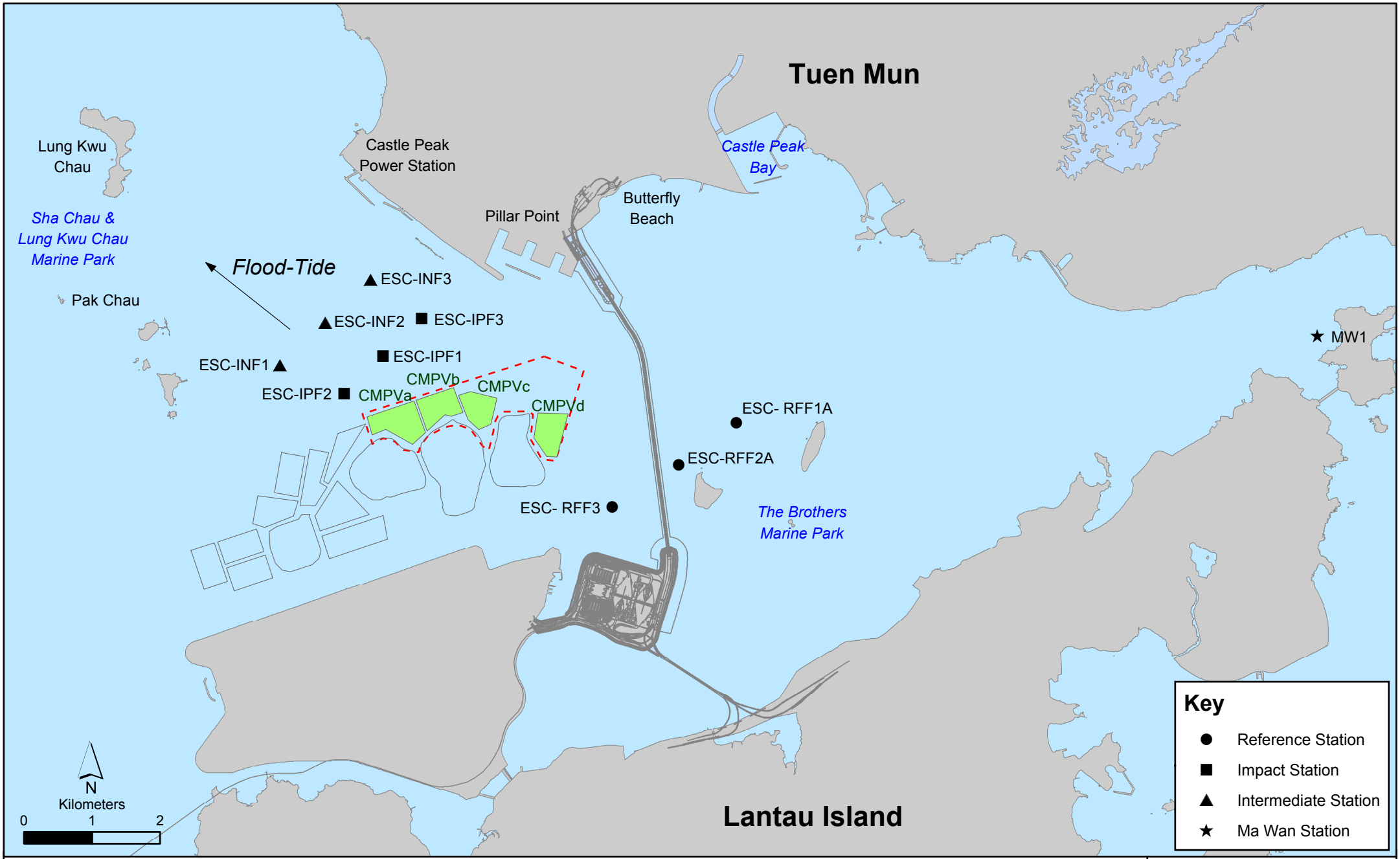


Figure 3.2

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

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 significantly higher in February 2017 and were the lowest in July 2013, August 2016, July 2017 and August 2018. DO levels were significantly higher at Intermediate stations than at other 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 significantly higher in November 2017 than in other sampling periods. Ma Wan station had the significantly lowest Turbidity than at other 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 2018). 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 significantly higher in August 2013 when compared to all other sampling periods. The concentration of Nickel was significantly higher in April 2012 and August 2013. The concentration of Zinc was significantly higher in November 2017 when compared to all other sampling periods. Concentrations of Copper and Zinc were significantly lower at Intermediate stations than at other stations while concentrations of Nickel were significantly higher at Reference stations than other stations.

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 significantly higher in April 2012. Concentrations of NH_3-N were significantly lower at Intermediate stations than at other stations.

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 significantly higher in April 2012 and May 2018. Concentrations of TIN were significantly lower at Ma Wan station than at other 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 significantly higher in August 2016. Levels of BOD_5 were significantly lower at the Intermediate stations than at other 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 significantly higher in November 2017. SS levels were significantly higher 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 Vd of the ESC area.

3.2.17 *Pit Specific Sediment Chemistry of ESC CMP Vd*

Background

3.2.18 *Pit Specific Sediment Chemistry of ESC CMP Vd* was conducted once every month from July to September 2018 as presented in *Table 3.1*. A total of six (6) monitoring stations for ESC CMP Vd 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 generally below the Lower Chemical Exceedance Levels (LCELs) at all monitoring stations from July to September 2018, except for the concentration of Arsenic which exceeded the LCEL at the Active Pit stations ESC-NPAA and ESC-NPAB in July 2018.

Summary of Statistical Analyses

3.2.19 Statistical analyses were performed for data obtained from *Pit Specific Sediment Chemistry of ESC CMP Vd* since March 2016. 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.

3.2.20 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*.

Metals and Metalloids

3.2.21 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. The concentrations of Cadmium, Lead, Mercury and Zinc were significantly higher at the Active Pit stations than at the Pit Edge stations than at Near Pit stations. Subsequent linear regression analysis for Cadmium, Lead, Mercury and Zinc 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, Lead, Mercury and Zinc levels and proximity to the pit ($r^2 < 0.60$).

Organic Contaminants

3.2.22 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.

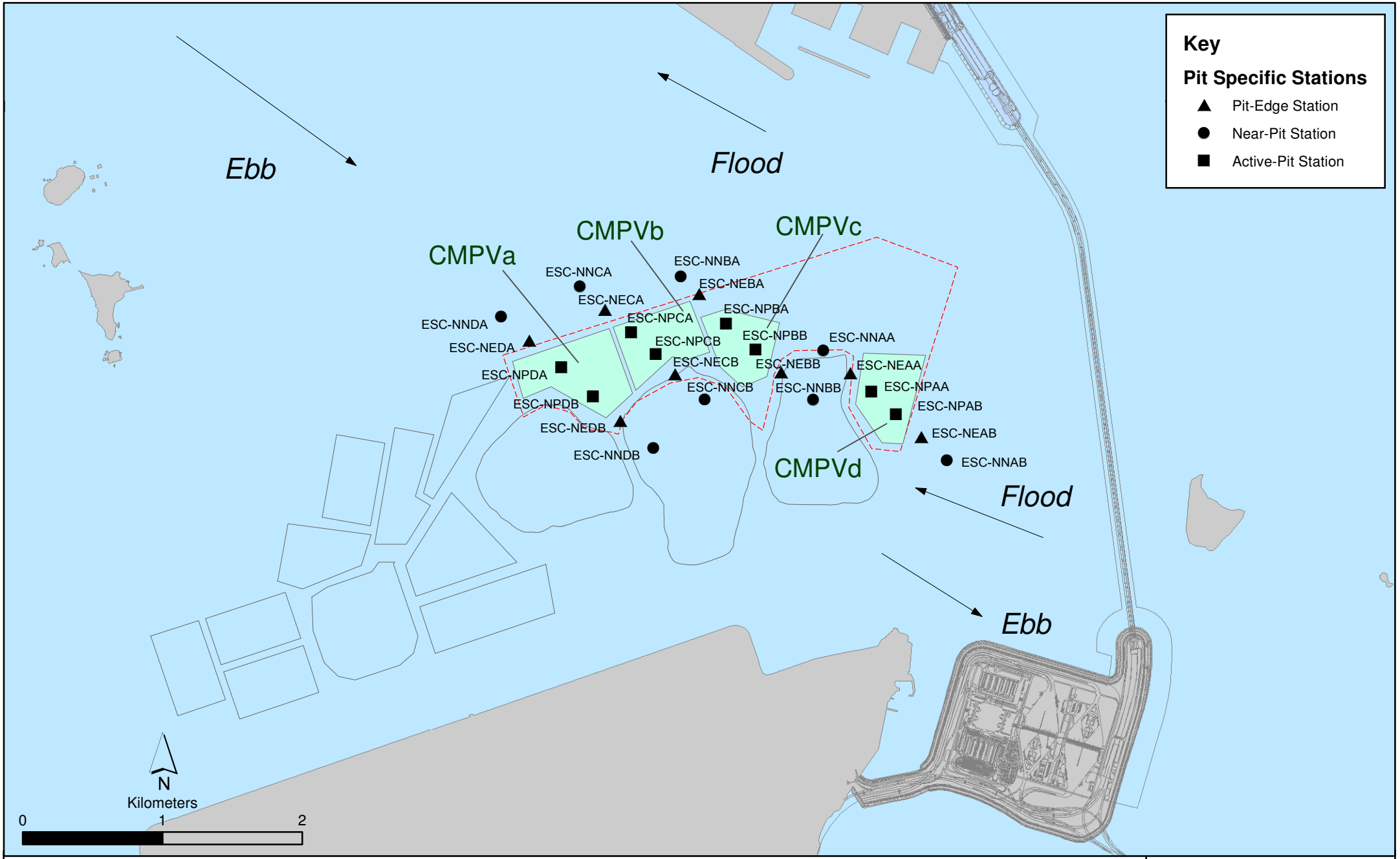


Figure 3.3

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

3.2.23 In this reporting period, only Total Organic Carbon (TOC) concentrations were statistically analysed. Levels of TOC varied significantly with sampling area and time. It was significantly higher at the Pit Edge and Active Pit stations. There was no consistent spatial trend of increasing concentrations of TOC with proximity to the pit or consistent temporal trend of increasing concentrations of TOC over time.

3.2.24 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 Vd.

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

Background

3.2.26 *Cumulative Impact Sediment Chemistry of ESC CMPs* was conducted in August 2018 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 2018, except for the concentration of Arsenic which exceeded the LCEL at Mid-field stations ESC-RMA and ESC-RMB.

Summary of Statistical Analysis

3.2.27 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.

3.2.28 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*.

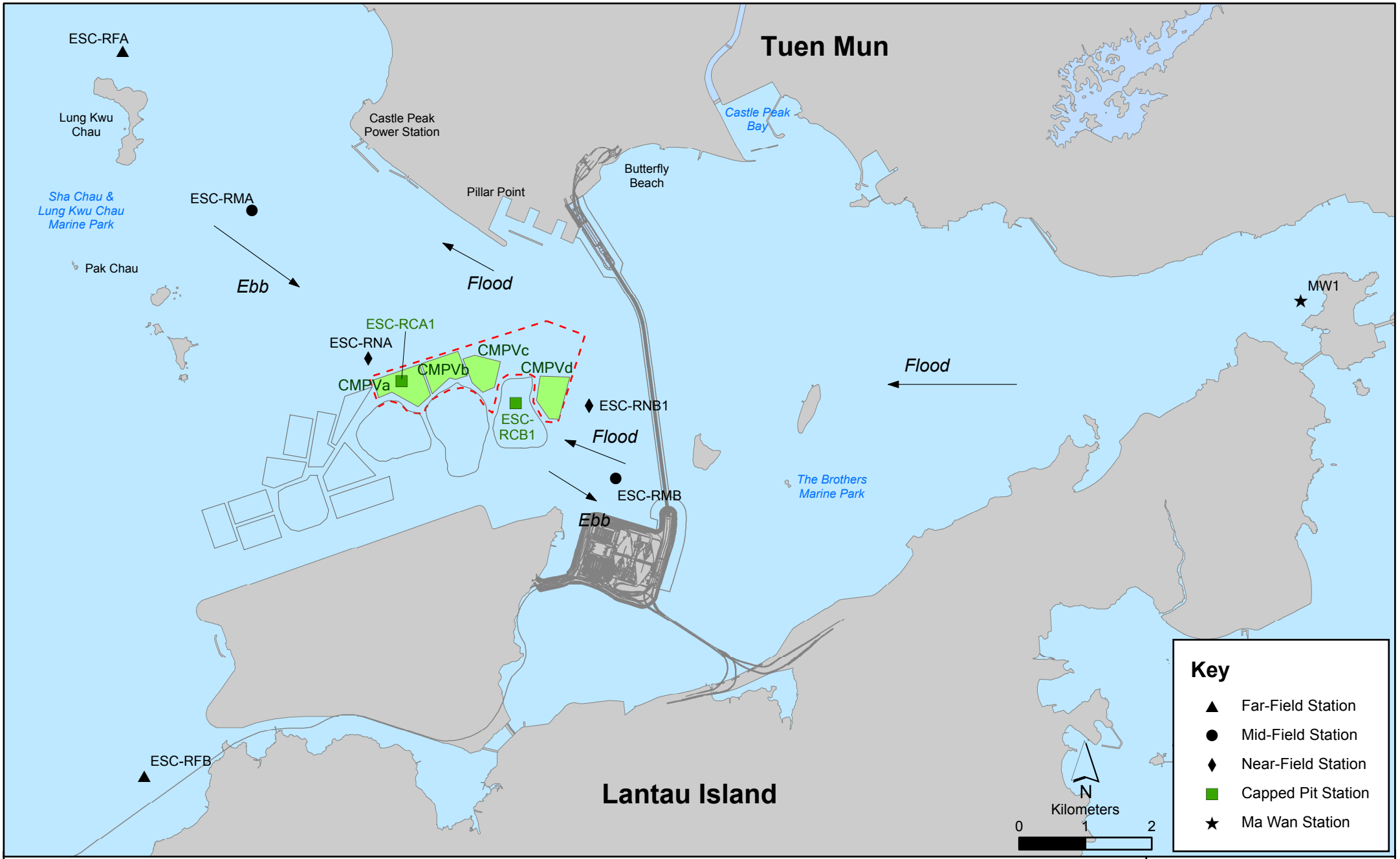


Figure 3.4

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

3.2.29 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 significantly higher at Mid-Field or Ma Wan stations. The concentrations of all measured metals and metalloids did not appear to increase over time.

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.

3.2.31 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. They were significantly higher at Ma Wan station than at other stations. 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.

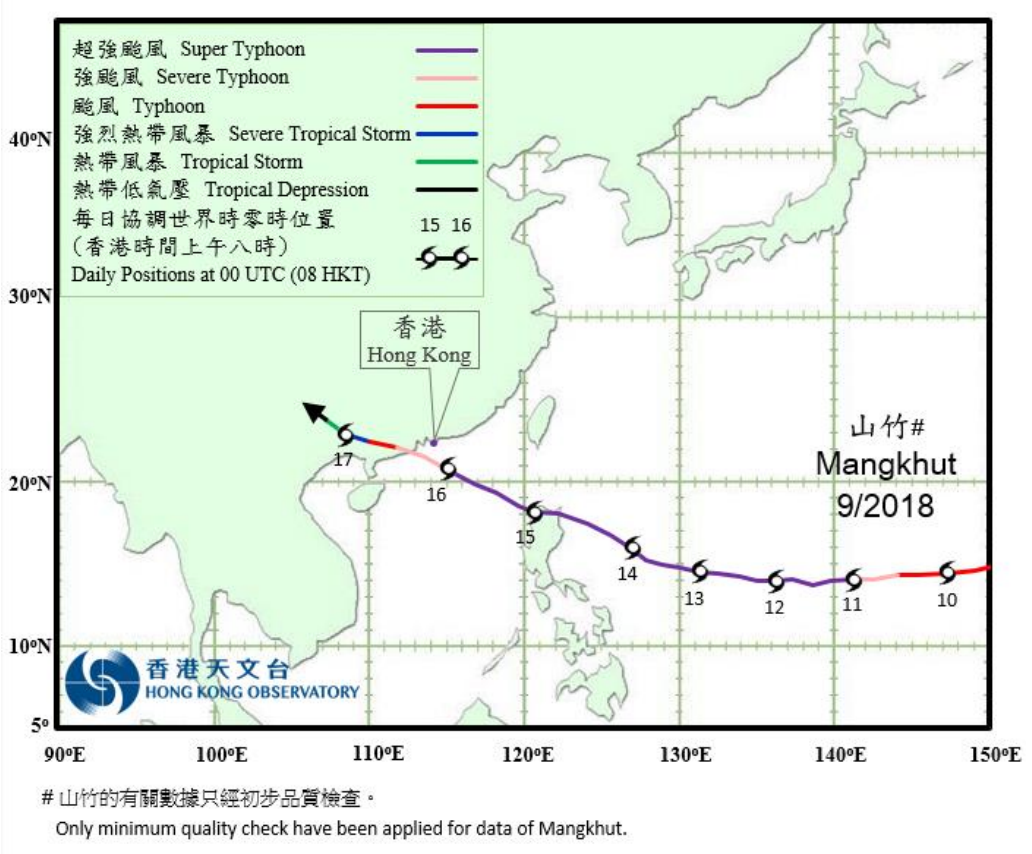
3.2.32 From the results of the above statistical analyses, there did not appear to be any significant trend of increasing sediment contaminants' concentrations with proximity to the pit or over time. Therefore, there is no evidence indicating any unacceptable environmental impacts to sediment quality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

3.2.33 ***Sediment Chemistry after a Major Storm of ESC CMPs – September 2018***

Background

3.2.34 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 20 September 2018 after the visit of tropical cyclone Mangkhut, which led to the issue of No. 10 Hurricane Signal on 16 September 2018. The tracks of Mangkhut are shown in *Figure 3.5*. The monitoring results showed that the concentrations of most inorganic contaminants were below the LCELs at all monitoring stations, except Arsenic at Capped Pit station ESC-RCB and Mid-field stations ESC-RMA and ESC-RMB in September 2018.

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



Summary of Statistical Analyses

3.2.35 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.

3.2.36 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*.

3.2.37 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 Vd in retaining disposed mud or causing contamination of sediments after the major storm event in September 2018.

3.2.38 ***Sediment Toxicity Test – August 2018***

3.2.39 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 2018 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*).

3.2.40 Appropriate statistical test, i.e. ANOVA, was applied for comparing and determining the level of significance in the results in August 2018. 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.

3.2.41 Results of the Sediment Toxicity Tests in August 2018 showed that there were no significant differences between Impact and Reference stations in the toxicity tests of all marine benthos. Therefore, there did not appear to be any evidence of unacceptable impacts to sediment toxicity due to the mud disposal operations at ESC CMP Vd.

3.2.42 ***Demersal Trawling – July and August 2018***

3.2.43 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 2018. Monitoring results are presented in the following sections.

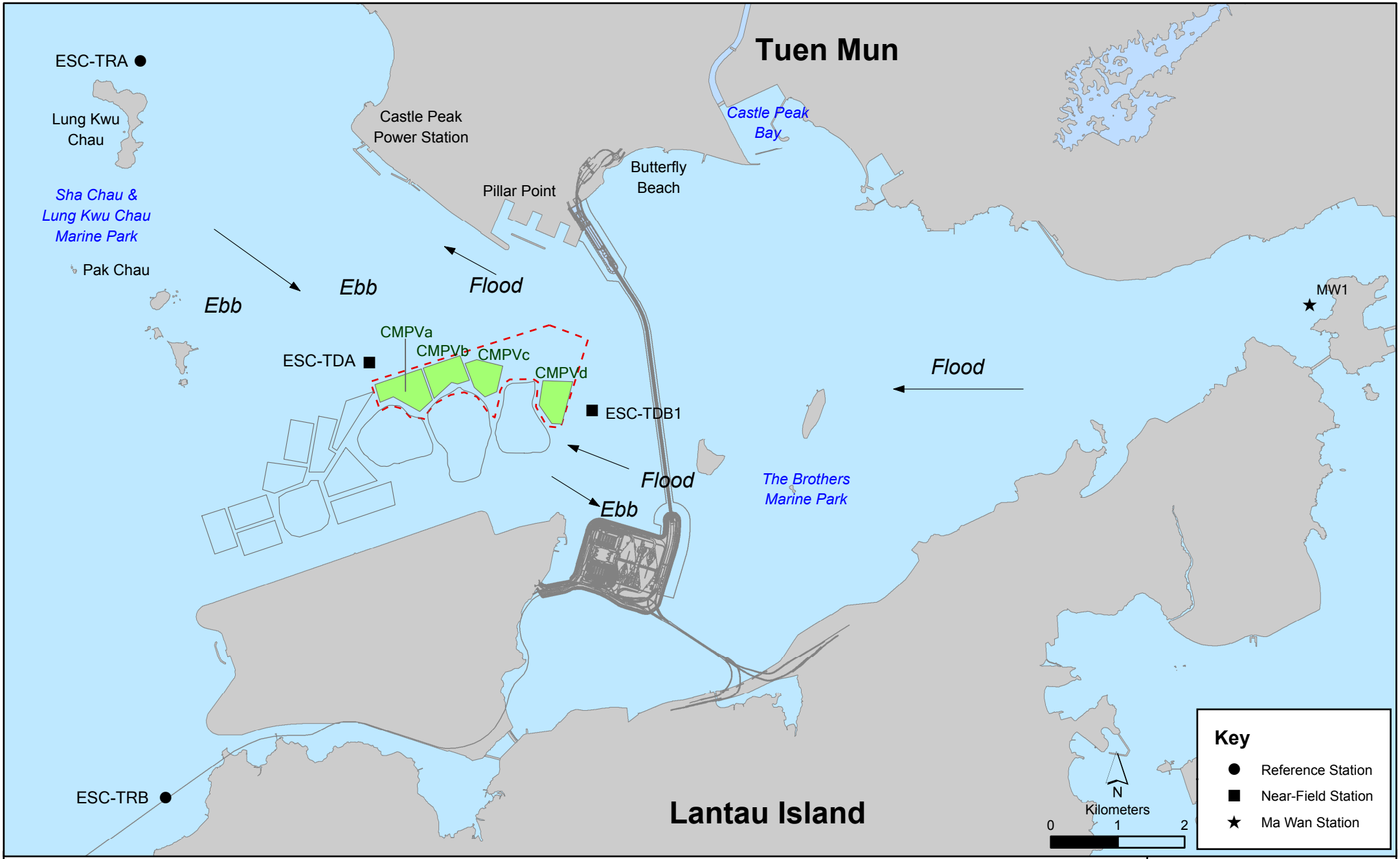


Figure 3.6

Sediment Toxicity Monitoring Stations for ESC CMPs

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

Environmental Resources Management

ERM

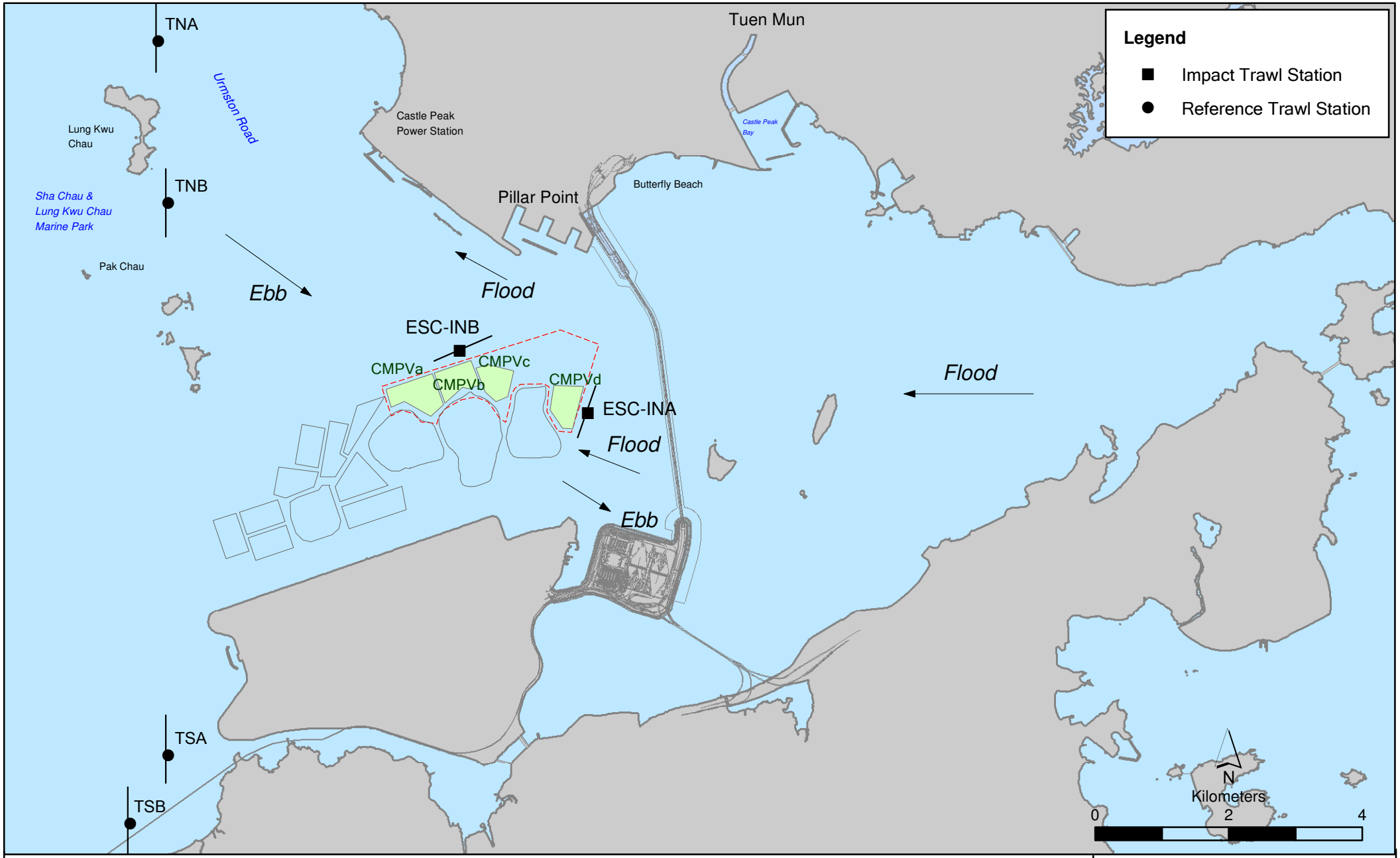


Figure 3.7

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

3.2.44 The average number of species collected in the period of July and August 2018 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 2018.

3.2.45 Biotic abundance, Biomass, Catch per Unit Effort (CPUE) and Yield per Unit Effort (YPUE) were lower at Impact stations ESC-INA and ESC-INB in July and August 2018 (*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 Vd.

Table 3.2 ***Summary of the Mean Number of Faunal Species Caught during July and August 2018 Monitoring***

Mean Number of Faunal Species	Impact Stations		Reference Stations			
	ESC-INA	ESC-INB	TNA	TNB	TSA	TSB
July 2018	58.8	44.2	40.4	47.8	61.0	62.0
August 2018	46.4	35.4	31.6	45.2	53.2	52.6

Table 3.3 **Summary of CPUE and YPUE during July and August 2018 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 2018	ESC-INA	Impact	5,491	65,226	1,098	13,045
Jul 2018	ESC-INB	Impact	4,298	55,527	860	11,105
Jul 2018	TNA	Reference	8,832	111,276	1,766	22,255
Jul 2018	TNB	Reference	12,734	159,950	2,547	31,990
Jul 2018	TSA	Reference	12,918	195,493	2,584	39,099
Jul 2018	TSB	Reference	17,166	281,304	3,433	56,261
Aug 2018	ESC-INA	Impact	2,869	38,637	574	7,727
Aug 2018	ESC-INB	Impact	2,397	31,675	479	6,335
Aug 2018	TNA	Reference	3,506	42,473	701	8,495
Aug 2018	TNB	Reference	7,505	99,988	1,501	19,998
Aug 2018	TSA	Reference	19,619	339,258	3,924	67,852
Aug 2018	TSB	Reference	3,310	60,861	662	12,172

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)

3.3 SUMMARY OF MONITORING RESULTS FOR SB CMPS

3.3.1 Benthic Recolonisation Studies for SB CMPs

3.3.2 A benthic survey was conducted at the SB Capped Mud Pit stations (SB-CPA and SB-CPB) and at the Reference stations to the south of Sha Chau in August 2018 (see *Figure 3.8* for the locations of the stations). A total of 930 individuals, belonging to 8 animal phyla, comprising of 42 families and 53 genera were obtained from all the monitoring stations. *Table 3.4* summarises the results of the benthic survey.

Table 3.4 Summary of Benthic Survey Results during August 2018 Monitoring

Area	No. of Samples	No. of Individuals (Total)	Biomass (g) (Total)	Average No. of Individuals (Per Station)	Biomass (g) (Per Station)	Average Biomass (g) (Per Individual) (g)	Average No. of Genera (Per Station)	Average Diversity H' (Per Station)
Capped Pit Station								
SB-CPA	12	151	31.38	12.58	2.62	0.21	6.33	1.64
SB-CPB	12	77	13.62	6.42	1.14	0.18	2.75	1.19
(Total)	-	*228*	*45.00*	-	-	-	-	-
Reference Stations								
SB-RBA	12	274	98.359	22.83	8.197	0.36	11.00	2.17
SB-RBB	12	222	176.540	18.50	14.712	0.80	9.92	2.15
SB-RBC	12	206	290.819	17.17	24.235	1.41	9.92	2.13
(Total)	-	*702*	*565.72*		-	-	-	-
Total	**60**	**930**	**610.72**	**-**	**-**	**-**	**-**	**-**

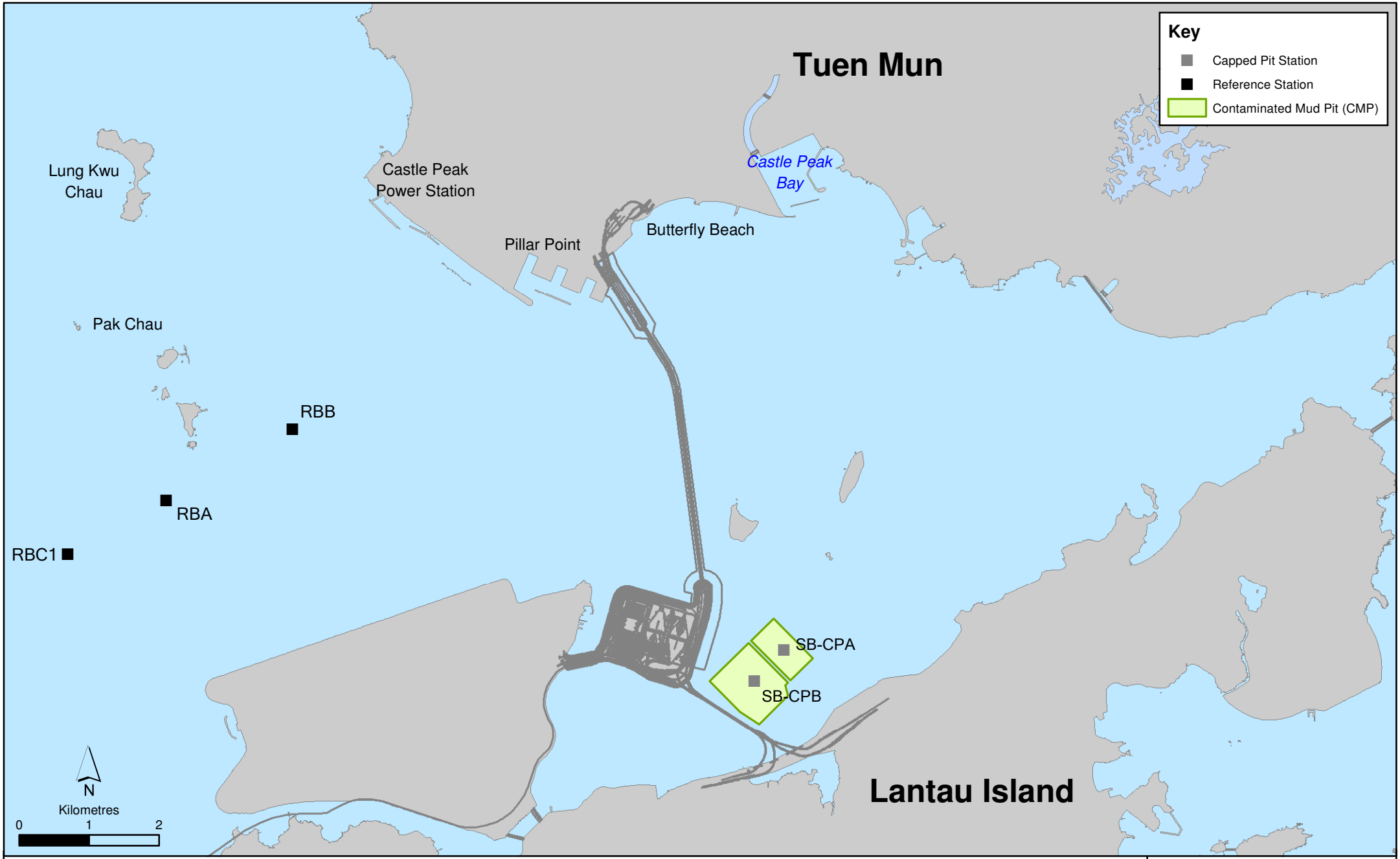


Figure 3.8

Benthic Monitoring Stations for SB CMPs

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_Benthic_Monitoring_Stations.mxd
Date: 27/11/2017

Environmental Resources Management

ERM

3.3.3 The average number of individuals, average biomass per area and diversity were lower at the Capped Pit station than at the Reference stations. Samples contained a variety of species, but each species was often in low abundance. The most dominant species recorded were mainly bivalve mollusks at the Capped Pit stations and the Reference stations during the reporting period.

Summary of Statistical Analysis

3.3.4 Data obtained during this reporting period were statistically compared with data obtained since August 2015. Details of the statistical analyses are presented in *Annex C*. Annual trends will be discussed in the subsequent *Annual EM&A Review Report*.

3.3.5 Spatial and temporal differences in means of species diversity indices, number of individuals and biomass were statistically tested using two-factor ANOVA with sampling period and stations as the fixed factors under investigation. Results of the statistical analysis showed that the Number of Genera, Number of Individuals, Genus Richness, Shannon-Weiner Diversity Index and Biomass were significantly higher at Reference than at Capped Pit stations, while Pielou's Evenness was similar among all stations, except lower at Reference Station SB-RBC. However, all parameters did not show any consistent temporal variations.

3.3.6 Overall, the results indicated that the abundance and diversity at the Capped Pit stations were lower than those at the Reference stations but recolonisation of similar types of macrobenthos infauna was observed at the Capped Pit stations. Further monitoring will be conducted to monitor the trend of species diversity and abundance within the Capped Pit and the Reference stations to verify the prediction made in the EIA that the benthic assemblage within the pit will resemble that of the surrounding areas following capping with uncontaminated mud.

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

4.1.1 During the reporting period, the Independent Auditor (IA) conducted an inspection on the demersal trawling monitoring on 17 August 2018. A total of 3 stations (ESC-INA, TNA and TNB) were sampled with 5 replicated trawling was conducted at each station during the monitoring day. Samples were then composited from all nets and tows at each station. The target species included all the major fisheries species such as shrimps, crabs, fish, and clams. These species were all collected and pooled, while the non-target species (especially the sea urchins and other dominant non-commercial gastropods) were immediately returned to the sea after the samples were sorted directly on the deck. The abundance and biomass of caught commercial fisheries species were then recorded and measured when these samples were brought back to the laboratory. The IA satisfied with the monitoring procedures and confirmed that the requirements as stated in the EM&A Manual were followed.

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 2018 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vd* in October, November and December 2018;
- *Routine Water Quality Monitoring of ESC CMPs* in October and November 2018;
- *Pit Specific Sediment Chemistry of ESC CMP Vd* in October, November and December 2018; and
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in December 2018.

5.1.2 The monitoring activities to be conducted in the next quarterly period of October to December 2018 for SB CMPs include:

- *Benthic Recolonisation Studies for SB CMPs* in December 2018.

5.1.3 The sampling schedules for ESC CMPs and SB CMPs are 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				3		3				3		3	
	ESC-IPE2A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPE3	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPE4	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPE5	4 times per year																							3				3		3				3		3				3		3				3		3	
Intermediate Station Downcurrent																																																		
	ESC-INE1A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE2A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE3A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE4A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE5A	4 times per year																							3				3		3				3		3				3		3				3		3	
Reference Station Upcurrent																																																		
	ESC-RFE1	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE2	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE3	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE4	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE5	4 times per year																							3				3		3				3		3				3		3				3		3	
Ma Wan Station																																																		
	MW1	4 times per year																							3				3		3				3		3				3		3				3		3	
Flood Tide																																																		
Impact Station Downcurrent																																																		
	ESC-IPF1	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPF2	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPF3	4 times per year																							3				3		3				3		3				3		3				3		3	
Intermediate Station Downcurrent																																																		
	ESC-INF1	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INF2	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INF3	4 times per year																							3				3		3				3		3				3		3				3		3	
Reference Station Upcurrent																																																		
	ESC-RFF1A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFF2A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFF3	4 times per year																							3				3		3				3		3				3		3				3		3	
Ma Wan Station																																																		
	MW1	4 times per year																							3				3		3				3		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																																										
	US2	3 times per week				2	2	2																																										
Downstream Stations																																																		
	DS1	3 times per week				2	2	2																																										
	DS2	3 times per week				2	2	2																																										
	DS3	3 times per week				2	2	2																																										
	DS4	3 times per week				2	2	2																																										
	DS5	3 times per week				2	2	2																																										
Ma Wan Station																																																		
	MW1	3 times per week				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 A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (April 2017 - December 2018)

			2017									2018												
Capping Water Quality Monitoring			**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Ebb Tide																								
Impact Stations Downcurrent																								
	SB-IPE1	4 times per year		3	3		3	3																
	SB-IPE2	4 times per year		3	3		3	3																
	SB-IPE3	4 times per year		3	3		3	3																
	SB-IPE4	4 times per year		3	3		3	3																
	SB-IPE5	4 times per year		3	3		3	3																
Intermediate Stations Downcurrent																								
	SB-INE1	4 times per year		3	3		3	3																
	SB-INE2	4 times per year		3	3		3	3																
	SB-INE3	4 times per year		3	3		3	3																
	SB-INE4	4 times per year		3	3		3	3																
	SB-INE5	4 times per year		3	3		3	3																
Reference Stations Upcurrent																								
	SB-RFE1	4 times per year		3	3		3	3																
	SB-RFE2	4 times per year		3	3		3	3																
	SB-RFE3	4 times per year		3	3		3	3																
	SB-RFE4	4 times per year		3	3		3	3																
	SB-RFE5	4 times per year		3	3		3	3																
Sensitive Receiver Stations																								
	MW1	4 times per year		3	3		3	3																
	THB1	4 times per year		3	3		3	3																
	THB2	4 times per year		3	3		3	3																
	WSR45C	4 times per year		3	3		3	3																
	WSR46	4 times per year		3	3		3	3																
Flood Tide																								
Impact Stations Downcurrent																								
	SB-IPF1	4 times per year		3	3		3	3																
	SB-IPF2	4 times per year		3	3		3	3																
	SB-IPF3	4 times per year		3	3		3	3																
Intermediate Stations Downcurrent																								
	SB-INF1	4 times per year		3	3		3	3																
	SB-INF2	4 times per year		3	3		3	3																
	SB-INF3	4 times per year		3	3		3	3																
Reference Stations Upcurrent																								
	SB-RFF1	4 times per year		3	3		3	3																
	SB-RFF2	4 times per year		3	3		3	3																
	SB-RFF3	4 times per year		3	3		3	3																
Sensitive Receiver Stations																								
	MW1	4 times per year		3	3		3	3																
	THB1	4 times per year		3	3		3	3																
	THB2	4 times per year		3	3		3	3																
	WSR45C	4 times per year		3	3		3	3																
	WSR46	4 times per year		3	3		3	3																

Benthic Recolonisation Studies			**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Capped Contaminated Mud Pits																							
	SB-CPA	2 times per year					12				12								12				12
	SB-CPB	2 times per year					12				12								12				12
Reference Stations																							
	RBA	2 times per year					12				12								12				12
	RBB	2 times per year					12				12								12				12
	RBC	2 times per year					12				12								12				12

Notes:
The number shown in each cell represents the numbers of replicates per monitoring station
Capping works are planned to be conducted between May and December 2017.

Annex B

Disposal Records

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Jul-2018	0	1,067,718
2-Jul-2018	0	1,067,718
3-Jul-2018	0	1,067,718
4-Jul-2018	0	1,067,718
5-Jul-2018	229	1,067,947
6-Jul-2018	304	1,068,251
7-Jul-2018	362	1,068,613
8-Jul-2018	698	1,069,311
9-Jul-2018	733	1,070,044
10-Jul-2018	172	1,070,216
11-Jul-2018	513	1,070,729
12-Jul-2018	1319	1,072,048
13-Jul-2018	865	1,072,913
14-Jul-2018	228	1,073,141
15-Jul-2018	0	1,073,141
16-Jul-2018	316	1,073,457
17-Jul-2018	271	1,073,728
18-Jul-2018	708	1,074,436
19-Jul-2018	170	1,074,606
20-Jul-2018	1050	1,075,656
21-Jul-2018	904	1,076,560
22-Jul-2018	0	1,076,560
23-Jul-2018	213	1,076,773
24-Jul-2018	667	1,077,440
25-Jul-2018	285	1,077,725
26-Jul-2018	1038	1,078,763
27-Jul-2018	597	1,079,360
28-Jul-2018	681	1,080,041
29-Jul-2018	0	1,080,041
30-Jul-2018	227	1,080,268
31-Jul-2018	345	1,080,613
1-Aug-2018	0	1,080,613
2-Aug-2018	741	1,081,354
3-Aug-2018	719	1,082,073
4-Aug-2018	964	1,083,037
5-Aug-2018	0	1,083,037
6-Aug-2018	0	1,083,037
7-Aug-2018	643	1,083,680
8-Aug-2018	992	1,084,672
9-Aug-2018	828	1,085,500
10-Aug-2018	683	1,086,183
11-Aug-2018	0	1,086,183
12-Aug-2018	0	1,086,183
13-Aug-2018	0	1,086,183
14-Aug-2018	0	1,086,183
15-Aug-2018	720	1,086,903
16-Aug-2018	1043	1,087,946
17-Aug-2018	420	1,088,366
18-Aug-2018	657	1,089,023
19-Aug-2018	0	1,089,023
20-Aug-2018	0	1,089,023
21-Aug-2018	1440	1,090,463
22-Aug-2018	949	1,091,412
23-Aug-2018	256	1,091,668
24-Aug-2018	607	1,092,275
25-Aug-2018	586	1,092,861
26-Aug-2018	0	1,092,861

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
27-Aug-2018	448	1,093,309
28-Aug-2018	344	1,093,653
29-Aug-2018	0	1,093,653
30-Aug-2018	256	1,093,909
31-Aug-2018	315	1,094,224
1-Sep-2018	315	1,094,539
2-Sep-2018	0	1,094,539
3-Sep-2018	389	1,094,928
4-Sep-2018	844	1,095,772
5-Sep-2018	359	1,096,131
6-Sep-2018	1021	1,097,152
7-Sep-2018	816	1,097,968
8-Sep-2018	735	1,098,703
9-Sep-2018	0	1,098,703
10-Sep-2018	538	1,099,241
11-Sep-2018	577	1,099,818
12-Sep-2018	0	1,099,818
13-Sep-2018	508	1,100,326
14-Sep-2018	0	1,100,326
15-Sep-2018	0	1,100,326
16-Sep-2018	0	1,100,326
17-Sep-2018	0	1,100,326
18-Sep-2018	0	1,100,326
19-Sep-2018	433	1,100,759
20-Sep-2018	612	1,101,371
21-Sep-2018	0	1,101,371
22-Sep-2018	500	1,101,871
23-Sep-2018	505	1,102,376
24-Sep-2018	889	1,103,265
25-Sep-2018	0	1,103,265
26-Sep-2018	902	1,104,167
27-Sep-2018	476	1,104,643
28-Sep-2018	1245	1,105,888
29-Sep-2018	1181	1,107,069
30-Sep-2018	0	1,107,069

Annex C

Statistical Analysis

Routine Water Quality Monitoring for ESC CMPs – Analysis of Variance and Linear Regression Analysis up to August 2018

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	613667.559	3	204555.853	6.837	**
Period	720632119.740	32	22519753.742	752.654	**
Area * Period	51161839.117	96	532935.824	17.812	**
Error	67919482.555	2270	29920.477		
Total	4622401533.000	2402			

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

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	33041506.750	3	11013835.583	85.994	**
Period	465823547.118	32	14556985.847	113.659	**
Area * Period	116111766.634	96	1209497.569	9.444	**
Error	290733204.192	2270	128076.301		
Total	4622336453.500	2402			

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

SNK Results:

- Nov 17 > Oct 17 = Aug 13 > Apr 17 ≥ **Aug 18** ≥ Apr 12 ≥ Aug 12 ≥ Nov 16 = Oct 16 = **Jul 18** = Nov 12 = Jul 16 ≥ Jul 17 = May 16 ≥ Apr 13 ≥ Feb 12 ≥ Apr 16 ≥ Jan 17 ≥ May 18 ≥ Oct 12 ≥ Jul 12 ≥ Jan 18 = Aug 17 = Aug 16 ≥ Feb 13 ≥ Feb 18 ≥ May 12 = Jan 13 = Apr 18 ≥ Jul 13 = 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	1708445960.066	31	55111160.002	790.216	**
Area	17702659.323	3	5900886.441	84.610	**
Station(Area)	24401927.811	24	1016746.992	14.579	**
Period * Area	305958257.122	90	3399536.190	48.745	**
Period * Station(Area)	280282215.626	264	1061675.059	15.223	**
Error	205041177.000	2940	69741.897		
Total	12612673849.500	3360			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1631350450.034	31	52624208.066	404.968	**
Area	28502533.192	3	9500844.397	73.113	**
Station(Area)	57612620.279	24	2400525.845	18.473	**
Period * Area	310457079.837	90	3449523.109	26.546	**
Period * Station(Area)	232344601.309	264	880093.187	6.773	**
Error	382043416.875	2940	129946.740		
Total	12606306918.000	3360			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	2067278401.428	31	66686400.046	837.562	**
Area	36536221.919	3	12178740.640	152.961	**
Station(Area)	39614604.944	24	1650608.539	20.731	**
Period * Area	205652849.760	90	2285031.664	28.699	**
Period * Station(Area)	300559245.702	264	1138481.991	14.299	**
Error	234081834.375	2940	79619.672		
Total	12648763530.500	3360			

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 = Aug 17 = Feb 18 = Jan 18 = May 17 = **Jul 18** > Apr 18 > May 18 > Apr 12 = Feb 12 = Aug 13 > **Aug 18** ≥Jul 12 ≥ Nov 12 = Jul 13 > May 16 = May 12 > Jan 17 ≥ Jan 13 = Apr 13 = Oct 16 = Apr 16 = Oct 12 > Nov 16 = Jul 16 > 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	2129666833.246	31	68698930.105	691.642	**
Area	6858942.448	3	2286314.149	23.018	**
Station(Area)	19240969.389	24	801707.058	8.071	**
Period * Area	120791350.202	90	1342126.113	13.512	**
Period * Station(Area)	113160712.957	264	428639.064	4.315	**
Error	292022413.000	2940	99327.351		
Total	12643077877.000	3360			

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

SNK Results:

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

Total Inorganic Nitrogen

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	2032722010.188	31	65571677.748	1283.437	**
Area	48415570.974	3	16138523.658	315.880	**
Station(Area)	61960054.937	24	2581668.956	50.531	**
Period * Area	156120671.834	90	1734674.131	33.953	**
Period * Station(Area)	161883150.300	264	613193.751	12.002	**
Error	150206634.000	2940	51090.692		
Total	12649522097.000	3360			

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

SNK Results:

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

BOD_5

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1154429246.588	31	37239653.116	192.080	**
Area	35746798.871	3	11915599.624	61.460	**
Station(Area)	21780345.668	24	907514.403	4.681	**
Period * Area	507130664.484	90	5634785.161	29.064	**
Period * Station(Area)	405112369.765	264	1534516.552	7.915	**
Error	569994493.875	2940	193875.678		
Total	12640519521.000	3360			

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

SNK Results:

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

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1497488864.776	31	48306092.412	1379.624	**
Area	14400094.204	3	4800031.401	137.089	**
Station(Area)	157202280.958	24	6550095.040	187.071	**
Period * Area	355493447.000	90	3949927.189	112.810	**
Period * Station(Area)	649458698.434	264	2460070.827	70.260	**
Error	102941025.500	2940	35013.954		
Total	12648763600.000	3360			

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

SNK Results:

- Nov 17 > Jul 12 > Nov 12 > Nov 16 = Jul 16 = Oct 16 = Aug 12 > Apr 12 ≥ Apr 17 = Oct 17 ≥ May 16 = Oct 12 > Aug 13 > Jan 17 = **Jul 18** = **Aug 18** = Apr 16 ≥ Jul 17 = Apr 13 > Feb 12 > Jan 18 > Aug 16 > May 18 = Feb 13 > Feb 18 = Apr 18 = Jan 13 > Aug 17 > May 13 > 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	-0.125	0.125	0.016	**

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

Pit Specific Sediment Chemistry for ESC CMP Vd – Analysis of Variance (up to September 2018)

Arsenic

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	528548250.962	30	17618275.032	326.679	**
Area	1661583.073	2	830791.537	15.405	**
Station(Area)	85911568.060	3	28637189.353	530.993	**
Period * Area	86552319.632	60	1442538.661	26.748	**
Period * Station(Area)	93744156.986	89	1053305.135	19.530	**
Error	109588601.423	2032	53931.398		
Total	3634640805.000	2217			

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

SNK Results:

- Oct 17 = **Jul 18** = Jun 18 > May 18 = Jul 17 = Nov 17 = Mar 18 ≥ **Sep 18** = **Aug 18** = Aug 16 = Sep 17 = Aug 17 > Dec 17 = Apr 18 = Feb 18 = Mar 16 = Jan 18 > May 17 = Jun 17 > Jul 16 ≥ Apr 16 = Feb 17 = Apr 17 > Oct 16 = May 16 = Nov 16 > Mar 17 = Jun 16 = Jan 17 = Sep 16 > Dec 16
- Pit Edge = Near Pit > Active Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	231202382.316	30	7706746.077	79.710	**
Area	238752748.616	2	119376374.308	1234.693	**
Station(Area)	14454110.544	3	4818036.848	49.832	**
Period * Area	98291723.358	60	1638195.389	16.944	**
Period * Station(Area)	112490348.278	89	1263936.498	13.073	**
Error	196173930.571	2029	96685.032		
Total	3613640387.000	2214			

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

SNK Results:

- Jun 18 > Jun 16 = May 17 ≥ Dec 17 = Jul 17 = Mar 18 ≥ May 18 ≥ Nov 17 ≥ Oct 17 ≥ Sep 17 = Aug 17 = Apr 16 ≥ Apr 18 ≥ May 16 = Sep 16 = Aug 16 = Feb 17 = Jun 17 = Feb 18 = Jan 18 = Dec 16 ≥ **Sep 18** ≥ **Aug 18** = Mar 17 ≥ Nov 16 = Mar 16 = Apr 17 = Jan 17 = Jul 16 > **July 18** > Oct 16
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-0.461	0.461	0.213	**

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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	311287965.522	30	10376265.517	106.813	**
Area	32591571.156	2	16295785.578	167.748	**
Station(Area)	54723333.782	3	18241111.261	187.773	**
Period * Area	167678243.702	60	2794637.395	28.768	**
Period * Station(Area)	142835053.199	89	1604888.238	16.521	**
Error	197397711.930	2032	97144.543		
Total	3634708037.000	2217			

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

SNK Results:

- Jul 17 > Oct 17 > Mar 16 > Jun 18 > Nov 17 ≥ **Jul 18** = Sep 17 = Aug 17 = Jun 16 = Mar 18 = Apr 16 > May 18 > Aug 16 = Feb 18 = Jan 18 = Jul 16 ≥ **Aug 18** = **Sep 18** > Sep 16 = Apr 18 > Nov 16 = May 16 = Dec 16 = Feb 17 = Oct 16 > May 17 = Dec 17 = Jan 17 > Jun 17 = Mar 17 > Apr 17
- Pit Edge = Active Pit > Near Pit

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	135283449.067	30	4509448.302	66.295	**
Area	282118317.945	2	141059158.973	2073.767	**
Station(Area)	48951190.245	3	16317063.415	239.884	**
Period * Area	144292422.286	60	2404873.705	35.355	**
Period * Station(Area)	160308759.338	89	1801222.015	26.480	**
Error	138218168.952	2032	68020.752		
Total	3634708316.500	2217			

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

SNK Results:

- Oct 17 > Nov 17 ≥ Mar 18 = Jun 18 ≥ May 18 ≥ Dec 17 ≥ Feb 18 ≥ Aug 16 = **Sep 18** = Apr 18 = **Aug 18** = Sep 17 = Aug 17 = **Jul 18** = Sep 16 = Feb 17 = Jan 18 = Jun 16 > Apr 16 = Jun 17 ≥ Mar 16 ≥ Dec 16 = May 16 ≥ Mar 17 = May 17 = Oct 16 = Jan 17 = Nov 16 = Jul 17 = Jul 16 > Apr 17
- Active Pit > Pit Edge = Near Pit

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	263477612.318	30	8782587.077	145.864	**
Area	62233639.089	2	31116819.545	516.796	**
Station(Area)	121789752.549	3	40596584.183	674.239	**
Period * Area	170311569.129	60	2838526.152	47.143	**
Period * Station(Area)	166583088.113	89	1871720.091	31.086	**
Error	122348708.198	2032	60210.978		
Total	3634707707.500	2217			

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

SNK Results:

- Jul 17 = Oct 17 > Jun 18 ≥ Mar 16 = May 17 = Jun 17 ≥ Nov 17 ≥ Sep 17 = Aug 17 = Apr 16 = Jul 16 = **Jul 18** = Jun 16 > May 18 = Mar 18 = Jan 18 ≥ Nov 16 = **Aug 18** = **Sep 18** ≥ Feb 18 = May 16 ≥ Aug 16 ≥ Sep 16 = Apr 18 = Dec 17 = Feb 17 = Dec 16 = Jan 17 = Apr 17 > Mar 17 > Oct 16
- Pit edge > Active Pit > Near Pit

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	215215840.827	30	7173861.361	61.127	**
Area	59381614.629	2	29690807.315	252.988	**
Station(Area)	110942336.724	3	36980778.908	315.104	**
Period * Area	118030489.027	60	1967174.817	16.762	**
Period * Station(Area)	165445553.841	89	1858938.807	15.840	**
Error	238476706.624	2032	117360.584		
Total	3634708127.500	2217			

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

SNK Results:

- Mar 17 > Jul 17 ≥ Jun 18 = Oct 17 = May 17 ≥ **Jul 18** ≥ Jun 17 ≥ Sep 17 = Aug 17 = May 18 = Mar 18 = Nov 17 ≥ Apr 16 ≥ Mar 16 = Jan 18 = Jun 16 = Jul 16 = Aug 16 ≥ Nov 16 = Apr 17 = **Aug 18** ≥ **Sep 18** = Feb 18 = May 16 = Dec 17 = Apr 18 = Oct 16 = Feb 17 > Dec 16 > Sep 16 > Jan 17
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-0.201	0.201	0.041	**

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

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	612493047.439	30	20416434.915	275.516	**
Area	13436204.200	2	6718102.100	90.660	**
Station(Area)	2574852.024	3	858284.008	11.582	**
Period * Area	58664308.571	60	977738.476	13.194	**
Period * Station(Area)	36755403.726	89	412982.064	5.573	**
Error	150576168.917	2032	74102.445		
Total	3606447608.500	2217			

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

SNK Results:

- Apr 16 = Mar 16 > May 16 = Jun 16 > Sep 16 = Jul 16 = Aug 16 ≥ Oct 16 = Jun 17 = Nov 16 > Dec 16 = May 17 ≥ May 18 = Nov 17 = Jan 17 > Mar 17 = Apr 17 = **Sep 18** = Feb 17 = Jun 18 = Jul 17 = Oct 17 = **Jul 18** > **Aug 18** = Dec 17 = Sep 17 = Aug 17 > Mar 18 = Jan 18 = Feb 18 = Apr 18
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-0.058	0.o58	0.003	**

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	118907815.163	30	3963593.839	52.060	**
Area	305570052.535	2	152785026.268	2006.747	**
Station(Area)	15556976.753	3	5185658.918	68.111	**
Period * Area	163158001.759	60	2719300.029	35.717	**
Period * Station(Area)	144374316.260	89	1622183.329	21.306	**
Error	154631529.027	2031	76135.662		
Total	3628833125.500	2216			

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

SNK Results:

- Dec 17 ≥ Nov 17 ≥ May 17 ≥ Apr 17 ≥ Jun 16 = May 18 = Aug 16 = Jun 18 = Mar 18 = Jun 17 ≥ Mar 17 = Feb 17 = Jul 17 = Sep 16 = Oct 17 ≥ Apr 18 ≥ Feb 18 = Sep 17 = Aug 17 = Jan 18 = Mar 16 = Apr 16 = **Sep 18** = May 16 = **Aug 18** ≥ Dec 16 = Jul 16 ≥ Nov 16 = Jan 17 = **Jul 18** > Oct 16
- Active Pit > Near Pit > Pit Edge

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	306427956.029	30	10214265.201	165.169	**
Area	80336799.143	2	40168399.572	649.541	**
Station(Area)	105892763.994	3	35297587.998	570.777	**
Period * Area	157649847.119	60	2627497.452	42.488	**
Period * Station(Area)	130138913.785	89	1462234.986	23.645	**
Error	125661426.157	2032	61841.253		
Total	3634705681.000	2217			

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

SNK Results:

- Jul 17 = Oct 17 = Jun 18 > Nov 17 = May 18 = Mar 18 > Apr 18 = **Jul 18** = Mar 16 = Feb 18 ≥ Sep 17 = Aug 17 = Apr 16 = Jan 18 = Aug 16 = Dec 17 = Jun 16 = **Aug 18** = **Sep 18** > Jul 16 > Nov 16 ≥ May 16 = Oct 16 = May 17 > Feb 17 = Dec 16 > Mar 17 ≥ Jan 17 ≥ Jun 17 = Sep 16 = Apr 17
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-0.297	0.297	0.088	**

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

Total Organic Carbon

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	319087852.803	30	10636261.760	187.168	**
Area	31621310.503	2	15810655.251	278.223	**
Station(Area)	39398876.551	3	13132958.850	231.103	**
Period * Area	185331923.287	60	3088865.388	54.355	**
Period * Station(Area)	217284889.514	89	2441403.253	42.962	**
Error	115472887.503	2032	56827.208		
Total	3634448909.500	2217			

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

SNK Results:

- Oct 17 = Feb 18 = Jun 18 > Apr 16 > **Aug 18** = Jul 17 = May 18 = Mar 16 = Mar 18 = Dec 17 = **Jul 18** > Jun 16 ≥ Aug 16 = Jul 16 = Nov 17 = Nov 16 = Jan 17 > May 17 ≥ Sep 16 = Oct 16 = Dec 16 = May 16 = Apr 18 = **Sep 18** = Sep 17 = Aug 17 = Jun 17 > Jan 18 > Mar 17 ≥ Apr 17 = Feb 17
- Pit Edge = Active Pit > Near Pit

Cumulative Impact Sediment Chemistry for ESC CMPs – Analysis of Variance (up to August 2018)

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	29039831.169	9	3226647.908	462.856	**
Area	11507319.820	4	2876829.955	412.675	**
Station(Area)	949281.943	4	237320.486	34.043	**
Period * Area	51827064.088	35	1480773.260	212.414	**
Period * Station(Area)	3688495.526	36	102458.209	14.697	**
Error	6901463.667	990	6971.175		
Total	420477128.000	1080			

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

SNK Results:

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

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	17065659.513	9	1896184.390	66.608	**
Area	8443879.213	4	2110969.803	74.153	**
Station(Area)	22730460.322	4	5682615.080	199.617	**
Period * Area	20067728.091	35	573363.660	20.141	**
Period * Station(Area)	7423262.105	36	206201.725	7.243	**
Error	28182959.042	990	28467.635		
Total	419656365.500	1080			

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

SNK Results:

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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	8086545.689	9	898505.077	97.043	**
Area	30881732.546	4	7720433.137	833.843	**
Station(Area)	9028433.503	4	2257108.376	243.778	**
Period * Area	28102658.630	35	802933.104	86.721	**
Period * Station(Area)	10648266.841	36	295785.190	31.946	**
Error	9166266.417	990	9258.855		
Total	420487279.000	1080			

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

SNK Results:

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	4994115.377	9	554901.709	56.943	**
Area	24260471.863	4	6065117.966	622.396	**
Station(Area)	30229081.189	4	7557270.297	775.519	**
Period * Area	21301088.924	35	608602.541	62.454	**
Period * Station(Area)	5837201.530	36	162144.487	16.639	**
Error	9647348.750	990	9744.797		
Total	420487301.000	1080			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	8604803.514	9	956089.279	119.963	**
Area	22005576.998	4	5501394.250	690.273	**
Station(Area)	12245151.085	4	3061287.771	384.107	**
Period * Area	34095130.340	35	974146.581	122.229	**
Period * Station(Area)	13320642.623	36	370017.851	46.427	**
Error	7890181.292	990	7969.880		
Total	420487184.000	1080			

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

SNK Results:

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	36721277.645	9	4080141.961	517.364	**
Area	18570881.968	4	4642720.492	588.699	**
Station(Area)	4861256.465	4	1215314.116	154.102	**
Period * Area	26681072.162	35	762316.347	96.662	**
Period * Station(Area)	6290321.181	36	174731.144	22.156	**
Error	7807546.500	990	7886.411		
Total	420487279.500	1080			

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

SNK Results:

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

Mercury

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	51509227.406	9	5723247.490	205.775	**
Area	2181399.086	4	545349.772	19.608	**
Station(Area)	2006710.286	4	501677.572	18.037	**
Period * Area	12456241.845	35	355892.624	12.796	**
Period * Station(Area)	3564597.828	36	99016.606	3.560	**
Error	27534967.208	990	27813.098		
Total	417850532.000	1080			

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

SNK Results:

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

Silver

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	18135966.576	9	2015107.397	165.976	**
Area	28518352.555	4	7129588.139	587.234	**
Station(Area)	24470886.439	4	6117721.610	503.891	**
Period * Area	7382661.741	35	210933.193	17.374	**
Period * Station(Area)	8829726.530	36	245270.181	20.202	**
Error	12019556.583	990	12140.966		
Total	420409036.000	1080			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6611194.948	9	734577.216	134.425	**
Area	22463047.814	4	5615761.953	1027.666	**
Station(Area)	20416728.134	4	5104182.034	934.048	**
Period * Area	33044373.935	35	944124.970	172.772	**
Period * Station(Area)	6929646.084	36	192490.169	35.225	**
Error	5409935.292	990	5464.581		
Total	420486876.500	1080			

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

SNK Results:

- Aug 16 > Jun 18 = Aug 17 ≥ Jun 16 = Dec 17 ≥ Jun 17 ≥ Feb 18 = Dec 16 > Feb 17 > **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	16409778.951	9	1823308.772	161.989	.000
Area	18660507.721	4	4665126.930	414.467	.000
Station(Area)	6121142.363	4	1530285.591	135.956	.000
Period * Area	32097473.995	35	917070.686	81.476	.000
Period * Station(Area)	13053057.908	36	362584.942	32.213	.000
Error	11143171.083	990	11255.728		
Total	420453215.500	1080			

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

SNK Results:

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

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	20175479.580	9	2241719.953	73.585	**
Area	22746242.302	4	5686560.576	186.662	**
Station(Area)	5057206.951	4	1264301.738	41.501	**
Period * Area	6399627.819	35	182846.509	6.002	**
Period * Station(Area)	6905063.205	36	191807.311	6.296	**
Error	30159849.167	990	30464.494		
Total	414796173.500	1080			

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

Sediment Chemistry after a Major Storm Event (20 September 2018) of ESC CMP Vd – Analysis of Variance

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	93012.646	4	23253.161	730.109	**
Station(Area)	8722.812	4	2180.703	68.470	**
Error	3153.042	99	31.849		
Total	425675.500	108			

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

SNK Results:

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

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	74665.406	4	18666.352	1078.555	**
Station(Area)	26201.719	4	6550.430	378.488	**
Error	1713.375	99	17.307		
Total	423367.500	108			

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

SNK Results:

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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	89582.250	4	22395.563	524.053	**
Station(Area)	11152.458	4	2788.115	65.242	**
Error	4230.792	99	42.735		
Total	425752.500	108			

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

SNK Results:

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	77963.167	4	19490.792	479.838	**
Station(Area)	22981.500	4	5745.375	141.444	**
Error	4021.333	99	40.620		
Total	425753.000	108			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	83048.583	4	20762.146	362.024	**
Station(Area)	16235.750	4	4058.938	70.775	**
Error	5677.667	99	57.350		
Total	425749.000	108			

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

SNK Results:

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	75897.646	4	18974.411	253.940	**
Station(Area)	21671.063	4	5417.766	72.507	**
Error	7397.292	99	74.720		
Total	425753.000	108			

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

SNK Results:

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

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	50551.531	4	12637.883	2590.597	**
Station(Area)	43448.010	4	10862.003	2226.565	**
Error	482.958	99	4.878		
Total	415269.500	108			

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

SNK Results:

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	40445.917	4	10111.479	450.680	**
Station(Area)	61092.917	4	15273.229	680.746	**
Error	2221.167	99	22.436		
Total	424547.000	108			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	73296.750	4	18324.187	456.678	**
Station(Area)	27685.875	4	6921.469	172.498	**
Error	3972.375	99	40.125		
Total	425742.000	108			

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

SNK Results:

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

Sediment Toxicity for ESC CMP Vd – August 2018

Survival rate for burrowing amphipod Leptochirus plumulosus

	Survival
Chi-Sqaure	2.642
Df	2
Asymp. Sig.	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	.007	2	.003	.431	NS
Within Groups	.983	122	.008		
Total	.990	124			

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

Survival rate for marine bivalve Crassostrea gigas

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	78.339	2	39.169	2.377	NS
Within Groups	2010.355	122	16.478		
Total	2088.694	124			

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

Mortality rate for barnacles Balanus Amphitrite

Source	Mortaility
Chi-Sqaure	1.866
Df	2
Asymp. Sig.	NS

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

Mortality rate for shrimp Penaeus vannaamei

Source	Mortality
Chi-Sqaure	1.182
df	2
Asymp. Sig.	NS

Note:
- NS: No significant difference;

**: Significant difference

Benthic Macro-infauna Recolonisation Study for SB CMPs – Analysis of Variance Analysis up to August 2018

Number of Genera

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1635088.481	8	204386.060	52.251	**
Period	1267460.835	5	253492.167	64.804	**
Period * Station	491746.342	17	28926.255	7.395	**
Error	1376899.833	352	3911.647		
Total	18895861.500	384			

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

SNK Results:

- SB-RBC > SB-RBA > SB-RBB > SB-CPA = SB-CPB
- Aug 17 > Aug 16 > Dec 16 = **Aug 18** = Aug 15 > Dec 15 = Dec 17

Number of Individuals

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1517605.494	4	379401.373	91.440	**
Period	943344.111	6	157224.018	37.893	**
Period * Station	814568.458	21	38788.974	9.349	**
Error	1460516.167	352	4149.194		
Total	18935919.500	384			

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

SNK Results:

- SB-RBC > SB-RBB = SB-RBA > SB-CPA = SB-CPB
- Aug 17 = Aug 16 > **Aug 18** ≥ Dec 16 ≥ Dec 15 = Aug 15 > Dec 17

Genus Richness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	889303.667	4	222325.917	39.701	**
Period	989211.210	6	164868.535	29.441	**
Period * Station	520535.963	21	24787.427	4.426	**
Error	1898407.129	339	5600.021		
Total	17085798.000	371			

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

SNK Results:

- SB-RBC = SB-RBA > SB-RBB > SB-CPA = SB-CPB
- Aug 17 > Aug 16 ≥ Dec 16 = Aug 15 = **Aug 18** > Dec 15 = Dec 17

Pielou's Evenness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	215577.560	4	53894.390	6.137	**
Period	239047.627	6	39841.271	4.537	**
Period * Station	466207.175	21	22200.342	2.528	**
Error	2880493.322	328	8781.992		
Total	15593038.000	360			

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

SNK Results:

- SB-RBA = SB-RBB = SB-CPA = SB-CPB > SB-RBC
- Aug 15 = Aug 17 **=** Dec17 ≥ Dec 16 ≥ **Aug 18** = Aug 16 = Dec 15

Shannon-Weiner Diversity Index

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1142317.087	4	285579.272	60.485	**
Period	1369910.810	6	228318.468	48.358	**
Period * Station	636877.404	21	30327.495	6.423	**
Error	1661954.542	352	4721.462		
Total	18944432.500	384			

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

SNK Results:

- SB-RBA = SB-RBC > SB-RBB > SB-CPA = SB-CPB
- Aug 17 > Aug 16 = Dec 16 ≥ Aug 15 = **Aug 18** > Dec 17 = Dec 15

Biomass

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1433339.836	4	358334.959	71.740	**
Period	1236779.363	6	206129.894	41.268	**
Period * Station	421626.530	21	20077.454	4.020	**
Error	1758200.292	352	4994.887		
Total	18947867.500	384			

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

SNK Results:

- SB-RBC = SB-RBA > SB-RBB > SB-CPA = SB-CPB
- **Aug 18** = Aug 16 > Aug 17 = Dec 16 = Dec 17 = Aug 15 > Dec 15