



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

Monthly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – January 2019

Revision 0

February 2019

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

Facsimile (852) 2723 5660

ERM

www.erm.com

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

Monthly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – January 2019

#### **Revision 0**

Document Code: 0400720\_Monthly January 2019\_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:		Proje	ct No	):		
Civil Eng	gineering and Development Department (CEDD)	0400	)720	)		
Summary		Date:				
		14 F	ebr	uary 201	9	
		Appro				
	ument presents the Monthly EM&A Report for nental Monitoring and Audit for Disposal Facility to the East hau.	1				
		Craiq Partr	-	Reid		
v0	Monthly EM&A Report for ESC CMPs	TT	-	RC	CAR	14/02/19
Revision	Description	Ву	,	Checked	Approved	Date
'ERM Hong- Contract with	has been prepared by Environmental Resources Management the trading name of Kong, Limited', with all reasonable skill, care and diligence within the terms of the in the client, incorporating our General Terms and Conditions of Business and int of the resources devoted to it by agreement with the client.	Distril		ernal	OHSAS Certificate 1	18001:2007 No. OHS 515956
We disclaim scope of the	any responsibility to the client and others in respect of any matters outside the above.	$\boxtimes$	Puk	olic		BSI
third parties	s confidential to the client and we accept no responsibility of whatsoever nature to to whom this report, or any part thereof, is made known. Any such party relies on their own risk.		Cor	nfidential	ISO 9 Certificate	001 : 2008 2 No. FS 32515







# 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:

Monthly EM&A Report for Contaminated Mud Pits to the

East of Sha Chau - January 2019

Date of Report:

14 February 2019

Date prepared by ET:

14 February 2019

Date received by IA:

14 February 2019

#### Reference EP Condition

**Environmental Permit Condition:** 

Condition 3.4 of EP-312/2008/A:

4 hard copies and 1 electronic copy of monthly EM&A Report shall be submitted to the Director within 2 weeks after the end of the reporting month. The EM&A Reports shall include a summary of all non-compliance (exceedances) of the environmental quality performance limits (Action and Limit Levels). The submissions shall be certified by the ET Leader and verified by the Independent Auditor. Additional copies of the submission shall be provided to the Director upon request by the Director.

#### **ET Certification**

I hereby certify that the above referenced document/ $\frac{1}{plan}$  complies with the above referenced condition of EP-312/2008/A

Craig Reid,

Environmental Team Leader:

Date:

14/02/2019

#### **IA Verification**

I hereby verify that the above referenced document/plan complies with the above referenced condition of

EP-312/2008/A

Dr Wang Wen Xiong, Independent Auditor: Date:

14/02/2019

#### **CONTENTS**

ANNEX C ANNEX D

1.1	BACKGROU	ND	1
1.2	REPORTING	PERIOD	2
1.3	<b>DETAILS OF</b>	SAMPLING AND LABORATORY TESTING ACTIVITIES	2
1.4	<b>D</b> ETAILS OF	OUTSTANDING SAMPLING AND/OR ANALYSIS	2
1.5	BRIEF DISC	USSION OF THE MONITORING RESULTS FOR ESC CMP V	2
1.6	<b>ACTIVITIES</b>	SCHEDULED FOR THE NEXT MONTH	5
1.7	STUDY PRO	GRAMME	6
	ANNEXES		
	ANNEX A	SAMPLING SCHEDULE	
	ANNEX B	WATER QUALITY MONITORING RESULTS	

**GRAPHICAL PRESENTATIONS** 

STUDY PROGRAMME

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

#### **MONTHLY EM&A REPORT FOR JANUARY 2019**

#### 1.1 BACKGROUND

- 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 opensea 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, 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)* 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. Detailed works schedule for ESC CMP V is shown in *Figure 1.1*. In January 2019, disposal of contaminated mud at ESC CMP Vd was undertaken.

ERM (2013) Final Report. Submitted under Agreement No. CE 4/2009 (EP) Environmental Monitoring and Audit for Contaminated Mud Pit at East Sha Chau. For CEDD.

<sup>(2)</sup> ERM (2017) Final Report. Submitted under Agreement No. CE 23/2012 (EP) Environmental Monitoring and Audit for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau (2012 - 2017). For CEDD.

Figure 1.1 Works Schedule for ESC CMP V and SB CMPs

D:4	Onorotion		2017						2018						2019							2020						2021																										
Pit	Operation	Α	N	IJ	Ι,	J	Α	s	C	) 	1	ο.	J	F	M	Α	М	J	J	J	Α :	s	0	N	D	J	F	М	ΙA	N	1 J	J,	J	A S	S	0	N	D	J	F	М	Α	М	J	J	Α	S	C	<b>N</b>	D	J	F		1
	Dredging																																																					1
ESC CMP V	Disposal				T																																															Г		
	Capping																																																					

#### 1.2 REPORTING PERIOD

1.2.1 This *Monthly EM&A Report for January 2019* covers the EM&A activities for the reporting month of January 2019.

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

- 1.3.1 The following monitoring activities were undertaken for ESC CMP V in January 2019:
  - Water Column Profiling of ESC CMP Vd;
  - Routine Water Quality Monitoring of ESC CMPs;
  - Pit Specific Sediment Chemistry of ESC CMP Vd; and
  - Demersal Trawling for ESC CMPs.

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

- 1.4.1 No outstanding sampling remained for January 2019.
- 1.4.2 The following analyses are in progress and will be presented in the corresponding quarterly report:
  - Species identification of the biota samples collected from *Demersal Trawling for ESC CMPs* in January 2019.

#### 1.5 Brief Discussion of the Monitoring Results for ESC CMP V

- 1.5.1 Brief discussion of the monitoring results of the following activities for ESC CMP V is presented in this *Monthly EM&A Report for January* 2019:
  - Water Column Profiling of ESC CMP Vd in January 2019;
  - Routine Water Quality Monitoring of ESC CMPs in January 2019; and
  - *Pit Specific Sediment Chemistry of ESC CMP Vd* in January 2019.

#### 1.5.2 Water Column Profiling of ESC CMP Vd - January 2019

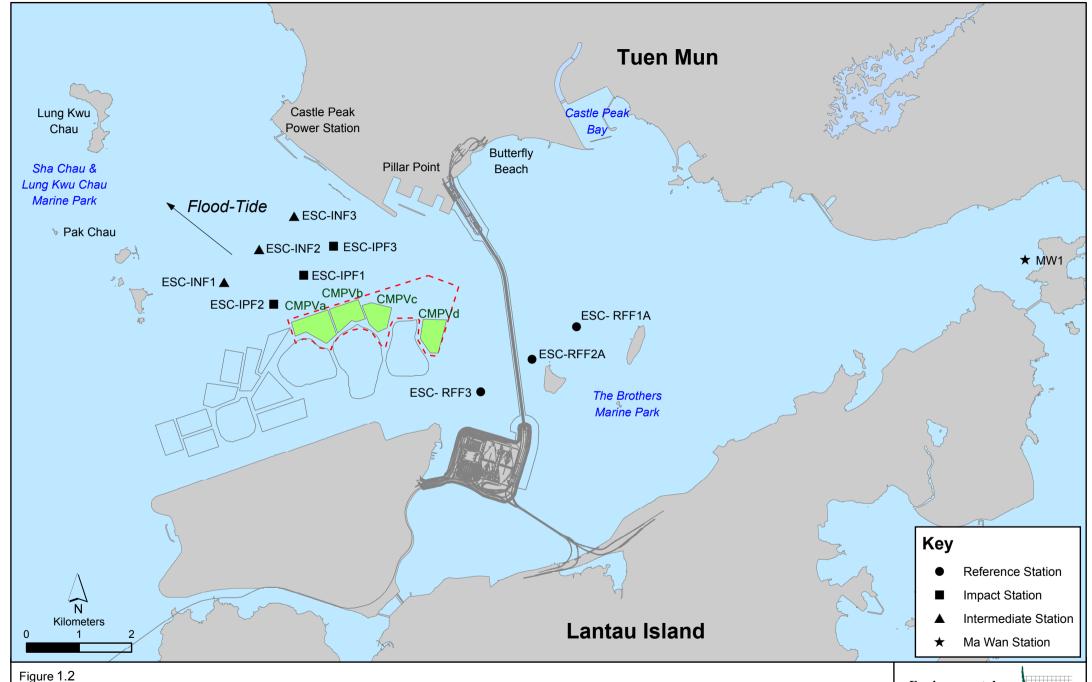
1.5.3 Water Column Profiling was undertaken at a total of two sampling stations (Upstream and Downstream stations) on 4 January 2019. The monitoring results have been assessed for compliance with the Water Quality Objectives (WQOs) set by Environmental Protection Department (EPD). This consists of a review of the EPD routine water quality monitoring data for the dry season period (November to March) of 2007 - 2016 from stations in the Northwestern Water Control Zone (WCZ), where the ESC CMPs are located (1). For Salinity, the averaged value obtained from the Reference (Upstream) station was used for the basis as the WQO. Levels of Dissolved Oxygen (DO) and Turbidity were also assessed for compliance with the Action and Limit Levels (see Table B1 of Annex B for details).

In-situ Measurements

1.5.4 Analyses of results for January 2019 indicated that levels of Salinity, pH and DO complied with the WQOs at both Downstream and Upstream stations (*Table B2* of *Annex B*). Levels of DO and Turbidity at all stations complied with the Action and Limit Levels (*Tables B1* and *B2* of *Annex B*).

Laboratory Measurements for Suspended Solids (SS)

- 1.5.5 Analyses of results for January 2019 indicated that the SS levels at both Downstream and Upstream stations complied with the WQO and the Action and Limit Levels at both Downstream and Upstream stations (*Tables B1* and *B2* of *Annex B*).
- 1.5.6 Overall, the monitoring results indicated that the mud disposal operation at ESC CMP Vd did not appear to cause any deterioration in water quality during this reporting period.
- 1.5.7 Routine Water Quality Monitoring of ESC CMPs January 2019
- 1.5.8 Routine Water Quality Monitoring of ESC CMPs was undertaken on 9 January 2019. The monitoring results have been assessed for compliance with the WQOs (see Section 1.5.3 for details). The monitoring results are shown in Tables B3 and B4 of Annex B and Figures 1 10 of Annex C. A total of ten (10) monitoring stations were sampled in January 2019 as shown in Figure 1.2.



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

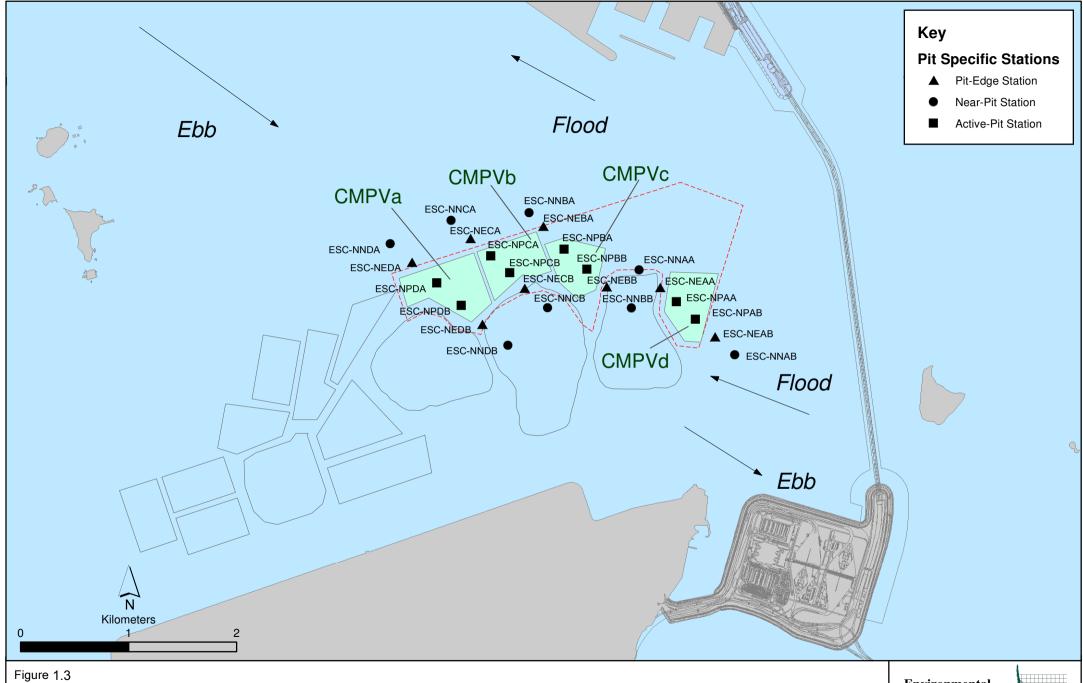


#### In-situ Measurements

- 1.5.9 Graphical presentation of the monitoring results (Temperature, DO, pH, Salinity and Turbidity) is shown in *Figures 1 6* of *Annex C*. Analyses of results for January 2019 indicated that the levels of pH, Salinity and DO complied with the WQOs at all stations (Impact, Intermediate, Reference and Ma Wan stations) in January 2019.
- 1.5.10 The levels of DO and Turbidity also complied with the Action and Limit Levels at all stations (*Table B3* of *Annex B*; *Figures 3* and 6 of *Annex C*).
- 1.5.11 Overall, *in-situ* measurement results of the *Routine Water Quality Monitoring* indicated that the disposal operation at ESC CMP Vd did not appear to cause any unacceptable impacts in water quality in January 2019.

Laboratory Measurements

- 1.5.12 Laboratory analysis of January 2019 results indicated that concentrations of Cadmium, Silver and Mercury were below their limit of reporting at all stations, while the concentrations of Chromium, Lead and Nickel were below their limit of reporting at most stations expect at Impact stations. Arsenic, Copper and Zinc were detected in January 2019 samples at all stations and the concentrations of these metals and metalloids were similar amongst the stations (*Table B4* of *Annex B*; *Figure 7* of *Annex C*).
- 1.5.13 For nutrients, concentrations of Total Inorganic Nitrogen (TIN) at all stations in January 2019 complied with the WQO (*Table B4* of *Annex B*; *Figure 8* of *Annex C*). Concentrations of Ammonia Nitrogen (NH<sub>3</sub>-N) and 5-day Biochemical Oxygen Demand (BOD<sub>5</sub>) were generally similar amongst the stations in January 2019 (*Table B4* of *Annex B*; *Figure 8 and 9* of *Annex C*).
- 1.5.14 Analyses of results for January 2019 indicated that the SS levels were higher than the WQO (12.8 mg/L for dry season) for Reference, Impact and Intermediate stations, however, the SS levels complied with the Action and Limit Levels at all stations (*Tables B1 and B4* of *Annex B*; *Figure 10* of *Annex C*).
- 1.5.15 Overall, results of the Routine Water Quality Monitoring indicated that the disposal operation at ESC CMP Vd did not appear to cause any unacceptable deterioration in water quality in January 2019. Detailed statistical analysis will be presented in the Quarterly Report to investigate any spatial and temporal trends of potential concern.
- 1.5.16 Pit Specific Sediment Chemistry of ESC CMP Vd January 2019
- 1.5.17 Monitoring locations for *Pit Specific Sediment Chemistry for ESC CMP Vd* are shown in *Figure 1.3.* A total of six (6) monitoring stations were sampled on 3 January 2019.



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

Pit Specific Sediment Quality Monitoring Stations for CMPV



- 1.5.18 The concentrations of all inorganic contaminants were lower than the Lower Chemical Exceedance Level (LCEL) at Pit-Edge and Near-Pit stations in January 2019. The concentrations of Arsenic were higher than the LCEL at Active Pit stations ESC-NPAA and ESC-NPAB. The concentrations of Chromium were higher than the LCEL at Active Pit station ESC-NPAB and the concentrations of Copper, Lead, Mercury, Nickel, Silver and Zinc were higher than the Upper Chemical Exceedance Level (UCEL) at Active Pit station ESC-NPAB (Figures 11 and 12 of Annex C).
- 1.5.19 For organic contaminants, the concentrations of Total Organic Carbon (TOC) varied between stations and were generally higher at Active-Pit ESC-NPAB station in January 2019 (*Figure 13* of *Annex C*). Tributyltin (TBT), Total Polychlorinated Biphenyls (PCBs), Total dichloro-diphenyl-trichloroethane (DDT) and 4,4′-dichlorodiphenyldichloroethylene (DDE) concentrations were below the limit of reporting at all stations, while Low and High Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs) exceeded the UCEL at Active-Pit ESC-NPAB station in January 2019 (*Figures 14 and 15* of *Annex C*).
- 1.5.20 Whilst the average concentration of Arsenic in the Earth's crust is generally ~2 mg/kg, significantly higher Arsenic concentrations (median = 14 mg/kg) have been recorded in Hong Kong's onshore sediments <sup>(1)</sup>. It is presumed that the natural concentrations of Arsenic are similar in onshore and offshore sediments <sup>(2)</sup>, and relatively high Arsenic levels may thus occur throughout Hong Kong. Therefore, the LCEL exceedances of Arsenic are unlikely to be caused by the disposal operations at ESC CMP Vd but rather as a result of naturally occurring deposits.
- 1.5.21 Considering that the higher levels of other contaminants occurred within one Active-Pit station ESC-NPAB only but not at the Pit-Edge and Near-Pit stations, 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 in January 2019. Statistical analysis will be undertaken and presented in the corresponding quarterly report to investigate whether there are any unacceptable impacts in the area caused by the contaminated mud disposal.

#### 1.6 ACTIVITIES SCHEDULED FOR THE NEXT MONTH

- 1.6.1 The following monitoring activities will be conducted in the next monthly period of February 2019 for ESC CMP V (see *Annex A* for the sampling schedule <sup>(3)</sup>):
  - Water Column Profiling of ESC CMP Vd;

<sup>(1)</sup> Sewell RJ (1999) Geochemical Atlas of Hong Kong. Geotechnical Engineering Office, Government of the Hong Kong Special Administrative Region

<sup>(2)</sup> Whiteside PGD (2000) Natural geochemistry and contamination of marine sediments in Hong Kong. In: The Urban Geology of Hong Kong (ed Page A & Reels SJ). Geological Society of Hong Kong Bulletin No. 6, p109-121

<sup>(3)</sup> The scheduled EM&A Programme for SB CMPs was completed in December 2018.

- Routine Water Quality Monitoring of ESC CMPs;
- Pit Specific Sediment Chemistry of ESC CMP Vd;
- Cumulative Impact Sediment Chemistry of ESC CMPs;
- Sediment Toxicity Tests of ESC CMPs; and
- Demersal Trawling for ESC CMPs.
- 1.7 STUDY PROGRAMME
- 1.7.1 A summary of the Study Programme is presented in *Annex D*.

#### Annex A

### Sampling Schedule

Pit Specific Sediment Chemistry	Code	Frequency	A M	J J	2017 A S	0 N	N D	J F	M	A M	2018 J J	A S	0 N I	) ј	F M A		19 J A S	0 1	N D	J F	МА		020 J A	s o	N D	J F
Active-Pit		Monthly			12 1		2 12										12 12 12			12 12 1						
Pit-Edge	ESC-NPAB ESC-NEAA	Monthly	12 12					12 12									12 12 12 12 12 12			12 12 1						
Near-Pit		Monthly							12 :	12 12	12 12	12 12	12 12 1	2 12 1	12 12 12	12 12	12 12 12	12 1	2 12	12 12 1	2 12	12 12	12 12	12 12	12 12	12 12
	ESC-NNAA ESC-NNAB	Monthly Monthly				2 12 1											12 12 12 12 12 12			12 12 1 12 12 1						
Cumulative Impact Sediment Che Jear-field Stations	mistry		A M	J J	A S	ON	N D	J F	M	A M	J J		0 N I	) ј	F M A	M J	J A S	0 1	I D	J F	M A	M J	J A	S O	N D	J F
	ESC-RNA ESC-RNB1	4 times per year 4 times per year		12 12	12 12		12 12				12 12	12 12	1		12	12 12	12 12		12 12	12 12		12 12	12 12		12 12	12 12
Aid-field Stations	ESC-RMA ESC-RMB	4 times per year 4 times per year		12 12	12 12		12				12 12	12 12			12	12	12 12		12 12	12 12		12			12 12	12
Capped Pit Stations	ESC-RVID	4 times per year		12	12		12				12	12	1		12	12	12		12	12		12			12	12
Far-Field Stations	ESC-RCB1	4 times per year		12	12		12				12	12	1	2 1	12	12	12		12	12		12	12		12	12
W W G G	ESC-RFA ESC-RFB	4 times per year 4 times per year		12 12	12 12		12 12				12 12	12 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	1	2 1	12	12	12		12	12		12	12		12	12
Sediment Toxicity Tests Near-Pit Stations			A M	J J	A 5	0 N	N D	J F	M	A M	J J	A S	O N I	) ј	F M A	M J	J A S	0 1	N D	J F I	M A	M J	J A	S O	N D	J F
	ESC-TDA ESC-TDB1	2 times per year 2 times per year			5			5 5				5			5		5 5			5			5			5 5
Reference Stations	ESC-TRA	2 times per year			5			5				5			5		5			5			5			5
Ma Wan Station	ESC-TRB MW1	2 times per year 2 times per year			5			5				5			5		5			5			5			5
Fissue/ Whole Body Sampling		2 amos por your	A M	JJ	A S	6 O N	N D	J F	M	A M	J J		O N I		F M A	M J	J A S	0 1	N D		МА	M J	J A		N D	
Near-Pit Stations	ESC-INA ESC-INB	2 times per year			*			*				*			*		*			*			*			*
Reference North	TNA	2 times per year 2 times per year			*			*				*			*		*			*			*			*
Reference South	TNB	2 times per year			*	H	ŀ	*		1		*			*		*			*	Ŧ		*		$\pm$	*
	TSA TSB	2 times per year 2 times per year			*			*				*		$oxed{\bot}$	*		*			*			*			*
Demersal Trawling Near Pit Stations			A M	JJ	A S	0 N	N D	J F	M	A M	JJ	A S	O N I	) J	F M A	M J	J A S	0 1	I D	J F I	МА	M J	J A	S O	N D	J F
von 1 n Statiofis	ESC-INA ESC-INB	4 times per year 4 times per year	Ħ		5			5 5 5 5			5				5		5 5 5			5 5 5 5	+		5 5		+	5 5 5 5
Reference North	TNA	4 times per year	Œ	5	5		L	5 5			5	5	H	5	5		5 5			5 5			5 5			5 5
Reference South	TNB	4 times per year			5	H	1	5 5		╁	5		H	5	5		5 5 5		Ħ	5 5	Ŧ		5 5			5 5
	TSA TSB	4 times per year 4 times per year			5			5 5	_		5				5		5 5			5 5			5 5			5 5
Capping Ebb Tide			A M	J J	A S	ON	N D	J F	M	A M	J J	A S	0 N I	J	F M A	M J	J A S	O	N D	J F I	M A	M J	J A	S O	N D	J F
mpact Station Downcurrent		4 times per year															3		3	3		3	3	-	3	3
	ESC-IPE3	4 times per year 4 times per year	H				F					H			+		3 3 3		3 3	3 3	F	3 3			3 3	3 3
ntermediate Station Downcurrent	ESC-IPE5	4 times per year 4 times per year	H							+		+			+		3		3	3	+	3	3		3	3
		4 times per year 4 times per year							Н			H					3 3		3	3		3	3		3	3
	ESC-INE4A	4 times per year 4 times per year															3		3	3		3	3		3	3
Reference Station Upcurrent	ESC-INE5A ESC-RFE1	4 times per year 4 times per year															3		3	3		3	3		3	3
	ESC-RFE2 ESC-RFE3	4 times per year 4 times per year															3		3	3		3	3		3	3
	ESC-RFE4 ESC-RFE5	4 times per year 4 times per year															3 3		3	3		3	3		3	3
Ma Wan Station  Flood Tide	MW1	4 times per year							Ш								3		3	3		3	3		3	3
Impact Station Downcurrent	ESC-IPF1	4 times per year															3		3	3		3	3		3	3
	ESC-IPF2 ESC-IPF3	4 times per year 4 times per year															3 3		3	3		3	3		3	3
Intermediate Station Downcurrent	ESC-INF1	4 times per year															3		3	3		3	3		3	3
Reference Station Upcurrent	ESC-INF2 ESC-INF3	4 times per year 4 times per year															3		3	3		3	3		3	3
	ESC-RFF1A ESC-RFF2A	4 times per year 4 times per year															3 3		3	3		3	3		3	3
Ma Wan Station	ESC-RFF3	4 times per year															3		3	3		3	3		3	3
Routine Water Quality Monitoring	MW1	4 times per year	A M	JJ	Α 6		y D	I I E	М	Λ M	1 1	A 6	0 N I	Т	F M A	мі	3 J A S	0 1	3 J D	3 I E 7	м А	3 M I	3 I A	s o	3 N D	3 J F
Ebb Tide Impact Station Downcurrent	3		A M	, ,	A	, U P	N D	J F	IVI	A M	) )	A 5	UNI	, ,	r M A	M J	J A S	U	и	J F I	VI A	M	JA	5 0	N D	J F
•	ESC-IPE1A ESC-IPE2A	8 times per year 8 times per year	8 8	8	8	8 8	3	8 8 8 8		8 8	8 8	8	8 8	8	8 8 8 8	8	8 8		3	8 8 8 8	8	8	8 8	8	8	8 8 8 8
	ESC-IPE3 ESC-IPE4	8 times per year 8 times per year	8 8	8	8	8 8	3	8 8		8 8	8	8	8 8	8	8 8	8	8 8	8 8	3	8 8	8	8	8 8	8	8	8 8
Intermediate Station Downcurrent	ESC-IPE5 ESC-INE1A	8 times per year 8 times per year	8 8	8	8	8 8	3	8 8		8 8	8		8 8	8	8 8		8 8	8 8	3	8 8	8		8 8	8	8	8 8
	ESC-INE2A ESC-INE3A	8 times per year 8 times per year	8 8 8 8	8	8	8 8	3	8 8 8 8		8 8	8 8	8	8 8	8	8 8 8 8	8	8 8	8 8	3	8 8 8 8	8	8	8 8	8	8	8 8 8 8
Defense Co. C.	ESC-INE4A ESC-INE5A	8 times per year 8 times per year	8 8 8 8	8		8 8	3	8 8		8 8	8	8	8 8 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 ESC-RFE2	8 times per year 8 times per year	8 8	8	8		3	8 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 ESC-RFE4	8 times per year 8 times per year	8 8	8	8	8 8	3	8 8 8 8		8 8	8 8	8	8 8	8	8 8 8 8	8	8 8	8 8	3	8 8	8	8	8 8 8 8	8	8	8 8 8 8
Ma Wan Station	ESC-RFE5	8 times per year	8 8	8	8		3	8 8		8 8	8	8	8 8		8 8	8	8 8	8 8	3	8 8	8		8 8	8	8	8 8
Flood Tide Impact Station Downcurrent	MW1	8 times per year	8 8	8	8	8 8	3	8 8		8 8	8	8	8 8	8	8 8	8	8 8	8 8	5	8 8	8	8	8 8	8	8	8 8
pact of auton DownCurrent	ESC-IPF1 ESC-IPF2	8 times per year 8 times per year	8 8	8		8 8	3	H	_	8 8 8 8	8	8	8 8	8	8 8	8	8 8	8 8	3	8 8	8	8	8 8	8	8	8 8 8 8
ntermediate Station Downcurrent	ESC-IPF3	8 times per year	8 8	8	8	8 8	3			8 8	8	8	8 8	8	8 8	8	8 8	8 8	3	8 8	8	8	8 8	8	8	8 8
	ESC-INF1 ESC-INF2	8 times per year 8 times per year	8 8	8		8 8	3			8 8	8	8	8 8	8	8 8	8	8 8 8	8 8	3	8 8	8	8	8 8	8	8	8 8
Reference Station Upcurrent	ESC-INF3	8 times per year	8 8	8			3			8 8	8		8 8		8 8		8 8		3	8 8	8		8 8		8	8 8
serereite sunton opeument	ESC-RFF1A	8 times per year 8 times per year	8 8 8 8 8 8	8 8		8 8	3			8 8 8 8 8 8	8 8	8	8 8 8 8 8 8	8	8 8 8 8 8 8	8	8 8 8 8 8 8	8 8 8	3	8 8 8 8 8 8	8 8	8	8 8 8 8 8 8	8	8 8	8 8 8 8 8 8
cercine sumon openion	ESC-RFF2A ESC-RFF3	8 times per year	- 0		8		3			8 8	8		8 8		8 8		8 8	8 8		8 8	8		8 8		8	8 8
	ESC-RFF2A		8 8	8				I E	M	A M			0 N I	рЈ	F M A	M J	J A S			J F I			J A	S O		J F
Aa Wan Station  Vater Column Profiling	ESC-RFF2A ESC-RFF3 MW1	8 times per year 8 times per year	A M	JJ							. 4 1 4	4 4					4 4 4				4 4	14 4		1 4 1 4	, 1	
Aa Wan Station	ESC-RFF2A ESC-RFF3	8 times per year	A M 4 4	J J 4 4	4 4	6 O N 4 4 4 4	1 4	4 4					1 - 1 - 1					4 4	1	4 4	4 4			4 4		
Aa Wan Station  Vater Column Profiling  Plume Stations  Fenthic Recolonisation Studies	ESC-RFF2A ESC-RFF3 MW1	8 times per year 8 times per year Monthly	A M 4 4 4 4	J J 4 4 4 4	4 4	4 4	1 4 1 4	4 4	4	4 4	4 4	4 4		) ј	F M A		J A S					4 4	4 4	4 4	4 4	4 4
Ma Wan Station  Water Column Profiling  Plume Stations	ESC-RFF2A ESC-RFF3 MW1 WCP1 WCP2	8 times per year 8 times per year Monthly	A M 4 4 4 4	J J 4 4 4 4	4 4	4 4	1 4 1 4	4 4	4	4 4	4 4	4 4		) J	F M A							4 4	4 4	4 4	4 4	4 4
Ma Wan Station  Water Column Profiling  Plume Stations  Benthic Recolonisation Studies  Capped Stations at CMPV	ESC-RFF2A ESC-RFF3 MW1 WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPC	8 times per year  8 times per year  Monthly Monthly 2 times per year	A M 4 4 4 4	J J 4 4 4 4	4 4	4 4	1 4 1 4	4 4	4	4 4	4 4	4 4		D J	F M A							4 4	4 4	4 4	4 4	4 4
Ma Wan Station  Water Column Profiling  Plume Stations  Benthic Recolonisation Studies  Capped Stations at CMPV	ESC-RFF2A ESC-RFF3 MW1  WCP1 WCP2  ESCV-CPA ESCV-CPB ESCV-CPC ESCV-CPD RBA	8 times per year  8 times per year  Monthly  Monthly  2 times per year	A M 4 4 4 4	J J 4 4 4 4	4 4	4 4	1 4 1 4	4 4	4	4 4	4 4	4 4		D J	F M A							4 4	4 4	4 4	4 4	4 4
Ma Wan Station  Water Column Profiling  Plume Stations  Benthic Recolonisation Studies  Capped Stations at CMPV	ESC-RFF2A ESC-RFF3 MW1 WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPC ESCV-CPD	8 times per year  8 times per year  Monthly Monthly  2 times per year 2 times per year 2 times per year	A M 4 4 4 4	J J 4 4 4 4	4 4	4 4	1 4 1 4	4 4	4	4 4	4 4	4 4		D J	F M A							4 4	4 4	4 4	4 4	4 4
Ma Wan Station  Water Column Profiling Plume Stations  Benthic Recolonisation Studies Capped Stations at CMPV  Reference Stations	ESC-RFF2A ESC-RFF3 MW1 WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPD RBA RBB	8 times per year  8 times per year  Monthly Monthly  2 times per year	A M 4 4 4 4	J J 4 4 4 4 4 J J J	4 4 4 4 4 A S	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	1 4 1 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 4 4 4 T	4 M	4 4 A M	J J	A S	O N I			M J		0 1	N D	J F 1	M A	M J	J A	S O	4 4 N D	J F
Ma Wan Station  Water Column Profiling  Plume Stations  Benthic Recolonisation Studies  Capped Stations at CMPV  Reference Stations	ESC-RFF2A ESC-RFF3 MW1 WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPD RBA RBB	8 times per year  8 times per year  Monthly Monthly  2 times per year	A M 4 4 4 4 4 4	J J 4 4 4 4 4 4 J J J J	4 4 4 4 4 A S	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	1 4 1 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 4 4 4 T	4 M	4 4 A M	J J	A S	O N I			M J	J A S	0 1	N D	J F 1	M A	M J	J A	S O	4 4 N D	J F
Ma Wan Station  Water Column Profiling Plume Stations  Senthic Recolonisation Studies Capped Stations at CMPV  Reference Stations	ESC-RFPA ESC-RFF3 MW1 WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPD RBA RBB RBC1 US1 US2 DS1	8 times per year  8 times per year  Monthly  Monthly  2 times per year 3 times per year	A M 4 4 4 4 4 4	J J J J J J J 2 2 2 2 2 2 2	A S  A S  A S  2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	4 4 4 4 4 6 O N	1 4 1 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 4 4 4 T	4 M	4 4 A M	J J	A S	O N I			M J	J A S	0 1	N D	J F 1	M A	M J	J A	S O	4 4 N D	J F
Vater Column Profiling Plume Stations  Senthic Recolonisation Studies Capped Stations at CMPV  Reference Stations  Impact Monitoring for Dredging Upstream Stations	ESC-RFPA ESC-RFF3 MWI WCPI WCP2 ESCV-CPA ESCV-CPB ESCV-CPD ESCV-CPD US1 US1 US2 US1 US2 US1 US2 US1 US2 US3	8 times per year  8 times per year  8 times per year  2 times per year  3 times per year  3 times per year  3 times per week	A M 4 4 4 4 4 4	J J J J J J J J J Z 2 2 2 2 2 2 2 2 2	A S  A S  2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	4 4 4 4 4 6 O N	1 4 1 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 4 4 4 T	4 M	4 4 A M	J J	A S	O N I			M J	J A S	0 1	N D	J F 1	M A	M J	J A	S O	4 4 N D	J F
Water Column Profiling Plume Stations  Senthic Recolonisation Studies Capped Stations at CMPV  Reference Stations  mpact Monitoring for Dredging  pstream Stations  Downstream Stations	ESC-RFFA ESC-RFF3 MW1  WCP1 WCP2  ESCV-CPA ESCV-CPA ESCV-CPC ESCV-CPD RBA RBB RBC1  US1 US2 DS1 DS2	8 times per year  8 times per year  8 times per year  2 times per year  3 times per year  3 times per week  3 times per week  3 times per week	A M 4 4 4 4 4 4	J J J J J J J J J Z 2 2 2 2 2 2 2 2 2 2	A S 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	4 4 4 4 4 6 O N	1 4 1 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 4 4 4 T	4 M	4 4 A M	J J	A S	O N I			M J	J A S	0 1	N D	J F 1	M A	M J	J A	S O	4 4 N D	J F
fa Wan Station  Vater Column Profiling  lume Stations  enthic Recolonisation Studies apped Stations at CMPV  eference Stations  mpact Monitoring for Dredging pstream Stations	ESC-RFPA ESC-RFF3 MW1 WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPD ESCV-CPD US1 US2 US1 US2 DS1 DS2 DS3 DS4	8 times per year  8 times per year  8 times per year  2 times per year  3 times per year  3 times per year  3 times per week  3 times per week	A M 4 4 4 4 4 4	J J 4 4 4 4 4 4 J J J J J J J J J J J J	A 5 A 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	1 4 1 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 4 4 4 T	4 M	4 4 A M	J J	A S	O N I			M J	J A S	0 1	N D	J F 1	M A	M J	J A	S O	4 4 N D	J F

#### Annex B

Water Quality Monitoring Results

Table B1 Action and Limit Levels of Water Quality for Dredging, Disposal and Capping Activities at ESC CMP V

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

#### Notes:

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

Table B2 Water Column Profiling Results for ESC CMP Vd in January 2019

Stations	Temp	Salinity	Turbidity	Dissolved	l Oxygen	pН	Suspended Solids
	(°C)	(ppt)	(NTU)	(%)	(mg L-1)		(mg L-1)
WCP 1	18.81	33.31	5.51	93.34	7.13	8.12	6.88
(Downstream) WCP 2	18.67	33.32	8.09	93.84	7.19	8.11	8.10
(Upstream) WQO (Dry Season)	N/A	29.99– 36.66#	N/A	N/A	>4	6.5-8.5	12.8

#### Note:

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

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

Cell shaded grey indicate value exceeding the WQO.

Table B3 In-situ Monitoring Results for Routine Water Quality Monitoring of ESC CMPs in January 2019

Sampling	Chaliana	Temp	Salinity	Turbidity	Dissolve	d Oxygen	pН
Period	Stations	(°C)	(ppt)	(NTU)	(%)	(mg L-1)	(mg L-1)
January	RFF (Reference)	18.56	31.77	12.69	93.68	7.26	8.09
2019	IPF (Impact)	18.61	31.62	9.89	92.96	7.20	8.06
	INF (Intermediate)	18.65	31.61	10.19	92.71	7.17	8.05
	Ma Wan	18.84	32.52	6.30	90.35	6.93	8.05
	WQO	N/A	28.60 - 34.95#	N/A	N/A	>4	6.5-8.5

#### Notes:

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

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

Cell shaded grey indicate value exceeding the WQO.

Table B4 Laboratory Results for Routine Water Quality Monitoring of ESC CMPs in January 2019

Sampling	Stations	As	Cd	Cr	Cu	Pb	Hg	Ni	Ag	Zn	NH <sub>3</sub>	TIN	BOD <sub>5</sub>	SS
Period	Stations	(μg/L)	(µg/L)	(µg/L)	(µg/L)	(μg/L)	(µg/L)	(μg/L)	(µg/L)	(µg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
January	RFF	0.83	< 0.50	<1.0	8.81	<1.0	< 0.50	<1.0	<1.0	6.43	0.08	0.36	1.13	18.33
2019	IPF	1.06	< 0.50	0.61	8.36	1.35	< 0.50	1.01	<1.0	15.92	0.10	0.45	0.88	12.91
	INF	0.94	< 0.50	<1.0	9.78	<1.0	< 0.50	<1.0	<1.0	14.43	0.12	0.44	1.04	15.18
	Ma	0.77	< 0.50	<1.0	6.49	<1.0	< 0.50	<1.0	<1.0	10.63	0.11	0.33	1.25	11.35
	Wan													

WQO of TIN: 0.5 mg/L

Dry Season WQO of SS: 12.8 mg/L

#### Notes:

Cell shaded yellow / red indicate value exceeding the  $\mbox{\it Action/Limit}$  levels.

Cell shaded grey indicate value exceeding the WQO.

#### Annex C

## **Graphical Presentations**

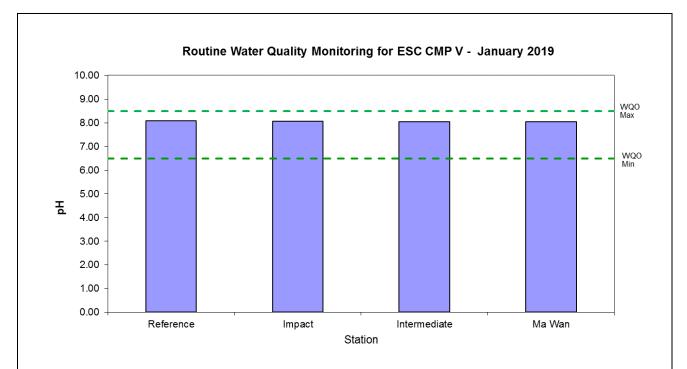


Figure 1: Level of pH recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

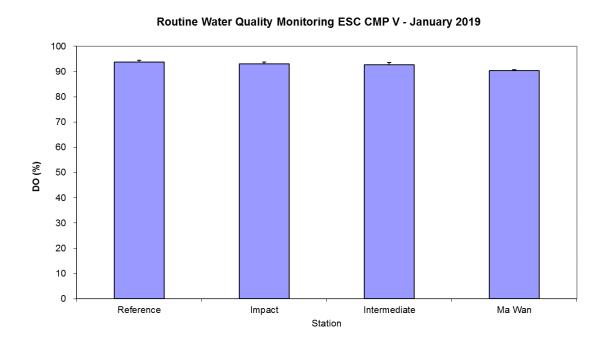


Figure 2: Level of Dissolved Oxygen (DO) (% saturation; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

Date: February 2019



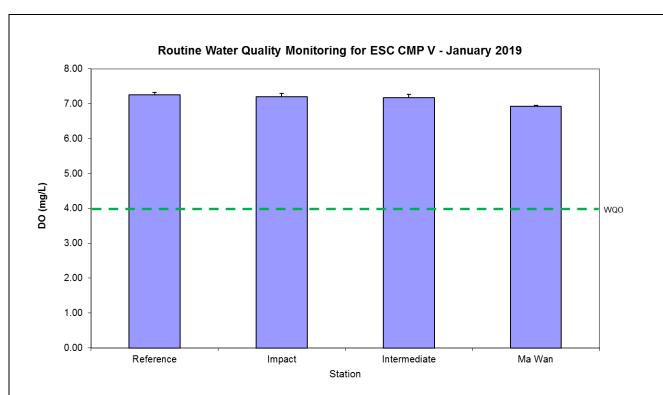


Figure 3: Concentration of Dissolved Oxygen (DO) (mg/L; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

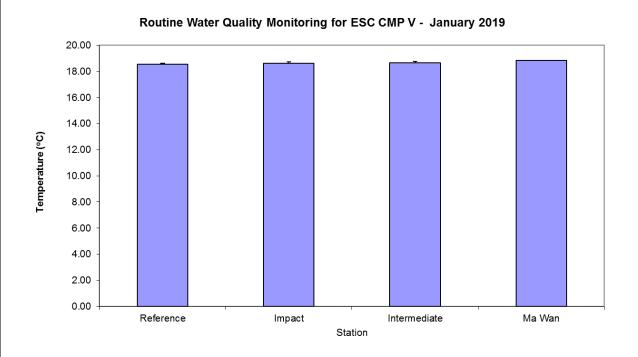


Figure 4: Level of Temperature (°C; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

Date: February 2019



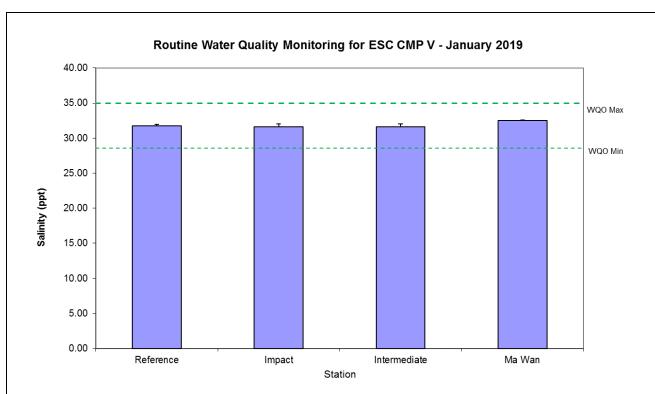


Figure 5: Level of Salinity (ppt; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

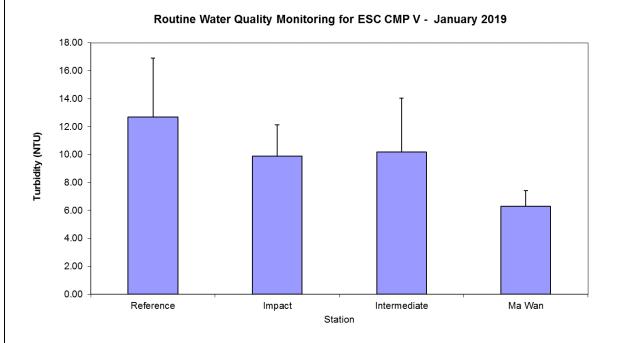


Figure 6: Levels of Turbidity (NTU; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

Date: February 2019



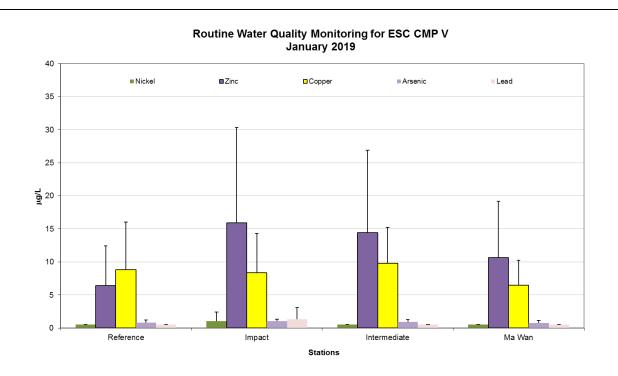


Figure 7: Concentration of Arsenic, Nickel, Lead, Copper and Zinc ( $\mu g/L$ ; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

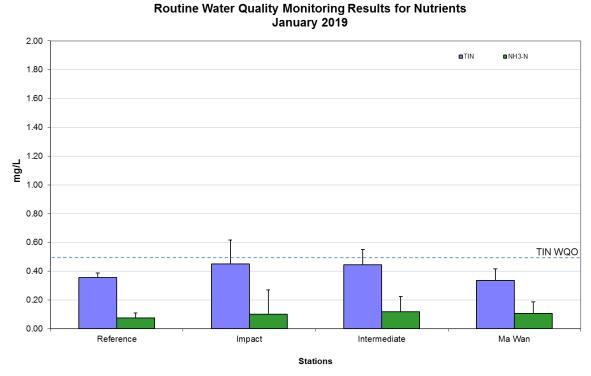


Figure 8: Concentration of Total Inorganic Nitrogen (TIN) and Ammonia Nitrogen (NH3-N)  $(\mu g/L; mean + SD)$  in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

Source: H:\Team\EM\GMS Projects\0400720 CEDD CMP EM&A 2017-2020\02
Deliverable\05 CMP Monthly Report\January 2019)

Date: February 2019

Environmental
Resources
Management

ERM

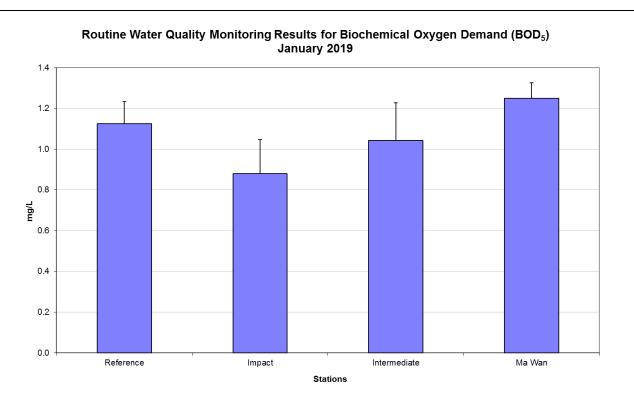


Figure 9: Level of Biochemical Oxygen Demand (BOD₅) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

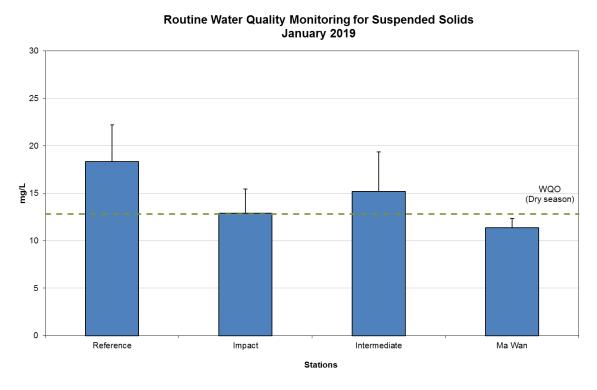


Figure 10: Concentration of Suspended Solids (SS) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in January 2019.

Date: February 2019



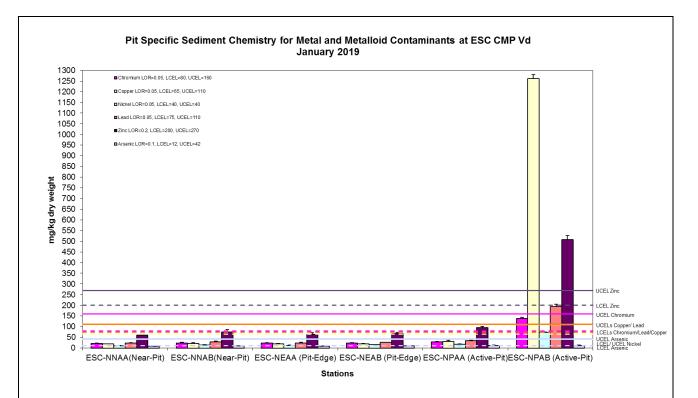


Figure 11: Concentration of Metals and Metalloid (Cr, Cu, Ni, Pb, Zn, As; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in January 2019.

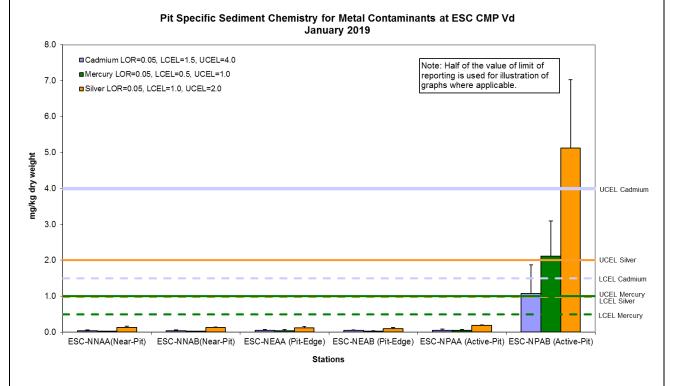


Figure 12: Concentration of Metals (Cd, Hg, Ag; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in January 2019.

Date: February 2019



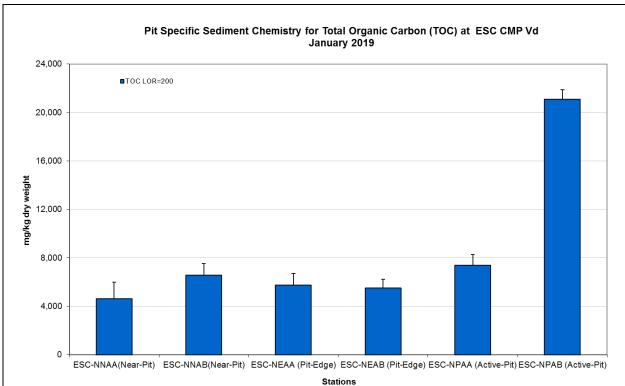


Figure 13: Concentration of Total Organic Carbon (TOC) (mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in January 2019.

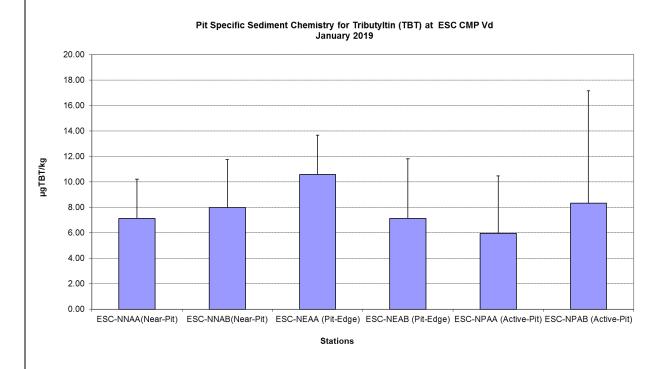


Figure 14: Concentration of Tributyltin (TBT) (µg TBT/kg; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in January 2019.

Date: February 2019



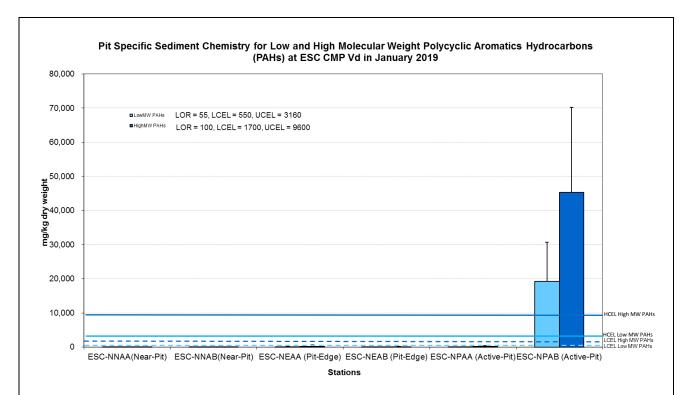


Figure 15: Concentration of Low and High Molecular Weight Polycyclic Aromatics (mg/kg dry weight; mean +SD) in sediment samples collected from Cumulative Impact Sediment Chemistry Monitoring for ESC CMPs in January 2019.

Date: February 2019



#### Annex D

## Study Programme

