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

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

Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – July to September 2019

Revision 0

January 2020

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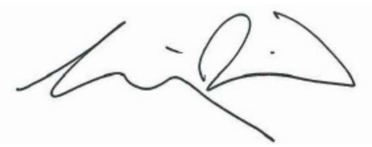
Client: Civil Engineering and Development Department (CEDD)	Project No: 0400720
Summary: This document presents the Quarterly EM&A Report for *Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau*.	Date: 31 January 2020 Approved by:  Craig A. Reid *Partner*

Revision	Description	By	Checked	Approved	Date
v0	Quarterly EM&A Report for ESC CMPs	GS	RC	CAR	31/1/20

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

Environmental Certification Sheet
EP-312/2008/A

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – July to September 2019
Date of Report:	31 January 2020
Date prepared by ET:	31 January 2020
Date received by IA:	31 January 2020

Reference EP Condition

Environmental Permit Condition:

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

ET Certification

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

Craig A. Reid,
Environmental Team Leader: [signature] Date: 31/1/2020

IA Verification

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

Dr Wang Wen Xiong,
Independent Auditor: [signature] Date: 31/1/2020

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 2019

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Pit Specific Sediment Chemistry, Cumulative Impact Sediment Chemistry, Sediment Chemistry after a Major Storm, Sediment Toxicity Test and Demersal Trawling were carried out for the Contaminated Mud Pits (CMPs) to the East of Sha Chau (ESC) during the quarterly period of July to September 2019. This report presents the results of these monitoring activities to identify whether the disposal operations at ESC CMP V are causing any unacceptable impact(s) to the surrounding aquatic environment or to those marine organisms that utilize these habitats.

Water Quality Monitoring for ESC CMPs

Water Column Profiling of ESC CMP Vd – July to September 2019

Results indicated that levels of Salinity, pH and Dissolved Oxygen (DO) complied with the Water Quality Objectives (WQOs) at both Upstream and Downstream stations. Levels of DO, Turbidity and Suspended Solids (SS) complied with the Action and Limit Levels at all stations. Overall, the results indicated that the mud disposal operation at ESC CMP 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 2019

Results of Routine Water Quality Monitoring conducted in July and August 2019 showed that levels of DO, Salinity and pH complied with the WQOs in most stations. The levels of DO, Turbidity and SS complied with the Action and Limit Levels at all stations.

From the monitoring results and statistical analysis, there were no trends indicating any increase in the concentrations of contaminants with proximity to the pit or with time. Thus, it appears that mud disposal operations at 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 2019

Monitoring results showed that the concentrations of inorganic contaminants were generally below the Lower Chemical Exceedance Levels (LCELs) at most monitoring stations. Statistical analysis indicated that there did not appear any trend of increasing sediment contaminants' concentrations with proximity

to the pit or with time. Thus, it appears that mud disposal operation 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 2019

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 – August 2019

Sampling for *Sediment Chemistry after a Major Storm Event* was conducted for ESC CMPs on 7 August 2019 after the visit of tropical cyclone Wipha, which led to the issue of No. 8 Gale Signal on 31 July 2019.

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 August 2019.

Sediment Toxicity Test of ESC CMPs – August 2019

Statistical analysis showed that there were no significant differences between Impact and Reference stations in the toxicity tests of all tested 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 CMPs.

Demersal Trawling for ESC CMPs – July and August 2019

During the sampling period in July and August 2019, the mean number of faunal species caught was generally lower at Impact stations. 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 2019.

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（二零一九年七月至九月）

行政摘要

在2019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、沉積物毒性測試及底棲漁業資源監察。本報告詳述以上的環境監察結果，從而分析在沙洲以東海泥卸置設施CMP V的卸置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 – 2019年7月至9月

監察結果顯示上游及下游監測站的鹽度、酸鹼值及溶解氧含量均符合海水水質指標。上游及下游監測站的溶解氧含量、混濁度及懸浮固體含量也符合行動及極限水平。總體而言，水層質量監察結果表明報告期內沙洲以東海泥卸置設施CMP 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 – 2019年7月和8月

2019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、鹽度及酸鹼值大致符合海水水質指標。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 – 2019年7月至9月

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

沉積物化學累積性影響監察 – 2019年8月

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

強颱風後的沉積物質素監察 – 2019年8月

熱帶氣旋韋帕在2019年7月31日吹襲香港，並在同日發出八號暴風信號。在熱帶氣旋過後，環境小組在2019年8月7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2019年8月的強颱風導致污泥從泥坑擴散或引起沉積物污染。

沙洲以東污泥坑之沉積物毒性測試 – 2019年8月

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

沙洲以東污泥坑之底棲漁業資源監察 – 2019年7月和8月

監察結果顯示，2019年7月和8月的底棲漁業資源在受影響監測站普遍錄得較低的品種數量。而在2019年7月及8月受影響監測站ESC-INA及ESC-INB的生物量、生物重量、單位努力漁獲量及單位努力生產量均錄得較低的數值。

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

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

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

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

1.2 ACTIVITIES CONDUCTED DURING THE REPORTING PERIOD

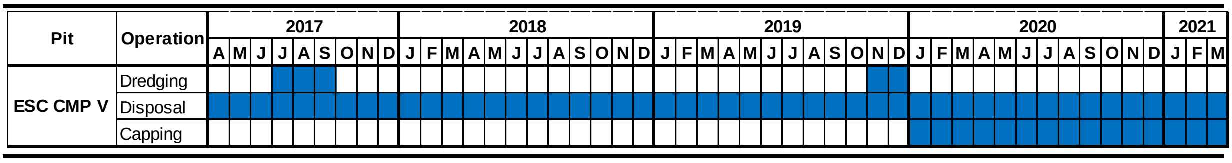
1.2.1 Detailed works schedule for ESC CMP V is shown in *Figure 1.1*. During the reporting period of July to September 2019, the following works were being undertaken at the ESC CMPs:

- 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 2019* is to provide information regarding the findings in the quarterly reporting period of July to September 2019 on the environmental impacts resulting from backfilling operation at ESC CMP Vd. Although the EM&A programme has been conducted since 1997, this report presents the analytical and statistical results of the quarterly reporting period. Results from previous monitoring will be presented and discussed in the Annual Review Report. Readers are referred to the *Monthly EM&A Reports* for this Study for graphical and tabular presentations of the monitoring results.

1.3.3 The objectives of this report are to:

- Confirm that all activities, tests, analyses, assessments etc. have been carried out as stated in the *EM&A Manual*; and,
- Report on any trend resulting from dredging, backfilling and capping operations at the CMPs.

2 *ENVIRONMENTAL MONITORING & AUDITING PROGRAMME*

2.1 *ENVIRONMENTAL MONITORING & AUDITING TASKS*

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

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

2.2 *EM&A SAMPLING AND ANALYSES*

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

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

3 MONITORING & AUDITING RESULTS

3.1 OVERVIEW OF THE MONITORING & AUDITING ACTIVITIES

3.1.1 *Sampling & Laboratory Analysis*

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

Table 3.1 Samplings Conducted and Monitoring Results Received from the Contractors for the Reporting Period of July to September 2019

Key Task	Date of Sampling & *in-situ* Measurement	Date of Results Received from the Contractors
ESC CMPs		
Water Column Profiling of ESC CMP Vd	11 July 2019 13 August 2019 17 September 2019	9 August 2019 5 September 2019 4 October 2019
Routine Water Quality Monitoring of ESC CMPs	12 July 2019 8 August 2019	9 August 2019 5 September 2019
Pit Specific Sediment Chemistry of ESC CMP Vd	8 July 2019 5 August 2019 16 September 2019	9 August 2019 5 September 2019 4 October 2019
Cumulative Impact Sediment Chemistry of ESC CMPs	20, 21 August 2019	4 October 2019
Sediment Chemistry after a Major Storm	7 August 2019	5 September 2019
Sediment Toxicity Test of ESC CMPs	9 August 2019	8 October 2019
Demersal Trawling of ESC CMPs	9, 10 July 2019 12, 13 August 2019	4 September 2019 10 October 2019

3.1.3 The monitoring results of the above environmental monitoring components for ESC CMPs have been presented in the respective *Monthly EM&A Reports* for this Study. The statistical analyses of these environmental monitoring components, where applicable, are presented in the following sections to report any trends caused by disposal activities at ESC CMPs during the reporting period. It should be noted that statistical analysis was not conducted for *Water Column Profiling for ESC CMP 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 2019 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 2019. 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 2019 as presented in *Table 3.1*. A total of sixteen (16) and ten (10) stations were sampled in July and August 2019 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, except higher levels of Salinity were recorded at Ma Wan station in July and August 2019, lower levels of Salinity were recorded at Impact stations in July 2019 and the levels of DO were lower than the WQO at Intermediate, Reference and Ma Wan stations in July 2019. The levels of DO, Turbidity and SS complied with the Action and Limit Levels at all stations in July and August 2019.

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 September 2019 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

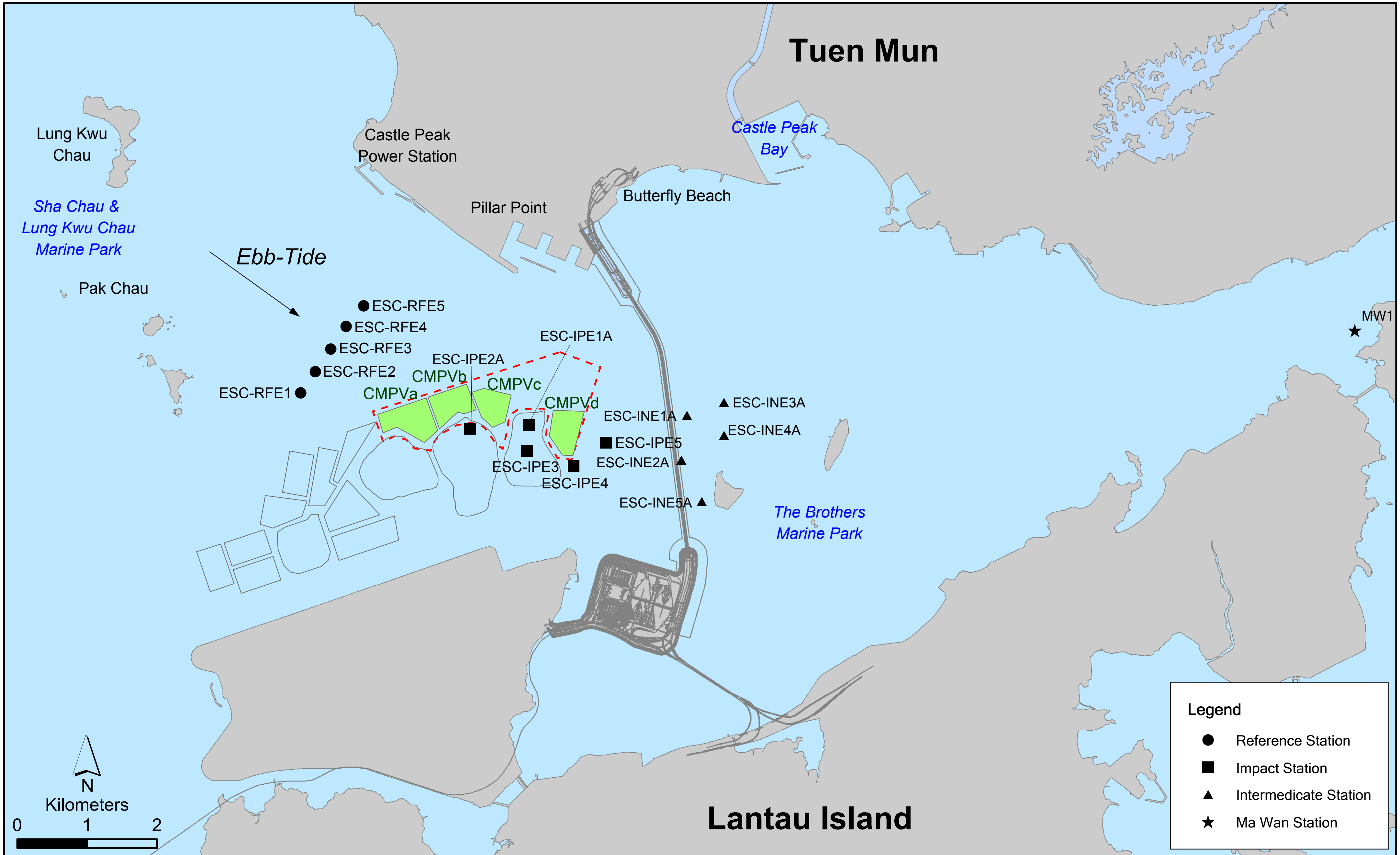


Figure 3.1

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

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Date: 19/4/2017

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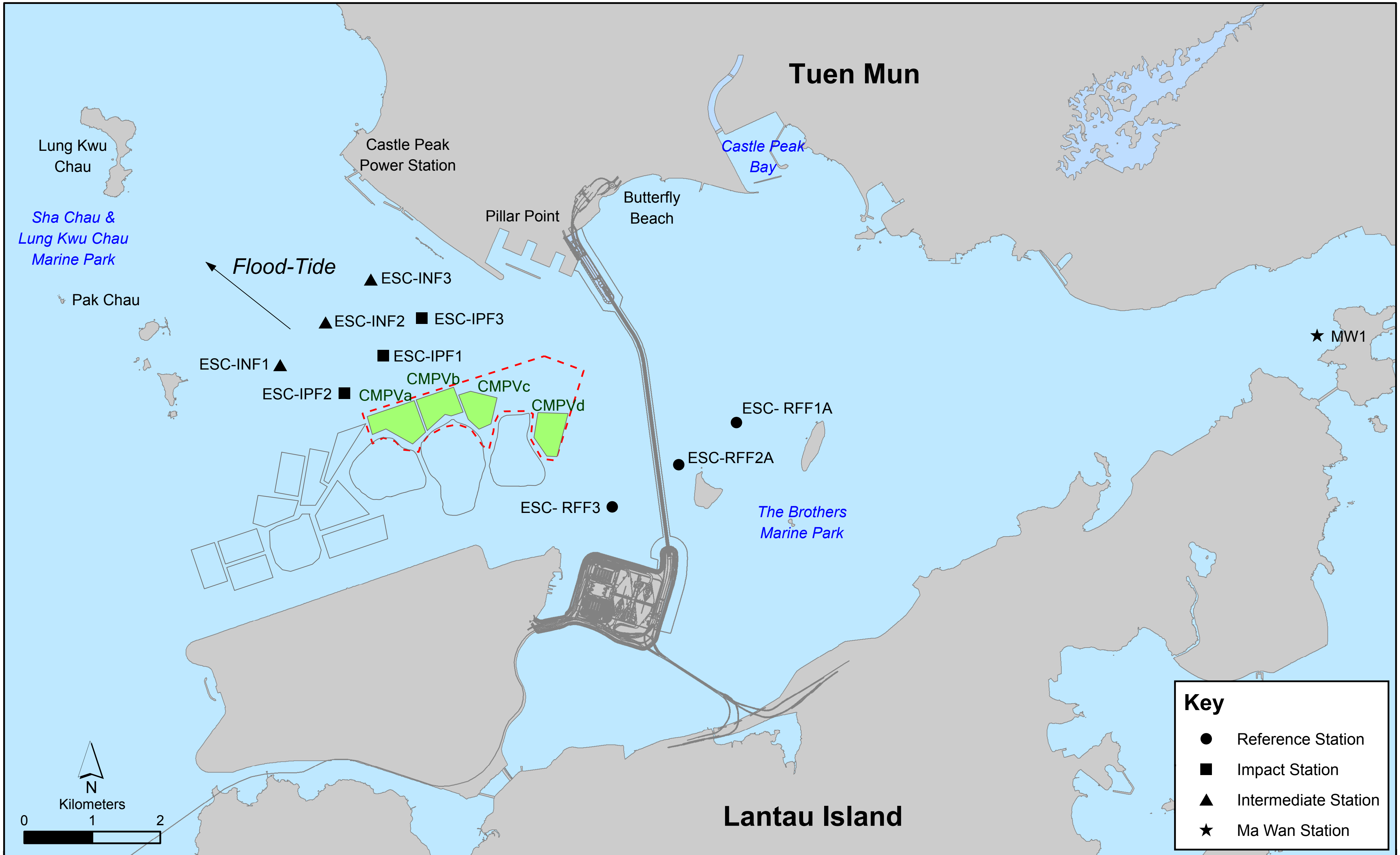

Figure 3.2

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

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Date: 25/4/2017

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contaminant contents were then tested by three-factor partially-nested Analysis of Variance (ANOVA). Area, Period and Station were treated as fixed factors under investigation with Station nested within Area.

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

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

<u>In-situ Measurement</u>

Dissolved Oxygen (DO)

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

Turbidity

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

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 2019). 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.

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.

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.

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.

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 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 2019 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 all inorganic contaminants were below the Lower Chemical Exceedance Levels (LCELs) at Pit-Edge and Near-Pit stations from July to September 2019, whilst the concentrations of some inorganic contaminants (e.g. Arsenic, Copper and Silver) were higher than LCEL / Upper Chemical Exceedance Level (UCEL) at Active Pit stations from July to September 2019.

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*.

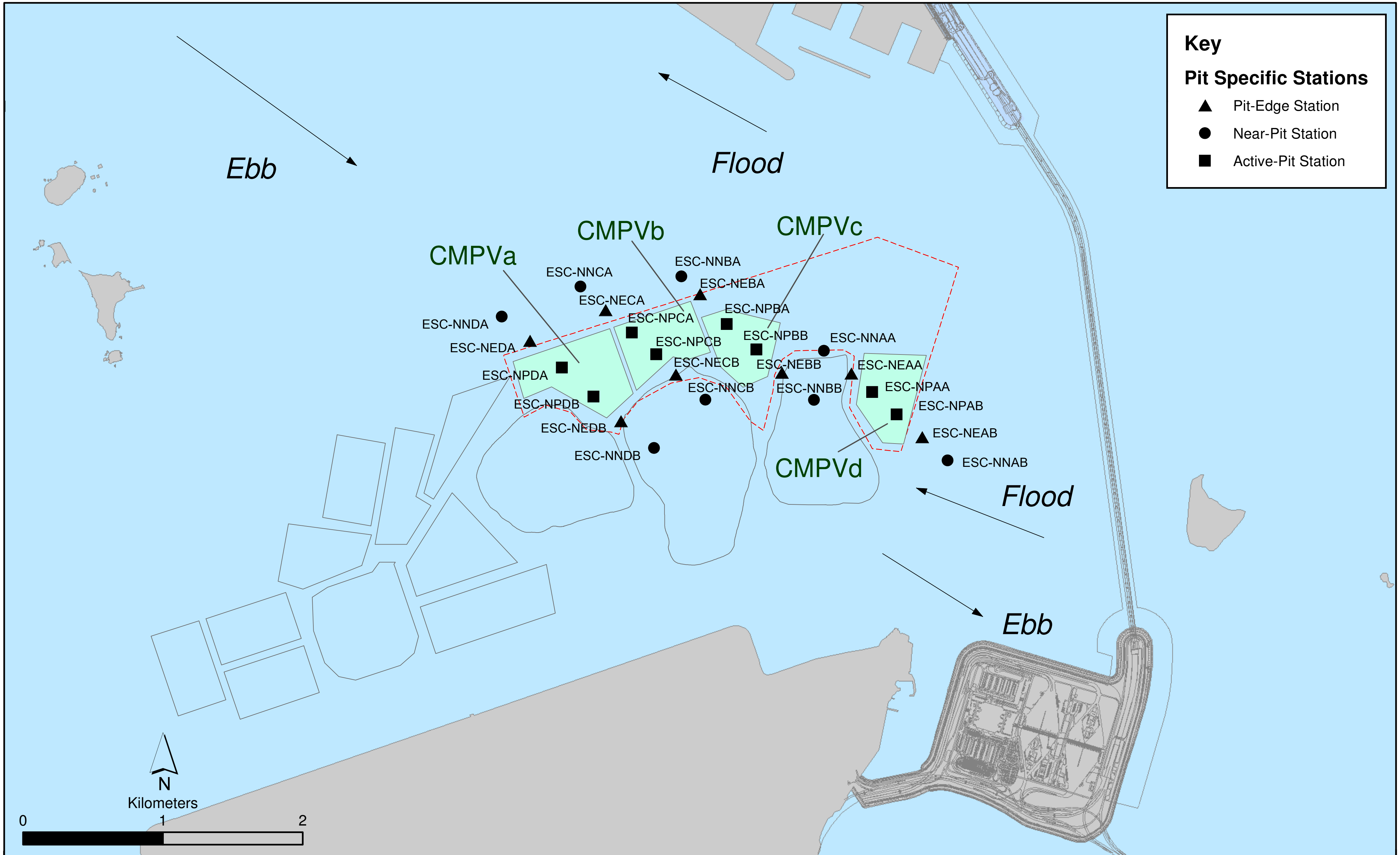

Figure 3.3

Pit Specific Sediment Quality Monitoring Stations for CMPV

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

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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, Chromium, Copper, Lead, Mercury, Nickel 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, Chromium, Copper, Lead, Mercury, Nickel 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, Chromium, Copper, Lead, Mercury, Nickel / 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.

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 Active Pit stations than at the Pit Edge stations than at Near Pit stations. Subsequent linear regression analysis for TOC 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 TOC levels and proximity to the pit ($r^2 < 0.60$). There was no 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 2019 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 2019, except the concentrations of Arsenic were higher than the LCEL at Near-field station ESC-RNB, Mid-field stations ESC-RMA and ESC-RMB, Capped Pit station ESC-RCB and Ma Wan station and concentrations of Zinc were higher than the LCEL at Ma Wan station.

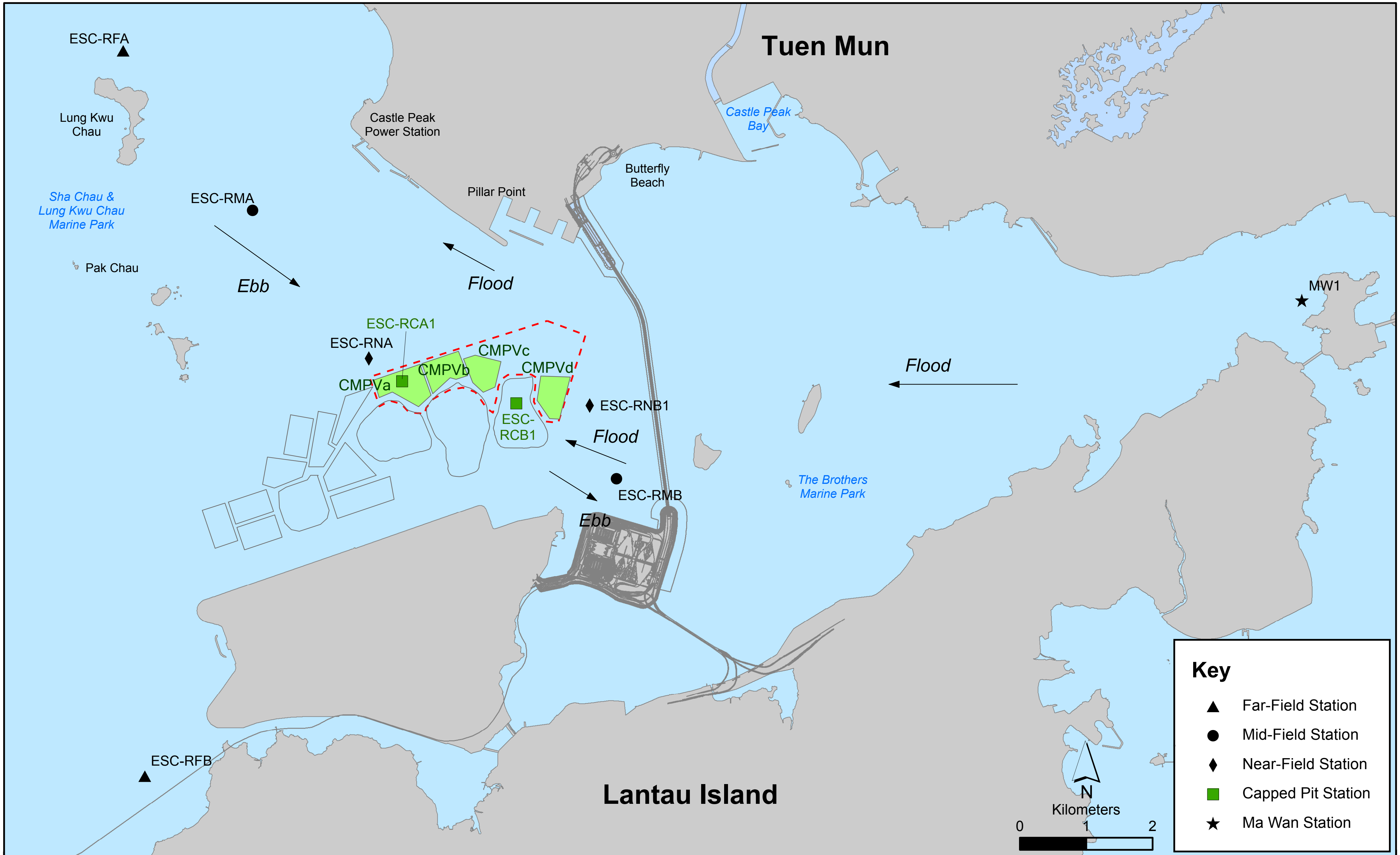

Figure 3.4

Cumulative Impacts Sediment Quality Monitoring Stations for ESC CMPs

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Date: 19/4/2017

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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*.

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. 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. 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 – August 2019***

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 7 August 2019 after the visit of tropical Wipha, which led to the issue of No. 8 Gale Signal on 31 July 2019. The tracks of Wipha are shown in *Figure 3.5*. The monitoring results showed that the concentrations of most inorganic contaminants were below the LCEL, except Arsenic at Capped Pit stations ESC-RCA and ESC-RCB, Mid-field stations ESC-RMA and ESC-RMB and Near-field station ESC-RNB as well as Copper at Ma Wan Station in August 2019.

Figure 3.5 Track of Tropical Cyclone Wipha ***(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 August 2019.

3.2.38 ***Sediment Toxicity Test – August 2019***

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 2019 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 2019. 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 2019 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 2019***

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 2019. Monitoring results are presented in the following sections.

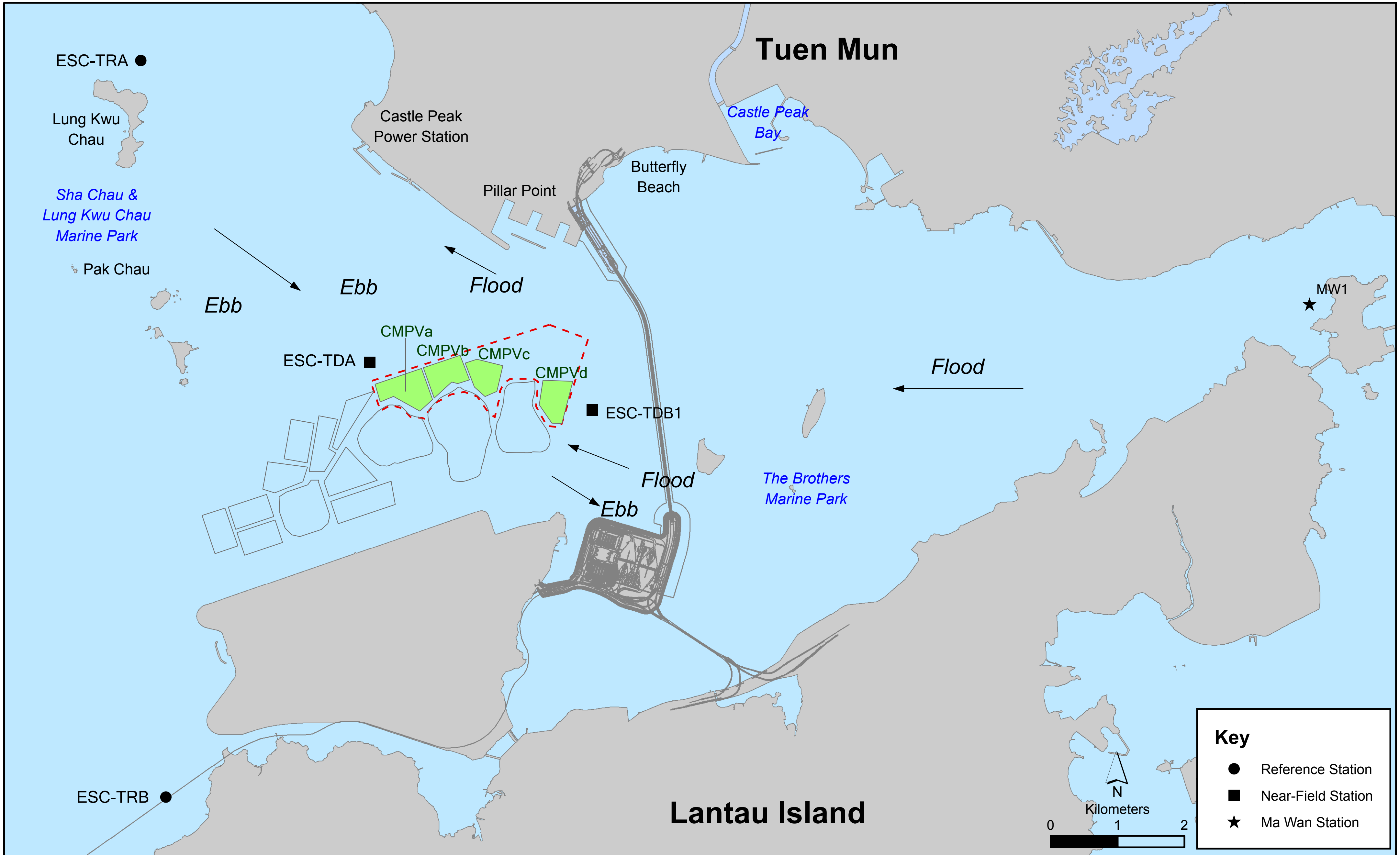

Figure 3.6

Sediment Toxicity Monitoring Stations for ESC CMPs

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Date: 19/4/2017

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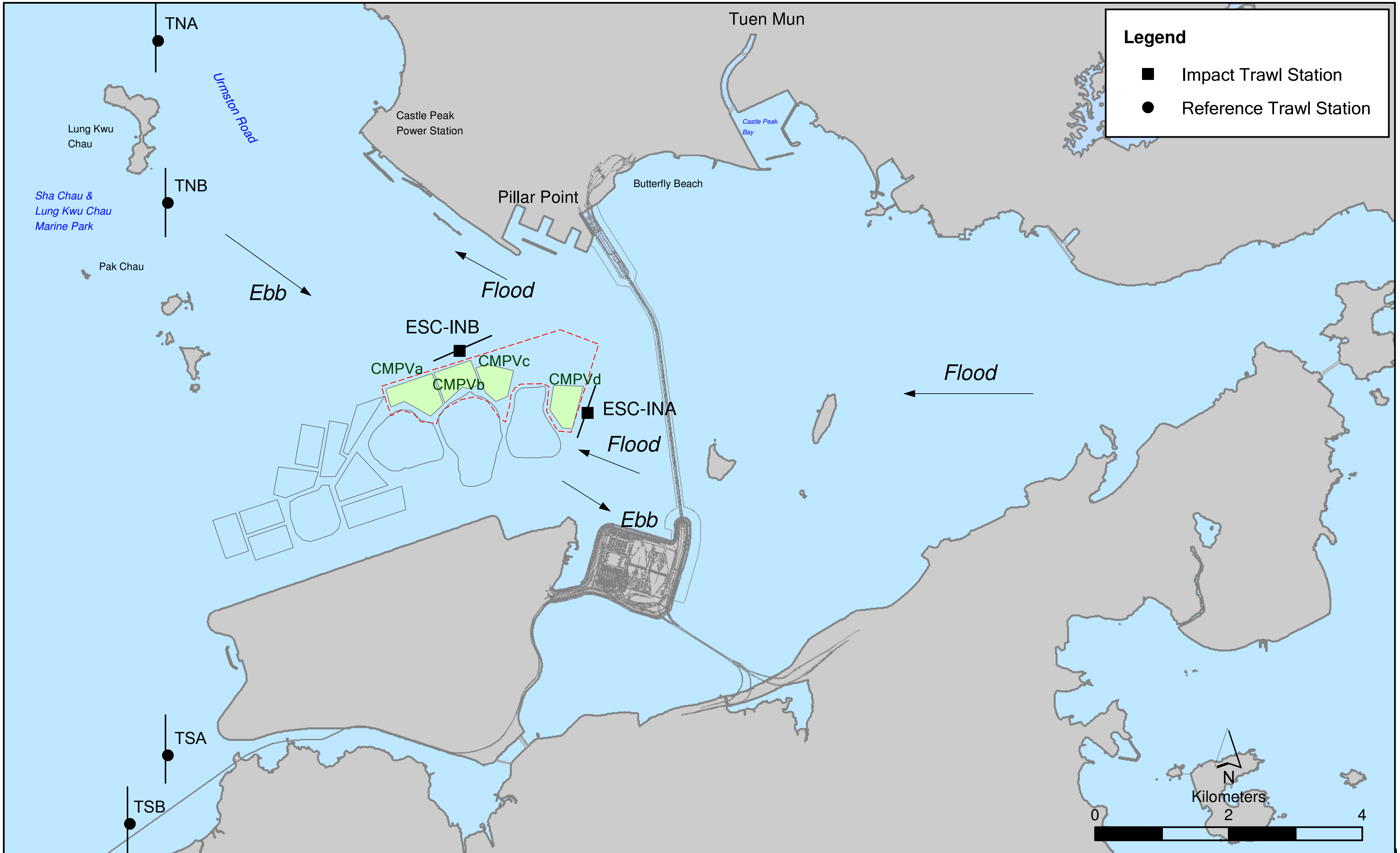

Figure 3.7

Marine Biota Monitoring Stations for CMPV

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Date: 2/6/2017

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Abundance and Biomass

3.2.44 The average number of species collected in the period of July and August 2019 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 2019.

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 2019 (*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 2019 Monitoring

Mean Number of Faunal Species	Impact Stations		Reference Stations			
	ESC-INA	ESC-INB	TNA	TNB	TSA	TSB
July 2019	35	30.4	54.6	55	59.4	54.6
August 2019	31	25.6	45.6	46	50	42.4

Table 3.3 **Summary of CPUE and YPUE during July and August 2019 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 2019	ESC-INA	Impact	2444	22426.6	488.8	4485.32
Jul 2019	ESC-INB	Impact	3088	30622.5	617.6	6124.50
Jul 2019	TNA	Reference	11269	113396.7	2253.8	22679.34
Jul 2019	TNB	Reference	8113	97400.4	1622.6	19480.08
Jul 2019	TSA	Reference	7084	84167.5	1416.8	16833.50
Jul 2019	TSB	Reference	5953	82475.3	1190.6	16495.06
Aug 2019	ESC-INA	Impact	1657	21741.4	331.4	4348.28
Aug 2019	ESC-INB	Impact	1225	11581.5	245.0	2316.30
Aug 2019	TNA	Reference	4954	55381.5	990.8	11076.30
Aug 2019	TNB	Reference	3998	54392.8	799.6	10878.56
Aug 2019	TSA	Reference	6798	99844.7	1359.6	19968.94
Aug 2019	TSB	Reference	3086	45318.7	617.2	9063.74

Notes:

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

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

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

4.1.1 During the reporting period, the Independent Auditor (IA) conducted 2 inspections. One of them was for the Routine Water Quality Monitoring conducted on 12 July 2019 and a total of 16 stations were sampled. *In situ* and laboratory measurements were conducted. The IA was generally satisfied with the sample collection and confirmed that the requirements as stated in the EM&A Manual were followed. The IA suggested that several precautious steps should be followed, including 1) first rinse of bottles using site-collected waters when these sampled waters are filled to the bottles; 2) avoidance of any plastic ribbons which many contain Zinc in their materials; 3) use of specific type of gloves (some gloves may also contain high metals such as vinyl used in the field), e.g., shoulder-length polyethylene or PVC type gloves were preferred.

4.1.2 The other inspection was conducted for Pit Specific Sediment Chemistry of ESC CMP Vd on 16 September 2019. A total of 6 stations were sampled on this day. The IA was generally satisfied with the sample collection 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 2019 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vd* in October, November and December 2019;
- *Routine Water Quality Monitoring of ESC CMPs* in October and November 2019;
- *Pit Specific Sediment Chemistry of ESC CMP Vd* in October, November and December 2019; and
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in December 2019.
- *Impact Monitoring for Dredging of ESC CMP Vb* in November and December 2019.

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

Annex A

Sampling Schedule

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

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

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

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

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

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

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

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

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

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

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

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

Annex B

Disposal Records

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Jul-2019	2000	1,464,180
2-Jul-2019	2000	1,466,180
3-Jul-2019	1000	1,467,180
4-Jul-2019	2000	1,469,180
5-Jul-2019	1000	1,470,180
6-Jul-2019	1500	1,471,680
7-Jul-2019	500	1,472,180
8-Jul-2019	0	1,472,180
9-Jul-2019	0	1,472,180
10-Jul-2019	500	1,472,680
11-Jul-2019	1500	1,474,180
12-Jul-2019	2000	1,476,180
13-Jul-2019	3500	1,479,680
14-Jul-2019	2500	1,482,180
15-Jul-2019	500	1,482,680
16-Jul-2019	1500	1,484,180
17-Jul-2019	1200	1,485,380
18-Jul-2019	1600	1,486,980
19-Jul-2019	1600	1,488,580
20-Jul-2019	1600	1,490,180
21-Jul-2019	2000	1,492,180
22-Jul-2019	1600	1,493,780
23-Jul-2019	1600	1,495,380
24-Jul-2019	0	1,495,380
25-Jul-2019	0	1,495,380
26-Jul-2019	800	1,496,180
27-Jul-2019	2000	1,498,180
28-Jul-2019	1600	1,499,780
29-Jul-2019	1400	1,501,180
30-Jul-2019	0	1,501,180
31-Jul-2019	0	1,501,180
1-Aug-2019	0	1,501,180
2-Aug-2019	0	1,501,180
3-Aug-2019	1000	1,502,180
4-Aug-2019	500	1,502,680
5-Aug-2019	500	1,503,180
6-Aug-2019	2500	1,505,680
7-Aug-2019	3000	1,508,680
8-Aug-2019	2500	1,511,180
9-Aug-2019	1000	1,512,180
10-Aug-2019	1600	1,513,780
11-Aug-2019	1600	1,515,380
12-Aug-2019	1600	1,516,980
13-Aug-2019	1600	1,518,580
14-Aug-2019	1900	1,520,480
15-Aug-2019	800	1,521,280
16-Aug-2019	2000	1,523,280
17-Aug-2019	2400	1,525,680
18-Aug-2019	2000	1,527,680
19-Aug-2019	1200	1,528,880
20-Aug-2019	1200	1,530,080
21-Aug-2019	1800	1,531,880
22-Aug-2019	0	1,531,880

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
23-Aug-2019	800	1,532,680
24-Aug-2019	400	1,533,080
25-Aug-2019	0	1,533,080
26-Aug-2019	0	1,533,080
27-Aug-2019	2000	1,535,080
28-Aug-2019	600	1,535,680
29-Aug-2019	0	1,535,680
30-Aug-2019	0	1,535,680
31-Aug-2019	0	1,535,680
1-Sep-2019	0	1,535,680
2-Sep-2019	0	1,535,680
3-Sep-2019	0	1,535,680
4-Sep-2019	170	1,535,850
5-Sep-2019	0	1,535,850
6-Sep-2019	0	1,535,850
7-Sep-2019	0	1,535,850
8-Sep-2019	0	1,535,850
9-Sep-2019	0	1,535,850
10-Sep-2019	0	1,535,850
11-Sep-2019	0	1,535,850
12-Sep-2019	0	1,535,850
13-Sep-2019	0	1,535,850
14-Sep-2019	0	1,535,850
15-Sep-2019	0	1,535,850
16-Sep-2019	720	1,536,570
17-Sep-2019	300	1,536,870
18-Sep-2019	372	1,537,242
19-Sep-2019	775	1,538,017
20-Sep-2019	403	1,538,420
21-Sep-2019	0	1,538,420
22-Sep-2019	0	1,538,420
23-Sep-2019	0	1,538,420
24-Sep-2019	314	1,538,734
25-Sep-2019	0	1,538,734
26-Sep-2019	0	1,538,734
27-Sep-2019	0	1,538,734
28-Sep-2019	1423	1,540,157
29-Sep-2019	150	1,540,307
30-Sep-2019	350	1,540,657

Annex C

Statistical Analysis

Routine Water Quality Monitoring for ESC CMPs – Analysis of Variance and Linear Regression Analysis up to August 2019

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	1786249.322	3	595416.441	13.867	**
Period	1816137202.570	40	45403430.064	1057.413	**
Area * Period	88313214.537	120	735943.454	17.140	**
Error	131820346.116	3070	42938.223		
Total	11279742067.000	3034			

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

SNK Results:

- Feb 17 ≥ Feb 13 ≥ Apr 16 ≥ Jan 17 > Feb 18 = Jan 13 > Jan 18 = Feb 12 ≥ Feb 19 ≥ Nov 18 > Jan 19 > Apr 13 = Apr 17 > Apr 18 = Nov 16= Apr 19 > Nov 17 > Apr 12 = May 13 ≥ Nov 12 ≥ May 19 ≥ May 16 = May 18 ≥ Oct 16 ≥ Oct 12 > Jul 12 ≥ May 17 ≥ Jul 18 = May 12 > Aug 17 = Jul 16 = Oct 18 = Oct 17 > Aug 12 > Aug 13 ≥ Aug 18 = **Aug 19** ≥ Jul 17 = Aug 16 = Jul 13 = **Jul19**
- Intermediate = Impact > Reference > Ma Wan Station

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	91388958.065	3	30462986.022	133.177	**
Period	1112943209.179	40	27823580.229	121.638	**
Area * Period	295195138.282	120	2459959.486	10.754	**
Error	702235605.461	3070	228741.240		
Total	11279590738.000	3234			

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

SNK Results:

- Nov 17 > Oct 17 = Aug 13 ≥ Jan 19 ≥ Apr 17 = Aug 18 = Apr 12 = Aug 12 ≥ Nov 18 = Nov 16 = Oct 16 ≥ Jul 18 = Nov 12 ≥ Jul 16 ≥ Jul 17 = May 16 = Oct 18 = **Aug 19** ≥ Apr 13 ≥ Feb 12 > Apr 16 ≥ Jan 17 = **Jul 19** ≥ May 18 ≥ Oct 12 ≥ Apr 19 = Jul 12 = Jan 18 = Aug 17 ≥ Aug 16 ≥ Feb 13 ≥ Feb 18 = May 12 = Jan 13 = Feb 19 ≥ 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	3341046338.557	39	85667854.835	683.611	**
Area	20201500.682	3	6733833.561	53.735	**
Station(Area)	41045318.990	24	1710221.625	13.647	**
Period * Area	554882831.946	114	4867393.263	38.841	**
Period * Station(Area)	687082719.622	336	2044889.046	16.318	**
Error	459661843.500	3668	125316.751		
Total	24520745687.500	4192			

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

SNK Results:

- Aug 13 > May 18 > Feb 12 > Nov 18 = Jul 18 = **Aug 19** ≥ Jul 13 ≥ Apr 12 > Feb 19 = Oct 18 = Aug 18 = Jan 13 > Jan 19 = Apr 13 = May 16 = May 19 = Apr 18 = Nov 12 > Apr 17 > May 12 > Apr 16 = Oct 12 > Jul 16 = May 13 ≥ Jan 18 ≥ Apr 19 ≥ May 17 ≥ Aug 16 > Aug 12 = **Jul 19** = 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	3295669687.464	39	84504350.961	438.337	**
Area	29854260.981	3	9951420.327	51.620	**
Station(Area)	99528528.687	24	4147022.029	21.511	**
Period * Area	603254703.960	114	5291707.929	27.449	**
Period * Station(Area)	418124220.340	336	1244417.322	6.455	**
Error	706745869.232	3666	192783.925		
Total	24435735588.500	4190			

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	3822304698.899	39	98007812.792	677.461	**
Area	63944579.573	3	21314859.858	147.335	**
Station(Area)	75441221.030	24	3143384.210	21.728	**
Period * Area	420877438.685	114	3691907.357	25.520	**
Period * Station(Area)	634470560.108	336	1888305.238	13.053	**
Error	530647028.375	3668	144669.310		
Total	24562559168.000	4192			

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

Ammonia Nitrogen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	4179545977.452	39	107167845.576	662.656	**
Area	7621995.639	3	2540665.213	15.710	**
Station(Area)	20400026.029	24	850001.085	5.256	**
Period * Area	231394036.345	114	2029772.249	12.551	**
Period * Station(Area)	214753628.588	336	639147.704	3.952	**
Error	593205779.750	3668	161724.586		
Total	24551859268.500	4192			

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

SNK Results:

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

Total Inorganic Nitrogen

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	3932445571.530	39	100831937.732	1131.932	**
Area	85026895.506	3	28342298.502	318.169	**
Station(Area)	114272444.752	24	4761351.865	53.451	**
Period * Area	356153257.970	114	3124151.386	35.071	**
Period * Station(Area)	354602861.569	336	1055365.659	11.847	**
Error	326743635.063	3668	89079.508		
Total	24562437531.500	4192			

Note:

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

SNK Results:

- Apr 12 = May 18 > Aug 13 > Apr 17 > **Aug 19** = Jul 16 = May 13 > Jul 12 > Nov 18 = Aug 17 > Jul 17 > May 12 = Aug 16 > **Jul 19** ≥ May 17 = Aug 12 = Apr 18 ≥ Jul 18 > Jul 13 = May 16 > May 19 > Aug 18 = Oct 17 > Apr 13 > Feb 17 = Apr 16 = Jan 18 > Oct 12 ≥ Apr 19 = Feb 19 ≥ Feb 12 > Nov 16 > Jan 17 = Oct 18 = Oct 16 > Nov 12 > Feb 18 > Jan 19 > 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	2230061395.231	39	57181061.416	191.385	**
Area	87548714.874	3	29182904.958	97.675	**
Station(Area)	50067530.930	24	2086147.122	6.982	**
Period * Area	1011861968.811	114	8875982.183	29.708	**
Period * Station(Area)	845599391.854	336	2516664.857	8.423	**
Error	1095904105.375	3668	298774.293		
Total	24545213565.500	4192			

Note:

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

SNK Results:

- Aug 16 > **Aug 19** = Nov 16 = Apr 16 > Jan 17 = Apr 19 = May 12 > Aug 18 = Jan 13 = May 18 = Jul 17 = Nov 17 = May 17 = May 16 > Oct 18 = **Jul 19** = Apr 18 = Feb 12 = Nov 18 = Jul 18 = Feb 18 = Apr 17 = May 19 = Oct 16 > Feb 19 = Oct 17 = Apr 13 ≥ Nov 12 ≥ Jan 19 = 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	3211976352.151	39	82358368.004	1402.261	**
Area	30433038.163	3	10144346.054	172.721	**
Station(Area)	230151334.535	24	9589638.939	163.276	**
Period * Area	643492637.137	114	5644672.256	96.108	**
Period * Station(Area)	1216397522.399	336	3620230.721	61.639	**
Error	215431008.438	3668	58732.554		
Total	24561891427.500	4192			

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

SNK Results:

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

Linear Regression Analysis					
Source	df	Slope	r	r^2	P
Area	1	-0.121	0.121	0.015	**

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

Pit Specific Sediment Chemistry for ESC CMP Vd – Analysis of Variance (up to September 2019)

Arsenic

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	1430662492.786	42	34063392.685	349.466	**
Area	31890556.940	2	15945278.470	163.587	**
Station(Area)	192295898.728	3	64098632.909	657.606	**
Period * Area	277407437.303	84	3302469.492	33.881	**
Period * Station(Area)	228266915.866	125	1826135.327	18.735	**
Error	275262710.458	2824	97472.631		
Total	9753454176.000	3081			

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

SNK Results:

- **Sep 19** ≥ Jun 19 ≥ **Aug 19** ≥ **Jul 19** ≥ Oct 17 = Jul 18 ≥ Jun 18 = Oct 18 = Nov 18 ≥ Feb 19 ≥ Jan 19 ≥ Apr 19 = Mar 19 ≥ May 19 = May 18 = Jul 17 = Mar 18 ≥ Nov 17 > Sep 18 = Aug 18 ≥ Aug 16 = Sep 17 = Aug 17 = Dec 18 ≥ Apr 18 ≥ Dec 17 = Feb 18 = Jan 18 = Mar 16 > 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
- Active Pit ≥ Pit Edge = Near Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	661566928.197	42	15751593.529	89.203	**
Area	602208882.818	2	301104441.409	1705.196	**
Station(Area)	34212922.926	3	11404307.642	64.584	**
Period * Area	270700742.418	84	3222627.886	18.250	**
Period * Station(Area)	336769569.448	125	2694156.556	15.257	**
Error	498133704.325	2821	176580.540		
Total	9709641154.500	3078			

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

SNK Results:

- Oct 18 = Jun 18 > Jun 16 = May 17 ≥ Dec 17 = **Aug 19** = Mar 18 = Jul 17 ≥ May 18 ≥ **Sep 19** ≥ Nov 17 ≥ Oct 17 ≥ Sep 17 = Aug 17 = Apr 16 ≥ Apr 18 ≥ Apr 19 = May 16 ≥ May 19 ≥ Sep 16 = Nov 18 = Aug 16 ≥ Feb 17 ≥ Jun 17 ≥ Feb 18 = Jan 18 ≥ Dec 16 ≥ Sep 18 ≥ Jun 19 = Aug 18 ≥ Mar 17 ≥ Mar 16 = Nov 16 ≥ Apr 17 ≥ **Jul 19** ≥ Jan 17 = Jul 16 ≥ Jan 19 = Feb 19 ≥ Dec 18 = Mar 19 = Jul 18 > Oct 16
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-0.039	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	781399141.527	42	18604741.465	100.469	**
Area	190499881.626	2	95249940.813	514.369	**
Station(Area)	83084923.582	3	27694974.527	149.558	**
Period * Area	461927601.922	84	5499138.118	29.696	**
Period * Station(Area)	395238063.133	125	3161904.505	17.075	**
Error	522943550.754	2824	185178.311		
Total	9753605469.500	3081			

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

SNK Results:

- Jul 17 > Oct 17 ≥ **Sep 19** ≥ Mar 16 ≥ Oct 18 ≥ Jun 18 = **Aug 19** ≥ Nov 17 ≥ Mar 19 ≥ **Jul 19** = Jan 19 = Feb 19 = Jul 18 = Nov 18 ≥ Apr 19 = Jun 19 ≥ Sep 17 = Aug 17 = Jun 16 ≥ Mar 18 = Apr 16 ≥ May 18 ≥ Aug 16 ≥ Feb 18 ≥ Jan 18 ≥ Jul 16 ≥ Aug 18 ≥ Sep 18 ≥ Dec 18 = Sep 16 = Apr 18 ≥ Nov 16 = May 16 ≥ Dec 16 ≥ Feb 17 = Oct 16 ≥ May 19 ≥ May 17 = Dec 17 = Jan 17 > Mar 17 = Jun 17 > Apr 17
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-1.343	0.168	0.028	**

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	427092592.478	42	10168871.249	85.398	**
Area	818152643.643	2	409076321.822	3435.411	**
Station(Area)	93080057.579	3	31026685.860	260.561	**
Period * Area	346858034.525	84	4129262.316	34.677	**
Period * Station(Area)	419605734.860	125	3356845.879	28.191	**
Error	336271701.735	2824	119076.382		
Total	9753606077.000	3081			

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

SNK Results:

- Nov 18 > **Aug 19** > **Sep 19** = Mar 19 = Oct 17 = Nov 17 ≥ Mar 18 = Oct 18 = Apr 19 = Jun 18 ≥ May 18 = Dec 17 ≥ Aug 16 = Jan 19 = Feb 19 ≥ Feb 18 ≥ Apr 18 = Sep 18 = Sep 17 = Aug 17 = Dec 18 = Aug 18 ≥ Jul 18 = Sep 16 = Feb 17 ≥ Jun 16 = Jan 18 ≥ **Jul 19** ≥ Jun 19 ≥ Apr 16 ≥ Jun 17 ≥ Mar 16 = Dec 16 ≥ May 16 ≥ May 19 ≥ May 17 = Mar 17 ≥ Oct 16 ≥ Jan 17 = Jul 17 ≥ Nov 16 ≥ Jul 16 > Apr 17
- Active Pit > Near Pit > Pit Edge

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-9.031	0.505	0.255	**

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	624826792.406	42	14876828.391	74.712	**
Area	291291109.033	2	145645554.516	731.437	**
Station(Area)	233269098.060	3	77756366.020	390.495	**
Period * Area	328056244.151	84	3905431.478	19.613	**
Period * Station(Area)	397595061.112	125	3180760.489	15.974	**
Error	562321624.669	2824	199122.388		
Total	9753605702.500	3081			

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

SNK Results:

- Mar 17 = May 19 > Nov 18 = Mar 19 = **Sep 19** = Oct 18 = Jul 17 ≥ Jun 18 = Oct 17 ≥ **Aug 19** = May 17 ≥ Apr 19 ≥ Jul 18 ≥ **Jul 19** = Jan 19 = Feb 19 = Jun 19 ≥ Jun 17 = Sep 17 = Aug 17 ≥ Mar 18 ≥ May 18 ≥ Nov 17 ≥ Apr 16 ≥ Mar 16 = Dec 18 = Jan 18 ≥ Jul 16 = Jun 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	-1.920	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	1420077941.827	42	33811379.567	214.466	**
Area	85877104.725	2	42938552.363	272.359	**
Station(Area)	8401573.569	3	2800524.523	17.764	**
Period * Area	226027689.362	84	2690805.826	17.068	**
Period * Station(Area)	164986297.542	125	1319890.380	8.372	**
Error	444584724.719	2820	157654.158		
Total	9651538607.500	3077			

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 = **Sep 19** ≥ Jun 17 ≥ Nov 16 > Dec 16 = May 17 = May 18 = Oct 18 = **Aug 19** ≥ Nov 17 = Jan 17 ≥ Jun 19 ≥ Jun 18 = Mar 17 ≥ Sep 18 = Apr 17 = Feb 17 = Jul 17 = Oct 17 = Jul 18 = Apr 19 ≥ May 19 ≥ Aug 18 ≥ Dec 17 = Sep 17 = Aug 17 = Jan 19 = Feb 19 = Mar 19 ≥ Nov 18 > Dec 18 > Mar 18 = **Jul 19** = Jan 18 = Feb 18 = Apr 18
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-0.011	0.058	0.003	**

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	628197943.351	42	14957093.889	134.052	**
Area	299982540.305	2	149991270.153	1344.286	**
Station(Area)	270532459.925	3	90177486.642	808.209	**
Period * Area	489537390.691	84	5827826.080	52.231	**
Period * Station(Area)	431963435.464	125	3455707.484	30.972	**
Error	315093245.333	2824	111576.928		
Total	9753604763.000	3081			

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

SNK Results:

- Jul 17 ≥ Oct 17 ≥ **Sep 19** > Jun 18 = Oct 18 = Mar 16 = May 17 = Jun 17 ≥ Nov 18 ≥ Aug 19 ≥ Jul 19 ≥ Nov 17 ≥ Mar 19 ≥ Sep 17 = Aug 17 = Apr 19 = Jun 19 ≥ Jan 19 = Feb 19 ≥ Apr 16 ≥ Jul 16 = Jul 18 ≥ Jun 16 ≥ May 19 ≥ Dec 18 = May 18 = Mar 18 = Jan 18 ≥ Nov 16 = Aug 18 = Sep 18 ≥ Feb 18 ≥ May 16 ≥ Aug 16 ≥ Sep 16 ≥ Apr 18 = Dec 17 = Dec 16= Feb 17 = Jan 17 = Apr 17 > Mar 17 > Oct 16
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-1.044	0.213	0.045	**

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	361531649.496	42	8607896.417	62.123	**
Area	824970331.349	2	412485165.674	2976.913	**
Station(Area)	16260596.875	3	5420198.958	39.118	**
Period * Area	435466678.446	84	5184127.124	37.414	**
Period * Station(Area)	397335287.244	125	3178682.298	22.941	**
Error	391158833.989	2827	138561.401		
Total	9741368320.000	3080			

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

SNK Results:

- May 19 > **Jul 19** ≥ Dec 17 ≥ Nov 17 ≥ May 17 ≥ Mar 19 = Apr 17 ≥ May 18 = Aug 16 = Jun 16 ≥ Jun 18 = Oct 18 = Mar 18 = **Aug 19** ≥ Jun 17 ≥ Mar 17 = Feb 17 = Jul 17 = Sep 16 ≥ **Sep 19** = Oct 17 ≥ Apr 19 ≥ Apr 18 ≥ Feb 18 = Feb 19 = Nov 18 = Sep 17 = Aug 17 = Jan 18 = Mar 16 = Apr 16 ≥ Sep 18 = May 16 = Aug 18 ≥ Jan 19 ≥ Dec 16 ≥ Jul 16 ≥ Nov 16 = Dec 18 = Jan 17 ≥ Jul 18 ≥ Jun 19 > Oct 16
- Active Pit > Near Pit > Pit Edge

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	916341422.339	42	21817652.913	218.241	**
Area	321726910.066	2	160863455.033	1609.113	**
Station(Area)	194484289.660	3	64828096.553	648.474	**
Period * Area	388892144.052	84	4629668.382	46.310	**
Period * Station(Area)	331520105.450	125	2652160.844	26.529	**
Error	282316074.192	2824	99970.281		
Total	9753600974.500	3081			

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

SNK Results:

- **Sep 19** > Nov 18 ≥ **Aug 19** ≥ Jul 17 = Oct 17 ≥ Jun 18 = Oct 18 = Mar 19 ≥ Nov 17 ≥ May 18 = Mar 18 ≥ Feb 19 ≥ **Jul 19** ≥ Jul 18 = Apr 18 = Apr 19 = Mar 16 = Feb 18 ≥ Jan 19 ≥ Jun 19 = Sep 17 = Aug 17 ≥ Apr 16 = Jan 18 = Aug 16 ≥ Dec 17 ≥ Jun 16 = Sep 18 = Aug 18 ≥ Dec 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 > May 19
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-11.183	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	730768799.048	42	17399257.120	144.364	**
Area	196397947.221	2	98198973.610	814.772	**
Station(Area)	95251779.526	3	31750593.175	263.440	**
Period * Area	522767577.490	84	6223423.542	51.637	**
Period * Station(Area)	551313011.495	125	4410504.092	36.595	**
Error	340357650.069	2824	120523.247		
Total	9752971588.000	3081			

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

SNK Results:

- Oct 17 = Feb 18 ≥ Jun 18 ≥ **Aug 19** ≥ Dec 18 ≥ Apr 16 ≥ Aug 18 ≥ Nov 18 ≥ Jul 17 = May 18 = Mar 16 = Dec 17 = Mar 18 = Jul 18 = Apr 19 ≥ Feb 19 ≥ Jun 16 ≥ Aug 16 = Jul 16 = Jan 19 = Jun 19 = Nov 17 = Mar 19 = Nov 16 ≥ **Sep 19** = Jan 17 > May 17 ≥ Sep 16 = Oct 16 = Dec 16 = May 16 = Apr 18 = Sep 18 ≥ Sep 17 = Aug 17= Jul 19 = Oct 18 ≥ Jun 17 ≥ May 19 > Jan 18 > Mar 17 = Apr 17 = Feb 17
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-601.314	0.167	0.028	**

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

Cumulative Impact Sediment Chemistry for ESC CMPs – Analysis of Variance (up to August 2019)

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	81179910.852	13	6244608.527	511.881	**
Area	49253887.684	4	12313471.921	1009.355	**
Area * Station	3088591.063	4	772147.766	63.294	**
Period * Area	125642452.894	51	2463577.508	201.943	**
Period * Area * Station	8932651.072	52	171781.751	14.081	**
Error	16908287.208	1386	12199.341		
Total	1153335631.500	1512			

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

SNK Results:

- Jun 19 = **Aug 19** > Jun 18 > Dec 18 = Feb 19 = 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	36824598.521	13	2832661.425	49.383	**
Area	20266161.098	4	5066540.275	88.327	**
Area * Station	50198198.398	4	12549549.600	218.780	**
Period * Area	65245881.142	51	1279331.003	22.303	**
Period * Area * Station	31717669.970	52	609955.192	10.634	**
Error	79330804.431	1383	57361.391		
Total	1143885237.500	1509			

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

SNK Results:

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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	15287907.613	13	1175992.893	64.596	**
Area	107236087.500	4	26809021.875	1472.582	**
Area * Station	20410544.967	4	5102636.242	280.281	**
Period * Area	77973484.283	51	1528891.849	83.980	**
Period * Area * Station	26207142.231	52	503983.504	27.683	**
Error	25232751.792	1386	18205.449		
Total	1153359663.500	1512			

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

SNK Results:

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	10679277.453	13	821482.881	47.022	**
Area	83202773.537	4	20800693.384	1190.636	**
Area * Station	77945966.956	4	19486491.739	1115.411	**
Period * Area	61869338.100	51	1213124.276	69.439	**
Period * Area * Station	14063603.096	52	270453.906	15.481	**
Error	24213751.000	1386	17470.239		
Total	1153359719.000	1512			

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

SNK Results:

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	78524964.461	13	6040381.882	311.885	**
Area	73228502.725	4	18307125.681	945.256	**
Area * Station	12538391.789	4	3134597.947	161.849	**
Period * Area	73742058.513	51	1445922.716	74.658	**
Period * Area * Station	17033643.533	52	327570.068	16.914	**
Error	26843170.417	1386	19367.367		
Total	1153359688.000	1512			

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

SNK Results:

- Aug 18 > Dec 18 > Aug 16 > **Aug 19** = Feb 19 = Aug 17 = Jun 18 > Jun 16 = Jun 19 > 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	118766497.217	13	9135884.401	172.566	**
Area	14243109.100	4	3560777.275	67.259	**
Area * Station	8731122.179	4	2182780.545	41.230	**
Period * Area	44851441.473	51	879440.029	16.612	**
Period * Area * Station	15374912.520	52	295671.395	5.585	**
Error	73323949.220	1385	52941.480		
Total	1146472448.000	1511			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	15464848.147	13	1189603.704	68.945	**
Area	91584013.171	4	22896003.293	1326.967	**
Area * Station	25348275.019	4	6337068.755	367.273	**
Period * Area	90390601.165	51	1772364.729	102.720	**
Period * Area * Station	30553522.846	52	587567.747	34.053	**
Error	23914576.417	1386	17254.384		
Total	1153359479.000	1512			

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

SNK Results:

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

Silver

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	41222879.747	13	3170990.750	120.258	**
Area	85094836.855	4	21273709.214	806.793	**
Area * Station	67416442.020	4	16854110.505	639.183	**
Period * Area	22433184.663	51	439866.366	16.682	**
Period * Area * Station	24208400.636	52	465546.166	17.656	**
Error	36546356.292	1386	26368.222		
Total	1153066697.000	1512			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	15759963.069	13	1212304.851	94.501	**
Area	80020086.030	4	20005021.507	1559.415	**
Area * Station	51169470.118	4	12792367.530	997.180	**
Period * Area	88360690.072	51	1732562.550	135.055	**
Period * Area * Station	16353053.788	52	314481.804	24.514	**
Error	17780363.208	1386	12828.545		
Total	1153358586.000	1512			

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

SNK Results:

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

TOC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	32355016.772	13	2488847.444	100.266	**
Area	68166134.111	4	17041533.528	686.539	**
Area * Station	12980376.501	4	3245094.125	130.733	**
Period * Area	87213987.722	51	1710078.191	68.893	**
Period * Area * Station	40122884.832	52	771593.939	31.085	**
Error	34403812.083	1386	24822.375		
Total	1153266947.000	1512			

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

SNK Results:

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

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	61013178.578	13	4693321.429	77.051	**
Area	47909723.029	4	11977430.757	196.636	**
Area * Station	5440458.498	4	1360114.624	22.329	**
Period * Area	25936190.370	51	508552.752	8.349	**
Period * Area * Station	20059988.283	52	385769.005	6.333	**
Error	84423681.625	1386	60911.747		
Total	1128847098.500	1512			

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

SNK Results:

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

Sediment Chemistry after a Major Storm Event (7 August 2019) of ESC CMPs – Analysis of Variance

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	79411.594	4	19852.898	209.515	**
Station(Area)	16119.031	4	4029.758	42.528	**
Error	9380.875	99	94.756		
Total	425698.500	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	30790.521	4	7697.630	16.848	**
Station(Area)	26452.146	4	6613.036	14.474	**
Error	45232.333	99	456.892		
Total	423262.000	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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	90860.708	4	22715.177	249.225	**
Station(Area)	5081.625	4	1270.406	13.939	**
Error	9023.167	99	91.143		
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	51413.917	4	12853.479	83.626	**
Station(Area)	38334.583	4	9583.646	62.352	**
Error	15216.500	99	153.702		
Total	425752.000	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	90380.563	4	22595.141	233.863	**
Station(Area)	5018.854	4	1254.714	12.986	**
Error	9565.083	99	96.617		
Total	425751.500	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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	80706.583	4	20176.646	180.010	**
Station(Area)	13163.375	4	3290.844	29.360	**
Error	11096.542	99	112.086		
Total	425753.500	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

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	28752.208	4	7188.052	18.744	**
Station(Area)	34658.542	4	8664.635	22.595	**
Error	37964.250	99	383.477		
Total	422162.000	108			

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

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	33723.354	4	8430.839	80.391	**
Station(Area)	60330.188	4	15082.547	143.817	**
Error	10382.458	99	104.873		
Total	425223.000	108			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	81042.792	4	20260.698	142.702	**
Station(Area)	9864.750	4	2466.188	17.370	**
Error	14055.958	99	141.979		
Total	425750.500	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

Sediment Toxicity for ESC CMP Vd – August 2019

Survival rate for burrowing amphipod Leptochirus plumulosus

	Survival
Chi-Square Df Asymp. Sig.	0.046 2 NS

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

Growth rate for benthic polychaete Neanthes arenaceodentata

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.247	2	1.123	.148	NS
Within Groups	926.621	122	7.595		
Total	928.868	124			

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

Survival rate for marine bivalve Crassostrea gigas

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.039	2	.019	1.257	NS
Within Groups	1.885	122	.015		
Total	1.924	124			

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

Mortality rate for barnacles Balanus Amphitrite

Source	Mortality
Chi-Square Df Asymp. Sig.	2.200 2 NS

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

Mortality rate for shrimp Penaeus vannaamei

Source	Mortality
Chi-Square df Asymp. Sig.	2.731 2 NS

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