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Civil Engineering and Development Department

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Environmental Impact Assessment Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters - Investigation

Project Profile for Sediment Removal at Yim Tin Tsai, Yim Tin Tsai East Fish Culture Zones and Shuen Wan Typhoon Shelter

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TABLE OF CONTENTS

Page

List of Tables

List of Figures

APPENDICES

Appendix A	Noise Impact Assessment
Appendix B	Water Quality Impact Assessment
Appendix C1	Coordinate, Type, Dredging Depth, Sampling Depth and Number of Sub-samples for Each Sediment Sampling Location
Appendix C2	Sediment Chemical Screening Results
Appendix C3	Sediment Chemistry Exceedance Summary and Biological Testing Results
Appendix C4	Environment, Transport and Works Bureau Technical Circular (Works) (ETWB TCW) No. 34/2002 - Management of Dredged / Excavated Sediment
Appendix C5	Sediment Testing Parameters and Analytical Methods
Appendix D	Ecological Impact Assessment
Appendix E	Fisheries Impact Assessment
Appendix F	Marine Archaeological Review
Appendix G	Environmental Monitoring and Audit Requirements

1. BASIC INFORMATION

Project Title

1.1 Sediment Removal at Yim Tin Tsai, Yim Tin Tsai (East) Fish Culture Zones and Shuen Wan Typhoon Shelter (hereinafter referred to as the Project).

Purpose and Nature of the Project

1.2 The scope of the Project is to remove the sediments at the Yim Tin Tsai and Yim Tin Tsai (East) Fish Culture Zones (FCZ) in order to improve the fish culture marine environment, as well as to carry out maintenance dredging at the Shuen Wan Typhoon Shelter to allow vessels to berth within the shelters at low tide and to enhance navigational safety. For sediment removal at the FCZs, the Project will also involve relocation of existing fish rafts and the setting up of temporary sites for the relocated fish rafts.

1.3 This Project Profile includes an assessment of the potential environmental impacts associated with the proposed sediment removal works. Upon completion of the sediment removal works, temporary relocated fish rafts will be moved back to the existing FCZs and no environment impact would be generated.

Name of Project Proponent

1.4 Civil Engineering and Development Department (CEDD) is the works department while Agriculture, Fisheries and Conservation Department (AFCD) and Marine Department (MD) is the client department.

Location and Scale of Project

1.5 The sediment removal work will be undertaken (by means of dredging) in the Yim Tin Tsai and Yim Tin Tsai (East) FCZs, as well as Shuen Wan Typhoon Shelter in Tolo Harbour. The boundaries of the areas to be dredged for the two FCZs will extend beyond the gazetted boundaries of the FCZs for a distance of 10m to remove the organic pollutants (excessive trash fish feed) deposited beyond the zone area. The proposed dredging areas for Yim Tin Tsai, Yim Tin Tsai (East) FCZs and Shuen Wan Typhoon Shelter are presented in **Figure 1.1.**

1.6 The existing fish rafts from the two FCZs will be relocated temporarily to areas which will not interfere with the dredging operation. Relocation of fish rafts will be undertaken before commencement of the dredging operation. The proposed temporary fish raft relocation plan is also shown in **Figure 1.1**. The marine culture activities will be resumed within the gazetted boundaries of the Yim Tin Tsai and Yim Tin Tsai (East) FCZs after completion of the sediment removal works.

1.7 A maximum dredging depth of 2m is proposed for Yim Tin Tsai and Yim Tin Tsai (East) FCZs, while a maximum dredging depth of 1m is proposed for Shuen Wan Typhoon Shelter. The existing seabed profile in the vicinity of Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ and Shuen Wan Typhoon Shelter are shown in **Figure 1.2** to **Figure 1.4** respectively.

1.8 The dredging areas and estimated dredging volumes for the Project are given in **Table 1.1**. The dredging volumes were estimated based on detailed engineering and environmental assessments and have been minimized to the amount necessary to meet the Project needs.

Table 1.1 Estimated Volume of Dredged Sediment at Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ and Shuen Wan Typhoon Shelter

Dredging sites	Gazetted Zone Area of FCZ	Approx. Dredging Area (m^2)	Approx. Volume of Dredged Material (m^3)
Yim Tin Tsai FCZ	137000	153000	210000
Yim Tin Tsai (East) FCZ	150000	168000	256000

Dredging sites	Gazetted Zone Area of FCZ	Approx. Dredging Area (m^2)	Approx. Volume of Dredged Material (m^3)
Shuen Wan Typhoon Shelter	-	145000	72000
		Total:	**538000**

Rationale for Sediment Removal

Yim Tin Tsai and Yim Tin Tsai (East) FCZs

Measures for Minimizing Recurrence of Sediment Pollution

1.9 Bottom sediments under the FCZ contain a certain amount of organic matter accumulated over the years. This was largely the result of the traditional practice of using trash fish as fish feed in the past decades. Continuous effort is being made by the Agriculture, Fisheries and Conservation Department (AFCD) in promoting the use of pellet feed to replace trash fish, traditional feed for marine culture at the FCZ. Dry pellet fish feed is getting popular among marine culture in recent years. The combined ingredients are extruded into pellets of different sizes and densities to suit the feeding behavior of different types of cultured fish. Dry pellet fish feed can significantly reduce pollution caused by fish feeding and improve both the feed efficiency as well as fish health, promoting a cleaner sea bottom in the long term. The improvement of sea bottom conditions through promotion of the environmental – friendly pellet feed alone could likely be a slow process. To achieve quick improvements in the marine environment and due to the silting up at the FCZ, it is proposed to remove the bottom sediment at the FCZ by dredging. There are several localized benefits in this Project in both fisheries and ecological views. They include:

- Improvement of the local water quality and sediment condition to be more suitable for fish culture and for benthic colonization.
- Removal of the anoxic sediments to enable fast recovery of bottom environment within weeks rather than years through decomposition by natural process.
- Removal of the bulk of nutrient trapped in the sediment in the FCZs can help to reduce the risks of local red tide.
- Minimizing fish kills due to the upwelling of anoxic and toxic gas.

1.10 The sedimentation problems at Yim Yin Tsai and Yim Tin Tsai (East) FCZs are subject to the long-term historic discharges, which has been significantly affecting the fish farming activities. Dredging is therefore the most effective and preferred option in dealing with the chronic sedimentation problems at the FCZ, whilst continuous effort in promoting the use of environmental-friendly pellet feed at the FCZ would minimize the recurrence of sediment pollution and associated pollution generated from the dredging work in the long run. This is the optimal approach for improving the local water conditions for marine culture operations as demonstrated from the past successful experience of similar dredging projects for Cheung Sha Wan and Sham Wan FCZs.

Sediment Quality Analysis and Determination of Dredging Extent

1.11 Sediment sampling and testing was conducted under this Project to collect information on the sediment quality in FCZ. The quality of marine sediments can serve as the indicator of the health of the sea for marine culture activities. Sediments with high measured nutrient contents (e.g. nitrogen) may exert a nutrient flux on the overlaying water. Deposition of organic particulate matter would exert oxygen demand on the overlaying water affecting the dissolved oxygen (DO) level (which is an important parameter for maintaining a healthy ecosystem). High negative redox potential as well as high levels of sediment oxygen demand (SOD) and total organic carbon (TOC) measured in the sediment samples would be an indication of anoxic condition signifying the lack of oxygen in the overlaying water. Sediment samples were collected at selected stations within and outside the Yim Tin Tsai and Yim Tin Tsai (East) FCZs for laboratory analysis of nutrients (including ammoniaical nitrogen, total kjeldahl nitrogen, nitrate nitrogen, nitrite nitrogen), SOD, redox potential and TOC levels. Based on the sediment sampling results, a certain degree of nutrient and organic contamination was identified in majority of the sediment samples collected from the FCZs up to a depth of 2m below the existing seabed. Besides, some of the existing water depths inside the FCZs were shallow (less than 3m) based on the recent echo sounding survey carried out under this Project. Hence, the culture fish in the FCZs could easily be affected by any possible contaminants release from bottom sediments. It is recommended to increase the water depths in these FCZs by a maximum of 2m to provide a suitable fish farming environment. As organic contamination was also found in the control stations outside the FCZ boundaries, it is recommended that the boundaries of the area to be dredged for the two FCZs should extend beyond the gazetted boundaries of the FCZs for a distance of 10 m to take account of the contaminated materials deposited beyond the FCZ boundaries. The proposed dredging extent is essential for improving the local water conditions needed for healthy fish culture environment.

<u>Shuen Wan Typhoon Shelter</u>

1.12 The Shuen Wan Shelter serves a wide range of vessels typically up to around 30m including fishing vessels, pleasure craft including motor cruisers, work boats and small crafts including sampan and motor boat. Except with the permission of the Marine Department, the following restrictions are imposed:

- No vessel with overall length longer than 30.4m is allowed;
- A vessel is only allowed to tow one vessel in a chain or not more than two vessels alongside.

1.13 There are also 4 government moorings inside the typhoon shelter. With overall length of the vessel up to 30.4m, it is reasonable to assume the draft of the design vessel to be 4m.

1.14 In order to allow vessels to berth within the shelter at low tide and to enhance navigational safety, a sufficiently large basin with sufficiently deep is required for the design vessel. The dredged depth for the typhoon shelter has been determined to suit the draft of design vessel, plus 10% for under-keel clearance and 0.5m allowance for siltation, with full consideration of relevant environmental influences (including tides, winds and waves). Taking the above factors into consideration, a seabed level of -5m CD [(1)] at the basin would be sufficient for vessels to berth within the shelter at low tide and ensure navigation safety. For seabed within the shelter with level above -5m CD, maintenance dredging will be carried out and as the optimal dredging depth is 1 m, 1m dredging will be carried out at seabed within the shelter with level above -5m CD with due consideration for structural integrity of the edge structures.

1.15 There are many edge structures along both northern shore and the eastern shore of the shelter. In order to ensure their stability, a reasonable distance will be kept between the dredging edge and the existing structures. A dredging slope of 1 in 8 or flatter will be adopted from the navigation point of view. With the toe of the dredging at -5.0m CD, the crest of the dredging slope will be at about -1 to -2m CD. There will be no dredging above the crest of the proposed dredging. Also for the seabed area with level at or below -5mCD, no dredging will be carried out. The proposed dredging boundary for Shuen Wan Typhoon Shelter is indicatively shown in **Figure 1.4**.

Need of Project and Project Benefits

Yim Tin Tsai and Yim Tin Tsai (East) FCZs

1.16 The aim of the Project is to remove the contaminated sediment within the FCZs to improve the fish farming environment. The extent of sediment which needs to be dredged at the FCZs is based on the sediment quality within the FCZs. Detailed sediment sampling and testing has been

[(1)] Designed dredged level= 0.61mCD(MLLW)- 4m (draft)-0.4m(under-keel clearance)
- 0.35m(Hs/2)
- 0.5m(allowance for bottom changes between maintenance dredging)
- 0.3m (dredging execution tolerance)
= - 4.94m CD (Say -5.00 m CD)

conducted under the Project to provide information on the sediment quality within and near the FCZs (refer to Section 1.11). The proposed extent of the sediment removal within the FCZ has been reviewed with reference to the sediment quality testing results and has been reduced to the minimum essential for improving the fish farming water environment and hence minimizing the volume of dredged sediment generated from the Project.

1.17 In fact, dredging at the FCZs will improve the FCZ fish farming environment and have the following environmental benefits:

- Improve of the seabed conditions under the FCZs will encourage colonization of bottom-dwelling marine organisms and helps provide a healthy marine ecological environment conducive to fish culture;
- Lower the risks of fish kills due to anoxic condition and upwelling of toxic gas from the bottom sediment;
- Removal of the bulk nutrient trapped in the sediment in the FCZ can help to reduce the risks of local red tide;
- General improvement of local marine ecological environment at the FCZs.

1.18 Water quality is an important factor affecting the productivity of marine culture operations in Hong Kong. Sufficient water depth would need to be maintained at the FCZ to avoid physical contact between the fish cage and the bottom sediment and to minimize any potential significant water quality impact upon the culture fish from the organic pollutants (excessive trash fish feed) deposited within the FCZ. Dredging is the most effective and optimum option in dealing with the chronic sedimentation problems at the FCZ (as a result of historic pollution discharges), whilst continuous effort in promoting the use of environmental-friendly pellet feed at the FCZ would minimize the recurrence of sediment pollution and associated pollution generated from the dredging work in the long run. Without the Project, the water condition at the FCZ and hence the quality and quantities of the marine culture products as well as the livelihood of the marine culturists will be adversely affected.

Shuen Wan Typhoon Shelter

1.19 The recommended dredged depth and dredging extent for the typhoon shelter has been determined by detailed engineering assessments with reference to the latest information on the existing seabed profile, drafts of anticipated vessels using the typhoon shelter and other environmental influences (including wave and climate data). The assessments were used to confirm the required navigation space for berthing of the vessels at the typhoon shelter. Without the proposed dredging works, the safety of the vessels' manoeuvring within the typhoon shelter will be in question.

Consideration of Alternatives

<u>Dredging Programme</u>

1.20 Due to silting up at the FCZs and typhoon shelter, the required sediment removal works have to be carried out as soon as possible. The current tentative programme is to commence the sediment removal works in late 2009 or 2010. Therefore, no alternative programme has been considered for the Project.

1.21 The environmental assessments provided in Section 3 of this Project Profile have assumed that the sediment removal works for the Yim Tin Tsai FCZ and the typhoon shelter would be undertaken concurrently, which would be a worst case in terms of the potential noise impact upon the noise sensitive receivers around the shore of the typhoon shelter as well as the overall water quality impact upon the inner Tolo Harbour. Besides, an alternative dredging programme was assessed in this Project Profile to address another possible scenario where the sediment removal work for Yim Tin Tsai FCZ cannot be undertaken as scheduled, and hence, no relocation of fish rafts in the existing Yim Tim Tsai FCZ would take place during the maintenance dredging at the typhoon shelter. This alternative scenario aimed to assess the worst case water quality impact upon existing Yim Tin Tsai FCZ with maintenance dredging activity in close proximity to the fish rafts. According to the assessment results, no unacceptable environmental impacts are expected under the alternative dredging programme with adoption of the recommended maximum dredging rates and implementation of the recommended mitigation measures.

Dredging Method

The maximum production rates for the proposed dredging activities were determined with reference to the results of detailed environmental assessments provided in this Project Profile. Based on the water quality impact assessments (refer to **Appendix B**), in case maintenance dredging for typhoon shelter is to be undertaken concurrently with the dredging works in Yim Tin Tsai FCZ (with fish raft relocation), the recommended maximum allowable production rates for dredging in Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter could be up to 2500 m^3 per day and 600 m^3 per day respectively. In an alternative case where dredging in Yim Tin Tsai FCZ and the associated fish raft relocation cannot be undertaken as scheduled during the maintenance dredging at the typhoon shelter, the maximum production rate for maintenance dredging at the typhoon shelter should be reduced to 300 m^3 per day to safeguard the beneficial use of the existing Yim Tin Tsai FCZ for marine culture. Dredging at Yim Tin Tsai (East) FCZ, on the other hand, would be undertaken at a maximum production rate of 4300 m^3 per day. It should be highlighted that the dredging rates specified above are the maximum allowable values. The average or actual production rate to be adopted on-site may be smaller.

1.22 Closed grab dredgers with grab capacity of approximately 8 m^3 are considered as the most suitable dredgers for relatively small volumes and contaminated mud in the FCZs. It is feasible to use small trailer suction dredgers although these will give less control over handling of contaminated mud and produce more marine sediment by volume (due to high water content) when compared with grab dredging. Larger equipment such as those adopted for major reclamation projects (e.g. Penny's Bay reclamation and Container Terminals in Kwai Chung) would not be feasible for the specific site locations with relatively small water depth and close to water and ecological sensitive receivers. Use of closed grab dredger would be the most cost effective construction method for dredging at the two FCZs. For maintenance dredging in Shuen Wan Typhoon Shelter, derrick lighter with small grab capacity of approximately 2 m^3 will need to be employed due to the shallow water depth and limited space inside the typhoon shelter as well as the limitation on anchorage length.

The environmental assessments conducted under this Project Profile have assumed that dredging in the Yim Tin Tsai FCZ would be carried out by 2 grab dredgers working simultaneously within the FCZ. Dredging at the Shuen Wan Typhoon Shelter would be undertaken using 1 derrick lighter with grab due to the limited space and water depth. Dredging at the Yim Tin Tsai (East) FCZ is assumed to be conducted by 3 grab dredgers operating concurrently within the FCZ. Hence, the proposed dredging areas are assumed to be able to sustain a maximum of 6 dredging plants (grab dredger / derrick lighter) operating simultaneously. Barges serving each dredger are assumed to have a capacity of 1,000m^3 and each barge can only complete one trip to the marine dumping area per day in view that the Project site is distant from the marine mud disposal grounds. It should be highlighted that the number of dredging plants to be working on-site concurrently as mentioned above represents a worst case for conservative predictions of environmental impacts (e.g. construction noise impacts). The actual or average number of construction plants to be used on-site is expected to be smaller.

1.23 The dredging locations, rates, timing and implementation have been analyzed and confirmed by the technical assessments performed for this Project Profile to be environmentally acceptable. In particular, modelling assessment has been carried out under this Project Profile to assess the water quality impacts of undertaking the dredging in either the dry or wet season (refer to **Appendix B**) and concluded that the proposed dredging rates, locations and timing would not cause any unacceptable water quality and marine ecological impact, provided that all the mitigation measures recommended are properly implemented. Further consideration of alternative dredging method and dredging rate is not necessary.

Recommended Traffic Management Measures

1.24 In view of the proposed relocation site is a popular for water ski and other water activities, it is recommended to adopt the following measures after the fish farm relocation during dredging.

- Small floating markers each yellow in colour and fitted with yellow flashing lights will be laid to mark the extent of the silt curtains, the work area and the position of the anchors extending from the dredger and derrick lighter or barge.
- Large yellow buoys fitted with yellow flashing lights will be laid to mark the temporary fish raft relocation sites to allow users of Tolo Harbour to easily identify the relocation sites.

1.25 Dredging will be avoided in October to prevent disturbance to the annual Cross Tolo Harbour Open Race event.

Waste Minimization

1.26 As mentioned in Sections 1.16 to 1.19, the volumes of dredged sediments generated from the Project sites were determined based on detailed engineering and environmental assessments and have been minimized to the amount necessary to meet the Project needs. It is not possible to reuse the dredged sediment under this Project (which involves dredging works only) regardless of the option of dredging methods to be finally adopted. Currently there is no construction method / technology available in Hong Kong that would be technically feasible or practicable to enhance the sediment reuse opportunity for this Project.

Siltation and Future Sediment Removal

1.27 Long term siltation rates may vary significantly across the Project areas. Periodic bathymetric surveys would be required after the Project completion to confirm the actual siltation rates to prevent siltation raising seabed levels higher than the required levels in the future. Any further sediment removal in the future for maintaining normal operation of the FCZs and the typhoon shelter will be subject to separate study and is not covered under this Project.

Number and Types of Designated Projects Covered by the Project Profile

1.28 The proposed sediment removal works are designated project under Part I, Schedule 2, Item C.12 of the Environmental Impact Assessment Ordinance (EIAO) by virtue of "dredging within 500m from the nearest fish culture zone".

Name and Telephone Number of Contact Person

1.29 All queries regarding the Project can be addressed to:

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Civil Engineering and Development Department

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2. OUTLINE OF PLANNING AND IMPLEMENTATION PROGRAMME

Outline of Planning

2.1 The Project will be planned and implemented by CEDD in collaboration with AFCD and MD. Dredging will be carried out by contractors to be appointed by CEDD.

Project Implementation and Timetable

2.2 The Project will involve the following works:

- Temporary relocation of fish rafts; and
- Dredging operation;

2.3 The Project works are tentatively scheduled to commence in late 2009 or 2010 for completion within six months. Relocation of fish rafts will start at least two weeks before the commencement of the dredging operation.

Interactions with Other Projects

2.4 No major project was identified to be carried out concurrently in the vicinity of the Project sites and within 500m from Project site boundary.

2.5 The closest possible concurrent marine works would be the “Development of a Bathing Beach at Lung Mei, Tai Po (Lung Mei Beach)” and the “Sediment Removal at Yung Shue Au FCZ” which is over 1km and 5km respectively away from the Project sites. Sediment removal at Yung Shue Au FCZ would be undertaken 2010 or 2011. The Lung Mei Beach project would commence in August 2010 for completion in August 2012. These concurrent dredging activities have been considered in the water quality impact assessment (refer to **Appendix B** of this Project Profile). Based on the water quality impact assessment, no unacceptable cumulative water quality impact would be anticipated from these concurrent marine works.

3. POSSIBLE IMPACT ON THE ENVIRONMENT

3.1 Based on the nature and location of the Project, potential environmental impacts associated with the Project are identified, as presented below.

Construction Phase

<u>Air Quality</u>

3.2 Air sensitive receivers (ASRs) (refer to **Figure 4.1** and **Table 4.1**) in the vicinity of the dredging sites may be impacted. The dredging activities are marine-based. Marine sediment will be dredged and disposed of at designated marine disposal sites by barge. The moisture content of dredged sediments is very high and negligible fugitive dust emissions are therefore anticipated during the dredging operation. Possible air quality impacts from the Project would be odour emission from dredged sediment and gas emissions from the dredging feet.

3.3 Marine site investigation and laboratory testing have been carried out to determine the contamination level of the dredged sediments. A sediment sampling and testing plan for the marine site investigation and laboratory testing was prepared in accordance with the *Environment, Transport and Works Bureau Technical Circular (Works) (ETWB TCW) No. 34/2002 "Management of Dredged / Excavated Sediment"* and was accepted by the Territorial Control Office (TCO) of EPD from the Dumping At Sea Ordinance (DASO) perspective. The sediment sampling work was conducted in the period from 10 January 2009 to 20 January 2009 comprised 59 sampling stations as shown in **Figure 3.1**.

3.4 The levels of acid volatile sulphide (AVS) were measured for the sediment samples collected under the marine site investigation to assess the potential odour impact from the dredged sediment. In general, high AVS concentrations in sediment indicated that odorous hydrogen sulphide gas is likely to be generated from the sediment. The AVS levels measured in the sediment samples collected at the Project sites were compared with the data measured at other reference / benchmark sites to assess the potential impact.

3.5 Bioremediation was previously undertaken at Shing Mun River and Sam Ka Tsuen Typhoon Shelter to eliminate the odour generating potential of the sediment. Percentage of AVS removal was taken as the primary acceptance criteria of the odour remediation works. Testing of the remediated sediments at these two locations was undertaken under a recent study [(2)] and the measured AVS levels of the sediments collected at Sam Ka Tsuen Typhoon Shelter and Shing Mun River ranged from 50 to 500 mg/kg and from 90 to 100 mg/kg respectively. These sediments are considered to have been remediated to a level with minimum odour impact to the surrounding environment.

3.6 Based on the results of marine site investigation conducted under this Project, the AVS levels of the sediments collected from the proposed dredging areas ranged from 19 to 160 mg/kg, which were within the range of AVS levels measured in the remediated sediments at Sam Ka Tsuen Typhoon Shelter and Shing Mun River. Therefore, it is expected that the potential odour emissions from the sediments within the dredging areas of this Project would be minimal and adverse odour impact from the dredging activities would not be anticipated.

3.7 Potential marine traffic emissions would be resulted from the dredgers. However, given that only a maximum of 6 dredging plants would be concurrently operated in Tolo Harbour, the associated emissions should be limited. It is recommended that ultra low sulphur diesel fuel should be used for all diesel-operated plants and equipment on-site. Therefore, potential gas emission impact arising from the Project is anticipated to be insignificant.

(2) Agreement No. CE 4/2004 (TP) South East Kowloon Development Comprehensive Planning and Engineering Review Stage 1: Planning Review Situation; Report on Odour Issue of Kai Tak Development, November 2006.

Noise

3.8 Noise impacts would be resulted from the proposed dredging works with the use of powered mechanical equipment (PME). Detailed noise impact assessment predicted that the noise levels related to the concurrent construction works at the typhoon shelter and the two FCZs would be in the range of 62 to 68 dB(A) during normal daytime working hours in the absence of mitigation measures. Details of the construction noise calculations and results are presented in **Appendix A**. The predicted construction noise levels arising from the Project works at all representative NSRs (as shown in **Figure 4.1** and **Table 4.1**) would comply with the construction noise criteria ($L_{eq\ (30\ minutes)}$ 75 dB(A) for residential uses / home for age and 70 dB(A) for church).

Water Quality

3.9 Potential water quality concerns from the Project would be fine sediment lost to suspension causing an increase in suspended solids (SS) concentrations in the water column as well as the potential release of sediment-bound contaminants during dredging. No dredging work would be required for temporary relocation of fish rafts. Therefore, no water quality impacts would be generated from the fish raft relocation. Detailed water quality impact from the dredging works has been quantitatively assessed using the Delft3D Model. Based on the model results, no exceedance of the assessment criteria for SS (of 10 mg/L) and sedimentation rate (of 0.1 kg/m^2/day) was predicted at all the identified Water Sensitive Receivers (WSRs) as shown in **Figure 4.2** with implementation of practical mitigation measures. The potential impact from the release of sediment-bound contaminants during dredging was also assessed by reviewing the results of elutriate testing conducted for the sediment collected within the Project sites and also by means of mathematical modelling. The assessment results indicated that the potential impact from contaminant release during dredging would be localized and would not affect any WSRs with implementation of the recommended mitigation measures. Increase in nutrients in the marine water during dredging was also predicted to be localized and minor after implementation of the recommended mitigation measures. Details of the water quality assessment criteria, methodology and results are presented in **Appendix B**.

3.10 Water quality impact could also result from liquid waste such as sewage effluent from the construction work force, spillage of oil, diesel or solvents by vessels involved during dredging and transport. Adoption of the guidelines and good site practices as outlined in Sections 5.7 to 5.9 below as part of the construction site management practices would minimize the potential impacts.

Waste Management

3.11 The total amount of sediments to be dredged and disposed is estimated to be approximately 538,000 m^3 (256,000 m^3 for Yim Tin Tsai East FCZ, 210,000 m^3 for Yim Tin Tsai FCZ and 72,000 m^3 for Shuen Wan Typhoon Shelter). Marine site investigation and laboratory testing have been carried out to determine the contamination level of the dredged sediments. A sediment sampling and testing plan for the marine site investigation and laboratory testing was prepared in accordance with the *ETWB TCW No. 34/2002* and was accepted by the Territorial Control Office (TCO) of EPD from the Dumping At Sea Ordinance (DASO) perspective. Details of the *ETWB TCW No. 34/2002* are provided in **Appendix C4** for easy reference. The sediment sampling work was conducted in the period from 10 January 2009 to 20 January 2009 comprised 59 sampling stations (based on a 100m x 100m sampling grid) as shown in **Figure 3.1**. The sampling types and depths of the sampling stations with reference to the proposed dredging levels are summarized in **Appendix C1**. The sediment testing parameters and the corresponding chemical screening results are presented in **Appendix C2**. The analytical methods and quality assurance / quality check procedures for the sediment sampling and testing are given in **Appendix C5**. The requirements of chemical and biological screening are detailed in **Appendix C4**. A summary of the sediment chemistry showing exceedances and the biological screening results are given in **Appendix C3**. The volume of sediment requiring different disposal options as identified in accordance with the *ETWB TCW No. 34/2002* are estimated in **Table 3.1** below. The estimation was undertaken with reference to the sediment quality data, proposed dredging area, existing seabed profile (obtained from recent echo sounding survey) and the dredging depth profile. The potential extent of the identified contaminated sediment is also illustrated in **Figure 3.1**. The quality and disposal requirements for the dredged mud were determined with reference to the requirements of the *ETWB TCW No. 34/2002* attached in **Appendix C4**.

Table 3.1 Volume of Sediment Requiring Different Disposal Options (in m^3)

Disposal Option	Yim Tin Tsai East FCZ	Yim Tin Tsai FCZ	Shuen Wan Typhoon Shelter	Total
Type 1 – Open Sea Disposal	145000	95000	24000	**264000**
Type 1 – Open Sea Disposal (Dedicated Sites) See Note 1	49000	8000	34000	**91000**
Type 2 – Confined Marine Disposal	62000	102000	14000	**178000**
Type 3 – Special Treatment / disposal	0	5000	0	**5000**
Total	**256000**	**210000**	**72000**	

Note 1: According to the ETWB TCW No. 34/2002, Open Sea Disposal at Dedicated Sites implies that monitoring will need to be undertaken to confirm that there is no adverse impact.

3.12 The basic requirements and procedures for dredged mud disposal are specified under the ETWB TCW No. 34/2002 attached in **Appendix C4**. The management of the dredging, use and disposal of marine mud is monitored by the Marine Fill Committee (MFC), while the licensing of marine dumping is required under the Dumping at Sea Ordinance and is the responsibility of the Director of Environmental Protection (DEP).

3.13 The dredged marine sediments would be loaded onto barges and transported to the designated disposal sites allocated by the MFC depending on their level of contamination. Sediment classified as Category L would be suitable for Type 1 - Open Sea Disposal. Contaminated sediment would require either Type 1 – Open Sea Disposal (Dedicated Sites) or Type 2 - Confined Marine Disposal and must be dredged and transported with great care in accordance with ETWB TCW No. 34/2002. Subject to the final allocation of the disposal sites by MFC, the dredged contaminated sediment must be effectively isolated from the environment upon final disposal and shall be disposed of at the designated Contaminated Mud Pits that are designated for the disposal of contaminated mud in Hong Kong. The disposal options as identified in this Project Profile will be subject to confirmation from MFC. The Project works will not be carried out before obtaining confirmation from MFC on the disposal options.

3.14 Approximate 5,000 m^3 (about 1%) of the dredged sediments would require Type 3 Special Treatment / Disposal. It is proposed that special disposal arrangements, rather than pre-treatment, would be appropriate for these Type 3 materials provided there would be negligible loss of sediment to the marine environment during the dumping operations. A detailed review of possible special disposal arrangements for contaminated sediment was carried out under the Design and Construction of Wan Chai Reclamation Phase II (WDII D&C) with the objective of keeping the loss of sediment to the surrounding marine environment to a negligible extent. The method pursued as having the least potential for loss of contaminants to the marine environment is by containment of the sediments in geosynthetic containers. A feasible containment method is proposed whereby the dredged sediments are sealed in geosynthetic containers and, at the disposal site, the containers would be dropped into the designated contaminated mud pit where they would be covered by further mud disposal and later by the mud pit capping, thereby meeting the requirements for fully confined mud disposal. The technology is readily available for the manufacture of the geosynthetic containers to the project-specific requirements. Field trials of geosynthetic containers were undertaken under the WDII D&C consultancy using uncontaminated mud to demonstrate the feasibility of the proposed method. The Report on the field trials of geosynthetic containers (provided on the public domain, refer to http://www.epd.gov.hk/eia/register/report/eiareport/eia_1412007 /html/Vol%206%20-%20Appendices%20(2%20of%202)/appendix-6.2.pdf) concluded that disposal by sealing the dredged sediments in geosynthetic containers and dropping these containers into the contaminated mud pits has been shown to be a successful and viable disposal method. The use of a geosynthetic container system for special disposal was considered to be an effective system with negligible loss of contaminants to the marine environment during disposal.

3.15 Besides the dredged sediments, a small amount of chemical wastes from the maintenance of plant/powered mechanical equipment and general refuse is also expected to be generated from the Project. Mitigation measures are recommended in this Project Profile to minimize potential environmental impacts associated with handling and disposal of different wastes arising from the Project. Provided that the recommended mitigation measures are properly followed, adverse environmental impacts would not be expected from the proposed dredging work.

Ecology

3.16 Possible direct impacts to marine ecological resources would include loss of subtidal soft bottom habitat of 40.7 ha and associated benthos communities in the Project Site due to the dredging activities. The benthos communities within the dredging areas were of low ecological value, with no rare species or species of conservation interest recorded. In view of low ecological value of the subtidal soft bottom habitat and temporary nature of the impact (lasts < 6 months), the ecological impact of temporary habitat loss due to dredging activities would be considered minor.

3.17 Potential indirect water quality concerns to marine ecological resources would be increased suspended solids (SS) levels, release of pollutants and contaminants, and decreased dissolved oxygen (DO) in the water column during dredging. Based on the water quality modelling results (**Appendix B**), no adverse impacts on DO levels in Tolo Harbour would be expected, while the potential water quality influence zone for increased SS levels, and increased pollutants and contaminants, would be localised with the implementation of practical mitigation measures. No exceedance of any Water Quality Objectives (WQOs) was predicted at all the identified important ecological resources in the Assessment Area as shown in **Figure 4.3**.

3.18 Only one species of conservation interest, locally common hard coral *Oulastrea crispata* was recorded within or in the vicinity of the Project Site, at northeast coast and breakwater of Shuen Wan Typhoon Shelter, coast at north of Yim Tin Tsai FCZ and coast of Tai Po Shuen Wan Golf Centre. Coral colonies in close proximity to the proposed dredging sites, Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter (at REA transects T1 to T5) (**Figure 4.5**), would be indirectly impacted by elevated SS resulting from the dredging operations. With the implementation of silt curtains around the dredging area in construction phase, the elevated SS level to the coral areas would be effectively minimised, however, still present due to the short distance.

3.19 Other indirect disturbance impacts arising from the Project would be temporary and minimised with implementation of proper mitigation measures. No unacceptable ecological impact on ecological resources is anticipated.

3.20 In addition, the Project has positive impacts to the local marine ecology in Tolo Harbour in long term. It improves the seabed conditions of the dredging areas, providing a healthy marine ecological environment for benthos colonization. Moreover, it removes the contaminated sediment, improving the anoxic condition and lowering the risks of upwelling of toxic gas from the bottom sediment and the occurrence of algal bloom in Tolo Harbour.

3.21 Details of the ecological assessment criteria, identification and evaluation of impacts are presented in **Appendix D**.

Fisheries

3.22 Possible direct fisheries impacts during construction phase are the temporary closure of about 28.6 ha of marine culture fisheries areas in Yim Tin Tsai and Yim Tin Tsai East, and temporary closure of 36.08 ha of fishing grounds at the 4 proposed relocation sites for fish rafts. In view of the small size of the affected area and temporary nature of the impact (lasts <6 months), the impacts to fisheries production are considered minor and acceptable.

3.23 Potential indirect impacts to the fisheries resources would be changes in water quality, i.e. increased SS levels, release of pollutants and contaminants, and decreased DO in the water column during dredging. Based on the water quality modelling results (**Appendix B**), no adverse impacts on the DO levels in Tolo Harbour would be expected, while the potential water quality influence zone for increased SS levels, and increased pollutants and contaminants, would be localised with the implementation of practical mitigation measures. No adverse water quality impact was predicted at sites of important fisheries resources, including important nursery grounds for commercial fisheries resources in Three Fathoms Cove and Hoi Ha Wan, and far-field FCZs in Lo Fu Wat and Yung Shue Au (**Figure 4.7**).

3.24 The livelihoods of the culture and capture fishers operating in Tolo Harbour may be affected due to the temporary closure of mariculture areas and fishing grounds. To minimise the impact to mariculture operations, mariculture activities can be continuously operated in the 4 proposed relocation sites in construction phase. In view of the temporary nature of impacts and availability of alterative mariculture areas, the impact to the livelihood of mariculture operators is considered minor and acceptable. For capture fisheries, the 4 relocation sites support generally low to moderate fisheries production, constituting an insignificant portion of the total fishing areas in Hong Kong, the temporary impact to the livelihood of capture fisheries operators would be insignificant.

3.25 In addition, the Project has positive impacts to the local culture and capture fisheries in Tolo Harbour in long term. It improves the seabed conditions under the two FCZs, providing a healthy marine ecological environment for mariculture operations. Moreover, it removes the contaminated sediment, improving the anoxic condition and lowering the risks of upwelling of toxic gas from the bottom sediment and the occurrence of algal bloom in Tolo Harbour. It may further improve the livelihood of the culture and capture fisheries operators in Tolo Harbour in long term.

3.26 Details of the fisheries assessment criteria, results and evaluation of impacts are presented in **Appendix E**.

<u>Visual</u>

3.27 Temporary visual impact may arise from dredging activities. The proposed sediment removal works would involve barges, tug boats and grab dredgers / derrick lighters working within and near the dredging site as well as transportation of the dredged sediments out of Tolo Harbour by barges. The Project sites, with shallow water depths, cannot sustain large vessel or large equipment and hence only small work vessels and small grab dredgers would be used for dredging. As the existing users of Tolo Harbour would also include a wide range of vessels including different kinds of work boats and container ships (such as cement and oil tankers), use of barges, tug boats and grab dredgers for the proposed sediment removal works are considered fairly compatible with the existing and surrounding environment.

3.28 As the Project works would be located in the marine waters, land uses surrounding the Tolo Harbour and users of the harbour could generally view part of the Project works. Except for the visual receptors located around the shore of Shuen Wan Typhoon Shelter, all of the visual receivers are considered fairly away or distant from the Project works with separation distances varying from over 100m to over 2km. As the Project areas would only occupy a very small portion of the marine water in Tolo Harbour and the construction plants to be used for the Project works would also be small in size, most of the identified visual receivers would have a wide range of alternative views from the dredging works.

3.29 Visual impact from any dredging work close to (e.g. within 100 m from) the sensitive visual receivers around the shore of Shuen Wan Typhoon Shelter would be transient and would take place typically within two weeks only. Most of the dredging areas within the typhoon shelter would be farther away (more than 100m) from the nearest visual receptors.

3.30 The existing fish rafts from the two FCZs will be relocated temporarily to areas which will not interfere with the dredging operation. As fish culture operation is already one of the current uses of Tolo Harbour, the temporary relocated fish rafts are considered compatible with the existing environment. All temporary relocated fish rafts would be kept at least a couple hundreds metres away from the sensitive visual receptors (e.g. residential premises) along the shore. No significant visual impact would be caused by the temporary fish rafts relocation.

3.31 The Project works are considered small in scale and any visual effects induced by the Project works would be temporary and reversible. The magnitude of visual impact contributed from the Project is considered small. No unacceptable visual impact would be anticipated from the Project with mitigation measures.

Cultural Heritage

3.32 Marine archaeological review was conducted through a desk-top review of existing available information (details refer to **Appendix F**). Based on the marine archaeological review, all the dredging sites are located in shallow embayed waters away from historic marine transportation routes. No evidence of any submerged cultural heritage sites including shipwrecks was identified for all the proposed dredging sites from the review of charts, literature and past relevant geophysical data.

Operation Phase

3.33 This is an environmental improvement project for enhancing the fish farming environment at the FCZs and for providing navigation safety at the typhoon shelter. No adverse environmental impact would be generated from the Project during operational phase. Flow and water quality impacts due to the increased water depths at the dredged area were assessed to be minor or minimal (details refer to **Appendix B**). This Project will result in long term environmental benefits as detailed in Sections 1.17 to 1.19.

4. MAJOR ELEMENTS OF THE SURROUNDING ENVIRONMENT

Air and Noise

4.1 Representative air sensitive receivers (ASRs) and noise sensitive receivers (NSRs) in the vicinity of the proposed dredging were identified and are summarized in **Table 4.1**. Their locations are shown in **Figure 4.1**. The study area for noise and air quality assessment is generally defined by a distance of 300m and 500 m respectively expanded from the boundary of the proposed dredging areas as indicated in **Figure 4.1**.

Table 4.1 Representative Air and Noise Sensitive Receivers in the Vicinity of the Proposed Dredging Sites

ASR/ NSR	Description	Type of Use	No. of Floors	Approximate Distance from Boundary of the Dredging Sites (m)		
				Yim Tin Tsai FCZ	Yim Tin Tsai (East) FCZ	Shuen Wan Typhoon Shelter
FM*	Wholesale Fish Market	G/IC	1	297	-	415
BH	The Beverly Hills	Residential	4	152	-	118
CAH1	TWGHS Wu York Yu Care and Attention Home	Home for the Age	3	207	-	100
CAH2	TWGHS Pao Siu Loong Care and Attention Home	Home for the Age	2	271	-	80
SMTC	Sam Mun Tsai Pentecostal Holiness Church	Church	5	451^	-	109
SMTN1	Sam Mun Tsai New Village	Residential	2	387^	483^	63
SMTN2	Sam Mun Tsai New Village	Residential	2	336^	439^	44
SMTN3	Sam Mun Tsai New Village	Residential	2	178	-	35
LYF	Luen Yick Fishermen Village	Residential	2	496^	276	200

Note:
* FM is an air sensitive receiver only.
\- ASRs with a separate distance of over 500 m from the boundary of a particular dredging site are not considered as representative ASRs for that particular dredging site.
^ NSRs with a separate distance of over 300 m from the boundary of a particular dredging site are not considered as representative NSRs for that particular dredging site.

4.2 The on-site survey has revealed that the Fish Marketing Organization Sam Mun Tsai New Village Primary School (namely SMTS) to the southeast of Shuen Wan Typhoon Shelter as shown in **Figure 4.1** was an abandoned school and not in operation. This primary school is therefore excluded in the noise assessment.

Water Quality

4.3 The proposed dredging works will be undertaken in the Tolo Harbour and Channel Water Control Zone (WCZ). Major water sensitive receivers (WSRs) identified in the WCZ include:

- WSD flushing water intakes;
- Cooling water intakes;
- Corals; and
- Fish culture zones.

4.4 Locations of identified WSRs are shown in **Figure 4.2**. According to the recent dive surveys, the seabed of the dredging site was found to be mainly composed of muddy and sandy bottom and of low habitat quality. Limited marine life was seen except only some small and isolated patches of single species of hard coral (*Oulastrea crispata*) were found near the breakwater and near the southeast shore of the Shuen Wan Typhoon Shelter, coast at north of Yim Tin Tsai FCZ and coast of Tai Po Shuen Wan Golf Centre and this species is common in Hong Kong waters and known to tolerate more turbid and harsh environment. Most of the isolated colonies were attached on the surface of the boulders and rocks with very low coverage (<1%) and small size (2 cm to 5 cm). These isolated coral colonies are not considered as sensitive coral site and are therefore not covered in the water quality impact assessment. Details of the dive surveys and full description of the identified coral colonies are provided in **Annex D5**. Details descriptions on the ecological baseline condition and important ecological resources are separately discussed in the subsequent sections and in **Appendix D**.

Ecology

4.5 Ecological habitats within the Tolo Harbour and Channel Water Control Zone (WCZ) included feeding grounds for ardeids, intertidal habitats (i.e. soft shore, rocky shore, mangrove and seagrass bed), subtidal soft bottom habitat and subtidal hard bottom habitat. Key ecological resources identified in the WCZ are shown in **Figure 4.3**, including:

- Egretries;
- Mangrove stands;
- Coral communities;
- Seagrass beds;
- Seahorse *Hippocampus kuda*; and
- Amphioxus *Branchiostoma belcheri*.

4.6 According to the current ecological surveys, the seabed of the Project Site was mainly composed of muddy and sandy bottom, and of low ecological value, with only low coverage (<1%) of locally common hard coral *Oulastrea crispata* recorded. Isolated colonies of *O. crispata* were recorded near the breakwater and southeast shore of Shuen Wan Typhoon Shelter, coast at north of Yim Tin Tsai FCZ and coast of Tai Po Shuen Wan Golf Centre (at REA transects T1 to T7, **Figure 4.5**). In general, most of the coral colonies were small in size (2 to 5 cm) and attached on the surface of big boulders and rocks. *O. crispata* is a pioneering species with high tolerance to turbid water and high sedimentation, and was previously recorded in the polluted and turbid waters along the runway of the Kai Tak Airport in Victoria Harbour. Locations of ecological survey conducted under this Project Profile are shown in **Figure 4.4**. Details of the dive surveys and full description of the identified coral colonies are provided in **Annex D5**. Ardeid species of conservation interest identified within the Assessment Area are shown in **Figure 4.6**. Detailed descriptions on the ecological baseline condition and important ecological resources are presented in **Appendix D**.

Fisheries

4.7 Important fisheries resources identified in the Tolo Harbour and Channel WCZ are shown in **Figure 4.7**, including:

- Yim Tin Tsai and Yim Tin Tsai East FCZs (the Project Site);
- Far field FCZs, in Lo Fu Wat and Yung Shue Au;
- Important nursery grounds for commercial fish resources, in Three Fathoms Cove and Hoi Ha Wan; and
- Proposed fisheries protection area, covering Tolo Harbour and most of Tolo Channel.

4.8 No important spawning or nursery grounds identified within or in the vicinity of the proposed dredging areas. Details descriptions on the fisheries baseline condition and important fisheries resources are presented in **Appendix E**.

Visual

4.9 The nearest groups of visual sensitive receivers (VSRs) from the dredging areas are residents living in Sam Mun Tsai New Village, road travelers along Sam Mun Tsai Road and walkers on breakwater of Shuen Wan Typhoon Shelter. Viewing distance from these VSRs to the dredging sites (i.e. Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter) will be less than 50m.

5. ENVIRONMENTAL PROTECTION MEASURES TO BE INCORPORATED IN THE DESIGN AND FURTHER ENVIRONMENTAL IMPLICATIONS

Construction Phase

Air Quality

5.1 Adverse odour impacts during the dredging operation would not be expected. In order to minimize the potential odour emissions, if any, the dredged sediment placed on barge will be properly covered as far as practicable to minimize the exposed area and hence the potential odour emissions during the transportation of the dredged sediment. Requirements of the Air Pollution Control (Construction Dust) Regulation, where relevant, will also be adhered to during the construction period. It is also recommended that ultra low sulphur diesel fuel should be used for all diesel-operated plants and equipment on-site to minimize the potential construction air pollution from gas emissions.

Noise

5.2 Predicted noise levels from dredging works at all representative NSRs would comply with the noise standards stipulated in the EIAO-TM in the absence of mitigation measures. In order to further ameliorate the construction noise impacts, good site practices will be adopted by all the contractors as far as practicable. Such good site practices include:

- Only well-maintained plants should be operated on-site and plants should be serviced regularly during the construction program.
- Plants should be sited as far away from nearby NSRs as possible.

Water Quality

5.3 Closed grab will be used for dredging to minimize release of sediment and other contaminants during dredging.

5.4 Maximum production rates for the dredging activities at Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ should follow those specified below for two alternative dredging scenarios:

- Alternative Case I: If maintenance dredging for typhoon shelter is to be undertaken concurrently with the dredging works in Yim Tin Tsai FCZ (with fish raft relocation), the maximum allowable production rate for dredging in Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter will be 2,500m^3 per day and 600m^3 per day respectively.
- Alternative Case 2: If dredging in Yim Tin Tsai FCZ and the associated fish raft relocation cannot be undertaken as scheduled during the maintenance dredging at the typhoon shelter, the maximum production rate for maintenance dredging at the typhoon shelter should be reduced to 300 m^3 per day to safeguard the beneficial use of the existing Yim Tin Tsai FCZ for marine culture.

5.5 The maximum production rates for the dredging activities at Yim Tin Tsai (East) FCZ should not be more than 4,300m^3 per day.

5.6 Deployment of silt curtains around the dredging operation is recommended as an appropriate mitigation measure.

5.7 The following good site practices are recommended to be undertaken during dredging and during transportation and disposal of dredged sediment:

- All vessels should be sized so that adequate clearance is maintained between vessels and the seabed in all tide conditions, to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash.

- All barges / dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material.
- Excess material shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved.
- Construction activities should not cause foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the site or dumping grounds;
- Barges or hoppers should not be filled to a level that will cause the overflow of materials or polluted water during loading or transportation.
- Monitoring of the barge loading shall be conducted to ensure that loss of material does not take place during transportation. Transport barges or vessels shall be equipped with automatic self-monitoring devices as required under the Dumping at Sea Ordinance and as specified by the DEP.

5.8 No discharge of sewage effluent into drainage and water environment should be adopted. Appropriate numbers of portable chemical toilets shall be provided by a licensed contractor as necessary to serve the construction workers. The Contractor shall also be responsible for waste disposal and maintenance practices.

5.9 Collection and removal of floating refuse should be performed at regular intervals on a daily basis at or near the dredging sites. The Contractor should be responsible for keeping the water within the site boundary and the neighbouring water free from rubbish during the dredging works.

5.10 Water quality monitoring and audit programme will be implemented to ensure that all the recommended mitigation measures are properly implemented. Details of the monitoring programme are given in **Appendix G**.

Waste Management

5.11 Disposal of dredged mud will follow the requirements and procedures specified under the ETWB TCW No. 34/2002. The management of the dredging, use and disposal of marine mud is monitored by the Marine Fill Committee (MFC), while the licensing of marine dumping is required under the Dumping at Sea Ordinance and is the responsibility of the Director of Environmental Protection (DEP). It is a requirement to satisfy the appropriate authorities that the contamination levels of the marine sediment to be dredged have been analysed and recorded. According to the ETWB TCW No. 34/2002, this will involve the submission of a formal Sediment Quality Report (SQR) to the DEP, prior to the dredging contract being tendered. Allocation of marine disposal sites and all necessary permits will be applied from relevant authorities for the disposal of dredged sediment. The Project Proponent will obtain confirmation from MFC on the disposal options before commencement of the Project works.

5.12 All chemical wastes from equipment maintenance will be handled, stored and disposed of in accordance with the requirements of the Waste Disposal (Chemical Waste) Regulation. General refuse should be stored and disposed of separately from dredged sediment and chemical waste. The storage bins for general refuse would be provided with lids, which should be kept closed to avoid odour nuisance and wind blown litter. The general refuse would be removed regularly and disposed of to licensed landfills, no adverse impact related to handling and disposal of general refuse is expected

Ecology

5.13 Refer to the results of the current coral surveys, coral colonies within the Project Site were mainly recorded at rocks / boulders of the edge structures along the southeast shore and breakwater of Shuen Wan Typhoon Shelter. To avoid direct impact on the coral colonies and impact to stability of the edge structures, the dredging area in Shuen Wan Typhoon Shelter is reduced in size with a reasonable distance away from the existing structures (refer to Section 1.15 and **Figure 1.4**).

5.14 To avoid the potential direct impact to coral colonies due to the anchoring of barges, anchoring should be prohibited at the edges of Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ. Anchoring point of the barges should be restricted within the dredging area.

5.15 The dredging areas are proposed to be as minimum as possible in order to avoid extensive direct impact on existing benthos communities and adjacent intertidal communities within the Project Site.

5.16 During dredging operations, a number of mitigation measures to control water quality (as detailed in the Water Quality Section above), i.e. restriction in dredging rate, use of closed grab for dredging and deployment of silt curtains, would be adopted to confine sediment plume within the proposed dredging area and to minimize indirect impact to the nearby intertidal and subtidal flora and fauna.

5.17 Standard good site practice and management proposed in the water quality impact assessment (as discussed in the Water Quality Section above), such as tight fitting seals to bottom openings of barges / dredgers, effective site drainage, and provision of chemical toilets would minimize any impacts to the marine environment resulting from dredging operations, transportation and disposal of dredged sediment in construction phase.

5.18 To minimize potential disturbance impacts on the foraging ardeid population in the Project Site, appropriate good site practices on noise control shall be adopted during the dredging works to reduce noise generated from the Project as suggested in the noise impact assessment (as discussed in the Noise Section above).

5.19 Coral colonies in close proximity to the proposed dredging sites, Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter, would be indirectly impacted by elevated suspended solids resulting from the dredging operations. Apart from implementation of silt curtains around the dredging area, a coral monitoring programme is recommended to ensure no adverse and unacceptable impacts to the nearby coral colonies.

5.20 The coral monitoring programme comprise a Baseline Survey, Impact Monitoring Surveys and a Post-Project Monitoring Survey. The health status of coral colonies would be carefully recorded in each monitoring, including information on sediment cover, coral mortality and bleaching. Coral monitoring results would be evaluated against Action and Limit Levels. The details of coral monitoring programme are discussed in **Appendix G**.

5.21 To further monitor the potential water quality impact to the nearby coral colonies, a water quality monitoring and audit programme is recommended. The water quality parameters including turbidity, DO and SS levels would be regularly measured to ensure that all the recommended water quality mitigation measures are implemented properly.

<u>Fisheries</u>

5.22 During dredging operations, a number of mitigation measures to control water quality (as detailed in the Water Quality Section above), i.e. constriction of dredging rate, use of closed grab for dredging and deployment of silt curtains, would be adopted to confine sediment plume within the proposed dredging area and to minimize indirect impact to the nearby fisheries resources.

5.23 Standard good site practice and management proposed in the water quality impact assessment (as discussed in the Water Quality Section above), such as tight fitting seals to bottom openings of barges / dredgers, effective site drainage, and provision of chemical toilets would minimize any impacts to the marine environment and associated fisheries resources resulting from dredging operations, transportation and disposal of dredged sediment in construction phase.

5.24 To minimise the impact to mariculture operation due to the temporary closure of FCZs during construction phase, the mariculture activities can be continuously operated in the existing fish rafts in the 4 proposed relocation sites, P1 to P4 (**Figure 4.7**) in construction phase.

Visual

5.25 The following mitigation measures have been incorporated into the design of the dredging works to minimize the potential visual impacts:

- Most of the sensitive visual receivers (e.g. residential premises) are situated on shore (rather than in the marine water), all construction plants used for the sediment removal works would be sited as far away from nearby shoreline as possible.
- All the sediment removal works would be carried out in day time (7:00 to 19:00) to minimize the use of night-time lighting. Lighting, if required, will be carefully controlled.
- The dredged sediment placed on barge will be properly covered as far as practicable to minimize the exposed area and hence the potential visual impact during the transportation of the dredged sediment.
- The recommended water quality mitigation measures (as detailed in the Water Quality Section above) would minimize the water pollution (such as oil, grease, scum, litter or other objectionable matter) and the size of any visible sediment plume to be present on the water within or near the Project sites.

Cultural Heritage

5.26 The Contractor to be employed for the dredging works should inform Antiquities and Monuments Office in case of any discovery of antiquities or supposed antiquities in the course of dredging work at all the Project sites in accordance with the Antiquities and Monuments Ordinance.

Environmental Monitoring and Audit Programme

5.27 An environmental monitoring and audit programme is recommended. Details of the monitoring requirements are given in **Appendix G**.

6. SUMMARY OF POTETNIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASRUES

6.1 The potential environmental impacts and proposed mitigation measures to be incorporated into the dredging works are summarized in **Table 6.1** below:

Table 6.1 Summary of Potential Environmental Impacts and Mitigation Measures

Project Stage / Location	Potential Environmental Impact	Mitigation Measure	Implementation Agent	Relevant Section in the Project Profile
Construction / Construction Site and along the dredged sediment transportation route	Air quality	(1) The dredged sediment placed on barge will be properly covered as far as practicable. (2) Requirements of the Air Pollution Control (Construction Dust) Regulation, where relevant, will be adhered to during the construction period. (3) Ultra low sulphur diesel fuel should be used for all diesel-operated plants and equipment on-site.	Contractor	Section 5
Construction / Construction Site	Construction noise	(1) Only well-maintained plants will be operated on-site and plants should be serviced regularly during the construction program. (2) Plants will be sited as far away from nearby NSRs as possible.	Contractor	Section 5
Construction/ Construction Site	Water quality impact	(1) Closed grab will be used for dredging to minimize release of fines and contaminants. (2) The maximum production rates as indicated in Sections 5.4 and 5.5 will be adopted for the proposed dredging activities. (3) Silt curtains will be deployed around the dredging operation. (4) Good site practices (as outlined in Section 5.7 above) will be adopted during dredging and during transportation and disposal of dredged sediments. (5) Discharge of sewage effluent into drainage and water environment is not allowed. Appropriate numbers of portable chemical toilets will be provided by a licensed contractor as necessary to serve the construction workers. (6) Collection and removal of floating refuse will be performed at regular intervals on a daily basis at or near the dredging sites. (7) Water quality monitoring will be undertaken before, during and after the dredging works (details refer to **Appendix G**)	Contractor	Section 5
Construction/ Construction Site	Waste management	(1) Disposal of dredged sediment will follow the requirements and procedures specified under the ETWB TCW No. 34/2002. (2) All chemical wastes from equipment	Contractor	Section 5

Project Stage / Location	Potential Environmental Impact	Mitigation Measure	Implementation Agent	Relevant Section in the Project Profile
		maintenance will be handled, stored and disposed of in accordance with the requirements of the Waste Disposal (Chemical Waste) Regulation. (3) General refuse will be stored and disposed of separately from general construction waste and chemical waste. The storage bins for general refuse will be provided with lids, which will be kept closed to avoid odour nuisance and wind blown litter. The general refuse would be removed regularly and disposed of to licensed landfills.		
Construction / Construction Site	Ecological impact	(1) Mitigation measures to control water quality, i.e. constriction of dredging rate, use of closed grab for dredging and deployment of silt curtains, proposed in the water quality impact assessment will be adopted. (2) Standard good site practice and management proposed in the water quality impact assessment, such as tight fitting seals to bottom openings of barges/dredgers, effective site drainage, and provision of chemical toilets will be adopted. (3) Good site practices on noise control proposed in the noise impact assessment will be adopted. (4) The health status of the nearby coral colonies will be regularly monitored during the construction phase (details refer to **Appendix D & Appendix G**).	Contractor	Section 5
Construction / Construction Site	Fisheries impact	(1) Mitigation measures to control water quality, i.e. constriction of dredging rate, use of closed grab for dredging and deployment of silt curtains, proposed in the water quality impact assessment will be adopted. (2) Standard good site practice and management proposed in the water quality impact assessment, such as tight fitting seals to bottom openings of barges/dredgers, effective site drainage, and provision of chemical toilets will be adopted.	Contractor	Section 5
Construction / Construction Site	Visual impact	(1) All construction plants would be sited as far away from nearby shoreline as possible. (2) All the sediment removal works will be carried out in day time (7:00 to 19:00) to minimize the use of night-time lighting. (3) Lighting will be carefully controlled if required.	Contractor	Section 5
Construction / Construction Site	Cultural heritage impact	Antiquities and Monuments Office should be informed of any discovery of antiquities or supposed antiquities in the course of	Contractor	Section 5

Project Stage / Location	Potential Environmental Impact	Mitigation Measure	Implementation Agent	Relevant Section in the Project Profile
		dredging work at all the Project sites in accordance with the Antiquities and Monuments Ordinance.		
Construction / Construction Site	Air quality, noise, water quality, ecology, fisheries, visual and cultural heritage	An environmental monitoring and audit programme as recommended in **Appendix G** should be followed.	Contractor	Section 5

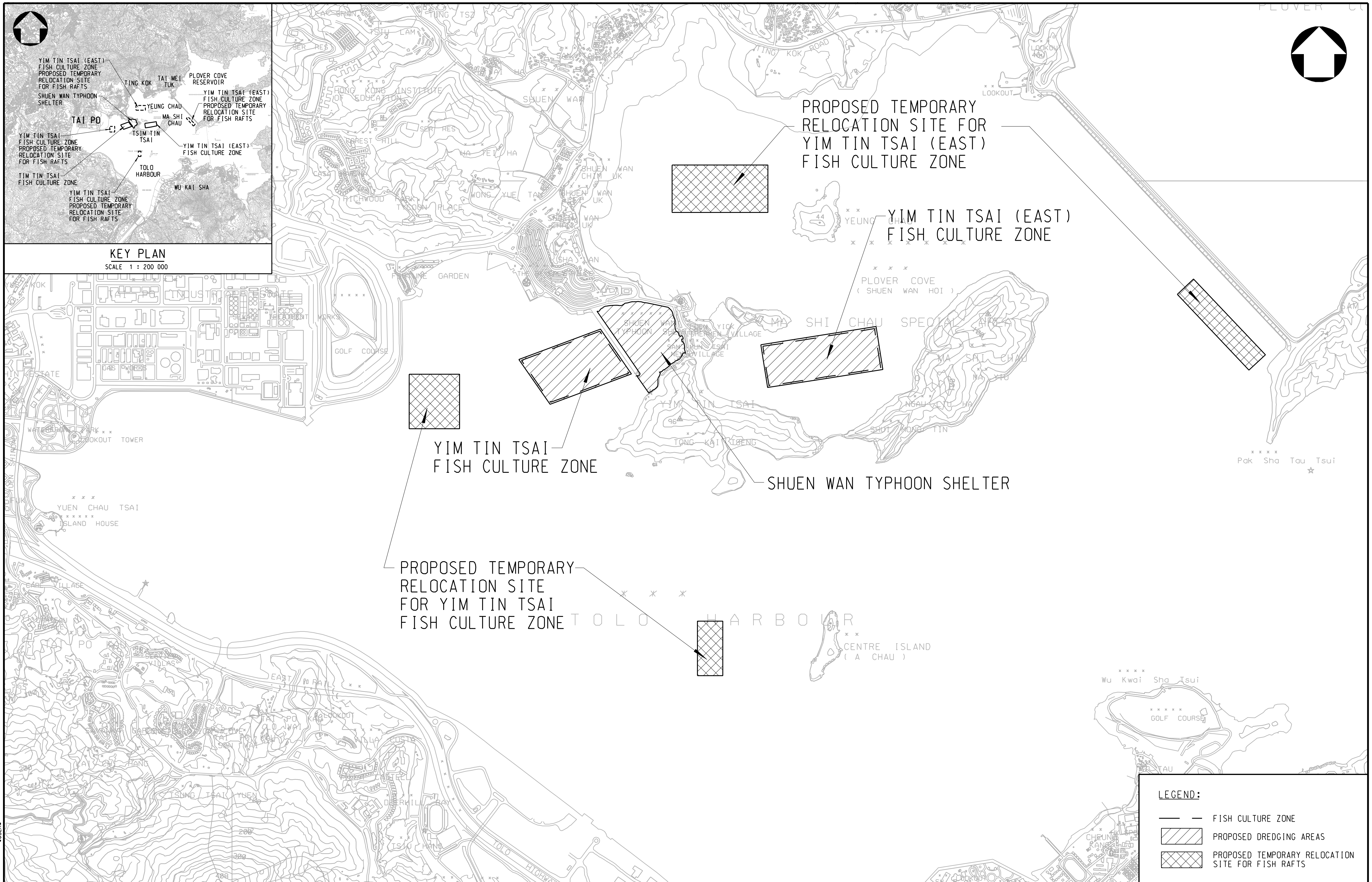
7. USE OF PREVIOUSLY APPROVED EIA REPORTS

7.1 The successful cases of similar nature and scale of designated projects for direct application of EP are summarised as follows:

Table 7.1 Previous Direct Application for Environmental Permit for Sediment Removal at Fish Culture Zones

EIAO Reference	Designated Project Title	Dredging Volume	Distance from Closest Sensitive Receiver
DIR-013/1998	Removal of Sediment in Sham Wan and Kau Sai Fish Culture Zones	226,800 m^3	Approx. 500 m

FIGURE



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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

Sediment Removal at Yim Tin Tsai, Yim Tin Tsai (East) Fish Culture Zones and Maintenance Dredging at Shuen Wan Typhoon Shelter

SCALE	A3 1:20000	DATE	AUG 2009
CHECK	AKYC	DRAWN	ILMW
JOB No.	60092464	DRAWING No.	1.1
		REV	-

Plotting By: $DATE$ $USER$

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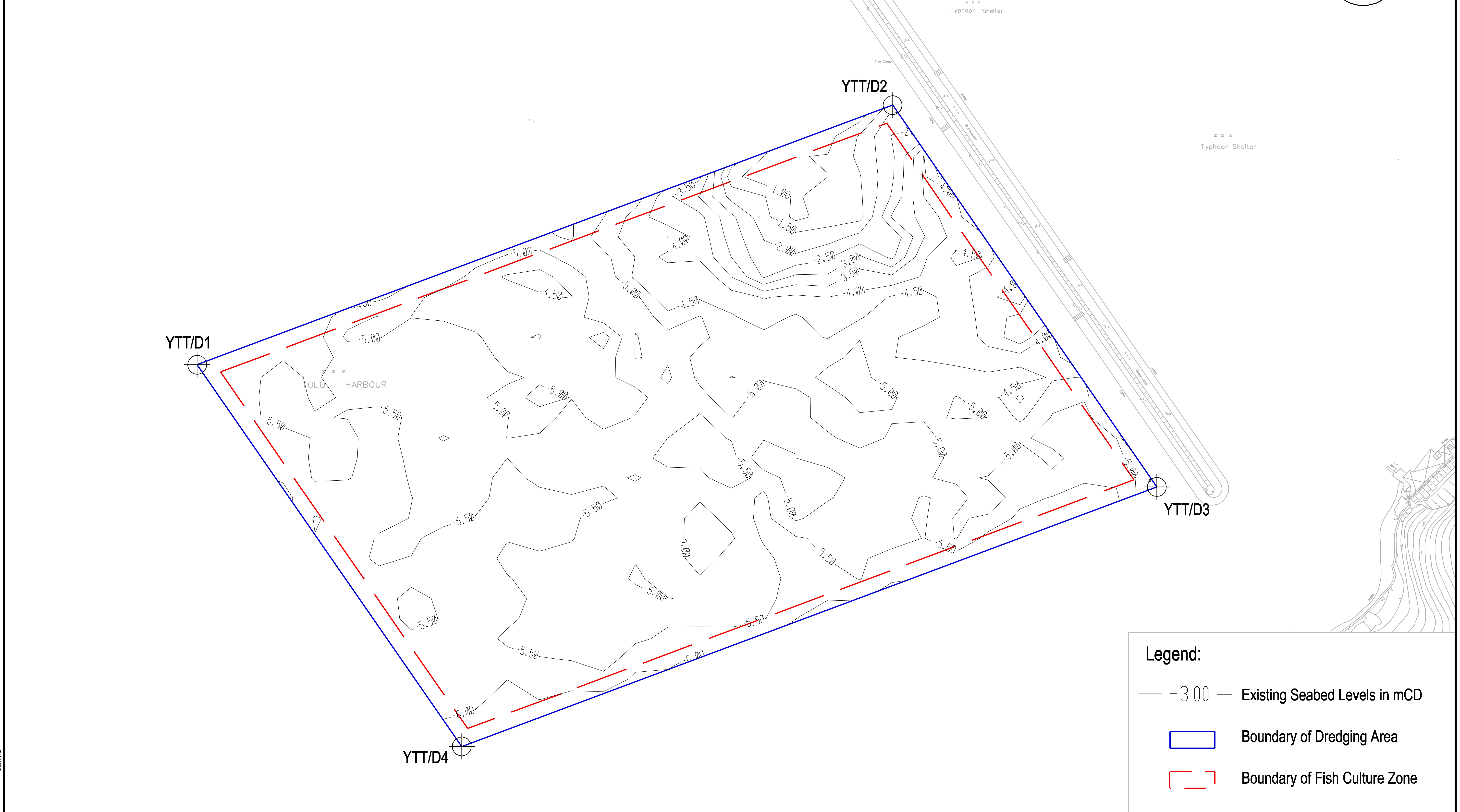
CO-ORDINATES OF DREDGING BOUNDARY

POINT	EASTING (m)	NORTHING (m)
YTT/D1	839147	834972
YTT/D2	839617	835148
YTT/D3	839795	834890
YTT/D4	839326	834715



AECOM

AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

EXISTING SEABED LEVELS - YIM TIN TSAI FISH CULTURE ZONE

SCALE	A3 1:2500	DATE	AUG 2009
CHECK	AKYC	DRAWN	ILMW
JOB No.	60092464	DRAWING No.	1.2
		REV	-

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Plotting By: $DATE$ $USER$

CO-ORDINATES OF DREDGING BOUNDARY

POINT	EASTING (m)	NORTHING (m)
YE/D1	840539	835055
YE/D2	841200	835160
YE/D3	841239	834913
YE/D4	840578	834808

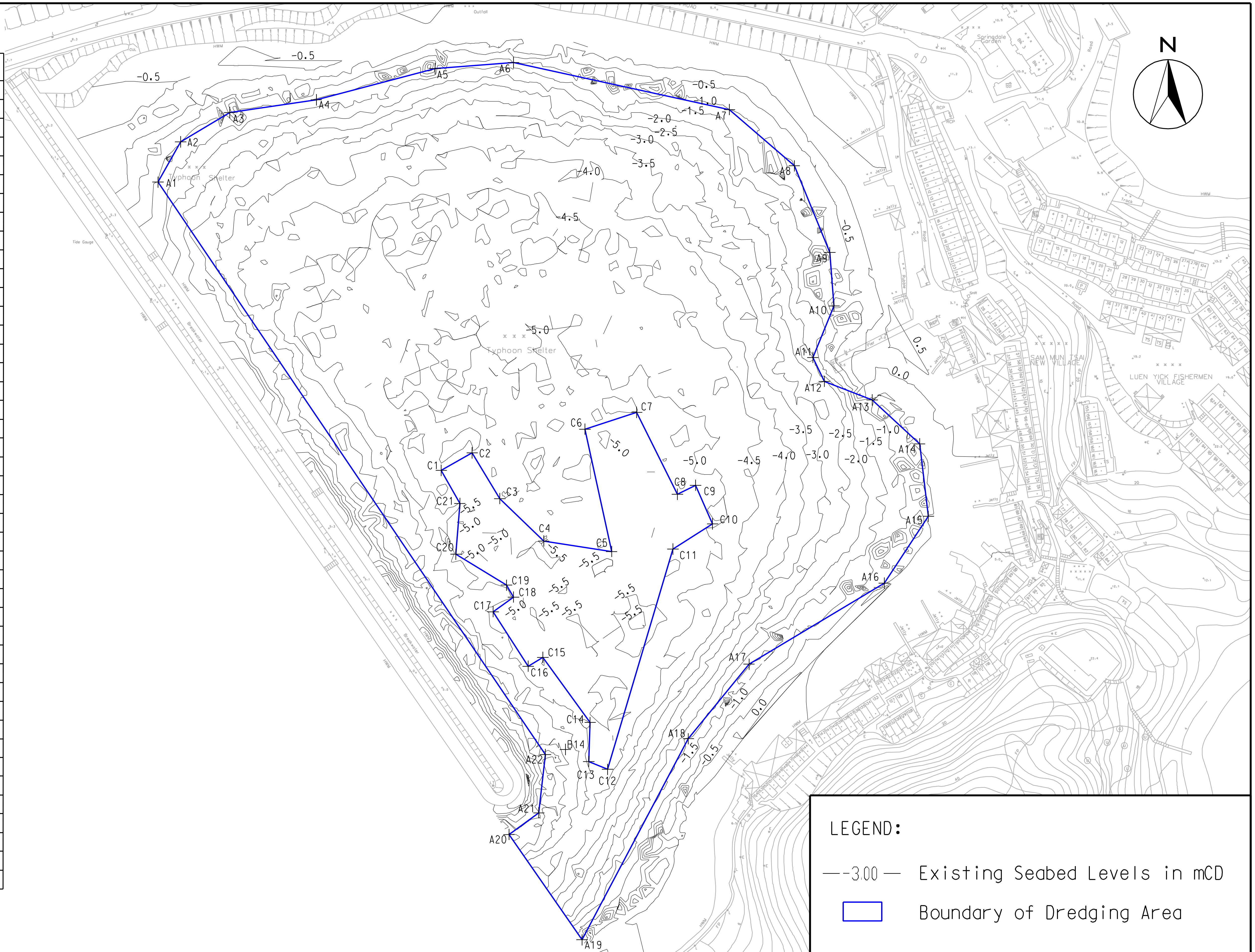
AECOM	AGREEMENT NO. CE 26/2008 (EP) ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION EXISTING SEABED LEVELS - YIM TIN TSAI (EAST) FISH CULTURE ZONE	SCALE A3 1:25000 CHECK AKYC JOB No. 60092464	DATE AUG 2009 DRAWN ILMW DRAWING No. 1.3 REV -

Plotting By: $DATE$ $USER$

P:/60092464/1.01/CAD/Drawing/Report/ Project Profile/YTT/Fig 1.3.dgn

CO-ORDINATES OF DREDGING BOUNDARY

POINT	EASTING (m)	NORTHING (m)
A1	839650.75	835209.65
A2	839662.75	835231.04
A3	839688.87	835246.66
A4	839734.90	835253.45
A5	839797.93	835270.04
A6	839839.63	835273.30
A7	839954.35	835248.26
A8	839988.78	835218.31
A9	840007.64	835172.24
A10	840009.90	835143.78
A11	839998.63	835116.45
A12	840004.73	835103.70
A13	840030.18	835093.87
A14	840055.36	835070.50
A15	840060.04	835031.93
A16	840036.56	834996.39
A17	839964.73	834953.33
A18	839932.50	834913.68
A19	839876.03	834806.75
A20	839837.21	834862.80
A21	839853.08	834874.32
A22	839856.53	834905.33
C1	839801.24	835056.39
C2	839817.68	835065.69
C3	839832.35	835041.37
C4	839855.64	835018.84
C5	839891.74	835013.25
C6	839877.60	835078.32
C7	839905.06	835087.25
C8	839926.72	835043.68
C9	839936.37	835048.48
C10	839945.38	835027.92
C11	839924.30	835014.57
C12	839889.62	834897.42
C13	839879.58	834901.62
C14	839880.32	834922.34
C15	839855.19	834957.02
C16	839847.44	834952.26
C17	839828.78	834981.22
C18	839839.65	834989.03
C19	839835.92	834995.33
C20	839809.04	835011.77
C21	839811.10	835038.82



LEGEND:

—-3.00— Existing Seabed Levels in mCD

Boundary of Dredging Area

AECOM

AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

EXISTING SEABED LEVELS - SHUEN WAN TYPHOON SHELTER

SCALE	A3 1:2000	DATE	AUG 2009
CHECK	AKYC	DRAWN	ILMW
JOB No.	60092464	DRAWING No.	1.4
		REV	-

$USER$
Plotting By: $DATE$

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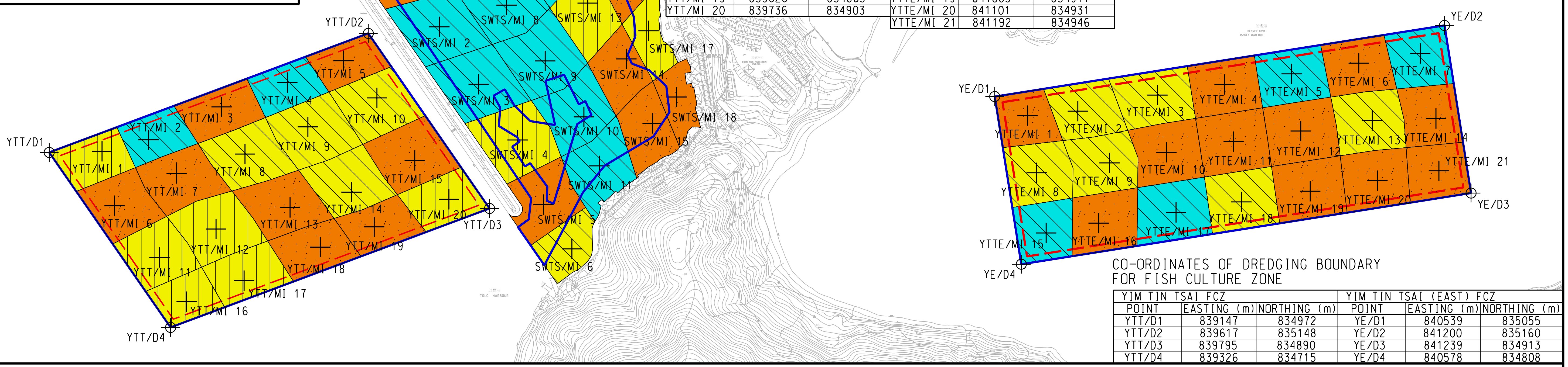
LEGEND:

- SEDIMENT SAMPLING LOCATION
- BOUNDARY OF DREDGING AREA
- BOUNDARY OF FISH CULTURE ZONE
- TYPE 1 - OPENSEA DISPOSAL (CATEGORY L SEDIMENT)
- TYPE 1 - OPEN SEA DISPOSAL (DEDICATED SITES) (CATEGORY M SEDIMENT)
- TYPE 2 - CONFINED MARINE DISPOSAL (CATEGORY M SEDIMENT)
- TYPE 2 - CONFINE MARINE DISPOSAL (CATEGORY H SEDIMENT)
- TYPE 3 - SPECIAL TREATMENT / DISPOSAL (CATEGORY H SEDIMENT)



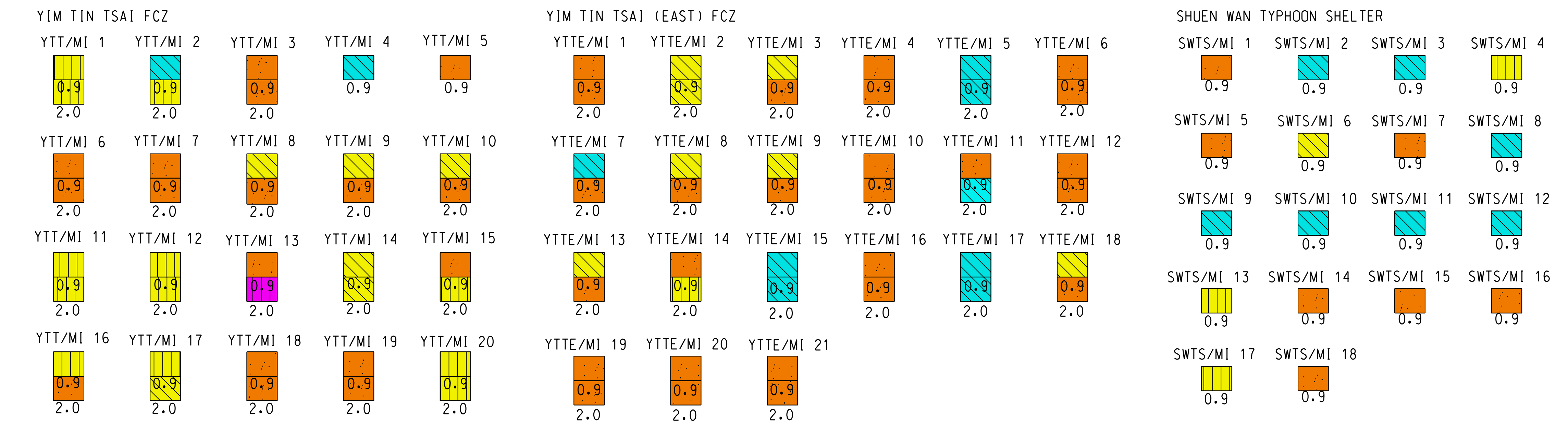
CO-ORDINATES OF SAMPLING LOCATION

YIM TIN TSAI FCZ			YIM TIN TSAI (EAST) FCZ			SHUEN WAN TYPHOON SHELTER			SHUEN WAN TYPHOON SHELTER		
POINT	EASTING (m)	NORTHING (m)	POINT	EASTING (m)	NORTHING (m)	POINT	EASTING (m)	NORTHING (m)	POINT	EASTING (m)	NORTHING (m)
YTT/MI 1	839224	834975	YTTE/MI 1	840587	835027	SWTS/MI 1	839665	835237	SWTS/MI 16	839998	835247
YTT/MI 2	839293	834992	YTTE/MI 2	840660	835033	SWTS/MI 2	839722	835158	SWTS/MI 17	840029	835153
YTT/MI 3	839401	835040	YTTE/MI 3	840779	835057	SWTS/MI 3	839779	835073	SWTS/MI 18	840070	835055
YTT/MI 4	839497	835075	YTTE/MI 4	840876	835073	SWTS/MI 4	839837	834992			
YTT/MI 5	839581	835108	YTTE/MI 5	840976	835088	SWTS/MI 5	839875	834896			
YTT/MI 6	839243	834894	YTTE/MI 6	841074	835105	SWTS/MI 6	839916	834831			
YTT/MI 7	839334	834942	YTTE/MI 7	841165	835118	SWTS/MI 7	839772	835261			
YTT/MI 8	839435	834970	YTTE/MI 8	840600	834942	SWTS/MI 8	839820	835189			
YTT/MI 9	839528	835010	YTTE/MI 9	840707	834957	SWTS/MI 9	839878	835108			
YTT/MI 10	839629	835053	YTTE/MI 10	840791	834974	SWTS/MI 10	839935	835025			
YTT/MI 11	839310	834818	YTTE/MI 11	840890	834988	SWTS/MI 11	839957	834953			
YTT/MI 12	839393	834861	YTTE/MI 12	840988	835005	SWTS/MI 12	839883	835274			
YTT/MI 13	839502	834892	YTTE/MI 13	841094	835020	SWTS/MI 13	839940	835193			
YTT/MI 14	839592	834914	YTTE/MI 14	841187	835024	SWTS/MI 14	839996	835110			
YTT/MI 15	839686	834960	YTTE/MI 15	840614	834854	SWTS/MI 15	840036	835016			
YTT/MI 16	839350	834754	YTTE/MI 16	840691	834868						
YTT/MI 17	839434	834783	YTTE/MI 17	840804	834885						
YTT/MI 18	839547	834833	YTTE/MI 18	840902	834900						
YTT/MI 19	839626	834863	YTTE/MI 19	841003	834917						
YTT/MI 20	839736	834903	YTTE/MI 20	841101	834931						
			YTTE/MI 21	841192	834946						

CO-ORDINATES OF DREDGING BOUNDARY FOR FISH CULTURE ZONE

YIM TIN TSAI FCZ			YIM TIN TSAI (EAST) FCZ		
POINT	EASTING (m)	NORTHING (m)	POINT	EASTING (m)	NORTHING (m)
YTT/D1	839147	834972	YE/D1	840539	835055
YTT/D2	839617	835148	YE/D2	841200	835160
YTT/D3	839795	834890	YE/D3	841239	834913
YTT/D4	839326	834715	YE/D4	840578	834808

VERTICLE PROFILE OF SAMPLING LOCATIONS



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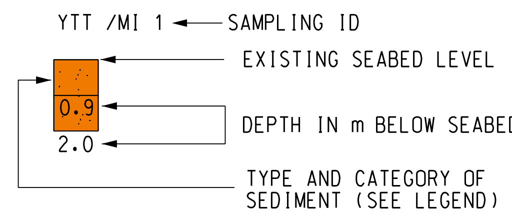

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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

SEDIMENT CATEGORISATION AND DISPOSAL PLAN - YIM TIN TSAI, YIM TIN TSAI (EAST) FISH CULTURE ZONES AND SHUEN WAN TYPHOON SHELTER

SCALE	A3 1:6000	DATE	MAY. 2009
CHECK	AKYC	DRAWN	HBF
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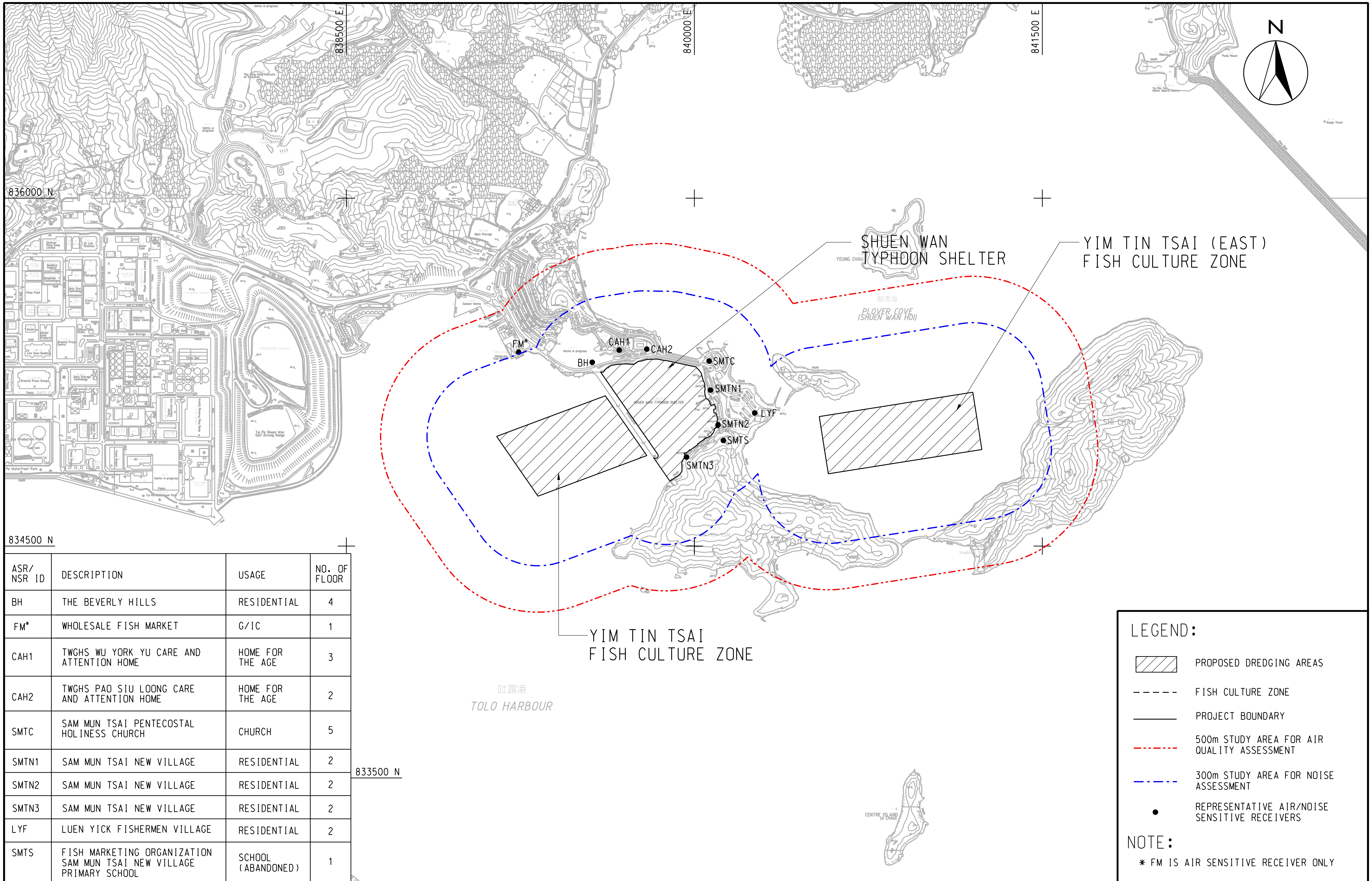

ASR/ NSR ID	DESCRIPTION	USAGE	NO. OF FLOOR
BH	THE BEVERLY HILLS	RESIDENTIAL	4
FM*	WHOLESALE FISH MARKET	G/IC	1
CAH1	TWGHS WU YORK YU CARE AND ATTENTION HOME	HOME FOR THE AGE	3
CAH2	TWGHS PAO SIU LOONG CARE AND ATTENTION HOME	HOME FOR THE AGE	2
SMTC	SAM MUN TSAI PENTECOSTAL HOLINESS CHURCH	CHURCH	5
SMTN1	SAM MUN TSAI NEW VILLAGE	RESIDENTIAL	2
SMTN2	SAM MUN TSAI NEW VILLAGE	RESIDENTIAL	2
SMTN3	SAM MUN TSAI NEW VILLAGE	RESIDENTIAL	2
LYF	LUEN YICK FISHERMEN VILLAGE	RESIDENTIAL	2
SMTS	FISH MARKETING ORGANIZATION SAM MUN TSAI NEW VILLAGE PRIMARY SCHOOL	SCHOOL (ABANDONED)	1

LEGEND:

- PROPOSED DREDGING AREAS
- FISH CULTURE ZONE
- PROJECT BOUNDARY
- 500m STUDY AREA FOR AIR QUALITY ASSESSMENT
- 300m STUDY AREA FOR NOISE ASSESSMENT
- REPRESENTATIVE AIR/NOISE SENSITIVE RECEIVERS

NOTE:

* FM IS AIR SENSITIVE RECEIVER ONLY

AECOM

AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

LOCATIONS OF REPRESENTATIVE AIR AND NOISE SENSITIVE RECEIVERS

SCALE	A3 1:15000	DATE	AUG 2009
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JOB No.	60092464	DRAWING No.	4.1
		REV	-

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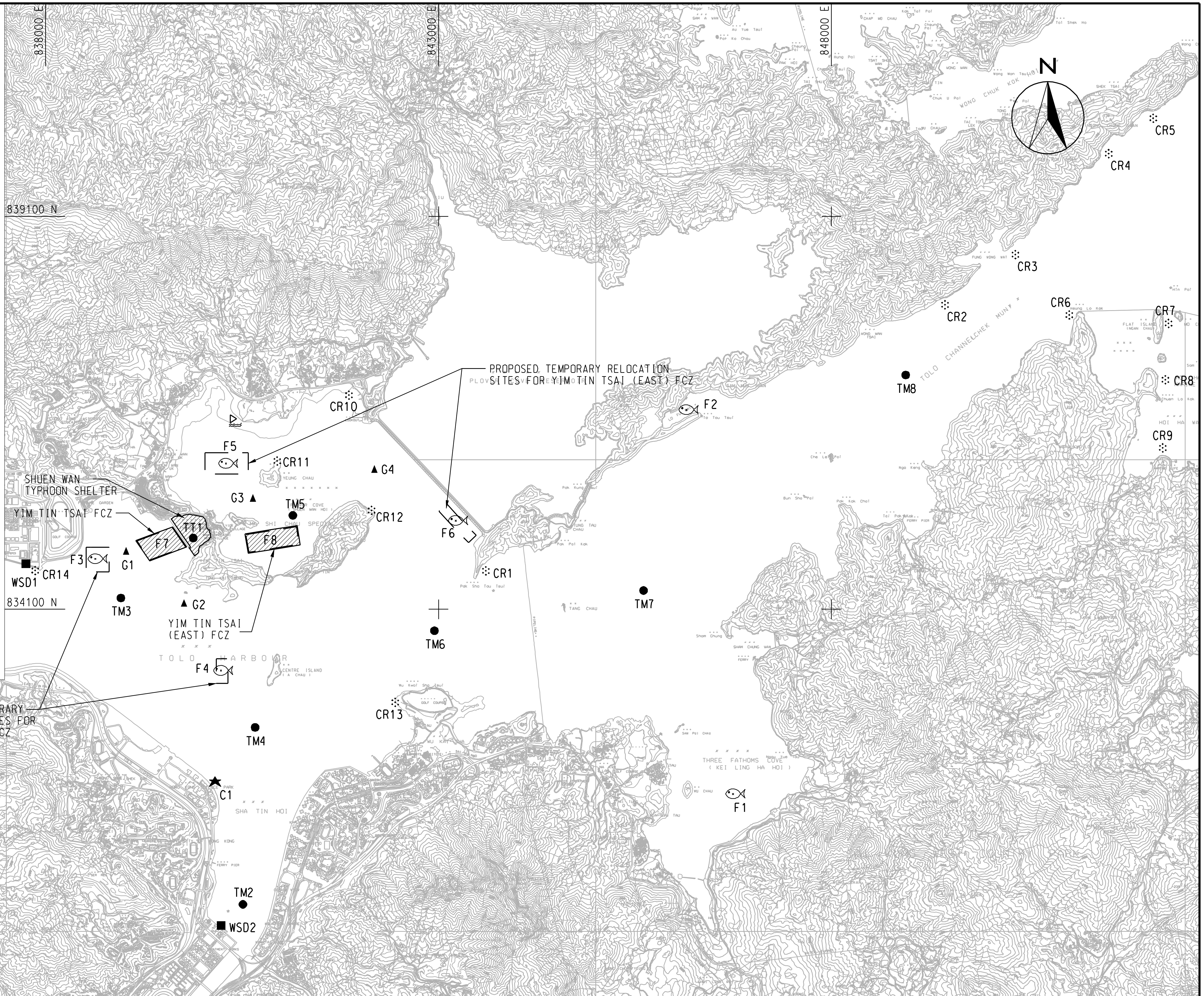
LEGEND:

- PROPOSED DREDGING AREAS
- PROPOSED TEMPORARY RELOCATION SITES FOR FISH RAFTS
- EPD WATER QUALITY MONITORING STATIONS
  - TM2 TM6
  - TM3 TM7
  - TM4 TM8
  - TM5 TT1
- WSD FLUSHING WATER INTAKES
  - WSD1 - TAI PO
  - WSD2 - SHA TIN
- COOLING WATER INTAKE
  - C1 - MARINE BIOLABORATARY
- FISH CULTURE ZONES
  - F1 - YUNG SHUE AU
  - F2 - LO FU WAT
  - F3 - PROPOSED TEMPORARY RELOCATION SITES FOR YIM TIN TSAI FCZ
  - F4 - PROPOSED TEMPORARY RELOCATION SITES FOR YIM TIN TSAI FCZ
  - F5 - PROPOSED TEMPORARY RELOCATION SITES FOR YIM TIN TSAI (EAST) FCZ
  - F6 - PROPOSED TEMPORARY RELOCATION SITES FOR YIM TIN TSAI (EAST) FCZ
  - F7 - YIM TIN TSAI
  - F8 - YIM TIN TSAI EAST
- CORALS
  - CR1 - PAK SHA TAU
  - CR2 - WONG WAN TSUI
  - CR3 - FUNG WONG WAT
  - CR4 - SOUTH WONG CHUK KOK TSUI
  - CR5 - WONG CHUK KOK TSUI
  - CR6 - GRUFF HEAD
  - CR7 - HOI HA WAN MOON ISLAND
  - CR8 - HOI HA WAN CORAL BEACH
  - CR9 - HOI HA WAN PIER
  - CR10 - TAI MEI TUK
  - CR11 - YEUNG CHAU
  - CR12 - MA SHI CHAU NORTH
  - CR13 - WHITEHEAD PENINSULA
  - CR14 - TAI PO INDUSTRIAL ESTATE
- NON - GAZETTED BEACH
- GRADIENT STATIONS
  - G1 G3
  - G2 G4



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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

LOCATIONS OF WATER SENSITIVE RECEIVERS

SCALE	A3 1:50000	DATE	OCT. 09
CHECK	AKYC	DRAWN	YJP
JOB No.	60092464	DRAWING No. 4.2	REV A

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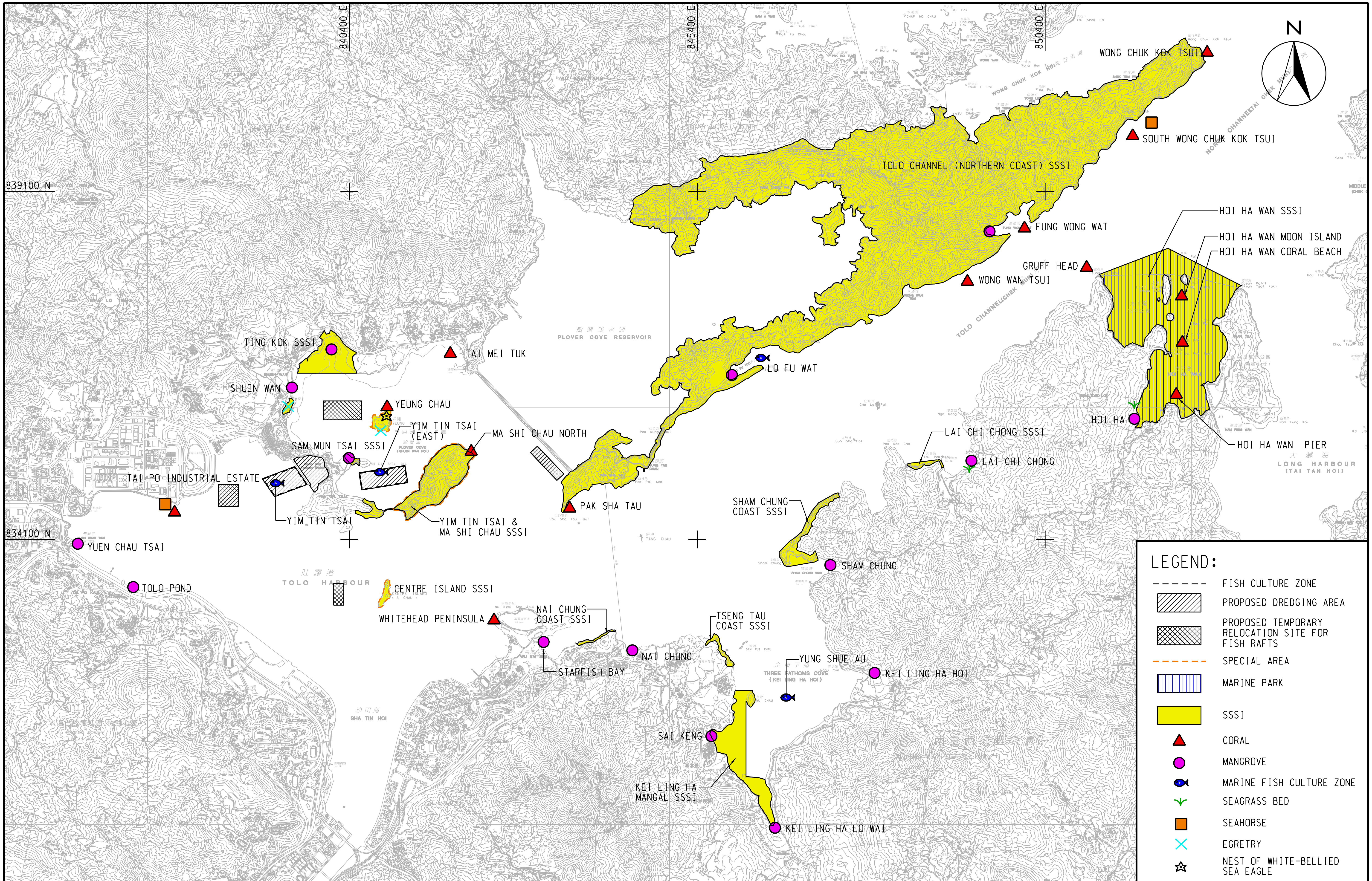

CHENYG 15 44 35 2009-10-23

AECOM	AGREEMENT NO. CE 26/2008 (EP) ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION ECOLOGICAL RESOURCES IDENTIFIED WITHIN ASSESSMENT AREA	SCALE	A3 1:50000	DATE	OCT. 2009
		CHECK	AKYC	DRAWN	DXL
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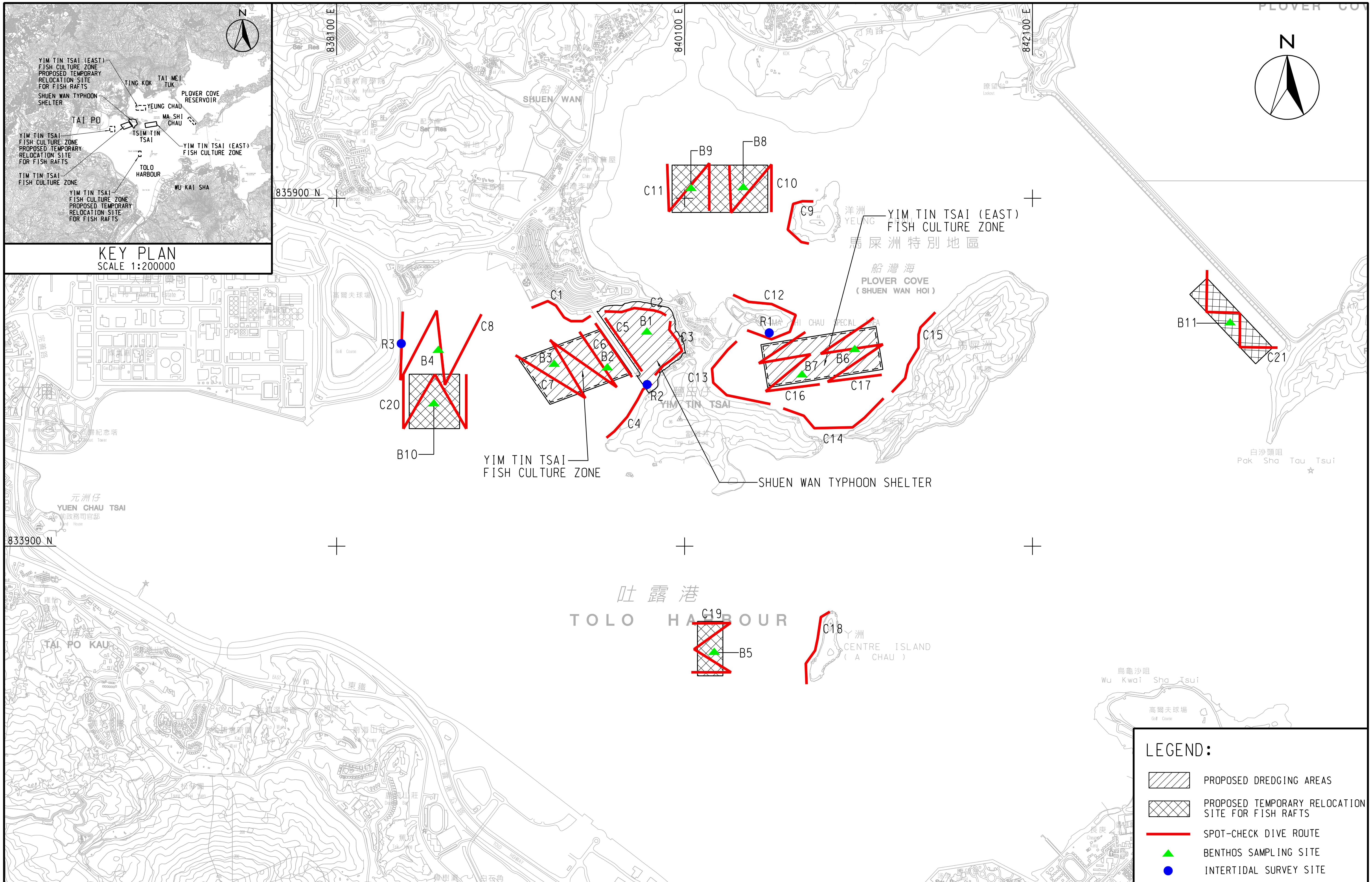
p \PROJECTS\60092464\DRAWING\FIGURE\4 3 dgn



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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

PROPOSED SURVEY LOCATIONS FOR PROPOSED WORKS AT YIM TIN TSAI, YIM TIN TSAI (EAST) FISH CULTURE ZONE AND SHUEN WAN TYPHOON SHELTER

SCALE	A3 1:20000	DATE	AUG. 2009
CHECK	AKYC	DRAWN	CYG
JOB No.	60092464	DRAWING No.	4.4
		REV	-

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p \PROJECTS\60092464\DRAWING\FIGURE\4 4 dgn

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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

SURVEY LOCATIONS OF SPOT-CHECK DIVE ROUTES AND RAPID ECOLOGICAL ASSESSMENT TRANSECTS

SCALE	A3 1:20000	DATE	AUG. 2009
CHECK	AKYC	DRAWN	CYG
JOB No.	60092461	DRAWING No.	4.5
		REV	-

2009-10-23 13 27 51 CHENYG

p \PROJECTS\60092464\DRAWING\FIGURE\4 5 dgn

AECOM

AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

ARDEID SPECIES OF CONSERVATION INTEREST WITHIN THE ASSESSMENT AREA

SCALE	A3 1:20000	DATE	JUL. 2009
CHECK	AKYC	DRAWN	HYLI
JOB No.	60092464	DRAWING No.	4.6
		REV	-

2009-8-28 9 08 37 ZHUCP

p \PROJECTS\60092464\DRAWING\FIGURE\4 6 dgn

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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

FISHERIES RESOURCES WITHIN THE ASSESSMENT AREA

SCALE	A3 1:50000	DATE	AUG. 09
CHECK	AKYC	DRAWN	YJP
JOB No.	60092464	DRAWING No.	4.7
		REV	-

2009-8-27 9 11 28 DAIXL

p \PROJECTS\60092464\DRAWING\FIGURE\4 7 dgn

APPENDIX A
NOISE IMPACT ASSESSMENT

TABLE OF CONTENTS

List of Tables

Annex

A1. INTRODUCTION

A1.1 The Project is to remove sediments at Yim Tin Tsai and Yim Tin Tsai (East) Fish Culture Zones (FCZ) and Shuen Wan Typhoon Shelter. Major source of noise impact would be generated from the dredging works. The study area for noise impact assessment is generally defined by a distance of 300 m expanded from the boundary of the proposed dredging areas as indicated in **Figure 4.1** attached in the main text of this Project Profile. No noise impacts would be occurred upon completion of dredging. This section provides an assessment of the potential noise impacts generated from the dredging works at the three proposed dredging sites.

A2. ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA

A2.1 Noise impacts were assessed in accordance with the criteria and methodology given in the Technical Memoranda made under the Noise Control Ordinance (NCO), and the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM).

A2.2 The NCO provides the statutory framework for noise control. Assessment procedures and standards are set out in four Technical Memoranda listed below:

- Technical Memorandum on Noise from Places other than Domestic Premises, Public Places or Construction Sites (IND-TM);
- Technical Memorandum on Noise from Construction Work in Designated Areas (DA-TM);
- Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM); and
- Technical Memorandum on Noise from Percussive Piling (PP-TM).

A2.3 The NCO and the accompanying Technical Memoranda provide a mechanism for assessing noise levels and the statutory power to control noise.

A2.4 The NCO provides the statutory framework for noise control of construction work other than percussive piling using powered mechanical equipment (PME) between the hours of 1900 and 0700 or at any time on Sundays and general holiday (that is, restricted hours). Noise control on construction activities taking place at other times is subject to the *Criteria for Evaluating Noise Impact* stated in Table 1A of Annex 5 in the EIAO-TM. The noise limit is $L_{eq\ (30minutes)}$ 75 dB(A) at the facades of dwellings and 70 dB(A) at the facade of church or schools (65 dB(A) during examinations).

A3. ASSESSMENT METHODOLOGY

A3.1 Noise impacts would be generated from the dredging works with the use of powered mechanical equipment (PME). The proposed dredging works are tentatively scheduled to be commenced in late 2009 or 2010. Under this noise assessment, the dredging works at all the three proposed dredging sites are assumed to be conducted concurrently. In case the dredging works for the three proposed dredging sites would be undertaken in separate periods or if the dredging works are to be conducted in a lower work rates, the amount of PME involved would be smaller than that assumed under this assessment and hence the associated noise impacts would be smaller than that predicted under this assessment.

A3.2 All dredging works are planned to be carried out during 0700 to 1900 hours (Monday to Saturday excluding general holidays). No dredging works would be carried out during restricted hours.

A3.3 In accordance with the EIAO-TM, the methodology outlined in the GW-TM has been used for the assessment of construction noise. The distance attenuation from Powered Mechanical Equipment (PME) to representative NSR was estimated using the standard formula:

Distance Attenuation in dB(A) = 20 log D + 8 [where D is the distance in meters]

A3.4 PME to be employed for the construction are shown in **Annex A1**. Sound Power Levels (SWLs) of the PMEs were taken from Table 3 of GM-TM.

A3.5 It was assumed that all PME items required for each dredging site would be located at the notional or probable source position of the segment where such activity is to be performed. The assessment is based on the cumulative SWL of PME likely to be used for each site, assuming all the PME are to be operated concurrently. As a worst case scenario, dredging works at the three proposed dredging sites are considered to be conducted concurrently. On-time percentage for all PMEs used at each dredging site is assumed to be 100%. The equipment lists are considered realistic and practicable. The sound pressure level of dredging works at each dredging site was calculated, depending on the number of plant and distance from receivers. The noise levels at NSRs are then predicted by adding up the SWLs of noise sources at or within 300m from the sensitive receiver.

A3.6 A positive 3 dB(A) facade correction was added to the predicted noise levels in order to account for the facade effect at each NSR.

A4. NOISE SENSITIVE RECEIVERS

A4.1 Potential noise sensitive receivers (NSRs) have been identified in accordance with the criteria set out in the EIAO-TM and through site inspection. The representative worst affected noise sensitive receivers are shown in **Table A1**. Locations of the NSRs are shown on Figure 4.1 in the main text of this Project Profile.

Table A1 Representative Noise Sensitive Receivers

NSR	Description	Type of Use	No. of Floors	Approximate Distance from Boundary of the Dredging Sites (m)		
				Yim Tin Tsai FCZ	Yim Tin Tsai (East) FCZ	Shuen Wan Typhoon Shelter
BH	The Beverly Hills	Residential	4	152	-	118
CAH1	TWGHS Wu York Yu Care and Attention Home	Home for the Age	3	207	-	100
CAH2	TWGHS Pao Siu Loong Care and Attention Home	Home for the Age	2	271	-	80
SMTC	Sam Mun Tsai Pentecostal Holiness Church	Church	5	-	-	109
SMTN1	Sam Mun Tsai New Village	Residential	2	-	-	63
SMTN2	Sam Mun Tsai New Village	Residential	2	-	-	44
SMTN3	Sam Mun Tsai New Village	Residential	2	178	-	35
LYF	Luen Yick Fishermen Village	Residential	2	-	276	200

Note:
- NSRs with a separation distance of over 300m from the boundary of a particular dredging site are not considered as representative NSRs for that particular dredging site.

A4.2 The on-site survey has revealed that the Fish Marketing Organization Sam Mun Tsai New Village Primary School (namely SMTS) in the vicinity of the Shuen Wan Typhoon Shelter as shown in Figure 4.1 (attached in the main text of this Project Profile) was an abandoned school and not in operation. This primary school is therefore excluded in the noise assessment.

A5. IDENTIFICATION AND EVALUATION OF ENVIRONMENTAL IMPACTS

A5.1 The predicted unmitigated noise levels at representative NSRs during normal daytime working hours within the dredging period of the Project are summarized in **Table A2**. The calculation is presented in **Annex A2.** Results indicated that the predicted noise levels would range between 62 to 68 dB(A). The NSRs are expected to comply with the construction noise criterion of 75 dB(A) for residential premises / home for age and 70 dB(A) for church as stated in Table 1A of Annex 5 in the EIAO-TM.

Table A2 Predicted Noise Levels at Representative Noise Sensitive Receivers (Unmitigated Scenario)

NSR	Predicted Noise Levels, dB(A)
BH	66
CAH1	65
CAH2	66
SMTC	62
SMTN1	65
SMTN2	67
SMTN3	68
LYF	64

A6. MITIGATION MEASURES AND EVALUATION OF RESIDUAL ENVIRONMENTAL IMPACTS

A6.1 Predicted noise levels from dredging works at all representative NSRs are comply with the noise standards stipulated in the EIAO-TM before the implementation of mitigation measures. In order to further ameliorate the construction noise impacts, good site practices should be adopted by all the contractors as far as practicable. Such good site practices should include:

- Only well-maintained plants should be operated on-site and plants should be serviced regularly during the construction program.
- Plants should be sited as far away from nearby NSRs as possible.

A7. CONCLUSIONS

A7.1 This assessment has predicted the construction noise impacts of the Project during normal daytime working hours. The predicted construction noise levels at representative NSRs would comply with the construction noise standard, and therefore no adverse noise impact is expected. Good site practices are recommended to further ameliorate the impacts.

ANNEX A1
POWERED MECHANICAL EQUIPMENT (PME) FOR DREDGING WORKS DURING NORMAL DAYTIME WORKING HOURS

Annex A1

Powered Mechanical Equipment (PME) for the Dredging Works during Normal Daytime Working Hours

Yim Tin Tsai FCZ

Powered Mechanical Equipment (PME)	TM Ref./ other Ref.	Scen 1 No. Items	SWL/Item dB(A)	On-time %	Total SWL dB(A)
Grab Dredgers	CNP063	2	112	100.0%	115
Tug Boats	CNP221	2	110	100.0%	113
Barge	-	4	0	100.0%	0
				Total	117

Shuen Wan Typhoon Shelter

Powered Mechanical Equipment (PME)	TM Ref./ other Ref.	Scen 1 No. Items	SWL/Item dB(A)	On-time %	Total SWL dB(A)
Derrick Lighter	CNP061	1	104	100.0%	104
Tug Boats	CNP221	1	110	100.0%	110
				Total	111

Yim Tin Tsai (East) FCZ

Powered Mechanical Equipment (PME)	TM Ref./ other Ref.	Scen 1 No. Items	SWL/Item dB(A)	On-time %	Total SWL dB(A)
Grab Dredgers	CNP063	3	112	100.0%	117
Tug Boats	CNP221	3	110	100.0%	115
Barge	-	6	0	100.0%	0
				Total	119

ANNEX A2
CALCULATION OF CONSTRUCTION NOISE LEVELS AT REPRESENTATIVE NOISE SENSITIVE RECEIVERS DURING NORMAL DAYTIME WORKING HOURS

Annex A2
Calculation of Construction Noise Levels at Representative Noise Sensitive Receivers During Normal Daytime Working Hours

NSR	Activity	Distance (m)	Distance Corr., dB(A)	Total SWL, dB(A)	Corrected Noise Level, dB(A) (including +3 dB(A) Façade Correction)
BH	Dredging at Yim Tin Tsai FCZ Only	238	55.5	117	65
	Dredging at Shuen Wan Typhoon Shelter Only	170	52.6	111	61
	Dredging at Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter Concurrently				66
CAH1	Dredging at Yim Tin Tsai FCZ Only	289	57.2	117	63
	Dredging at Shuen Wan Typhoon Shelter Only	162	52.2	111	62
	Dredging at Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter Concurrently				65
CAH2	Dredging at Yim Tin Tsai FCZ Only	323	58.2	117	62
	Dredging at Shuen Wan Typhoon Shelter Only	131	50.3	111	64
	Dredging at Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter Concurrently				66
SMTC	Dredging at Shuen Wan Typhoon Shelter Only	159	52.0	111	62
SMTN1	Dredging at Shuen Wan Typhoon Shelter Only	116	49.3	111	65
SMTN2	Dredging at Shuen Wan Typhoon Shelter Only	91	47.2	111	67
SMTN3	Dredging at Yim Tin Tsai FCZ Only	229	55.2	117	65
	Dredging at Shuen Wan Typhoon Shelter Only	100	48.0	111	66
	Dredging at Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter Concurrently				68
LYF	Dredging at Shuen Wan Typhoon Shelter Only	277	56.8	111	57
	Dredging at Yim Tin Tsai (East) FCZ Only	332	58.4	119	63
	Dredging at Shuen Wan Typhoon Shelter and Yim Tin Tsai (East) FCZ Concurrently				64

APPENDIX B
WATER QUALITY IMPACT ASSESSMENT

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

B1. INTRODUCTION

B1.1 This section presents the assessment of the potential water quality impacts associated with the Project during construction and operational phases. The study area for this water quality impact assessment covers the Tolo Harbour and Channel Water Control Zone (WCZ).

B2. WATER SENSITIVE RECEIVERS

B2.1 In order to evaluate the potential water quality impacts from the Project, water quality sensitive receivers (WSRs) in the Tolo Harbour and Channel WCZ were identified in accordance with the criteria set out in Annex 14 of the EIAO-TM. Major WSRs identified include:

- WSD Flushing Water Intakes;
- Cooling Water Intakes;
- Corals; and
- Fish Culture Zones

B2.2 Locations of WSRs are shown on Figure 4.2 in the main text of this Project Profile. According to the recent dive surveys, the seabed of the dredging sites was found to be mainly composed of muddy and sandy bottom and of low habitat quality. Limited marine life was seen except only some small and isolated patches of single species of hard coral (*Oulastrea crispata*) were found near the breakwater and near the southeast shore of the Shuen Wan Typhoon Shelter, coast at north of Yim Tin Tsai FCZ and coast of Tai Po Shuen Wan Golf Centre and this species is common in Hong Kong waters and known to tolerate more turbid and harsh environment. Most of the isolated colonies were attached on the surface of the boulders and rocks with very low coverage (<1%) and small size (2 cm to 5 cm). These isolated coral colonies are not considered as sensitive coral site and are therefore not covered in the water quality impact assessment. Details descriptions on the ecological baseline condition and ecological resources are separately presented in Appendix D of this Project Profile.

B3. ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA

B3.1 The criteria for evaluating water quality impacts in this EIA Study include:

<u>Environmental Impact Assessment Ordinance (EIAO)</u>

B3.2 The Technical Memorandum on Environmental Impact Assessment Process (Environmental Impact Assessment Ordinance) (EIAO-TM) was issued by EPD under Section 16 of the EIAO. It specifies the assessment method and criteria that are to be followed in this Study. Reference sections in the EIAO-TM provide the details of assessment criteria and guidelines that are relevant to the water quality impact assessment, including:

- Annex 6 – Criteria for Evaluating Water Pollution
- Annex 14 – Guidelines for Assessment of Water Pollution

<u>Water Quality Objectives</u>

B3.3 The Water Pollution Control Ordinance (WPCO) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZs). Corresponding statements of Water Quality Objectives (WQOs) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZs based on their beneficial uses. Selected WQOs for the Tolo Harbour and Channel WCZ is listed in **Table B3.1** respectively.

Table B3.1 Summary of Water Quality Objectives for Tolo Harbour and Channel WCZ

Parameters	Objectives	Sub-Zone
Offensive odour, tints	Not to be present	Harbour Subzone, Buffer Subzone, Channel Subzone
Visible foam, oil scum, litter	Not to be present	Harbour Subzone, Buffer Subzone, Channel Subzone
Dissolved oxygen (DO)	Not less than 2mg/L within two metres of the bottom, or not less than 4mg/L in the remainder of the water column	Harbour Subzone
	Not less than 3mg/L within two metres of the bottom, or not less than 4mg/L in the remainder of the water column	Buffer Subzone
	Not less than 4mg/L at any point in the water column	Channel Subzone
pH	Not to cause the normal pH range to be extended by more than ±0.5 pH units at any time.	Harbour Subzone
	Not to cause the normal pH range to be extended by more than ±0.3 pH units at any time.	Buffer Subzone
	Not to cause the normal pH range to be extended by more than ±0.1 pH units at any time.	Channel Subzone
Light Penetration	Should not reduce light transmission by more than 20% of the normal level at any location or any time.	Harbour Subzone
	Should not reduce light transmission by more than 15% of the normal level at any location or any time.	Buffer Subzone
	Should not reduce light transmission by more than 10% of the normal level at any location or any time.	Channel Subzone
Salinity	Not to cause the normal salinity range to be extended by more than ±3 parts per thousand at any time.	Harbour Subzone, Buffer Subzone, Channel Subzone
Temperature	Not to cause the natural daily temperature range to be extended by greater than ±1.0 ℃ at any location or time. The rate of temperature change shall not exceed 0.5 ℃ per hour at any location, unless due to natural phenomena.	Harbour Subzone, Buffer Subzone, Channel Subzone
Settleable Material	Bottom deposits or submerged objects should not adversely influence bottom-living communities, alter the basic Harbour geometry or shipping channels, present any hazard to shipping or diving activities, or affect any other beneficial use of the waters.	Harbour Subzone, Buffer Subzone, Channel Subzone
Bacteria	Not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in one calendar year	Secondary Contact Recreation Subzone and Fish Culture Zone
Chlorophyll-*a*	Not to cause the level of chlorophyll-*a* in waters of the subzone to exceed 20 mg/m^3, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Harbour Subzone
	Not to cause the level of chlorophyll-*a* in waters of the subzone to exceed 10 mg/m^3, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Buffer Subzone
	Not to cause the level of chlorophyll-*a* in waters of the subzone to exceed 6 mg/m^3, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Channel Subzone
Toxic substances	Should not attain such a level as to produce significant toxic effects in humans, fish or any other aquatic organisms.	Harbour Subzone, Buffer Subzone, Channel Subzone

Source: Statement of Water Quality Objectives (Tolo Harbour and Channel Water Control Zone).

Water Supplies Department (WSD) Water Quality Criteria

B3.4 Besides the WQOs stipulated under the WPCO, the WSD has specified a set of objectives for water quality at flushing water intakes. The list is shown in **Table B3.2**. The target limit for suspended solids (SS) at these intakes is 10mg/l or less.

Table B3.2 WSD's Water Quality Criteria for Flushing Water at Sea Water Intakes

Parameter (in mg/L unless otherwise stated)	Target Limit
Turbidity (NTU)	< 10
Ammoniacal Nitrogen	< 1
Suspended Solids	< 10
Dissolved Oxygen	> 2
Biochemical Oxygen Demand	< 10

Cooling Water Intake Standards

B3.5 Based on a questionnaire survey conducted under the approved EIA for Tai Po Sewage Treatment Works Stage V [(1)], no specific water quality (including SS) requirement was available for all the cooling water intakes identified in Tolo Harbour. These findings have been further confirmed by a telephone survey conducted in 2009.

Sediment Deposition

B3.6 Potential impacts on benthic organisms, including corals, may arise through excessive sediment deposition. The magnitude of impacts on marine ecological sensitive receivers was assessed based on the predicted sedimentation rate.

B3.7 A sedimentation rate of no more than 0.1 kg/m^2/day has been adopted as the assessment criterion for protecting the sediment sensitive ecological resources in Tolo Harbour based on the approved EIA for "*Development of a Bathing Beach at Lung Mei, Tai Po*". This sedimentation rate criterion is considered to offer sufficient protection to marine ecological sensitive receivers and is anticipated to guard against unacceptable impacts.

B3.8 There is no marine WQO for suspended solids within the Tolo Harbour and Channel WCZ. To assess impacts associated with SS in the Tolo Harbour, a criterion of 10 mg/L has been adopted and is considered suitable for use in this Study. Using this criterion, if SS levels exceed 10 mg/L at sediment sensitive ecological receivers such as coral sites, adverse impacts would be predicted (and suitable mitigation pursued). This criterion was adopted in the approved EIA for "*Development of a Bathing Beach at Lung Mei, Tai Po*".

Others

B3.9 Elutriate tests were conducted to estimate the amount of pollutants that would be released into the water during dredging. There are no existing legislative standards or guidelines for dissolved metals and organic compounds in the marine waters of Hong Kong. It is thus proposed to make reference to the relevant water quality standards in the EU, Australia and USEPA, following the approach adopted under the approved EIA for "*Development of a Bathing Beach at Lung Mei, Tai Po*". The proposed assessment criteria are summarised in **Table B3.3** and these criteria values have been adopted in the water quality assessment of the approved EIA for "*Development of a Bathing Beach at Lung Mei, Tai Po*".

Table B3.3 Proposed Assessment Criteria for Dissolved Metals and Micro-Pollutants with Reference to Standards Adopted by Other Countries

Metals and Metalloid	Proposed Assessment Criteria for this Study (µg/L)
Arsenic	25 [(a)]
Cadmium	2.5 [(a)]
Chromium	15 [(a)]

(1) Maunsell Consultants Asia Limited (2003). Tai Po Sewage Treatment Works Stage V, EIA Report, Drainage Services Department, 2003.

Metals and Metalloid	Proposed Assessment Criteria for this Study (µg/L)
Copper	4.8 [(c)]
Lead	25 [(a)]
Mercury	0.3 [(a)]
Nickel	30 [(a)]
Silver	1.9 [(c)]
Zinc	40 [(a)]
Total Polychlorinated Biphenyl (PCBs)	0.03 [(d)]
Polychlorinated Aromatic Hydrocarbons (PAHs)	50 [(b)]
Tributyltin (TBT)	0.1 [(e)]

Notes: [a] European Union Environmental Quality Standard (EQS) Values for Protection of Marine Life
[b] Australia and New Zealand Guidelines for Fresh and Marine Water Quality (2000). Trigger values for toxicants at protection level of 99% species.
[c] Criteria Maximum Concentration (CMC) of National Recommended Water Quality Criteria for Saltwater of the USEPA (2006). The CMC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an acceptable effect (source: USEPA).
[d] Criterion Continuous Concentration (CCC) of National Recommended Water Quality Criteria for Saltwater of the USEPA (2006). The CCC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an acceptable effect (source: USEPA)
[e] Michael H. Salazar and Sandra M. Salazar (1996), "Mussels as Bioindicators: Effects of TBT on Survival, Bioaccumulation, and Growth under Natural Conditions" in Organotin, edited by M. A. Champ and P. F. Seligman, Chapman & Hall, London.
[g] "-" denotes no water quality criterion is defined in the guideline or standard.

B4. DESCRIPTION OF THE ENVIRONMENT

Marine Water Quality in Tolo Harbour

B4.1 The marine water quality monitoring data routinely collected by EPD in the Tolo Harbour were used to establish the baseline condition. A summary of water quality data for selected EPD monitoring stations is presented in **Table B4.1** for the Tolo Harbour and Channel WCZ (TM2-TM8). Locations of the monitoring stations are shown on Figure 4.2 in the main text of this Project Profile. Descriptions of the baseline conditions for Tolo Harbour and Channel WCZ provided in the subsequent sections were extracted from the EPD's report *"Marine Water Quality Monitoring in Hong Kong 2007"* issued in 2008 which contains the latest information published by EPD on marine water quality at the moment of preparing this water quality impact assessment.

B4.2 The Tolo Harbour and Channel WCZ experienced a decrease of the overall WQO compliance from 86% in 2006 to 64% in 2007, with a very low compliance of 29% for Dissolved Oxygen (DO); whereas the levels of pollutants such as 5-day Biochemical Oxygen Demand (BOD_5), *E.coli* and nitrogen remained stable. The compliance with WQO for chlorophyll-*a* was 90% in 2007. Full compliance with WQO for secondary contact recreational use for *E.coli* was achieved in 2007 (**Table B4.1**).

Table B4.1 Summary Statistics of 2007 Marine Water Quality in Tolo Harbour

Parameter		Harbour Subzone			Buffer Subzone		Channel Subzone		WPCO WQO (in marine waters)
		TM2	TM3	TM4	TM5	TM6	TM7	TM8	
Temperature (℃)		24.0 (17.6-28.3)	23.9 (17.5-28.5)	23.6 (17.6-28.0)	24.2 (17.6-29.5)	23.4 (17.4-28.1)	23.1 (17.3-28.0)	22.8 (17.0-27.9)	Not more than 1℃ in daily temperature range
Salinity		32.0 (30.6-33.3)	32.0 (29.9-33.4)	32.3 (30.8-33.5)	32.2 (31.1-33.3)	32.6 (31.9-33.6)	32.7 (31.9-33.9)	33.0 (32.1-34.1)	Not to cause more than 3ppt change
Dissolved Oxygen (DO) (mg/L)	Depth Average	6.3 (2.8-8.6)	6.7 (4.0-8.4)	6.5 (3.3-8.0)	6.4 (5.4-8.1)	6.1 (4.4-7.8)	6.3 (4.5-7.8)	6.0 (3.3-7.7)	Harbour and Buffer Subzones: not <4mg/L other than within 2m of the bottom; Channel Subzone: not <4mg/L
	Bottom	5.7 (2.0-8.3)	6.3 (3.1-7.9)	5.6 (1.6-7.3)	6.3 (5.1-8.0)	5.2 (2.4-7.4)	5.7 (1.8-7.5)	5.3 (1.4-8.1)	Harbour Subzone: not <2mg/L within 2m of the bottom; Buffer Subzone: not <3mg/L within 2m of the bottom; Channel Subzone: not <4mg/L
Dissolved Oxygen (DO) (% Saturation)	Depth Average	89 (41-115)	95 (59-118)	92 (49-111)	91 (78-111)	86 (65-108)	88 (68-106)	84 (50-103)	Not Available
	Bottom	81 (29-109)	89 (45-110)	78 (24-103)	89 (75-109)	72 (36-100)	79 (26-100)	72 (20-102)	Not Available
pH		8.0 (7.6-8.3)	8.1 (7.5-8.4)	8.1 (7.6-8.3)	8.0 (7.4-8.4)	8.0 (6.8-8.3)	8.1 (7.6-8.3)	8.1 (7.7-8.3)	Harbour Subzone: not to exceed by ±0.5 pH units; Buffer Subzone: not to exceed by ±0.3 pH units; Channel Subzone: not to exceed by ±0.1 pH units
Secchi Disc Depth (m)		2.0 (1.0-3.0)	2.1 (1.0-4.1)	2.2 (1.5-3.4)	2.2 (1.2-4.0)	2.6 (1.9-4.8)	2.8 (2.0-3.8)	3.1 (2.0-4.5)	Not Available
Turbidity (NTU)		8.8 (4.4-13.5)	9.3 (4.4-15.3)	9.7 (4.4-17.7)	9.4 (4.4-14.2)	9.2 (4.3-15.2)	9.2 (4.3-14.4)	9.3 (4.5-15.4)	Not Available
Suspended Solids (SS) (mg/L)		2.2 (1.3-3.2)	2.0 (1.0-3.6)	1.7 (0.9-2.3)	3.3 (1.0-15.6)	1.5 (1.0-1.9)	1.5 (0.8-2.8)	1.8 (1.1-3.0)	Not Available
5-day Biochemical Oxygen Demand (BOD_5), (mg/L)		1.6 (0.5-2.8)	1.5 (0.5-2.4)	1.5 (0.6-2.0)	1.3 (0.7-2.5)	1.2 (0.8-1.8)	1.1 (0.4-1.6)	1.0 (0.4-1.9)	Not Available
Ammonia Nitrogen (NH_3-N) (mg/L)		0.05 (0.01-0.15)	0.04 (0.02-0.07)	0.04 (0.01-0.09)	0.04 (0.01-0.09)	0.04 (0.01-0.06)	0.03 (0.01-0.06)	0.03 (0.01-0.06)	Not Available
Unionized Ammonia (UIA) (mg/L)		0.002 (<0.001-0.004)	0.002 (<0.001-0.004)	0.002 (<0.001-0.004)	0.002 (<0.001-0.004)	0.002 (<0.001-0.004)	0.002 (<0.001-0.005)	0.001 (<0.001-0.004)	Not Available
Nitrite Nitrogen (NO_2-N) (mg/L)		0.006 (0.002-0.054)	0.005 (0.002-0.040)	0.006 (0.002-0.049)	0.003 (0.002-0.014)	0.005 (0.002-0.029)	0.005 (0.002-0.021)	0.007 (0.002-0.023)	Not Available
Nitrate Nitrogen (NO_3-N) (mg/L)		0.008 (0.002-0.034)	0.009 (0.002-0.040)	0.008 (0.002-0.043)	0.006 (0.002-0.016)	0.006 (0.002-0.016)	0.006 (0.002-0.013)	0.015 (0.002-0.049)	Not Available
Total Inorganic Nitrogen (TIN) (mg/L)		0.06 (0.01-0.23)	0.06 (0.02-0.14)	0.06 (0.02-0.16)	0.05 (0.01-0.10)	0.05 (0.01-0.09)	0.04 (0.01-0.08)	0.05 (0.01-0.11)	Not Available
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.25 (0.19-0.32)	0.24 (0.18-0.29)	0.23 (0.19-0.27)	0.23 (0.16-0.31)	0.21 (0.17-0.24)	0.18 (0.15-0.23)	0.17 (0.13-0.24)	Not Available
Total Nitrogen (TN) (mg/L)		0.27 (0.19-0.40)	0.25 (0.18-0.32)	0.25 (0.19-0.34)	0.24 (0.17-0.32)	0.22 (0.18-0.26)	0.19 (0.15-0.23)	0.19 (0.15-0.24)	Not Available

Parameter	Harbour Subzone			Buffer Subzone		Channel Subzone		WPCO WQO (in marine waters)
	TM2	TM3	TM4	TM5	TM6	TM7	TM8	
Orthophosphate Phosphorus (PO_4) (mg/L)	0.008 (0.004-0.031)	0.007 (0.002-0.019)	0.008 (0.002-0.024)	0.007 (0.004-0.023)	0.008 (0.005-0.021)	0.008 (0.005-0.020)	0.009 (0.005-0.020)	Not Available
Total Phosphorus (TP) (mg/L)	0.03 (0.02-0.05)	0.02 (0.02-0.04)	0.03 (0.02-0.04)	0.03 (0.02-0.05)	0.03 (0.02-0.05)	0.02 (0.02-0.04)	0.03 (0.02-0.04)	Not Available
Silica (as SiO_2) (mg/L)	0.5 (0.1-1.9)	0.4 (0.1-1.3)	0.5 (0.1-1.5)	0.5 (0.1-1.1)	0.5 (0.1-1.1)	0.4 (0.1-1.0)	0.5 (0.1-1.4)	Not Available
Chlorophy-ll-*a* (μg/L)	7.8 (1.4-16.5)	7.1 (1.1-18.3)	5.8 (0.9-17.0)	5.5 (1.4-17.0)	4.6 (1.2-12.9)	4.5 (0.9-12.3)	3.6 (1.1-7.9)	Harbour Subzone: not >20μg/L; Buffer Subzone: not >10μg/L; Channel Subzone: not >6μg/L
E.coli (count/100mL)	12 (1-140)	4 (1-180)	3 (1-53)	2 (1-14)	1 (1-13)	2 (1-32)	1 (1-3)	Geometric mean not to exceed 610 per 100mL at the secondary contact recreation subzone and fish culture zones
Faecal Coliforms (count/100mL)	100 (5-1400)	23 (2-1100)	18 (1-610)	7 (1-250)	4 (1-88)	3 (1-170)	2 (1-17)	Not Available

Notes:
1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, mid-depth, bottom.
2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means.
3. Data in brackets indicate the ranges.
4. Chlorophyll-*a* level is calculated as a running arithmetic mean of five daily measurements for any single location and depth.

Marine Water Quality within Shuen Wan Typhoon Shelter

B4.3 A summary of published EPD monitoring data collected in 2007 from the monitoring station at the Shuen Wan Typhoon Shelter (TT1) is presented in **Table B4.2**. Locations of TT1 are shown on Figure 4.2 in the main text of this Project Profile.

Table B4.2 Summary Statistics of 2007 Marine Water Quality at the Shuen Wan Typhoon Shelter

Parameter		TT1	WPCO WQO (in marine waters)
Temperature (℃)		24.0 (17.9-27.9)	Not more than 1℃ in daily temperature range
Salinity		32.4 (31.5-33.6)	Not to cause more than 3ppt change
Dissolved Oxygen (DO) (mg/L)	Depth Average	5.2 (4.1-6.8)	not less than 4mg/L other than within 2m of the bottom.
	Bottom	4.7 (2.0-6.6)	not less than 2mg/L within 2m of the bottom.
Dissolved Oxygen (DO) (% Saturation)	Depth Average	75 (62-93)	Not Available
	Bottom	66 (29-95)	Not Available
pH		7.9 (7.6-8.2)	not to exceed by ±0.5 pH units.
Secchi Disc Depth (m)		2.4 (1.2-3.5)	Not Available
Turbidity (NTU)		11.4 (4.3-19.0)	Not Available
Suspended Solids (SS) (mg/L)		2.4 (1.5-5.7)	Not Available
5-day Biochemical Oxygen Demand (BOD_5), (mg/L)		1.5 (1.2-1.7)	Not Available
Ammonia Nitrogen (NH_3-N) (mg/L)		0.06 (0.02-0.11)	Not Available
Unionized Ammonia (UIA) (mg/L)		0.003 (<0.001-0.005)	Not Available
Nitrite Nitrogen (NO_2-N) (mg/L)		0.003 (0.002-0.004)	Not Available
Nitrate Nitrogen (NO_3-N) (mg/L)		0.010 (0.004-0.024)	Not Available
Total Inorganic Nitrogen (TIN) (mg/L)		0.07 (0.03-0.14)	Not Available
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.26 (0.24-0.32)	Not Available
Total Nitrogen (TN) (mg/L)		0.28 (0.24-0.35)	Not Available
Orthophosphate Phosphorus (PO_4) (mg/L)		0.009 (0.004-0.015)	Not Available
Total Phosphorus (TP) (mg/L)		0.03 (0.02-0.05)	Not Available
Silica (as SiO_2) (mg/L)		0.5 (0.1-1.3)	Not Available
Chlorophy-ll-*a* (μg/L)		6.3 (2.0-9.6)	not to exceed 20μg/L.
E.coli (count/100mL)		11 (4-49)	Geometric mean not to exceed 610 per 100mL at the secondary contact recreation subzone and fish culture zones
Faecal Coliforms (count/100mL)		45 (15-190)	Not Available

Notes:
1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, mid-depth, bottom.
2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means.
3. Data in brackets indicate the ranges.
4. Chlorophyll-*a* level is calculated as a running arithmetic mean of five daily measurements for any single location and depth.

B4.4 In 2007, high DO (4.1-6.8 mg/L) and low chlorophyll-a (2-9.6μg/L) and *E.coli* (4-49cfu/100mL) levels were recorded at the Shuen Wan Typhoon Shelter.

Sediment Quality

B4.5 Marine site investigation and laboratory testing have been carried out to determine the contamination level of the dredged sediments (details refer to Section 3.11 in the main text of this Project Profile). The results of marine sediment quality analysis from the marine site investigation works indicated that the marine sediments to be dredged at the Project sites were potentially contaminated with metals. The recorded levels of metalloid (arsenic) and trace organics (PCBs and PAHs) in the sediment samples were however low or not detected.

B5. EVALUATION OF POTENTIAL IMPACTS

B5.1 Potential water quality concerns from the Project would be fine sediment lost to suspension causing an increase in suspended solids (SS) concentrations in the water column as well as the potential release of sediment-bound contaminants and oxygen depletion during dredging. Increase in water depth after dredging could also reduce the local water currents and stimulate sediment deposition.

Suspended Solids

Ambient SS Concentration

B5.2 The sediment plumes passing over a sensitive receiver will cause the ambient suspended solids (SS) concentrations to be elevated. The level of elevation will determine whether the impact is adverse. A SS concentration of 10mg/L has been adopted as the assessment criterion. It is proposed to represent the ambient SS value by the 90th percentile of SS concentrations measured under the EPD routine marine water quality monitoring programme at the stations (namely TM2, TM3, TM4, TM5, TM6, TM7 and TM8) nearest to the sensitive receivers that would be potentially affected by the dredging works as shown in Figure 4.2 (attached in the main text of this Project Profile). The relevant EPD data in suspended sediment concentration are summarized in **Table B5.1**. The 90th percentile SS values presented in **Table B5.1** were calculated based on the EPD monitoring data collected in the period from 2006 to 2007.

Table B5.1 Ambient Suspended Solids Concentrations in the Vicinity of Sensitive Receivers

EPD Monitoring Station	Ambient SS Concentration (90th percentile, mg/L)		Water Sensitive Receiver (refer to Figure 4.2 in the main text of this Project Profile)
	Dry Season	Wet Season	
TM2	3.19	3.13	WSD Flushing Water Intake: Sha Tin (WSD2).
TM3	3.50	7.52	Existing Yim Yin Tsai FCZ: F7 Proposed Temporary Relocation Site for Yim Tin Tsai FCZ: F3; Corals: Pak Sha Tau (CR1), Tai Po Industrial Estate (CR14); WSD Flushing Water Intake: Tai Po (WSD1).
TM4	2.33	2.21	Proposed Temporary Relocation Site for Yim Tin Tsai FCZ: F4; Cooling Water Intake: Marine Biolaboratary (C1)
TM5	3.90	5.76	Proposed Temporary Relocation Site for Yim Tin Tsai East FCZ: F5; Corals: Tai Mei Tuk (CR10), Yeung Chau (CR11), Ma Shi Chau North (CR12); Non-Gazetted Beach: Lung Mei.
TM6	2.15	2.31	Proposed Temporary Relocation Site for Yim Tin Tsai East FCZ: F6; Corals: Pak Sha Tau (CR1), Whitehead Peninsula (CR13).
TM7	2.64	1.84	Fish Culture Zone: Yung Shue Au (F1), Lo Fu Wat (F2).
TM8	2.68	3.17	Corals: Wong Wan Tsui (CR2), Fung Wong Wat (CR3), South Wong Chuk Kok Tsui (CR4), Wong Chuk Kok Tsui (CR5), Gruff Head (CR6), Hoi Ha Wan Moon Island (CR7), Hoi Ha Wan Coral Beach (CR8), Hoi Ha Wan Pier (CR9).

B5.3 The allowable SS concentration would be 10mg/L. The predicted maximum SS elevations caused by the dredging activities would be combined with the relevant ambient SS concentrations as shown in the above table to determine the acceptability of the impacts.

Modelling Scenarios

B5.4 Two modelling scenarios are proposed for the sediment plume simulation. The first modelling scenario (namely Scenario 1) assumed that the dredging works at Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ and Shue Wan Typhoon Shelter would take place concurrently, while the second modelling scenario (namely Scenario 2) assumed that the dredging work at Shue Wan Typhoon Shelter will take place alone with the existing fish rafts at Yim Tin Tsai FCZ remains in its place. The concurrent dredging activities assumed under Scenario 1 and Scenario 2 are listed below.

Scenario 1

- Dredging at the Yim Tin Tsai FCZ;
- Dredging at the Yim Tin Tsai (East) FCZ; and
- Dredging at the Shuen Wan Typhoon Shelter.

Scenario 2

- Dredging at the Shuen Wan Typhoon Shelter.

B5.5 The dredging rate at Yim Tin Tsai and Yim Tin Tsai (East) FCZs was assumed in Scenario 1 to be 3,500 m^3/d and 4,300 m^3/d respectively under the unmitigated situation. The dredging rate at Shuen Wan Typhoon Shelter was assumed to be 1,200 m^3/d in both scenarios for unmitigated situation. Dredging would be carried out for 12 hours per day (6 days per week).

B5.6 Based on the approved EIA for *"Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures* (Theme Park)", the sediment loss rate from grab dredging in areas with significant amount of debris or big boulders on the seabed would be 25 kg/m^3 dredged, whilst the loss rate in areas where debris is less likely to hinder operations would be 17 kg/m^3 dredged.

B5.7 For this Study, the loss rate of 25 kg/m^3 dredged is thus assumed for grab dredging at the Shuen Wan Typhoon Shelter where there may be significant quantities of debris or big boulders on the seabed.

B5.8 Dredging in the two FCZs is unlikely to encounter significant amount of debris or big boulder as confirmed by the marine site investigation. A loss rate of 20 kg/m^3 dredged is assumed for the FCZs. The assumed loss rate of 20 kg/m^3 dredged is higher than the loss rate (17 kg/m^3 dredged) adopted in the approved EIA for Theme Pak for areas with no significant debris on the seabed, and is therefore conservative.

B5.9 Based on the proposed dredging rates, a total of 6 dredgers is assumed to be operated concurrently at the Project sites (including 2 dredgers at Yim Tin Tsai FCZ, 3 dredgers at Yim Tin Tsai East FCZs and 1 dredger at Shuen Wan Typhoon Shelter) for Scenario 1. For modelling purpose, only three sediment source points (namely YTTFCZ, YTTEFCZ and SWTS respectively) are assumed to represent the dredging works and each source point may cover more than 1 grab dredgers. All the three assumed sediment source points were chosen at locations close to the WSRs for worst case assessment. It should be highlighted that the dredging rates and number of dredging plants adopted in the modelling represent the worst case for conservative predictions. The actual or average dredging rates and number of construction plants to be actually used on-site may be smaller. The sediment loss rates for the three assumed source points assumed under Scenario 1 (refer to **Figure B1** of this appendix) are calculated as follows:

- YTTFCZ: 1.62 kg/s (covering the sediment loss from 2 dredgers at Yim Tin Tsai FCZ)
- YTTEFCZ: 1.99 kg/s (covering the sediment loss from 3 dredgers at Yim Tin Tsai East FCZ)
- SWTS: 0.7 kg/s (covering the sediment loss from 1 dredger at Shuen Wan Typhoon Shelter)

B5.10 For scenario 2, only one sediment source point would be deployed within Shuen Wan Typhoon at SWTS shown in **Figure B1**. The sediment loss rate for the assumed source point under Scenario 2 is calculated as follows:

- SWTS: 0.7 kg/s (covering the sediment loss from 1 dredger at Shuen Wan Typhoon Shelter)

Coastline Configuration and Bathymetry

B5.11 The coastline configuration and bathymetry of the THMB Model was updated, taking account of the layout of the reclamation at Pak Shek Kok and the latest seabed information obtained from this Study and from the marine charts published by the Marine Department in 2008. No further major reclamation within the Tolo Harbour and Channel is expected.

Sediment Plume Modelling Tools

B5.12 The Tolo Harbour and Mirs Bay (THMB) Fine Grid Model, originally developed by EPD using the Delft3D suite of models under Agreement No. WP01-27 and adopted under the approved EIA for Tai Po Sewage Treatment Works Stage V, was used as the basis for hydrodynamic and water quality modelling. This detailed model was fully calibrated and verified by comparing computational results with field measurements. The grid layout and grid properties of the THMB model are given in **Annex B1** of this appendix.

B5.13 The 3-dimensional particle tracking model (Delft3D-PART) was employed to simulate the sediment plumes arising from the mud dredging activities based on the THMB Model. This model has been used for sediment plume modelling in a number of previous studies in Hong Kong including the recent approved Cruise Terminal Dredging EIA [(2)]. The loss of fines to the water column during dredging operations is represented by discrete particles in the model. These discrete particles are transported by advection, due to the tidal flows determined from hydrodynamic simulation, and turbulent diffusion and dispersion, based on a random walk technique. The Delft3D-FLOW was used to provide the hydrodynamic information for particle tracking.

B5.14 The Delft3D-PART model takes into account the sedimentation process by means of a settling velocity, while erosion of bed sediment, causing re-suspension of sediment, is governed by a function of the bed shear stress. The parameters to be adopted in the present study are summarized in **Table B5.2**.

Table B5.2 Summary of Parameters for Sediment Plume Model (Delft3D-PART)

Sediment Plume Model Parameters		
Horizontal Dispersion Coefficient D_H, (m^2/s)	a = 0.003 b = 0.4	$D_H = a \cdot t^b$, where t is the age of particle from the instant of discharge in seconds
Vertical Dispersion Coefficient D_V, (m^2/s)	$5x10^{-3}$ $1x10^{-5}$	Dry Season Wet Season
Particle Settling Velocity	0.0001 m/s (Constant)	Grain size diameter of 10μm
Critical Shear Stress	0.05 Pa 0.15 Pa	Sedimentation Erosion

(2) Maunsell Consultants Asia Ltd. (Oct 2007), Agreement No. CE 35/2006 (CE), Kai Tak Development Engineering Study cum Design and Construction of Advance Works – Investigation, Design and Construction, Dredging Works for Proposed Cruise Terminal at Kai Tak Environmental Impact Assessment Report

Simulation Period

B5.15 The proposed modeling scenarios were simulated for both dry and wet seasons. The spin-up period of the hydrodynamic model of the THMB covered at least a calendar year as adopted in Agreement No. WP01-27. The actual simulation period of the hydrodynamic model covered two typical 15-day full spring-neap cycles (preceded by the spin-up period) for dry and wet seasons respectively as shown below:

- Spin-up period for dry season: 1 January 2009 – 6 February 2010
- Actual simulation period for dry season: 6 February 2010 – 21 February 2010
- Spin-up period for wet season: 1 January 2009 – 25 July 2010
- Actual simulation period for wet season: 25 July 2010 – 9 August 2010

B5.16 The hydrodynamic results (for the actual simulation period) will be used repeatedly to drive the particle tracking simulations (Delft3D-PART). The simulation period of the Delft3D-PART model covered two 15-day full spring-neap cycles (preceded by sufficient spin-up period) for dry and wet seasons respectively. A spin-up period (covering two complete spring-neap cycles) has been checked to be sufficient to ensure that initial condition effects are neglected.

Model Results for Unmitigated Scenario

Scenario 1

B5.17 The modelling scenario was simulated with an actual simulation period (excluding spin-up) of one typical spring-neap tidal cycle in both dry and wet seasons. Absolute maximum and tidal-averaged SS concentrations predicted over a spring-neap cycle at the FCZs and seawater intakes, taking into account the background SS concentration, are presented in **Table B5.3** for the unmitigated scenario. The 90 percentile values of the SS levels measured by EPD in 2006-2007 were used as the background SS concentrations for the corresponding indicator points. Use of the 90th percentile of SS concentrations to represent the ambient SS value has been adopted in numerous recently approved EIAs such as those for the "*Dredging Works for Proposed Cruise Terminal at Kai Tak*" and "*Wan Chai Development Phase II and Central-Wan Chai Bypass*". The SS elevations and sedimentation rates predicted at the coral communities are provided in **Table B5.4** for the unmitigated scenario. The results shown in these tables indicate that only the proposed temporary relocation site for Yim Tin Tsai FCZ (namely F3) marginally exceeded (highlighted in bold) the assessment criterion for SS under the unmitigated scenario. All the coral sites would comply with the relevant criteria (as shown in **Table B5.4**) under the unmitigated scenario. Mitigation measures are considered in later sections to mitigate the water quality impacts.

B5.18 The contour maps of cumulative SS elevations and sedimentation rates caused by the dredging activities predicted under the unmitigated scenario are given in **Annex B2** and **Annex B3** for wet and dry seasons respectively. The contour plots are presented for the maximum instantaneous concentrations as well as the tidal averaged values predicted over the entire simulation (i.e. one full spring neap cycle). Each figure attached to these appendices contains two contour plots where the upper plot shows the unmitigated scenario and the lower plot shows the mitigated scenario. Discussion on the mitigated scenarios is given in later sections.

Table B5.3 Predicted SS Concentrations at Fish Culture Zones and Seawater Intakes for Unmitigated Scenario

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	SS Concentration						
	Criteria	Wet Season			Dry Season		
		Mean	Maximum	% time in compliance	Mean	Maximum	% time in compliance
Fish Culture Zones							
Yung Shue Au (F1)	< 10	1.84	1.84	100.00%	2.64	2.64	100.00%
Lo Fu Wat (F2)	< 10	1.84	1.84	100.00%	2.64	2.64	100.00%

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	Criteria	SS Concentration					
		Wet Season			Dry Season		
		Mean	Maximum	% time in compliance	Mean	Maximum	% time in compliance
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F3)	< 10	7.75	**10.47**	**99.72%**	3.51	3.76	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F4)	< 10	2.21	2.28	100.00%	2.33	2.33	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F5)	< 10	5.77	5.97	100.00%	3.90	3.90	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F6)	< 10	2.31	2.36	100.00%	2.15	2.15	100.00%
Cooling Water Intake							
Marine Biolaboratory (C1)	See Note 3	2.21	2.21	100.00%	2.33	2.33	100.00%
WSD Flushing Water Intakes							
Tai Po (WSD1)	< 10	7.52	7.52	100.00%	3.50	3.50	100.00%
Sha Tin (WSD2)	< 10	3.13	3.13	100.00%	3.19	3.19	100.00%

Note:
1. The SS values shown above are in mid-depth for Seawater Intakes (i.e. Cooling Water Intakes and WSD Flushing Water Intakes) and depth-averaged for Fish Culture Zones.
2. Bold and shaded number indicates exceedence of criterion.
3. No criterion value is available for cooling water intake (refer to Section B3.5).

Table B5.4 Predicted SS Concentrations and Sedimentation Rates at Coral Sites for Unmitigated Scenario

Corals (ID), refer to Figure 4.2 in the main text	SS Concentration in bottom layer (mg/L)				Sedimentation Rate ($g/m^2/day$)			
	Criterion	Mean	Maximum	% time in compliance	Criterion	Mean	Maximum	% time in compliance
Wet Season								
Pak Sha Tau (CR1)	< 10	2.31	2.31	100.00%	< 100	<10	<10	100.00%
Wong Wan Tsui (CR2)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Fung Wong Wat (CR3)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
South Wong Chuk Kok Tsui (CR4)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Wong Chuk Kok Tsui (CR5)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Gruff Head (CR6)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Hoi Ha Wan Moon Island (CR7)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Hoi Ha Wan Coral Site (CR8)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Hoi Ha Wan Pier (CR9)	< 10	3.17	3.17	100.00%	< 100	<10	<10	100.00%
Tai Mei Tuk (CR10)	< 10	5.76	5.76	100.00%	< 100	<10	<10	100.00%
Yeung Chau (CR11)	< 10	5.76	5.76	100.00%	< 100	<10	<10	100.00%
Ma Shi Chau North (CR12)	< 10	5.76	5.76	100.00%	< 100	<10	<10	100.00%
Whitehead Peninsula (CR13)	< 10	2.31	2.31	100.00%	< 100	<10	<10	100.00%
Tai Po Industrial Estate (CR14)	< 10	7.52	7.52	100.00%	< 100	<10	<10	100.00%
Dry Season								
Pak Sha Tau (CR1)	< 10	2..15	2.15	100.00%	< 100	<10	<10	100.00%
Wong Wan Tsui (CR2)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Fung Wong Wat (CR3)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
South Wong Chuk Kok Tsui (CR4)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Wong Chuk Kok Tsui (CR5)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Gruff Head (CR6)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Hoi Ha Wan Moon Island (CR7)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Hoi Ha Wan Coral Site (CR8)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Hoi Ha Wan Pier (CR9)	< 10	2.68	2.68	100.00%	< 100	<10	<10	100.00%
Tai Mei Tuk (CR10)	< 10	3.90	3.90	100.00%	< 100	<10	<10	100.00%
Yeung Chau (CR11)	< 10	3.90	3.90	100.00%	< 100	<10	<10	100.00%
Ma Shi Chau North (CR12)	< 10	3.90	3.90	100.00%	< 100	<10	<10	100.00%
Whitehead Peninsula (CR13)	< 10	2.15	2.15	100.00%	< 100	<10	<10	100.00%
Tai Po Industrial Estate (CR14)	< 10	3.50	3.50	100.00%	< 100	<10	<10	100.00%

<u>Scenario 2</u>

B5.19 Scenario 2 aimed to assess the potential impact upon the existing Yim Tin Tsai FCZ due to the maintenance dredging at Shuen Wan Typhoon Shelter alone assuming that the fish rafts at Yim Tin Tsai FCZ are not relocated. The water quality effect due to dredging at Yim Tin Tsai (East) FCZ would be shielded by the coastal land area of Yim Tin Tsai and hence, the dredging work at Yim Tin Tsai (East) FCZ would have minimal effect on the water quality at the existing Yim Tin Tsai FCZ as demonstrated by the modelling results for Scenario 1. As a result, dredging at Yim Tin Tsai

FCZ and Yim Tin Tsai (East) FCZ is not considered under Scenario 2 while dredging within Shuen Wan Typhoon Shelter is assumed to be carried out alone. For assessing the effect of SS elevation on the Yim Tin Tsai FCZ, a worst case scenario was set up with the dredging source located at the opening of Shuen Wan Typhoon Shelter. The modelling scenario was simulated with an actual simulation period (excluding spin-up) of one typical spring-neap tidal cycle in both dry and wet seasons. Absolute maximum and tidal-averaged SS concentrations predicted over the entire simulation period at the existing Yim Tin Tsai FCZ taking into account the background SS concentration, are presented in **Table B5.5** for the unmitigated scenario. The 90 percentile values of the SS levels measured by EPD in 2006-2007 at TM3 were used as the background SS concentrations for the corresponding indicator points. The results shown in the table indicates that the SS levels predicted at the existing Yim Tin Tsai FCZ (namely F7) would exceed (highlighted in bold) the assessment criterion for SS in wet season under the unmitigated scenario. The water quality impacts on other WSRs were found to be minimal, as assessed in Scenario 1. The contour plots attached in **Annex B4** and **Annex B5** present the maximum instantaneous values and tidal averaged values for SS levels predicted over the entire simulation (i.e. one full spring neap cycle). Each figure attached to these appendices contains two contour plots where the upper plot shows the unmitigated scenario and the lower plot shows the mitigated scenario. Mitigation measures are considered in later sections to mitigate the water quality impacts on the existing Yim Tin Tsai FCZ.

Table B5.5 Predicted SS Concentrations at Yim Tin Tsai FCZ for Unmitigated Scenario

Water Sensitive Receivers (ID), refer to Figure 4.2 of the man text	SS Concentration						
	Criteria	Wet Season			Dry Season		
		Mean	Maximum	% time in compliance	Mean	Maximum	% time in compliance
Yim Tin Tsai FCZ (F7)	< 10	**13.94**	**47.25**	**34.25%**	3.90	8.18	100.00%

Model Results for Mitigated Scenario

Scenario 1

B5.20 Deployment of silt curtains around the dredging operations is recommended for dredging at Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ and Shuen Wan Typhoon Shelter to minimize the potential water quality impacts. According to the Contaminated Spoil Management Study, Final Report (Table 6.12) [(3)], the implementation of silt curtains around the dredging area will reduce the dispersion of SS by a factor of 4 (or about 75%). Under Section 10.6.31 of the Spoil Management Study Final Report [(3)], silt curtains are defined as screens that extend over the full water depth in the dredging area to confine most of the suspended sediments. This is equivalent to the silt curtains to be adopted for this Project which involve the use of impervious sheets or filter fabrics combined with flotation and anchoring devices extending over the full water depth. Furthermore, this reduction factor (75%) has also been adopted for deployment of silt curtains under the approved EIAs for "*Dredging Works for Proposed Cruise Terminal at Kai Tak*", "*Wan Chai Development Phase II & Central-Wan Chai Bypass*" and "*Reclamation of Yau Tong Bay*". The effectiveness of silt curtains is inversely proportional to the flow velocities. Under this Study, silt curtains are assumed to be deployed within the Tolo Harbour which is a semi-enclosed bay with small current where the silt curtains would be highly effective and practical. Hence, the assumed reduction factor (75%) is considered applicable / appropriate for silt curtains to be adopted for this Project. The typical arrangement of silt curtains including the number and type of silt curtains is indicatively shown in **Figure B2**.

B5.21 **Table B5.6** summaries the predicted SS levels at the water quality sensitive receivers after deployment of silt curtains. **Annex B2** and **Annex B3** showed the contour maps of cumulative SS elevations under the mitigated scenario (refer to Section B5.18). With the recommended

(3) Mott MacDonald (1991). Contaminated Spoil Management Study, Final Report, Volume 1, for EPD, October 1991.

measures, the SS levels predicted at all the sensitive receivers would fully comply with the assessment criteria.

Table B5.6 Predicted SS Concentrations at Fish Culture Zones and Seawater Intakes for Mitigated Scenario

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	SS Concentration						
	Criteria	Wet Season			Dry Season		
		Mean	Maximum	% time in compliance	Mean	Maximum	% time in compliance
Fish Culture Zones							
Yung Shue Au (F1)	< 10	1.84	1.84	100.00%	2.64	2.64	100.00%
Lo Fu Wat (F2)	< 10	1.84	1.84	100.00%	2.64	2.64	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F3)	< 10	7.58	8.25	100.00%	3.50	3.56	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F4)	< 10	2.21	2.23	100.00%	2.33	2.33	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F5)	< 10	5.76	5.81	100.00%	3.90	3.90	100.00%
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F6)	< 10	2.31	2.32	100.00%	2.15	2.15	100.00%
Cooling Water Intake							
Marine Biolaboratory (C1)	See Note 3	2.21	2.21	100.00%	2.33	2.33	100.00%
WSD Flushing Water Intakes							
Tai Po (WSD1)	< 10	7.52	7.52	100.00%	3.50	3.50	100.00%
Sha Tin (WSD2)	< 10	3.13	3.13	100.00%	3.19	3.19	100.00%

Note:
1. The SS values shown above are in mid-depth for Seawater Intakes (i.e. Cooling Water Intakes and WSD Flushing Water Intakes) and depth-averaged for Fish Culture Zones.
2. Bold and shaded number indicates exceedence of criterion.
3. No criterion value is available for cooling water intake (refer to Section B3.5).

Scenario 2

B5.22 Deployment of silt curtains around the dredging operations is recommended for dredging at Shuen Wan Typhoon Shelter to minimize the potential water quality impacts on Yim Tin Tsai FCZ. Deployment of silt curtain is considered highly effective and practical within Shuen Wan Typhoon Shelter due to its low water current as indicated in Section B5.20.

B5.23 The model results indicated that exceedances of the target SS objective were still predicted at the existing Yim Tin Tsai FCZ even after deployment of silt curtain around the dredging operation. To further mitigate the SS impacts, it is recommended to reduce the maximum production rate for maintenance dredging at Shuen Wan Typhoon Shelter. Based on the result of sensitivity tests, the maximum allowable production rates for maintenance dredging at the typhoon shelter were determined to be 300 m^3 per day.

B5.24 **Table B5.7** below summarizes the predicted SS levels at the FCZ after implementation of the recommended mitigation measures. **Annex B4** and **Annex B5** showed the contour maps of SS elevations and sedimentation rates under the mitigated scenario. With reduction of the dredging rates as well as deployment of silt curtain around the dredging operation, the SS levels predicted at the FCZ would fully comply with the assessment criterion.

Table B5.7 Predicted SS Concentrations at Yim Tin Tsai FCZ for Mitigated Scenario

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	SS Concentration						
	Criteria	Wet Season			Dry Season		
		Mean	Maximum	% time in compliance	Mean	Maximum	% time in compliance
Yim Tin Tsai FCZ (F7)	< 10	7.92	10.00	100.00%	3.53	3.79	100.00%

Impact on Coral Communities and Dimension of Water Quality Mixing Zone

B5.25 The model results as shown in **Table B5.4** indicated that full compliance with the WQO for SS elevation and the criteria value for sedimentation rate would be achieved at all the identified coral sites identified in the Tolo Harbour and Channel WCZ. Hence, no adverse effect upon these coral sites would be expected from the proposed dredging works.

B5.26 Non-compliance with the SS criteria (10mg/L) is predicted in the Tolo Harbour near the Project sites during dredging. The worst case impact in terms of the relative SS elevation would occur in the wet season. The maximum dimension of the mixing zone for SS elevation is indicated in **Annex B2** and **Annex B3**. The model results predicted under Scenario 1 were used to determine the maximum size of mixing zone. Since the extent of SS elevation predicted under Scenario 2 would be significantly smaller, the model results for Scenario 1 would represent the worst case in relation to the size of sediment plume induced by the Project. The appendices contain two contour plots where the upper plot shows the unmitigated scenario and the lower plot shows the mitigated scenario. As shown in the contour plots, the mixing zone predicted under the dredging scenario would be localized. Full compliance in SS criteria is predicted at all the identified WSRs with implementation of mitigation measures.

Potential Contaminant Release during Dredging

Metals, Metalloid and Trace Organic Compounds

B5.27 An indication of the likelihood of release of contaminants from the marine mud during dredging is given by the results of the elutriation tests from the laboratory testing conducted under the marine SI for selected sediment sampling stations as shown in **Table B5.8** below. Locations of the sampling stations are shown on Figure 3.1 in the main text of this Project Profile.

B5.28 Under the elutriate testing, sediment samples are mixed with a solution, i.e. the ambient seawater collected from the same site, were vigorously agitated during the tests to simulate the strong disturbance to the seabed sediment during dredging. Pollutants absorbed onto the sediment particles would be released and increasing the pollutant concentrations in the solution. The laboratory testing was to analyze the pollutant concentrations in the solution (elutriate).

B5.29 The elutriate samples were analyzed for metals including cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), silver (Ag) and zinc (Zn), as well as metalloid (arsenic, As), tributyltin (TBT), total polychlorinated biphenyl (PCBs) and total polyaromatic hydrocarbons (PAHs). **Table B5.8** below shows the elutriate testing results. As there is no existing legislative standard or guideline for individual contaminant contents in Tolo Harbour, relevant overseas standards for metals, metalloid and trace organic compounds as indicated in Section B3.9 have been adopted as the assessment criteria.

Table B5.8 Sediment Elutriate Test Results with the Water Quality Standards

Sampling ID	Sampling Depth (m)	Metal Content (μg/L)									Organic Compounds Content (μg/L)		
		Ag	Cd	Cu	Ni	Pb	Zn	Cr	As	Hg	Total PCBs	Total PAHs	TBT
Assessment Criterion (2)		**1.9**	**2.5**	**4.8**	**30**	**25**	**40**	**15**	**25**	**0.3**	**0.03**	**50**	**0.1**
YTT/MI7	0.0-0.9	<1	<0.5	**9**	8	5	29	11	**30**	<1	<0.02	<0.1	<0.015
	1.0-2.0	<1	<0.5	**9**	12	14	**47**	14	**27**	<1	<0.02	<0.1	<0.015
	Blank/ Ambient	<1	<0.5	**9**	7	2	16	11	**30**	<1	<0.02	<0.1	<0.015
YTT/MI19	0.0-0.9	<1	<0.5	**17**	10	4	20	5	**28**	<1	<0.02	<0.1	<0.015
	1.0-2.0	<1	<0.5	**10**	11	4	18	5	**31**	<1	<0.02	<0.1	<0.015
	Blank/ Ambient	1	<0.5	**14**	**51**	5	36	4	23	<1	<0.02	<0.1	<0.015
YTTE/MI6	0.0-0.9	<1	<0.5	**9**	16	2	28	3	**28**	<1	<0.02	<0.1	<0.015
	1.0-2.0	<1	<0.5	**9**	16	2	36	6	**26**	<1	<0.02	<0.1	<0.015
	Blank/ Ambient	<1	<0.5	**12**	20	3	38	4	23	<1	<0.02	<0.1	<0.015
YTTE/MI15	0.0-0.9	<1	<0.5	**10**	17	4	35	5	24	<1	<0.02	<0.1	<0.015
	1.0-2.0	<1	<0.5	**13**	18	5	35	8	**27**	<1	<0.02	<0.1	<0.015
	Blank/ Ambient	<1	<0.5	**9**	15	4	35	5	23	<1	<0.02	<0.1	<0.015
YTTE/MI10	0.0-0.9	<1	<0.5	**12**	14	11	**53**	5	**29**	<1	<0.02	<0.1	<0.015
	1.0-2.0	<1	<0.5	**11**	15	2	37	3	**31**	<1	<0.02	<0.1	<0.015
	Blank/ Ambient	<1	<0.5	**10**	16	2	**43**	4	21	<1	<0.02	<0.1	<0.015
SWTS/MI4	0.0-0.9	<1	<0.5	**14**	14	5	**110**	6	**37**	<1	<0.02	<0.1	<0.015
	Blank	<1	<0.5	**13**	11	4	32	5	24	<1	<0.02	<0.1	<0.015
SWTS/MI13	0.0-0.9	<1	<0.5	**40**	13	**32**	**96**	5	**46**	<1	<0.02	<0.1	<0.015
	Blank/ Ambient	<1	<0.5	**12**	10	4	32	13	22	<1	<0.02	<0.1	<0.015

Notes: (1) Value in bold and shaded indicates exceedance of the Water Quality Standard.
(2) Details of the proposed assessment criteria refer to Section B3.9.

B5.30 As shown in **Table B5.8**, the concentrations of copper, lead, zinc and arsenic in the elutriate samples exceeded the assessment criteria. All copper concentrations (measured in total 12 elutriate samples) were higher than the assessment criteria where the highest copper value was recorded at Station SWTS/MI13 (40μg/L). Exceedances for the lead, arsenic and zinc values were recorded in 1, 4 and 11 elutriate samples respectively. The highest concentrations of lead (32μg/L) and arsenic (46μg/L) were also recorded at Station SWTS/MI13. The highest concentration of zinc (110μg/L) was recorded at Station SWTS/MI4. Both of Station SWTS/MI4 and SWTS/MI13 are located in the Shuen Wan Typhoon Shelter where the release of any contaminants into the open harbour during dredging is expected to be limited as the typhoon shelter is semi-enclosed by a breakwater. The levels of silver, cadmium, chromium and mercury measured in the elutriate samples compiled well with the relevant water quality criteria. High nickel concentration was recorded only in one blank sample where all the other measured nickel values complied well with the assessment criterion. The reason for the high nickel value recorded in the blank sample was unknown.

B5.31 The elutriate test results of TBT, total PCBs and total PAHs do not indicate any levels higher than the blank results nor the water quality criteria. It is therefore concluded that adverse water quality impacts due to the potential release of TBT, total PCBs and total PAHs from the sediment are not expected during the dredging activities.

B5.32 Based on the elutriate testing results, the required dilutions to meet the assessment criteria were calculated to be roughly 1.3 for lead (at Station SWTS/MI 13), 9.8 [(4)] for zinc (at Station SWTS/MI 4), 13 [(4)] for arsenic (at Station SWTS/MI 4) and 20 [(5)] for copper (at Station SWTS/MI 13). The recorded exceedances for lead and zinc are considered less critical as their required dilutions to meet the assessment criteria were relatively smaller. Furthermore, exceedances for lead and zinc were only recorded in a small portion of elutriate samples and therefore any significant elevation of lead and zinc in marine water caused by the dredging activities would likely be highly transient and any transient release of lead and zinc from dredging would be diluted by a large volume of marine water. The lead and zinc concentrations recorded in most of the elutriate samples complied well with the assessment criteria. Release of arsenic and copper is thus considered more critical (as compared to lead and zinc) and was therefore selected for tracer dispersion modelling as detailed in the subsequent sections.

<u>Release of Metals from Dredging</u>

B5.33 An assessment of metal release for copper and arsenic has been made in relation to the sediment quality results (refer to Section B5.32). The sediment sampling work was conducted in the period from 10 January 2009 to 20 January 2009 which comprised 59 sampling stations (based on a 100m x 100m sampling grid) as shown in Figure 3.1 attached in the main text of this Project Profile. The sampling types and depths of the sampling stations are summarized in Appendix C1 of this Project Profile. The sediment testing parameters and the corresponding laboratory testing results are presented in Appendix C2 of this Project Profile. The analytical methods and quality assurance / quality check procedures for the sediment sampling and testing are given in Appendix C5 of this Project Profile.

B5.34 Based on the chemical testing results in Appendix C2, the measured copper concentrations ranged from 7.4 to 17 mg/kg (for Yim Tin Tsai FCZ), 7 to 32 mg/kg (for Yim Tin Tsai East FCZ) and 20 to 140 mg/kg (for Shuen Wan Typhoon Shelter) with mean values of 10.2, 10.5 and 68.4 mg/kg respectively. The measured arsenic concentrations ranged from 3.1 to 11 mg/kg (for Yim Tin Tsai

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(4) The dilution factor for zinc and arsenic would be affected by the concentration of zinc and arsenic present in the ambient water. The required dilution factor (DF) to achieve compliance with water quality criteria was calculated according to the following:
<Pollutant concentration (in elutriates)> x (1) + <Ambient water concentration> x (DF – 1) = <Assessment criterion of pollutant. X (DF)

(5) The copper value in the ambient water sample for Station SWTS/MI 13 (12μg/L) already exceeded the assessment criterion of 4.8μg/L. The measured ambient value (12μg/L) was used as the reference value to assess the potential copper impact. The dilution factor (DF) of 20 calculated for copper is the DF required for the copper elevation to decrease to 2μg/L which is small as compared to the ambient level of 12μg/L.

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FCZ), 1.9 to 9.2 mg/kg (for Yim Tin Tsai East FCZ) and 2 to 9.7 mg/kg (for Shuen Wan Typhoon Shelter) with mean values of 7.7, 4.6 and 5.6 mg/kg respectively.

B5.35 Inert tracers (with zero decay) were introduced into the Delft3D-WAQ model at the dredging locations to determine the dilution in the vicinity of the dredging site. The dilution information was then used to determine the decreases in concentrations of the concerned parameters and to evaluate the potential impacts to the marine environment.

B5.36 Discharge of inert tracers was assumed at the three source points (discharge locations) as shown in **Figure B1**. In the calculation of the loss rate of metal for model input, it was conservatively assumed that all contaminants contained in the sediments that are lost to the water environment during dredging will be dissolved into the water phase. The metal loss rate was calculated using the average metal levels measured in the sediment samples collected from the proposed dredging sites (refer to Section B5.34) for continuous model input. As shown in Appendix C2, high metal concentrations were only recorded in a very small number of sediment samples collected from the Project sites. Most of the metal concentrations recorded in the sediment samples were much lower than the identified maximum values. It is therefore considered reasonable to use the average metal concentrations measured in the sediment samples in calculation of the metal loss rates for continuous model input so as to provide a more realistic prediction. **Table B5.9** below tabulates the metal loss rates adopted for continuous model input.

Table B5.9 Calculated Metal Loss Rates for Unmitigated Scenario

Concurrent Source ID (See Figure B1)	Metal Concentration in Sediments(mg/kg)	Sediment Loss Rate (kg/m^3), refer to Sections B5.7and B5.8	Production Rate (m^3 per day)	Metal Loss Rate (g/s)
Copper				
Scenario 1				
YTTFCZ	10.2	20	3,500	0.017
YTTEFCZ	10.5	20	4,300	0.021
SWTS	68.4	25	1,200	0.048
Scenario 2				
SWTS	68.4	25	1,200	0.048
Arsenic				
Scenario 1				
YTTFCZ	7.7	20	3,500	0.012
YTTEFCZ	4.6	20	4,300	0.009
SWTS	5.6	25	1,200	0.004
Scenario 2				
SWTS	5.6	25	1,200	0.004

B5.37 Tracer simulations were performed to determine the maximum dimensions of mixing zones for copper and arsenic. Each simulation covered two model runs for dry and wet seasons respectively. In order to meet the assessment criterion for arsenic of 25 μg/l (refer to Section B3.9) and taking into account the average ambient arsenic values (as measured in the blank samples, refer to **Table B5.8**) of about 24 μg/l, the maximum arsenic elevations caused by the dredging activities should not be no more than 1 μg/l. **Annex B6** and **Annex B7** show the contour plots of maximum instantaneous arsenic elevations predicted over the entire simulation period for Scenario 1 and Scenario 2 respectively. Each figure attached to these appendices contains two contour plots where the upper plot shows the unmitigated scenario and the lower plot shows the mitigated scenario. As shown in **Annex B6**, the arsenic elevations predicted under Scenario 1 would exceed 1 μg/l (or 0.001 mg/l) in the Shuen Wan Typhoon Shelter and the existing Yim Tin Tsai FCZ for dry season under the unmitigated scenario. The plume of arsenic elevations predicted under Scenario 1 was much smaller during the wet season. As shown in **Annex B7**, the arsenic elevations predicted under Scenario 2 would exceed 1 μg/l (or 0.001 mg/l) in a very small localized area within the Shuen Wan Typhoon Shelter under the unmitigated scenario for dry season only. All the arsenic elevations predicted under Scenario 2 were below 1 μg/l during the wet season.

B5.38 The ambient copper concentrations (as measured in the blank samples, refer to **Table B5.8**) ranged from 9 to 14 μg/l which already exceeded the assessment criteria of 4.8 μg/l. It is considered that a copper elevation of 2 μg/l is small as compared to the measured ambient copper value and therefore an elevation of 2 μg/l is used as a reference value to determine the potential influence zone of copper release. **Annex B6** and **Annex B7** showed the contour plots of maximum instantaneous copper elevations predicted over the entire simulation period for Scenario 1 and Scenario 2 respectively. As shown in **Annex B6**, the copper elevations predicted under Scenario 1 would exceed 2 μg/l (or 0.002 mg/l) in the Shuen Wan Typhoon Shelter, the existing Yim Tin Tsai FCZ and the nearby water areas for dry season under the unmitigated scenario. The plume of copper elevations predicted under Scenario 1 was relatively smaller during the wet season. As shown in **Annex B7**, the copper elevations predicted under Scenario 2 would exceed 2 μg/l (or 0.002 mg/l) within the Shuen Wan Typhoon Shelter and part of the existing Yim Tin Tsai FCZ under the unmitigated scenario for both dry and wet seasons.

B5.39 To further mitigate the potential impact of metal release, it is recommended to reduce the dredging rates for Yim Tin Tsai FCZ and Sheun Wan Typhoon Shelter to 2,500 m^3 per day and 600m^3 per day respectively under Scenario 1. For Scenario 2, it is recommended to reduce the rate of maintenance dredging in Shuen Wan Typhoon Shelter to 300 m^3 per day to minimize the potential impact upon the Yim Tin Tsai FCZ. As shown in **Annex B6** and **Annex 7**, the plumes of metal elevations predicted under the mitigated scenarios (with reduction of the dredging rates) would become localized and confined within close proximity to the dredging sites. It should be highlighted that the effect of silt curtain was not considered in the model prediction for metals under the mitigated scenario and as such the change in plume sizes between the unmitigated and mitigated scenarios as shown in the contour plots was solely the effect of adoption of the recommended reduced dredging rates. It is considered that the mixing zone of any contaminant release from the dredging operation would be moving around the dredging site as driven by the changing water current. As the model results are presented as the maximum values predicted over the entire simulation period, the areas of mixing zones shown in the contour plots do not represent the actual maximum plume size. They are considered as the areas which envelop the moving plumes over the entire simulation period. The actual maximum instantaneous coverage of the mixing zone for these contaminants would be much smaller than that predicted under this assessment. It is expected that any release of contaminants during dredging would be quickly diluted by the large volume of marine water within the dredging site. Thus, it is considered that long-term off-site marine water quality impact is unlikely and any local water quality impact will be transient.

B5.40 Water quality monitoring of heavy metals is recommended for the proposed dredging works. If the water quality monitoring data indicate that the proposed dredging works result in unacceptable water quality impacts in terms of metal elevations in the receiving water, appropriate actions would be taken to review the dredging operation and additional measures such as slowing down, or rescheduling of works would be implemented as necessary. Details of the monitoring programme are given in **Annex G** of this appendix.

<u>Release of Nutrients from Dredging</u>

B5.41 An assessment of nutrient release has been made in relation to the sediment quality results. The highest measured organic nitrogen (Org-N) values recorded in Yim Yin Tsai FCZ, Yim Tin Tsai East FCZ and Shuen Wan Typhoon Shelter were 782 mg/kg, 871 mg/kg and 762 mg/kg respectively. The highest measured ammonia nitrogen (NH_3-N) values recorded in Yim Yin Tsai FCZ, Yim Tin Tsai East FCZ and Shuen Wan Typhoon Shelter were 18 mg/kg, 32 mg/kg and 11 mg/kg respectively. Negligible nitrite and nitrate was found in the sediment samples. Details of the sediment sampling and testing for nutrients and the associated testing results are given in **Annex B10**.

B5.42 Release of nutrients from dredging was assessed using the Delft3D-WAQ model of the THMB Model (refer to Section B5.12). Discharge of Org-N & NH_3-N from dredging was assumed at the three source points (discharge locations) as shown in **Figure B1** of this appendix. In the calculation of the loss rate of Org-N & NH_3-N for model input, it was conservatively assumed that when the sediments are lost to the water environment during dredging, all of the Org-N and NH_3-N contained in the sediments would be released to the water phase instantaneously after the sediment is released from the dredging locations. The calculation was performed using the Org-N and NH_3-N levels measured in the sediment samples (as detailed in Section B5.41). **Table B5.10** below tabulates the nutrient loss rates adopted for continuous model input. The mitigated scenario with reduced dredging rates as discussed in Section B5.39 was simulated in this assessment.

Table B5.10 Calculated Nutrient Loss Rates for Scenario 1 - Mitigated

Concurrent Source ID (See Figure B1)	Nutrient Concentration in Sediments(mg/kg)	Sediment Loss Rate (kg/m^3), refer to Sections B5.7and B5.8	Production Rate (m^3 per day)	Nutrient Loss Rate (g/s)
Organic Nitrogen				
YTTFCZ	782	20	2,500	0.91
YTTEFCZ	871	20	4,300	1.73
SWTS	762	25	600	0.26
Ammonia Nitrogen				
YTTFCZ	18	20	2,500	0.02
YTTEFCZ	32	20	4,300	0.06
SWTS	11	25	600	0.00

B5.43 The baseline water quality in Tolo Harbour was recently simulated using the Delft3D-WAQ model of the THMB Model under Agreement No. IP 06-193 (6) for a Do-Nothing Scenario assuming that the Tai Po and Shatin Sewage Treatment Works would reach their design flows without further upgrading or improvement of the existing sewerage facilities to address the worse-case condition in terms of the pollution discharges into the Tolo Harbour. This Do-Nothing Scenario had taken account of the cumulative effect from all the coastal pollution discharges in Tolo Harbour. The pollution loading inventory adopted under Agreement No. IP 06-193 (for the Do-Nothing Scenario) was based on the 2012 Scenario II pollution inventory of the Update Study (7) and had been reviewed under Agreement No. IP 06-193 with reference to the latest planning and population statistics to be representative and valid. For performing the water quality model run under this Study to address the nutrient release from dredging, the model set-up and background pollution inventory were based on those adopted under the Do-Nothing Scenario for Agreement No. IP 06-193. The water quality simulation period of the THMB Model covered 2 calendar years (including 1 calendar year for spin-up and 1 calendar year for actual simulation) following the approach adopted in Agreement No. WP01-27 (refer to Section B5.12) as well as in Agreement No. IP 06-193. Additional Org-N and NH_3-N loadings from dredging were input to the model at the three source points (discharge locations) as shown in **Table B5.10**. Suspended solid loadings from the dredging operations for the mitigated scenarios with reduced dredging rates were also input to the model. The additional nutrient and SS loadings from dredging activities were input to the model continuously for the entire spin-up and simulation period (i.e. 2 calendar years). The potential water quality impact was then evaluated by comparing the water quality model results for Scenario 1 (with mitigation) against the model results for the baseline Do-Nothing scenario (without this Project).

B5.44 There is no WQO available for unionized ammonia (UIA) and total inorganic nitrogen (TIN) in Tolo Harbour. The assessment therefore focused on the change in chlorophyll-*a* levels due to the dredging operations. During dredging operations, the suspension of sediment and associated release of nutrients may affect the chlorophyll-*a* level in the vicinity of the Project area. The chlorophyll-*a* levels predicted at the WSRs close to the dredging sites are shown in **Table 5.11** for maximum 5-day running average (which is the peak value predicted over the simulation year) for comparison with the WQO (refer to **Table B3.1**).

(6) Investigation for the Upgrading of Tolo Harbour Effluent Export Scheme, Working Paper on Water Quality Impact Assessment for Evaluation of Upgrading Options (Final), March 2009

(7) CE42/97 Update on Cumulative Water Quality and Hydrological Effect of Coastal Development and Upgrading of Assessment Tool

Table B5.11 Predicted Chlorophyll-*a* Concentrations for Scenario 1 - Mitigated

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	Depth	Maximum 5-day Moving Average Chlorophyll-*a* (µg/L)		
		WQO	Baseline Do-Nothing Scenario	Scenario 1 (with Project)
Existing Yim Tin Tsai FCZ (F7) in Harbour Subzone	Surface	<20	**23.8**	**24.4**
	Mid-Depth	<20	18.2	13.6
	Bottom	<20	11.9	8.4
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F3) in Harbour Subzone	Surface	<20	**27.5**	**28.4**
	Mid-Depth	<20	18.9	15.0
	Bottom	<20	11.9	8.8
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F5) in Buffer Subzone	Surface	<10	**17.3**	**18.8**
	Mid-Depth	<10	**16.4**	**11.8**
	Bottom	<10	**11.9**	9.0

Note: 1. Bold and shaded number indicates exceedence of criterion.

B5.45 As shown in **Table B5.11**, only small increases in the chlorophyll-*a* levels were predicted at the water surface due to the dredging operation. The Project did not cause any exceedance of the WQO for chlorophyll-*a*, as the baseline chlorophyll-*a* levels (without the Project) already exceeded the WQO. The predicted chlorophyll-*a* levels were found to decrease in the middle and bottom layers due to the presence of relatively higher SS level from the dredging operations which reduced the light penetration and limited the solar energy source for excessive algal growth.

B5.46 **Annex B8** showed the contour plots for maximum depth-averaged 5-day running mean chlorophyll-*a* values predicted over the entire simulation period for Scenario 1 under the mitigated scenario. As shown in the contour plots, the Project did not cause any significant change in the pattern of chlorophyll-*a* levels in the Study Area.

B5.47 **Annex B9** showed the contour plots of the predicted unionized ammonia (UIA) levels in Tolo Harbour for reference. No WQO is available for UIA in Tolo Harbour. As shown in the contour plots, the annual mean UIA levels would be lower than 0.01 mg/l under Scenario 1. The predicted UIA levels were considered low as compared to the WQO of 0.0021 mg/l defined for the rest of the HK waters.

B5.48 The water quality impact in relation to the chlorophyll-a and UIA levels predicted at the WSRs including the existing Yim Tin Tsai FCZ (namely F7) under Scenario 1 (with larger extent of dredging activities) would be worse than that under Scenario 2. The predicted chlorophyll-*a* and UIA levels for Scenario 2 are therefore not presented.

Red Tide Monitoring Programme and Action Plan

B5.49 The potential impacts from red tide or harmful algal blooms (HABs) that may arise in the Tolo Harbour during the sediment removal works will be managed and responded under the routine red tide monitoring and management protocol and response plan currently adopted by the government in Hong Kong. AFCD shall be acting as the coordinator of the Red Tide Reporting Network, to receive reports of red tide, conduct investigation and provide warning of the risk associated and appropriate mitigation measures. The objectives of this red tide monitoring programme are to provide coordination of monitoring and response to red tides/HABs and fish kills and to compile and synthesize data necessary to effectively manage fisheries resources, protect human health and the marine ecosystems. Details of the existing red tide monitoring and management plan are provided in the website (http://www.hkredtide.org/). An outline of the red tide monitoring and management framework is given in **Annex B11** of this appendix for easy reference.

Oxygen Depletion from Dredging

B5.50 The sediment oxygen demand (SOD) of the sediment samples collected from marine site investigation (SI) has been used to determine the reductions in dissolved oxygen (DO) concentration, based on the predicted increases in suspended sediment concentrations at various indicator points in accordance with the following equation:

$$DO_{DEP} = C * SOD * K * 10^{-6}$$

where DO_{DEP} = Dissolved oxygen (DO) depletion (mg/l)

C = Predicted maximum suspended solids (SS) concentration (mg/l)

SOD = Sediment oxygen demand (mg/kg) measured in the sediment samples collected from marine SI

K = Daily oxygen uptake factor (set as 1)

B5.51 The calculation was performed using the highest levels of sediment oxygen demand (SOD) measured in the sediment samples collected during the marine SI for conservative predictions. The highest SOD level (3300mg/kg) was recorded in the Yim Tin Tsai (East) FCZ. Details of the sediment sampling for SOD and the associated testing results are given in **Annex B10**.

B5.52 In the calculation, the daily oxygen uptake factor, K, was set to be 1, which means instantaneous oxidation of the sediment oxygen demand. This was a conservative prediction of DO depletion since oxygen depletion is not instantaneous. It is worth noting that the above equation does not account for re-aeration which would tend to reduce impacts of the SS on the DO concentrations in the water column.

B5.53 The predicted maximum DO depletion during dredging was used to evaluate the water quality impacts. The calculated maximum DO depletion was subtracted from the measured background DO level to determine the resultant DO level in marine water. The 10 percentile values of the measured DO levels were used as the background levels, following the approach adopted in the approved EIAs for "*Dredging Works for Proposed Cruise Terminal at Kai Tak*" and "*Wan Chai Development Phase II & Central-Wan Chai Bypass*". The proposed analysis, which is on the conservative side, will likely overestimate the impact on DO. The predicted maximum DO depletions are given in **Table B5.12** and **Table B5.13**.

Table B5.12 Calculation of the Effects of Increased Suspended Solids Concentrations on Dissolved Oxygen Concentrations at Fish Culture Zones and Seawater Intakes under Unmitigated Scenario

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	Maximum Predicted Depth-averaged SS Elevation (mg/L)	SOD in Sediment (mg/kg)	Maximum DO Depletion (mg/L)	Background Depth-averaged DO (mg/L)	Resultant DO (mg/L)	WQO for Surface Water and Middle Layer (refer to Table B3.1)	Subzone
Wet Season							
Yung Shue Au (F1)	0.00	-	0.00	4.75	4.75	≥4 mg/l	Channel Subzone
Lo Fu Wat (F2)	0.00	-	0.00	4.75	4.75	≥4 mg/l	
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F3)	2.9513	2300	0.0068	5.49	5.48	≥4 mg/l	Harbour Subzone
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F4)	0.0653	2300	0.0002	4.54	4.54	≥4 mg/l	
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F5)	0.2190	3300	0.0007	5.37	5.37	≥4 mg/l	Buffer Subzone
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F6)	0.0447	3300	0.0001	4.71	4.71	≥4 mg/l	
Marine Biolaboratory (C1)	0.00	-	0.00	4.54	4.54	≥4 mg/l	Harbour Subzone
Tai Po (WSD1)	0.00	-	0.00	5.49	5.49	≥4 mg/l	
Sha Tin (WSD2)	0.00	-	0.00	3.59	3.59	≥4 mg/l	
Dry Season							
Yung Shue Au (F1)	0.00	-	0.00	6.77	6.77	≥4 mg/l	Channel Subzone
Lo Fu Wat (F2)	0.00	-	0.00	6.77	6.77	≥4 mg/l	

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	Maximum Predicted Depth-averaged SS Elevation (mg/L)	SOD in Sediment (mg/kg)	Maximum DO Depletion (mg/L)	Background Depth-averaged DO (mg/L)	Resultant DO (mg/L)	WQO for Surface Water and Middle Layer (refer to Table B3.1)	Subzone
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F3)	0.2595	2300	0.0006	6.14	6.14	≥4 mg/l	Harbour Subzone
Proposed Temporary Relocation Sites for Yim Tin Tsai FCZ (F4)	0.00	-	0.00	5.98	5.98	≥4 mg/l	
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F5)	0.00	-	0.00	5.81	5.81	≥4 mg/l	Buffer Subzone
Proposed Temporary Relocation Sites for Yim Tin Tsai (East) FCZ (F6)	0.00	-	0.00	5.72	5.72	≥4 mg/l	
Marine Biolaboratory (C1)	0.00	-	0.00	5.98	5.98	≥4 mg/l	Harbour Subzone
Tai Po (WSD1)	0.00	-	0.00	6.14	6.14	≥4 mg/l	
Sha Tin (WSD2)	0.00	-	0.00	4.50	4.50	≥4 mg/l	

Table B5.13 Calculation of the Effects of Increased Suspended Solids Concentrations on Dissolved Oxygen Concentrations at Coral Sites under Unmitigated Scenario

Water Sensitive Receivers (ID), refer to Figure 4.2 in the main text	Maximum Predicted Depth-averaged SS Elevation (mg/L)	SOD in Sediment (mg/kg)	Maximum DO Depletion (mg/L)	Background Depth-averaged DO (mg/L)	Resultant DO (mg/L)	WQO for Bottom Water Layer (refer to Table B3.1)	Subzone
Wet Season							
Pak Sha Tau (CR1)	0.00	-	0.00	4.71	4.71	≥3 mg/l	Buffer Subzone
Wong Wan Tsui (CR2)	0.00	-	0.00	3.36	3.36	≥4 mg/l	Channel Subzone
Fung Wong Wat (CR3)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
South Wong Chuk Kok Tsui (CR4)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
Wong Chuk Kok Tsui (CR5)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
Gruff Head (CR6)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
Hoi Ha Wan Moon Island (CR7)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
Hoi Ha Wan Coral Site (CR8)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
Hoi Ha Wan Pier (CR9)	0.00	-	0.00	3.36	3.36	≥4 mg/l	
Tai Mei Tuk (CR10)	0.00	-	0.00	5.37	5.37	≥3 mg/l	Buffer Subzone
Yeung Chau (CR11)	0.1030	3300	0.0003	5.37	5.37	≥3 mg/l	
Ma Shi Chau North (CR12)	0.0008	3300	0.0000	5.37	5.37	≥3 mg/l	
Whitehead Peninsula (CR13)	0.00	-	0.00	4.71	4.71	≥2 mg/l	Harbour Subzone
Tai Po Industrial Estate (CR14)	0.00	-	0.00	5.49	5.49	≥2 mg/l	
Dry Season							
Pak Sha Tau (CR1)	0.00	-	0.00	5.72	5.72	≥3 mg/l	Buffer Subzone
Wong Wan Tsui (CR2)	0.00	-	0.00	6.69	6.69	≥4 mg/l	Channel Subzone
Fung Wong Wat (CR3)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
South Wong Chuk Kok Tsui (CR4)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
Wong Chuk Kok Tsui (CR5)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
Gruff Head (CR6)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
Hoi Ha Wan Moon Island (CR7)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
Hoi Ha Wan Coral Site (CR8)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
Hoi Ha Wan Pier (CR9)	0.00	-	0.00	6.69	6.69	≥4 mg/l	
Tai Mei Tuk (CR10)	0.00	-	0.00	5.81	5.81	≥3 mg/l	Buffer Subzone
Yeung Chau (CR11)	0.00	-	0.00	5.81	5.81	≥3 mg/l	
Ma Shi Chau North (CR12)	0.00	-	0.00	5.81	5.81	≥3 mg/l	Harbour Subzone
Whitehead Peninsula (CR13)	0.00	-	0.00	5.72	5.72	≥2 mg/l	
Tai Po Industrial Estate (CR14)	0.00	-	0.00	6.14	6.14	≥2 mg/l	

B5.54 No significant DO depletion was predicted under the unmitigated scenarios. The concurrent dredging activities would cause a maximum DO depletion of less than 0.01mg/L at the nearby sensitive receivers. Full compliance with the WQO for depth-averaged and bottom DO was predicted in the Tolo Harbour. No mixing zone for DO can therefore be identified. No adverse impacts on the DO levels in Tolo Harbour would be expected from the dredging works.

Consideration of Concurrent Projects

B5.55 No major project was identified to be carried out concurrently in the vicinity of the Project sites and within the 500m from Project site boundary.

B5.56 The closest possible concurrent marine works would be the "Development of a Bathing Beach at Lung Mei, Tai Po (Lung Mei Beach)" over 1km away to the north of the existing Yim Tin Tsai (East) FCZ. This concurrent project would commence in August 2010 for completion in August 2012. Quantitative assessments are provided in this section to assess possible cumulative water quality impacts from the Lung Mei Beach project. The key water sensitive receiver that may potentially be affected by the cumulative water quality impact would be the temporary relocated fish rafts for Yim Tin Tsai (East) FCZ (namely F5) as shown in Figure 4.2 of this Project Profile. As demonstrated in **Annex B2** and **Annex B3**, the sediment plumes (for SS elevation) generated from this Project alone would become localized after implementation of mitigation measures and would not encroach on the temporary relocated fish rafts (F5). As shown in **Table B5.6**, the maximum SS level (with incorporation of the background SS concentrations) predicted at the relocated fish rafts (F5) due to this Project alone under the mitigated scenario was 5.8 mg/l as compared to the assessment criteria of 10 mg/l. Based on the model predictions available from the approved EIA for the Lung Mei Beach project, the SS elevations predicated at the location of the proposed temporary fish rafts F5 (generated by the Lung Mei Beach project alone) would be less than 0.1 mg/l in most areas of the relocation site. The north eastern boundary of the proposed relocation fish rafts (F5) is closest to the Lung Mei Beach project. The SS elevation predicted near the north eastern boundary of the fish raft relocation site (F5) contributed from the Lung Mei Beach project alone would be less than 0.5 mg/l (refer to the contour plots for SS elevation shown in Figure 6.4 to Figure 6.7 of the Lung Mei Beach EIA report available on the EPD website, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1402007/For%20HTML%20version/Fig6.4-6.7.htm). Hence, the maximum possible SS elevation due to the cumulative impacts from the Lung Mei Beach project would be about 6.3 mg/l (= 5.8 mg/l (i.e. the maximum SS elevation contributed from this Project alone plus ambient SS levels) + 0.5 mg/l (i.e. the maximum SS elevation contributed from Lung Mei Beach project alone)), which would well comply with the assessment criterion of 10 mg/l. As such, no unacceptable cumulative water quality impact would be contributed from the Lung Mei Beach project and this Project.

B5.57 Another possible concurrent marine works would be the "Sediment Removal at Yung Shue Au FCZ" which is over 5 km away from the Project sites. As mentioned above, the water quality influence zone of this Project would be localized and confined in close proximity to (within a few hundreds metres from) the Project sites. No observable water quality change was predicted at the water sensitive receivers in the far field including Yung Shue Au FCZ. The scale and programme of the possible concurrent sediment removal works at Yung Shue Au FCZ would be similar to that proposed under this Project and with implementation of mitigation measures such as deployment of silt curtains around the dredging works, it is not expected that the possible dredging works at Yung Shue Au (which is over 5km away) would have any major influence on the water quality around the Project sites. As such, no cumulative water quality impact would be anticipated from the possible sediment removal works at Yung Shue Au FCZ.

Operational Phase Water Quality Impact

B5.58 Increase in water depth after dredging could reduce the local currents and stimulate sediment deposition within the dredged area, which may have an effect on the ecological sensitive receivers at or near the Project sites. However, as Tolo Harbour is an embayed area with small tidal flow velocities, significant change to the flow regime in the Tolo Harbour associated with the change of seabed profile at the Project sites (with a dredged depth of 1 to 2 m only) is not expected. The assessment criterion for sedimentation rate of 100 g/m^2/day (refer to Section B3.7) is considered to offer sufficient protection to marine ecological sensitive receivers and is anticipated to guard against unacceptable impacts. This protection has been confirmed by previous EM&A results which have indicated no adverse impacts to sediment sensitive ecological receivers have occurred when this assessment criterion has been adopted.

B5.59 The baseline sedimentation rates in Tolo Harbour were recently simulated by the THMB Model under Agreement No. IP 06-193 [(8)] for a Do-Nothing Scenario assuming that the Tai Po and Shatin Sewage Treatment Works would reach their design flows without further upgrading or improvement of the existing sewerage facilities to address the worse-case condition in terms of the pollution discharges into the Tolo Harbour. This Do-Nothing Scenario had taken account of the cumulative effect from all the coastal pollution discharges including the pollution (SS) loading from Yim Tin Tsai and Yim Tin Tsai East FCZs [(9)]. The maximum baseline sedimentation rates predicted in the Study Area under this Do-Nothing Scenario were lower than 10 g/m^2/day (based on the model results available from the Agreement No. IP 06-193 for the Do-Nothing Scenario [(8)]) which is considered low or minimal as compared to the assessment criterion of 100 g/m^2/day (refer to Section B3.7).

B5.60 Reduction in the local tidal currents may be expected within or near the dredged areas. However, as there was a great safety margin between the baseline sedimentation rates (as predicted under the Do-Nothing Scenario) and the assessment criterion for sedimentation, and in view that this Project would not induce any additional pollution loading discharges into the Study Area, it is not expected that the Project would cause any exceedance of the assessment criterion for sedimentation. Based the ecological survey results (details refer to Appendix D of this Project Profile), all marine life identified within and near the dredging sites are of low ecological values. Hence, the ecological impact associated with any potential increase in the sedimentation at or near the Project sites would be limited.

B6. MITIGATION MEASURES

B6.1 Closed grab will be used for dredging to minimize release of sediment and other contaminants during dredging.

B6.2 The maximum production rates for the dredging activities at Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ should follow those specified below for two alternative dredging scenarios:

- Alternative Case I: If maintenance dredging for Shuen Wan Typhoon Shelter is to be undertaken concurrently with the dredging works in Yim Tin Tsai FCZ (with fish raft relocation), the maximum allowable production rate for dredging in Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter will be 2,500m^3 per day and 600m^3 per day respectively.
- Alternative Case 2: If dredging in Yim Tin Tsai FCZ and the associated fish raft relocation cannot be undertaken as scheduled during the maintenance dredging at the typhoon shelter, the maximum production rate for maintenance dredging at the typhoon shelter should be reduced to 300 m^3 per day to safeguard the beneficial use of the existing Yim Tin Tsai FCZ for marine culture.

B6.3 The maximum production rates for the dredging activities at Yim Tin Tsai (East) FCZ should not be more than 4,300m^3 per day for any case.

B6.4 As an appropriate mitigation measure, silt curtains will be erected around the dredging area to minimize the potential SS impact from dredging. Furthermore, an additional silt curtain will also be deployed to fully enclose the grab while the dredging works are in progress. The typical arrangement (including the type and number) of silt curtains is indicative shown in **Figure B2**.

B6.5 The following good site practices are recommended to be undertaken during dredging and during transportation and disposal of dredged sediment:

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(8) Investigation for the Upgrading of Tolo Harbour Effluent Export Scheme, Working Paper on Water Quality Impact Assessment for Evaluation of Upgrading Options (Final), March 2009

(9) Pollution loading from the FCZs (due to feeding, excreta and faecal materials produced by fish and disposal of dead fish) was based on the data available from “Agreement No. 42/97 Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool” for Year 2012.

- All vessels should be sized so that adequate clearance is maintained between vessels and the seabed in all tide conditions, to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;
- All barges / dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material;
- Excess material shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved.
- Construction activities should not cause foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the site or dumping grounds;
- Barges or hoppers should not be filled to a level that will cause the overflow of materials or polluted water during loading or transportation.
- Monitoring of the barge loading shall be conducted to ensure that loss of material does not take place during transportation. Transport barges or vessels shall be equipped with automatic self-monitoring devices as required under the Dumping at Sea Ordinance and as specified by the DEP.

B6.6 No discharge of sewage effluent into drainage and water environment should be adopted. Appropriate numbers of portable chemical toilets shall be provided by a licensed contractor as necessary to serve the construction workers. The Contractor shall also be responsible for waste disposal and maintenance practices.

B6.7 Collection and removal of floating refuse at or near the dredging sites should be performed at regular intervals on a daily basis. The Contractor should be responsible for keeping the water within the site boundary and the neighbouring water free from rubbish during the dredging works.

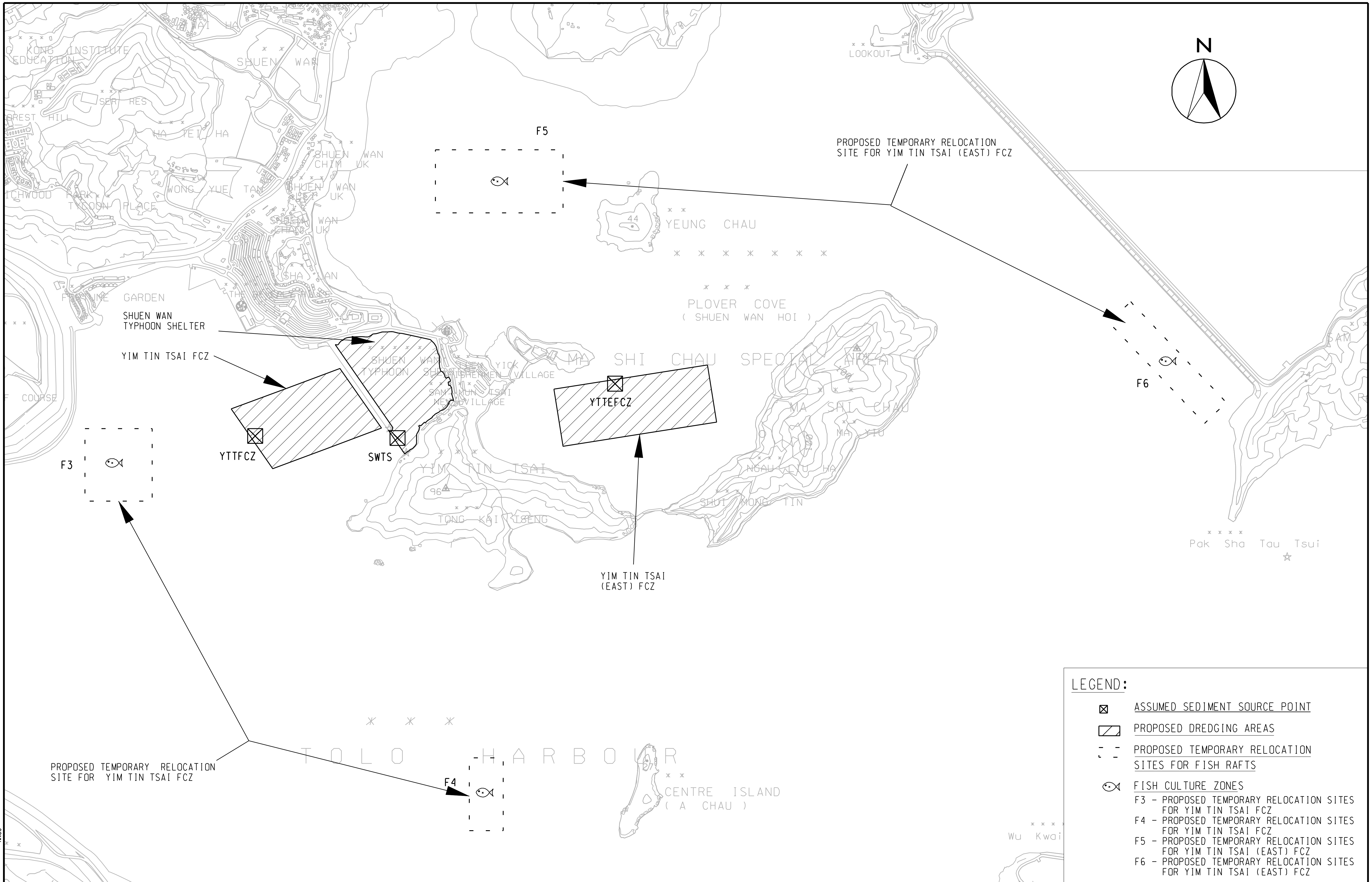
B7. EVALUATION OF RESIDUAL IMPACTS

B7.1 Provided that the recommended mitigation measures are properly implemented, there would be no unacceptable residual water quality impact due to the proposed dredging works.

B8. MONITORING REQUIREMENTS

B8.1 A water quality monitoring and audit programme is required to ensure that all the recommended mitigation measures are implemented properly. If the water quality monitoring data indicate that the proposed dredging works result in unacceptable water quality impacts in the receiving water, appropriate actions should be taken to review the dredging operation and additional measures such as slowing down, or rescheduling of works should be implemented as necessary. Details of the monitoring programme are given in **Annex G** of this appendix.

FIGURE



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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

ASSUMED SEDIMENT SOURCE POINTS FOR DREDGING ACTIVITIES

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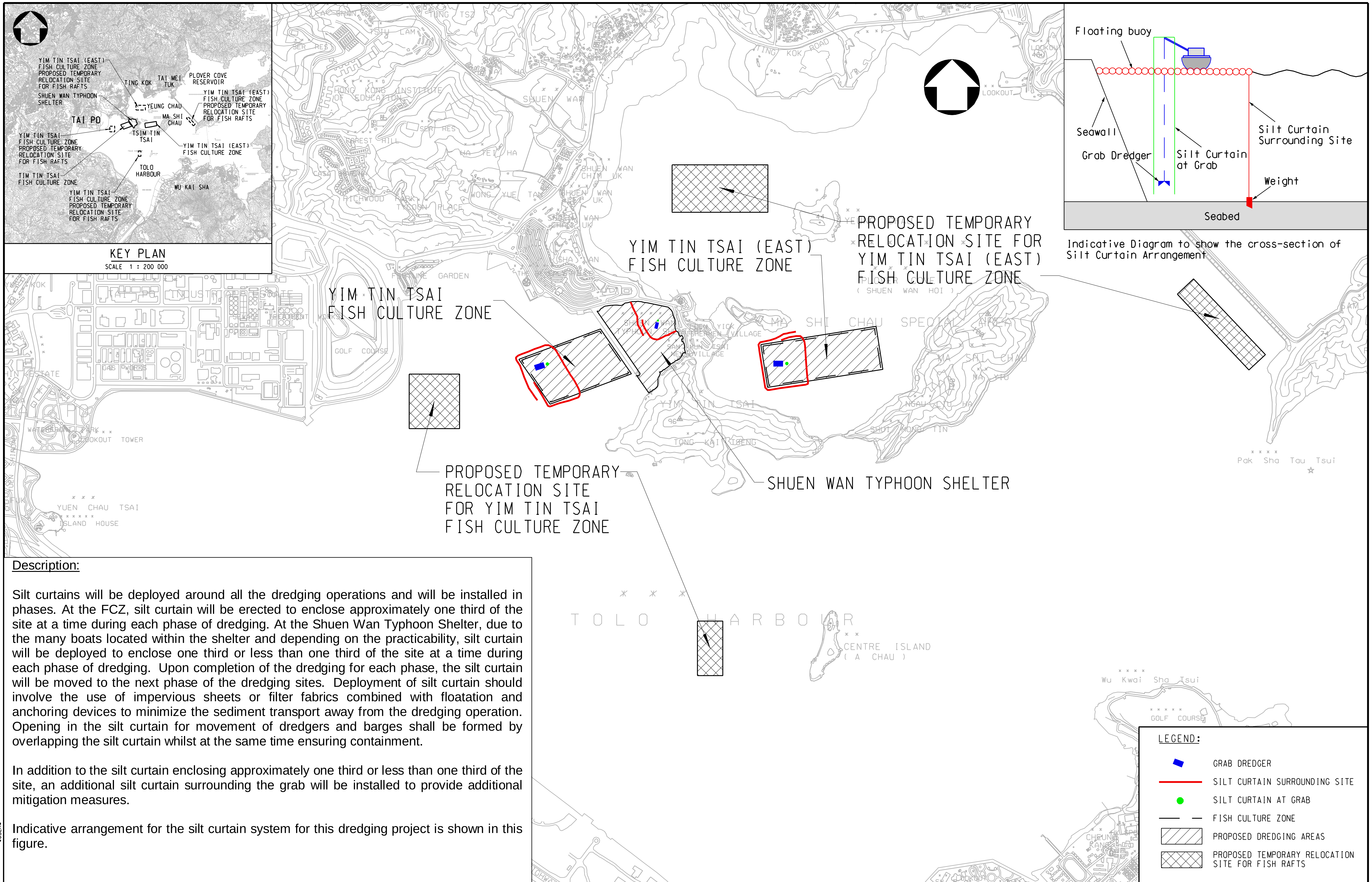

Description:

Silt curtains will be deployed around all the dredging operations and will be installed in phases. At the FCZ, silt curtain will be erected to enclose approximately one third of the site at a time during each phase of dredging. At the Shuen Wan Typhoon Shelter, due to the many boats located within the shelter and depending on the practicability, silt curtain will be deployed to enclose one third or less than one third of the site at a time during each phase of dredging. Upon completion of the dredging for each phase, the silt curtain will be moved to the next phase of the dredging sites. Deployment of silt curtain should involve the use of impervious sheets or filter fabrics combined with floatation and anchoring devices to minimize the sediment transport away from the dredging operation. Opening in the silt curtain for movement of dredgers and barges shall be formed by overlapping the silt curtain whilst at the same time ensuring containment.

In addition to the silt curtain enclosing approximately one third or less than one third of the site, an additional silt curtain surrounding the grab will be installed to provide additional mitigation measures.

Indicative arrangement for the silt curtain system for this dredging project is shown in this figure.

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AGREEMENT NO. CE 26/2008 (EP)
ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DREDGING AT 5 FISH CULTURE ZONES AND 2 BOAT/TYPHOON SHELTERS - INVESTIGATION

Indicative Silt Curtain Arrangement

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		REV	-

Plotting By: $DATE$ $USER$

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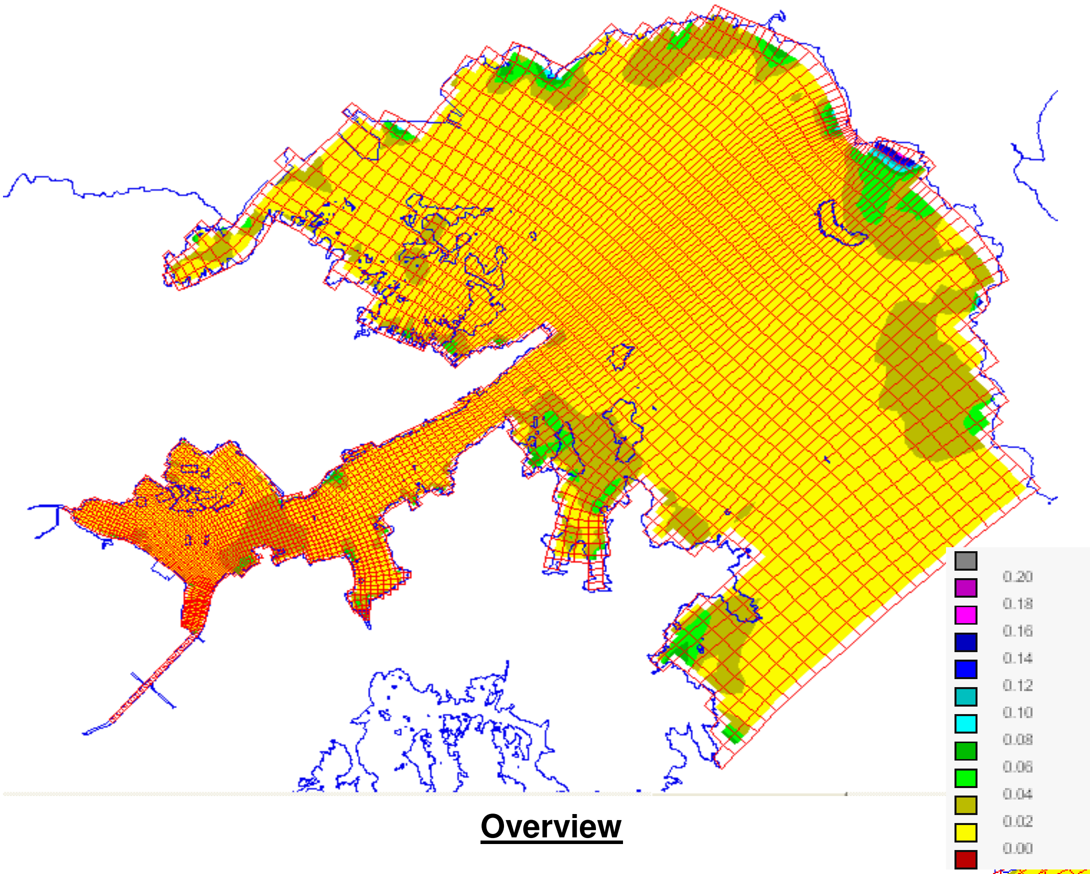
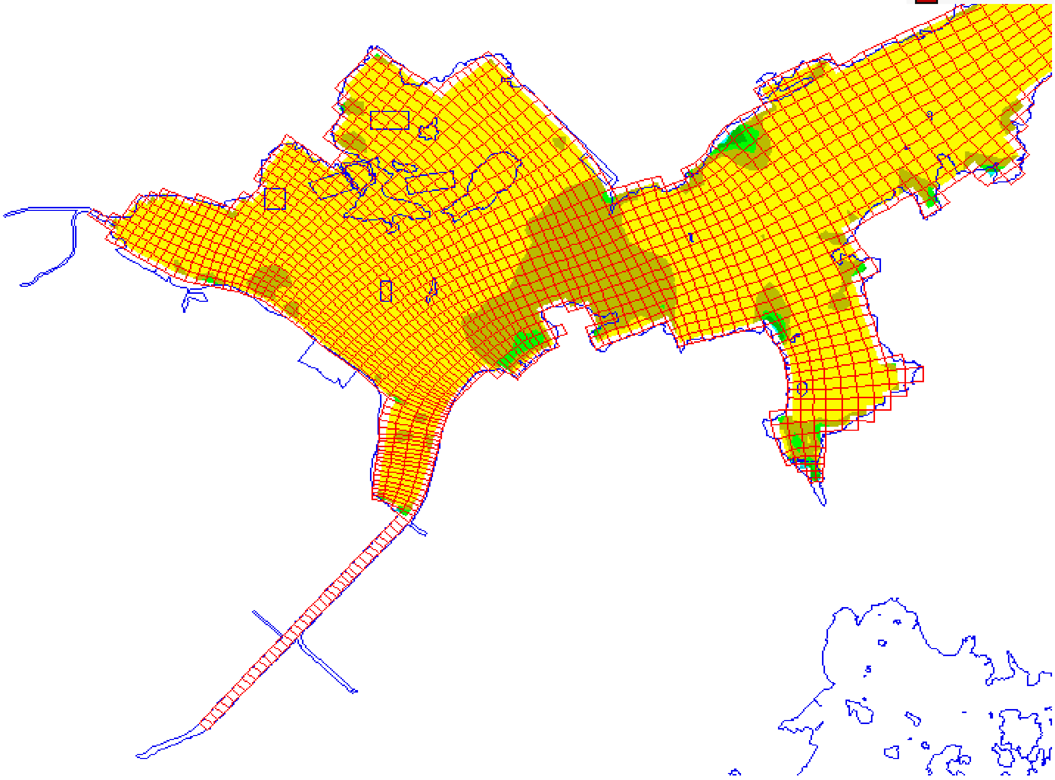
ANNEX B1
THMB Model Grid

Grid Orthogonality of THMB Model

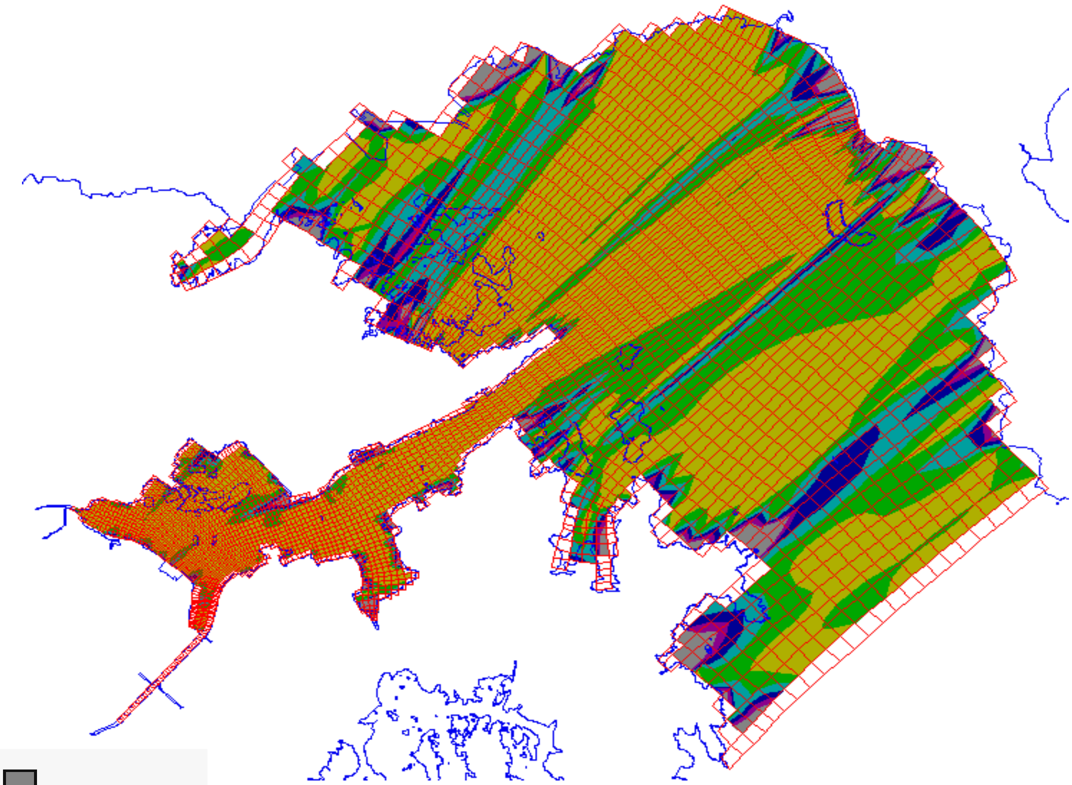


Overview



Close Up at Tolo Harbour

M-Smoothness of THMB Model



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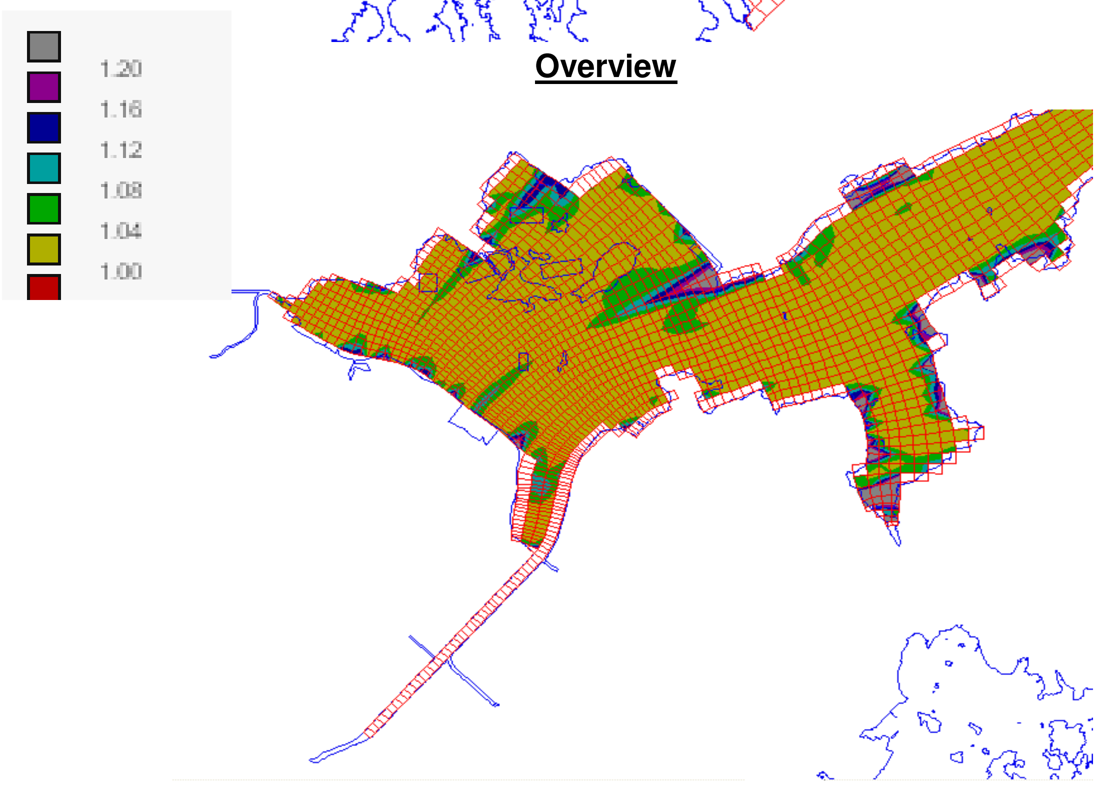
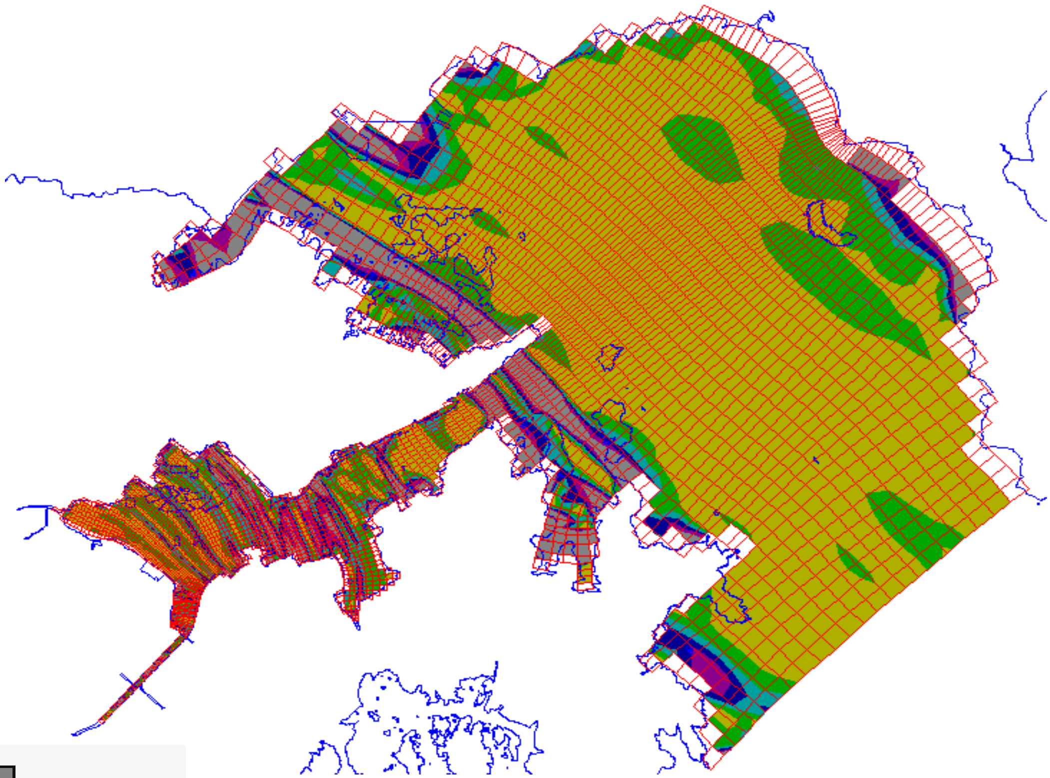
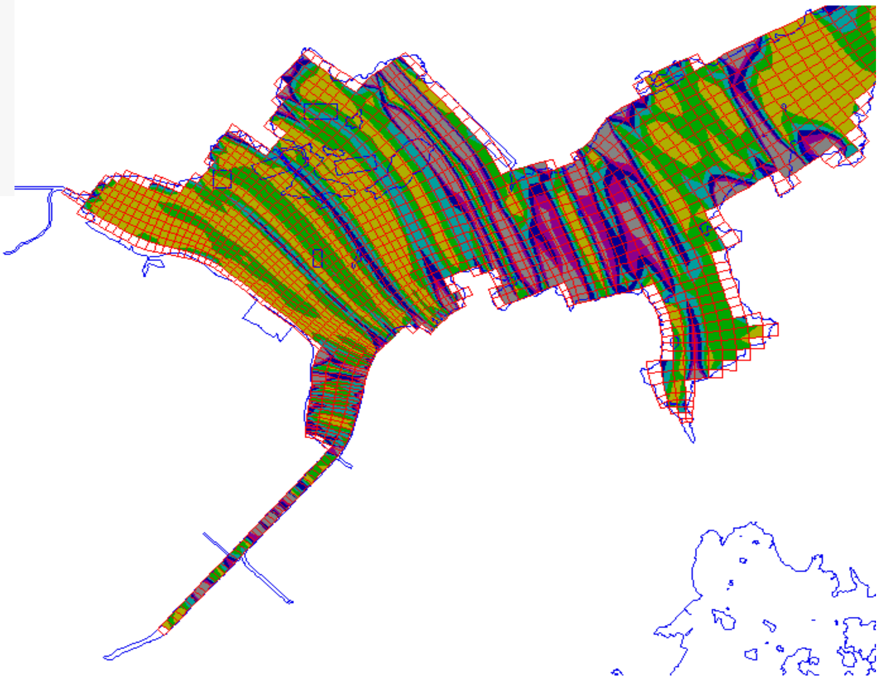


Close Up at Tolo Harbour

N-Smoothness of THMB Model

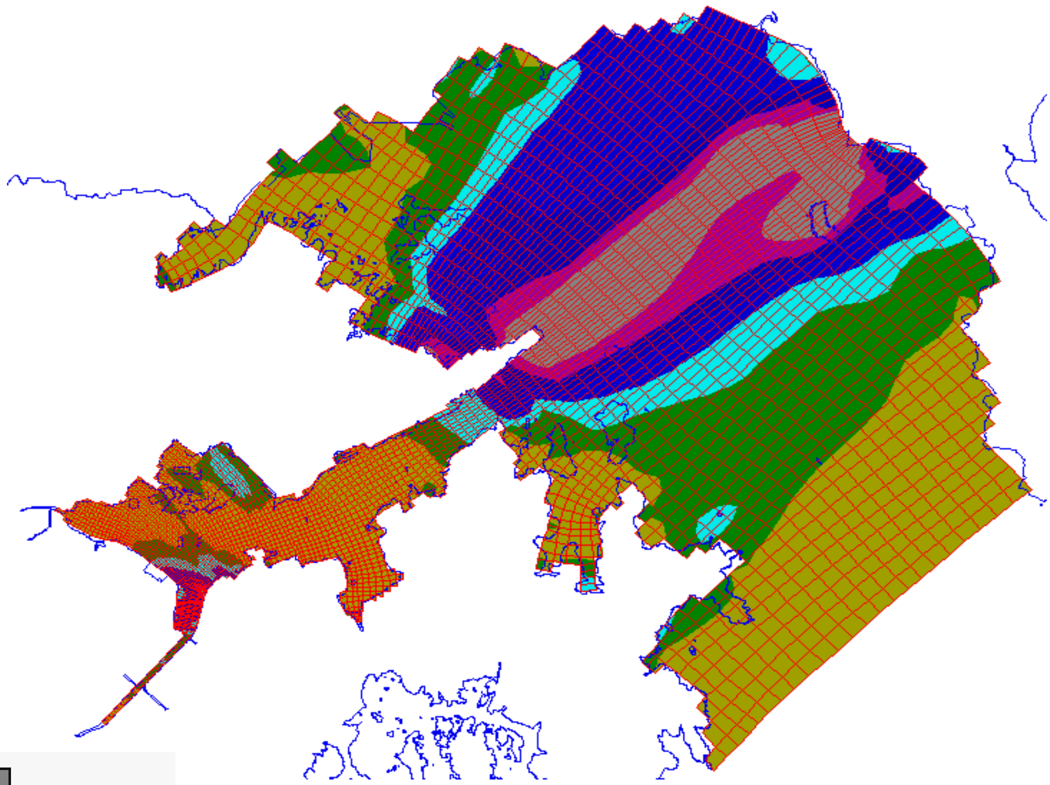


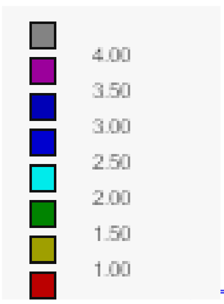
Overview



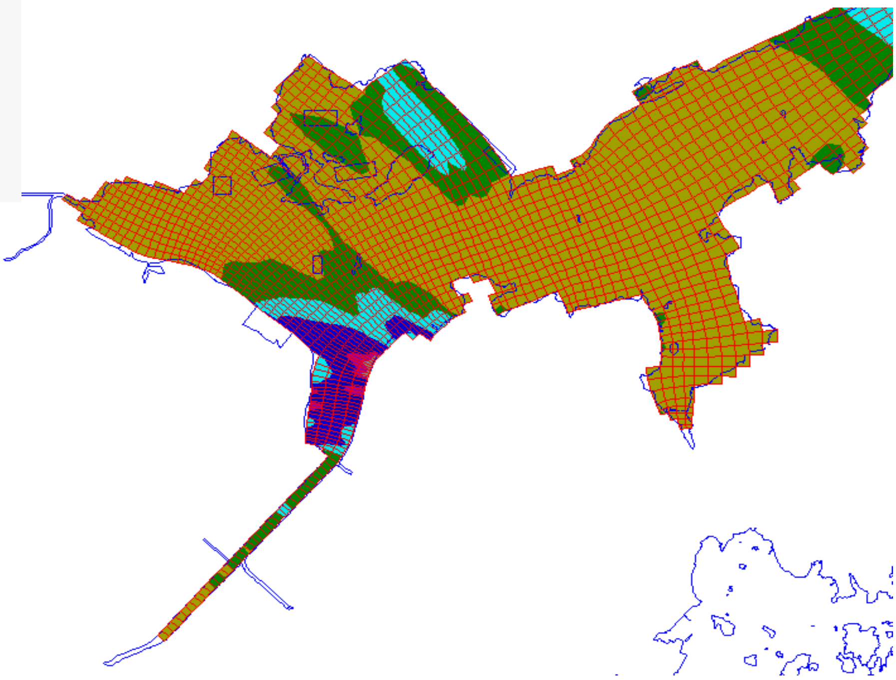
Close Up at Tolo Harbour

Aspect Ratio of THMB Model



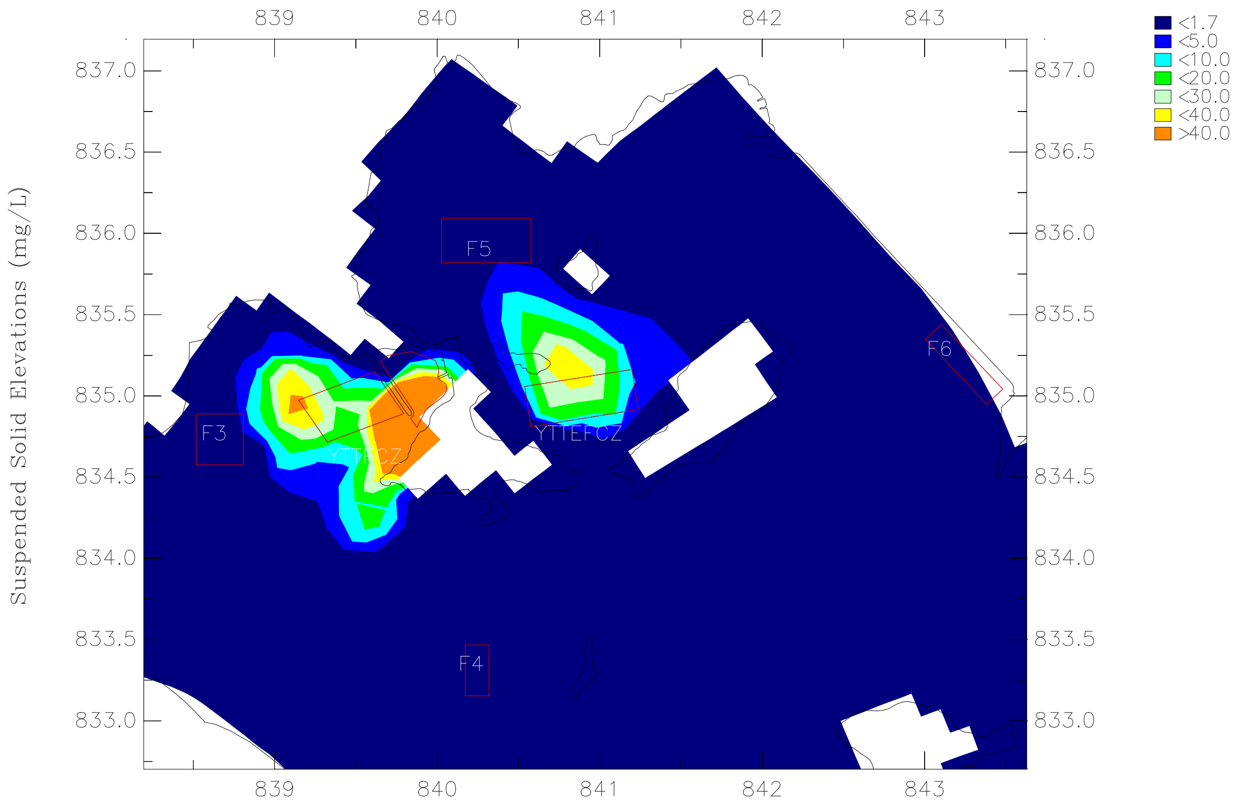


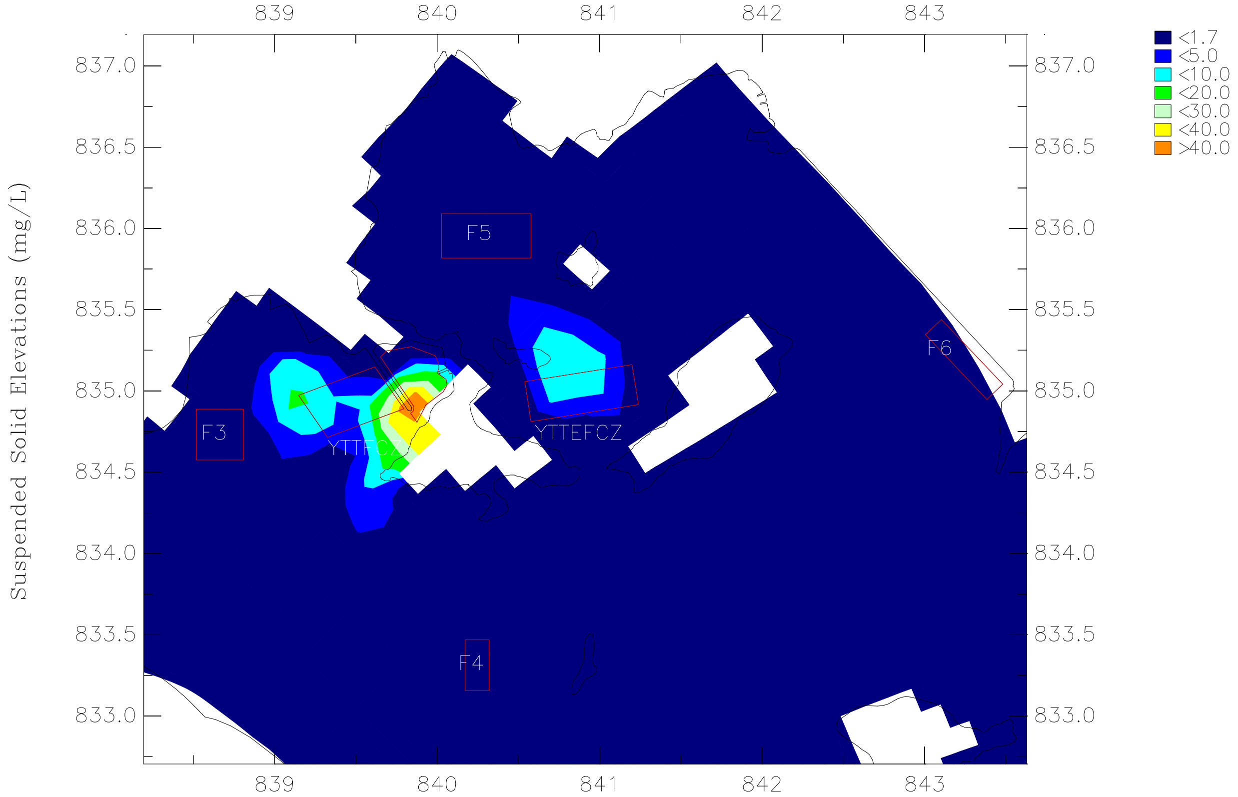
Overview



Close Up at Tolo Harbour

ANNEX B2
SEDIMENT PLUME MODELLING RESULTS – WET SEASON
FOR SCENARIO 1





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Surface SS Elevations under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
	Annex B2–1	
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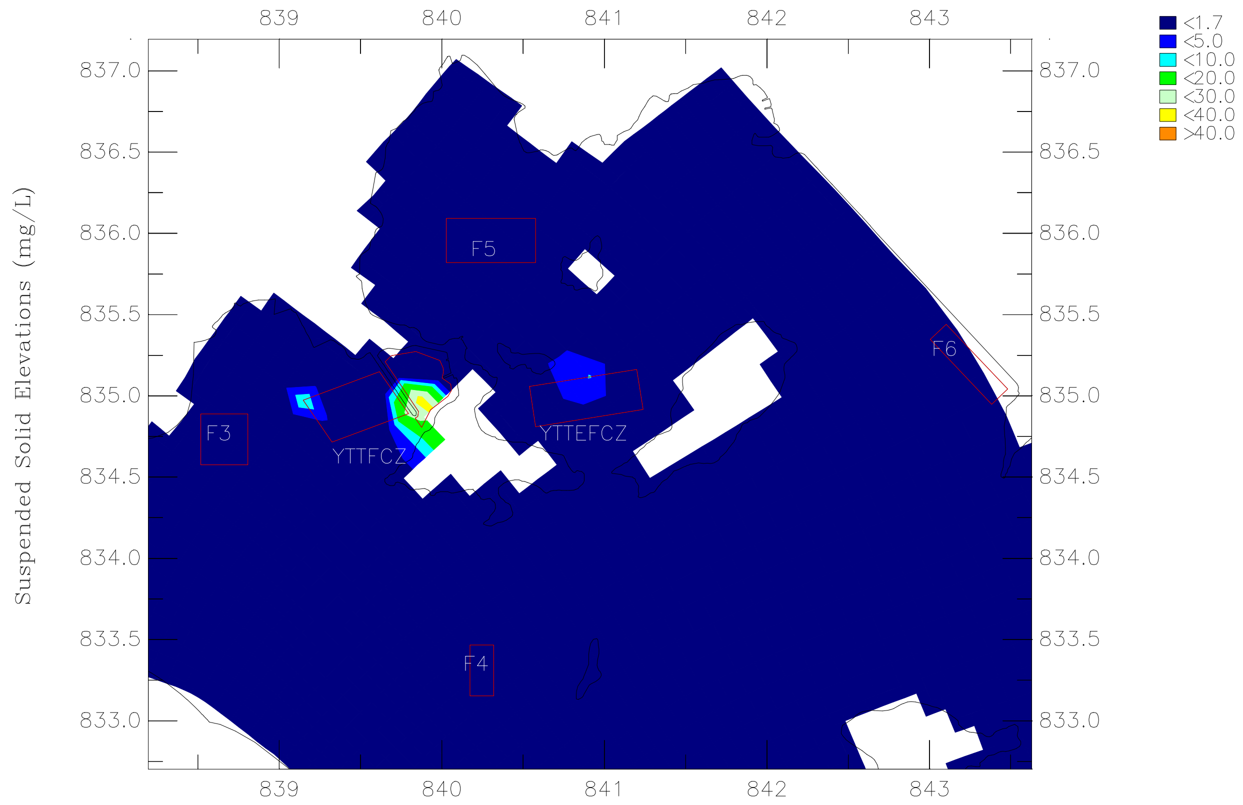

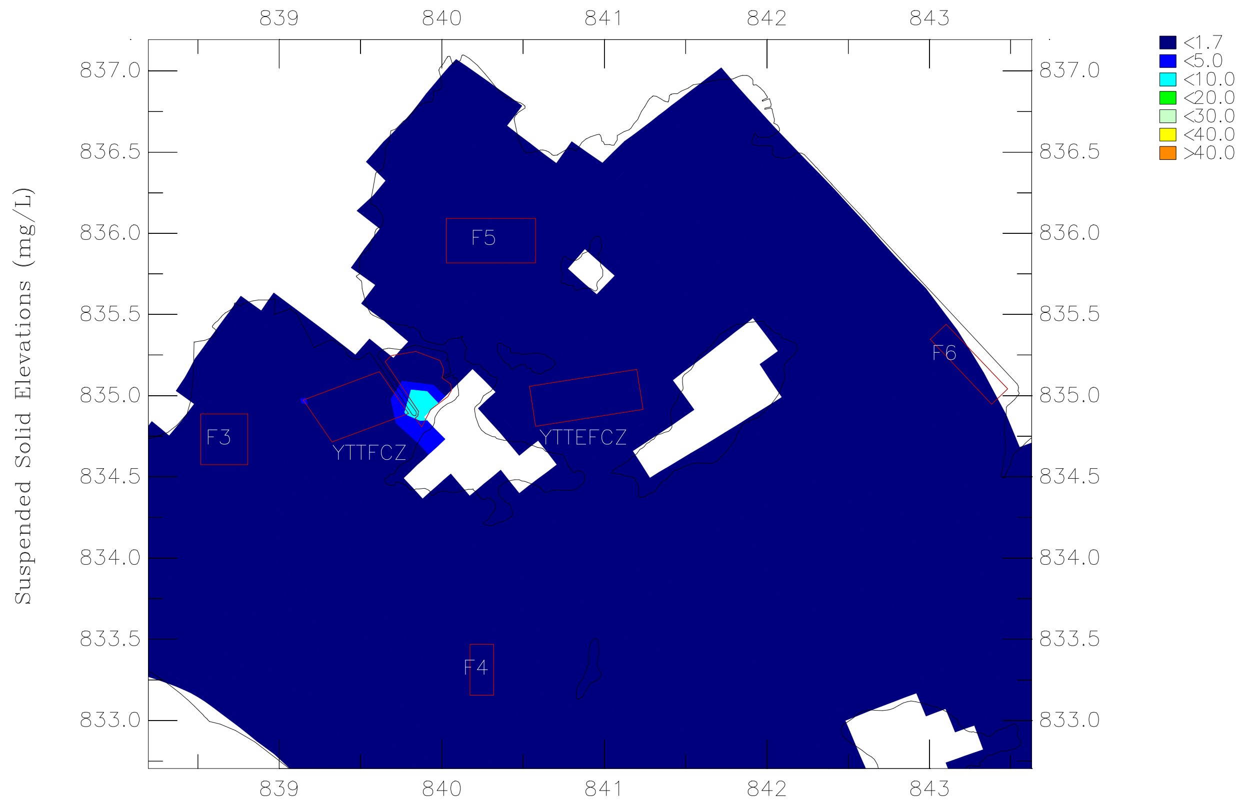

Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Surface SS Elevations under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
	Annex B2–2	
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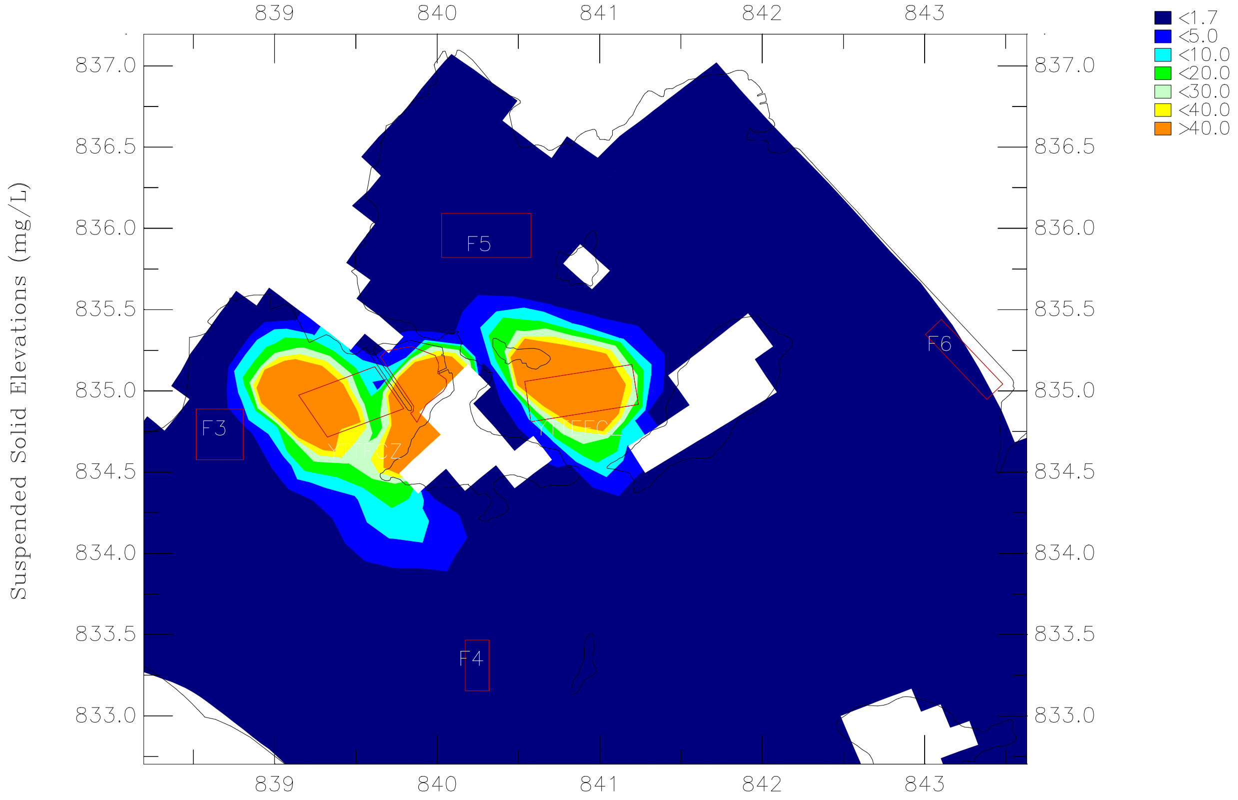

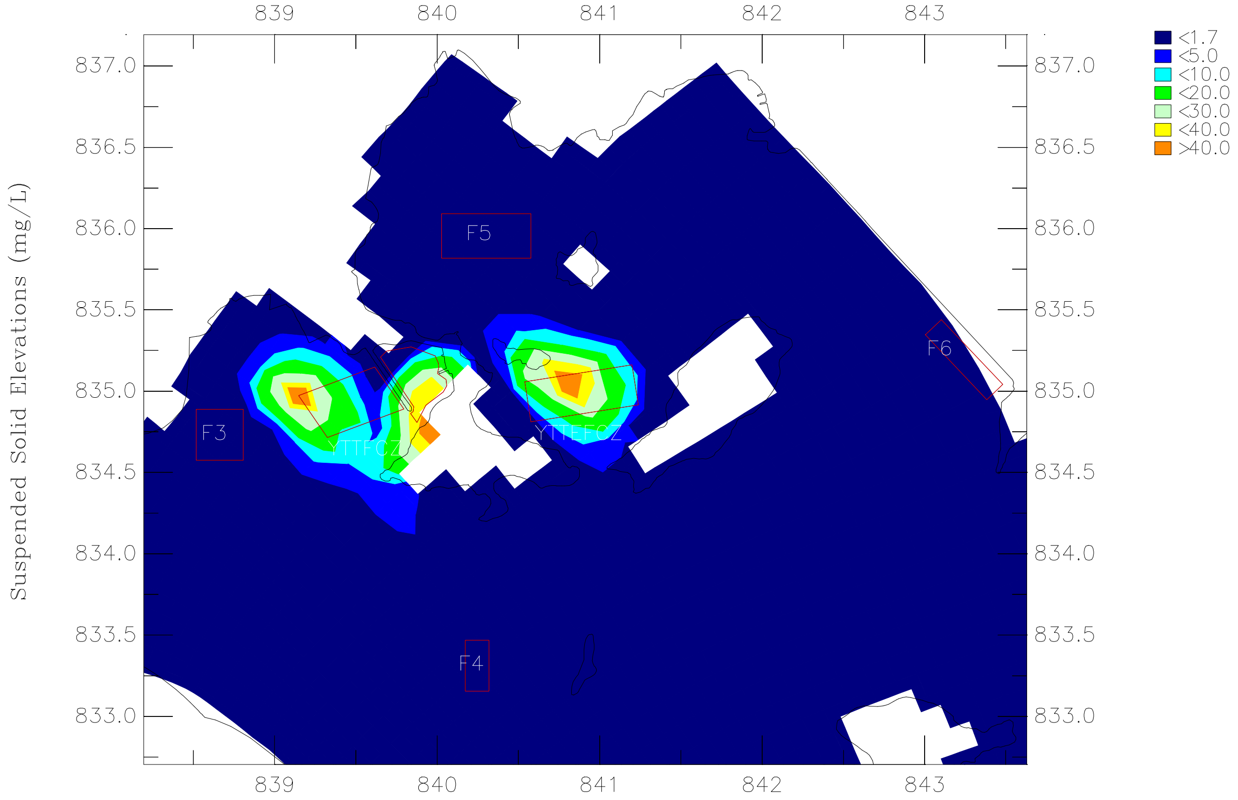

Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Mid–Depth SS Elevations under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
	Annex B2–3	
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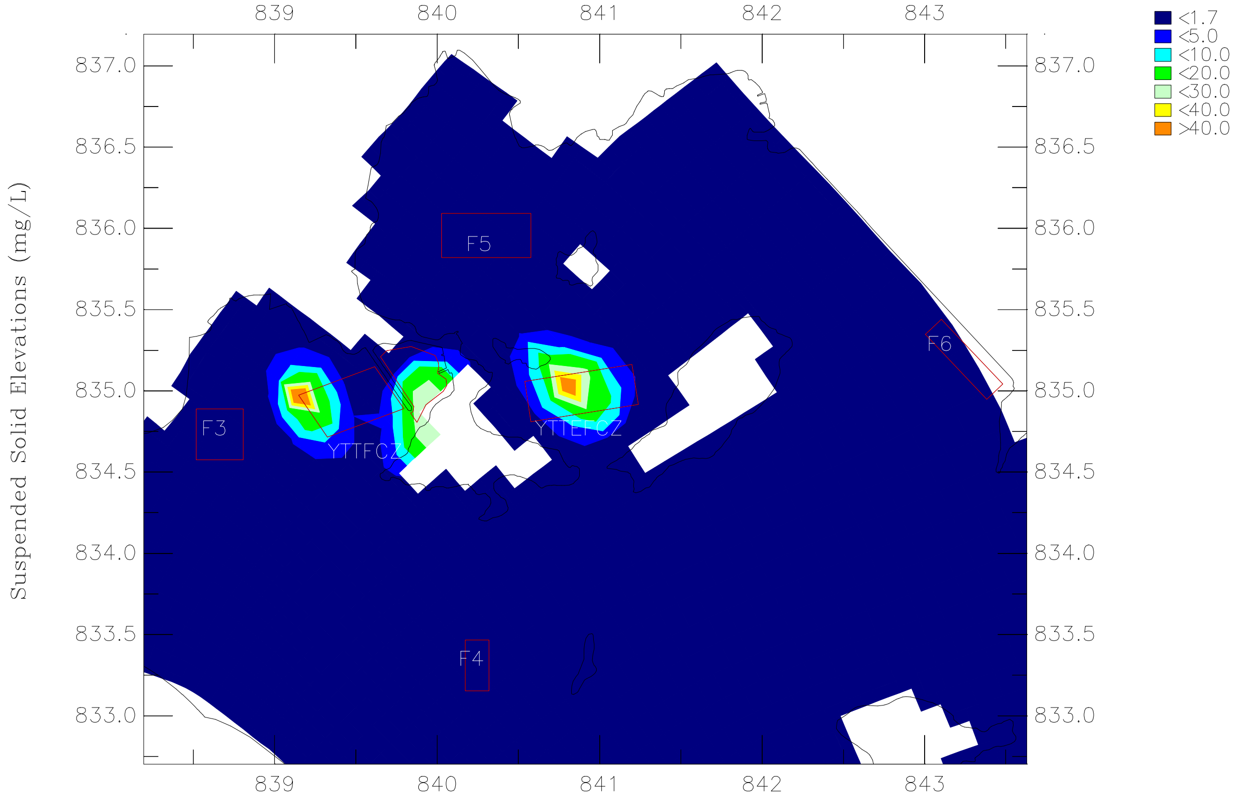

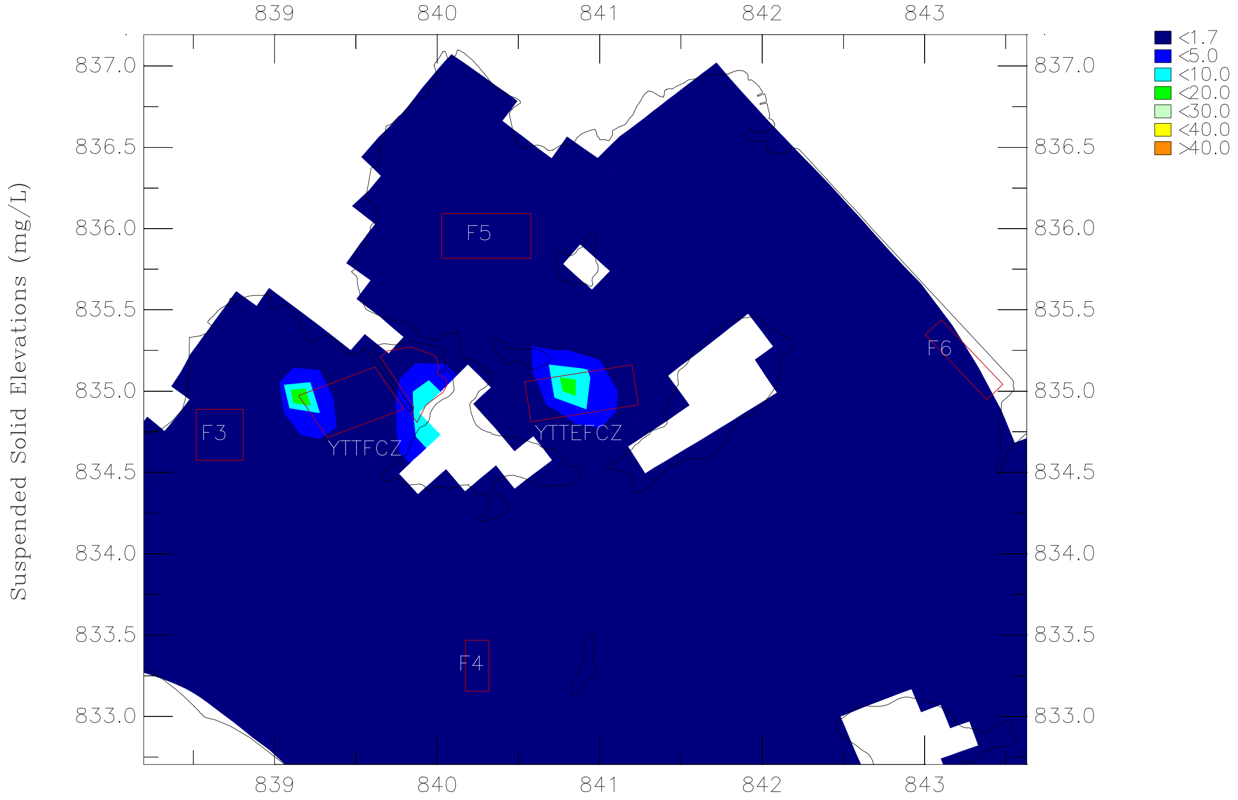

Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Mid-Depth SS Elevations under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
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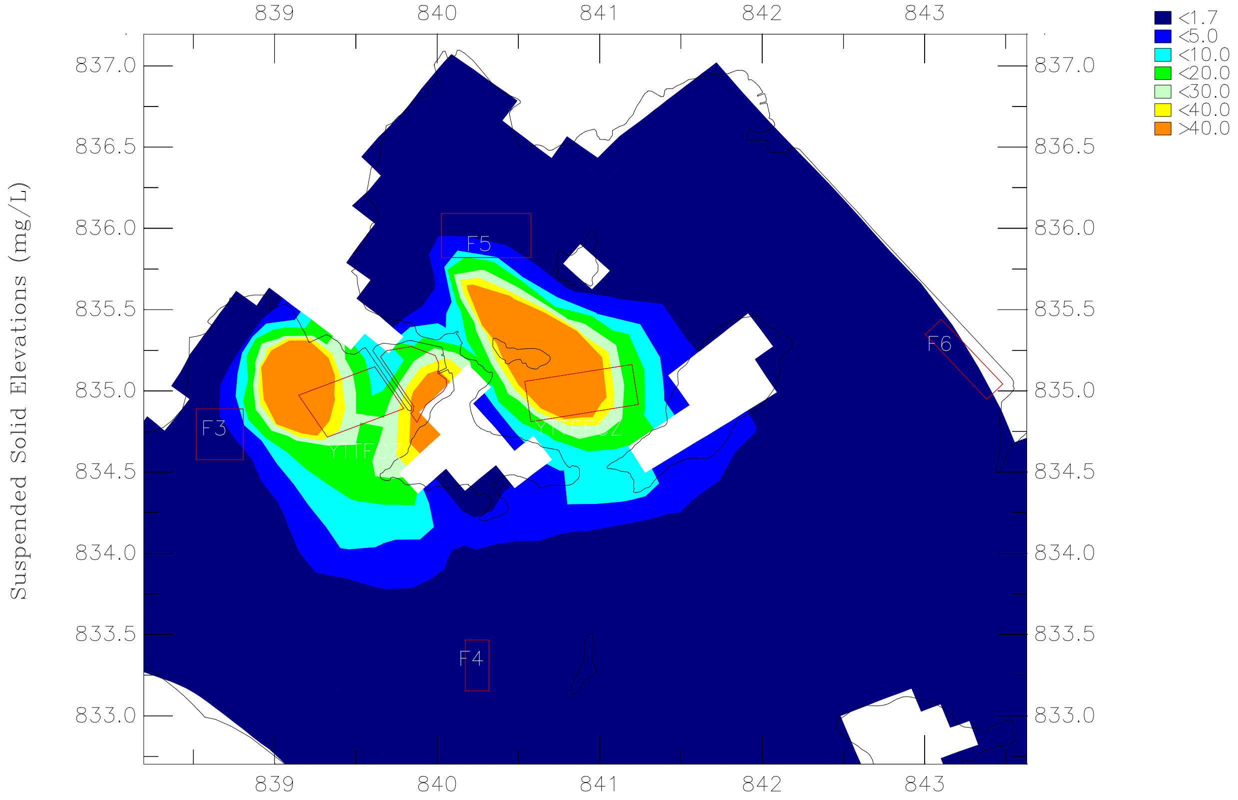
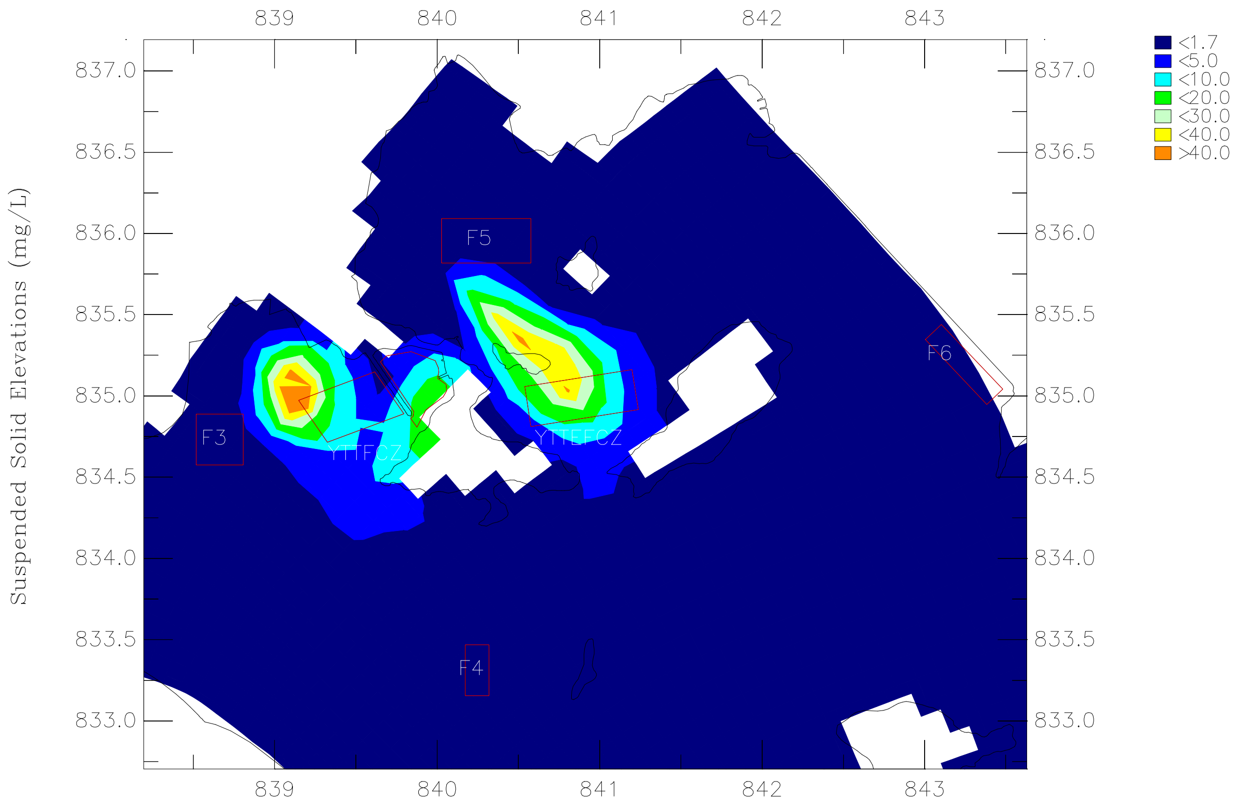
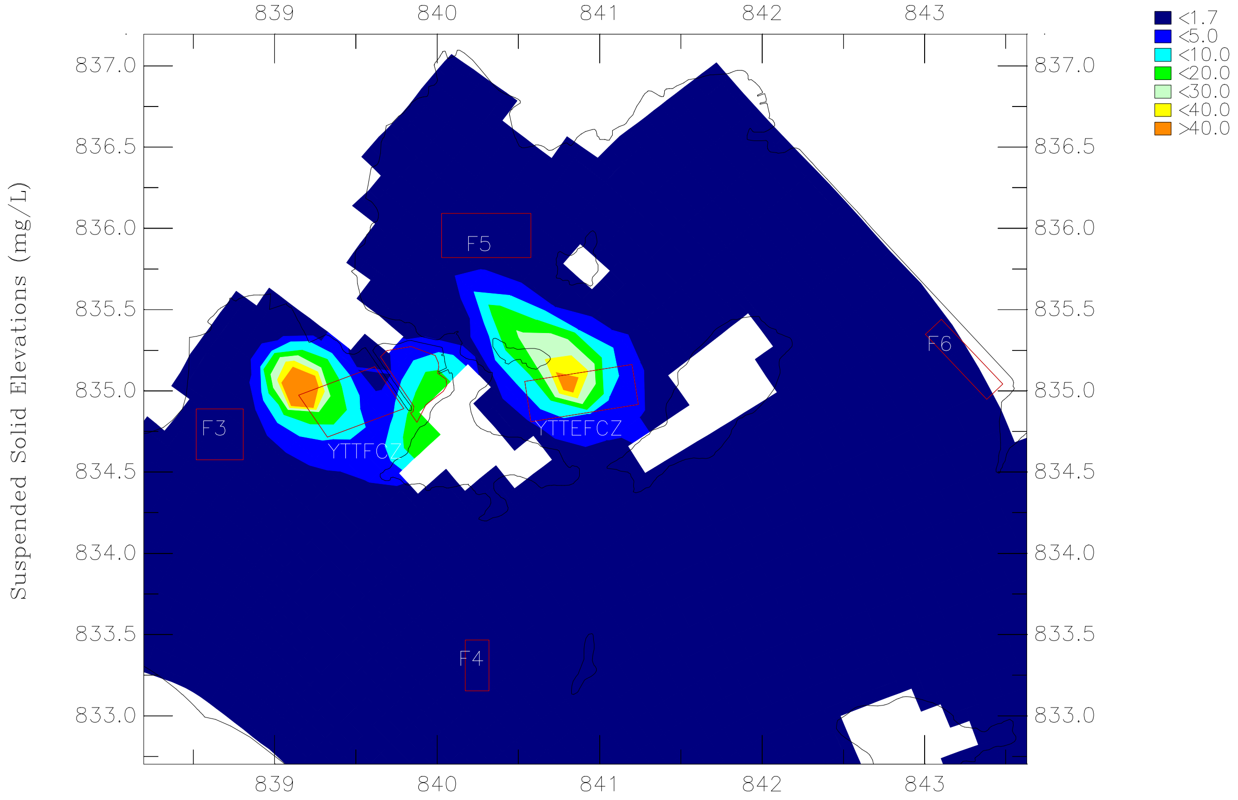
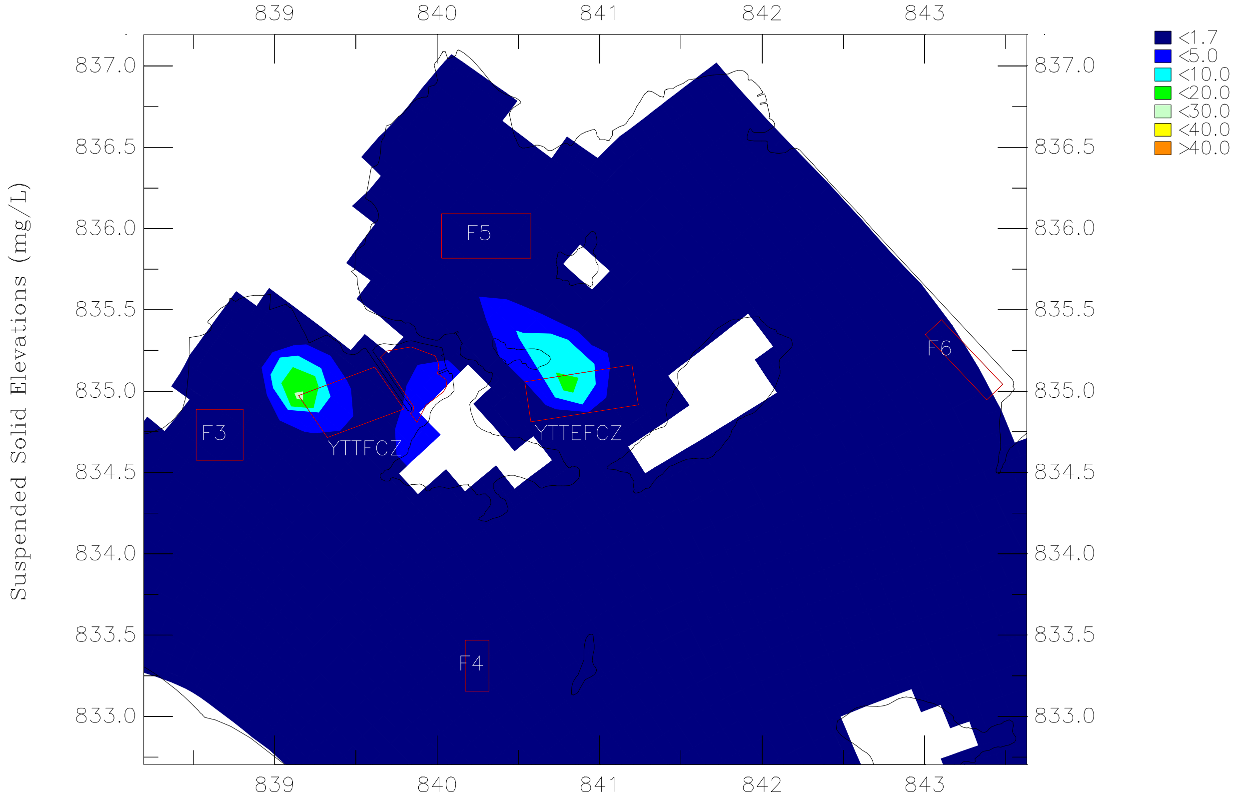


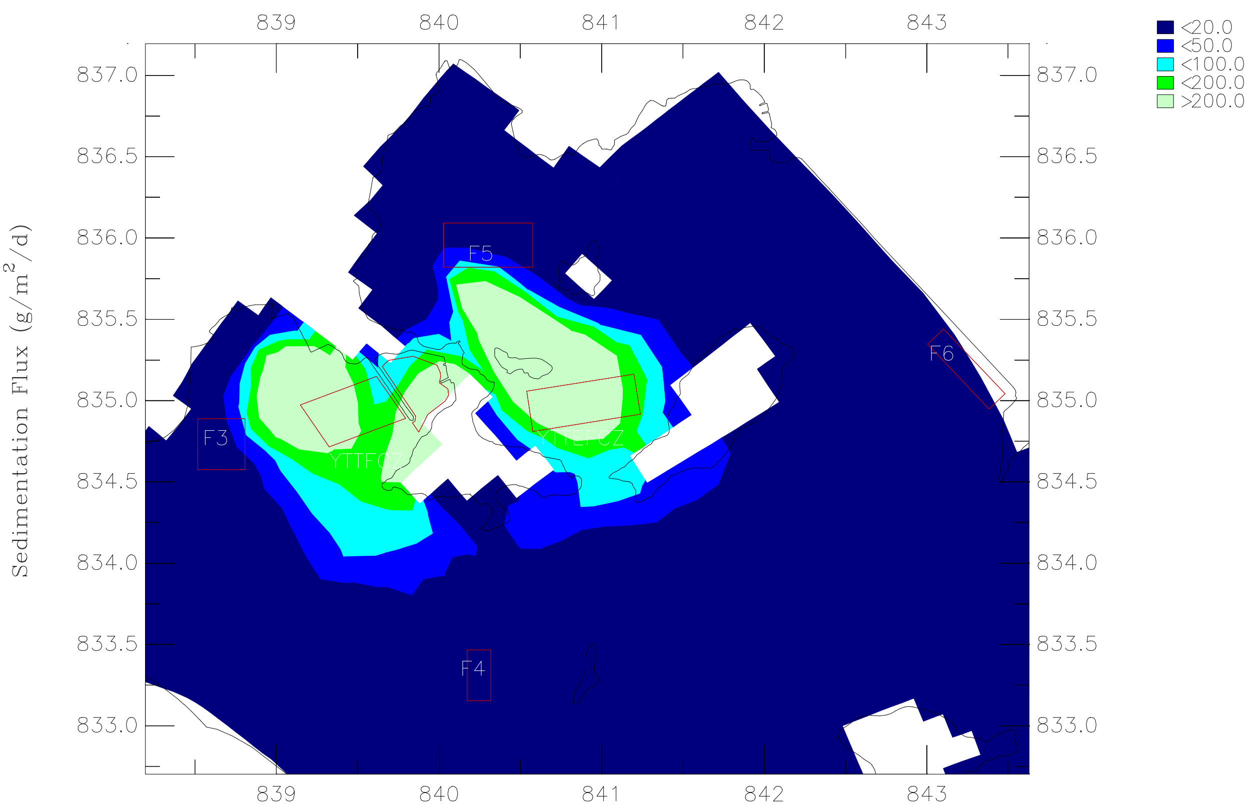


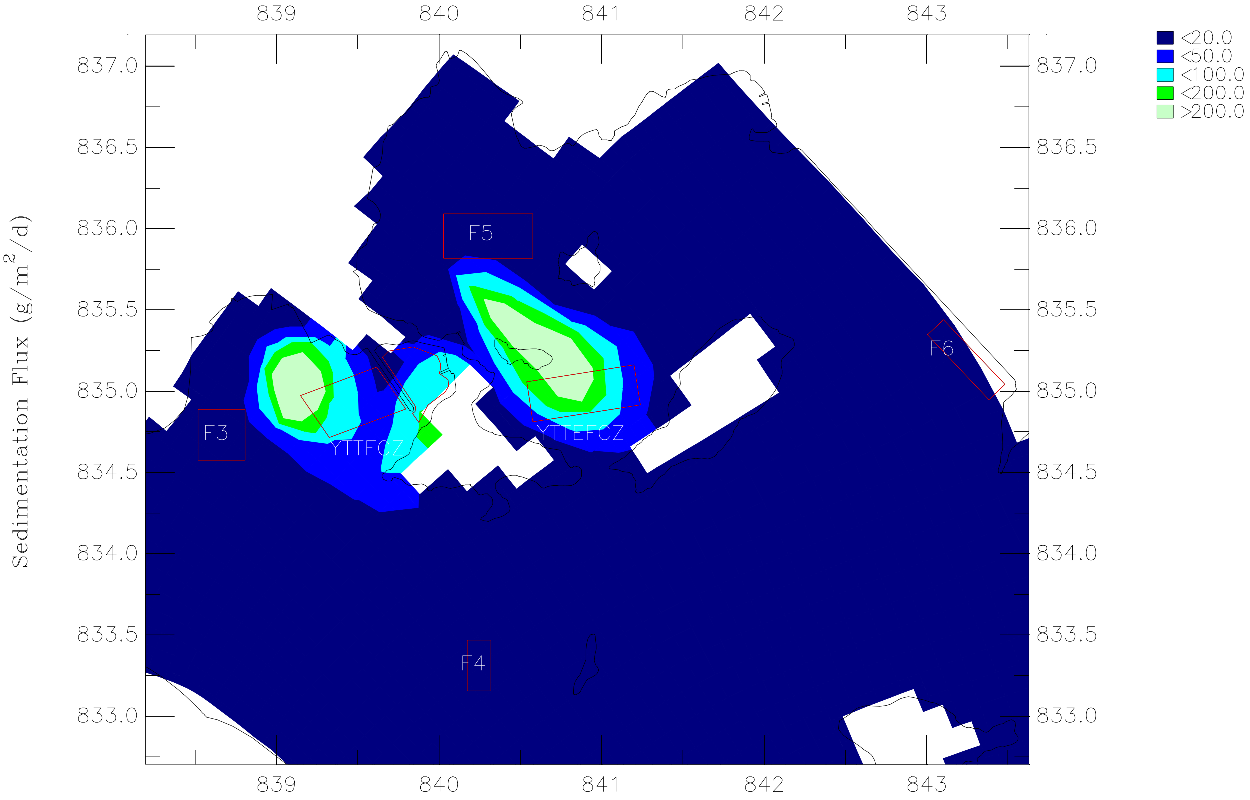
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Bottom SS Elevations under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
	Annex B2-5	
AECOM ASIA COMPANY LTD	/GPP/	YTT-PT-wet.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Bottom SS Elevations under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
	Annex B2–6	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–wet.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Sedimentation Flux under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
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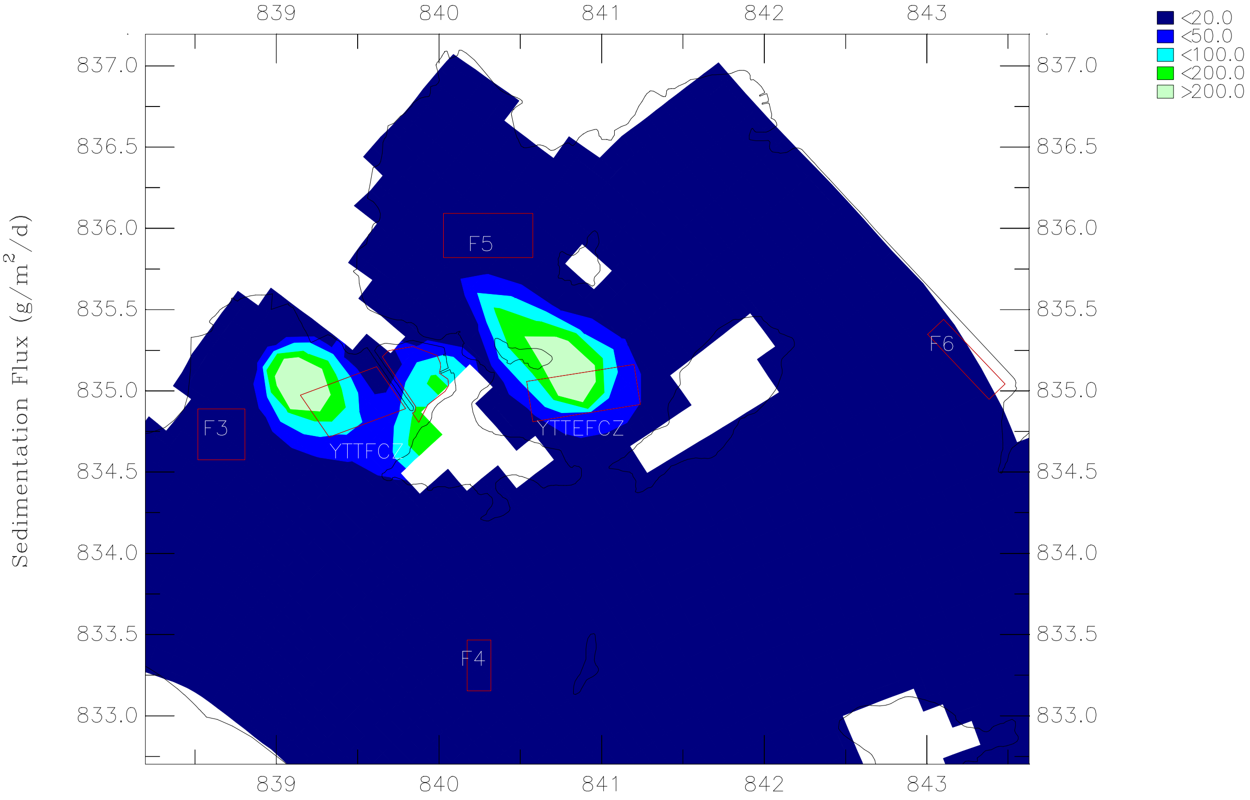
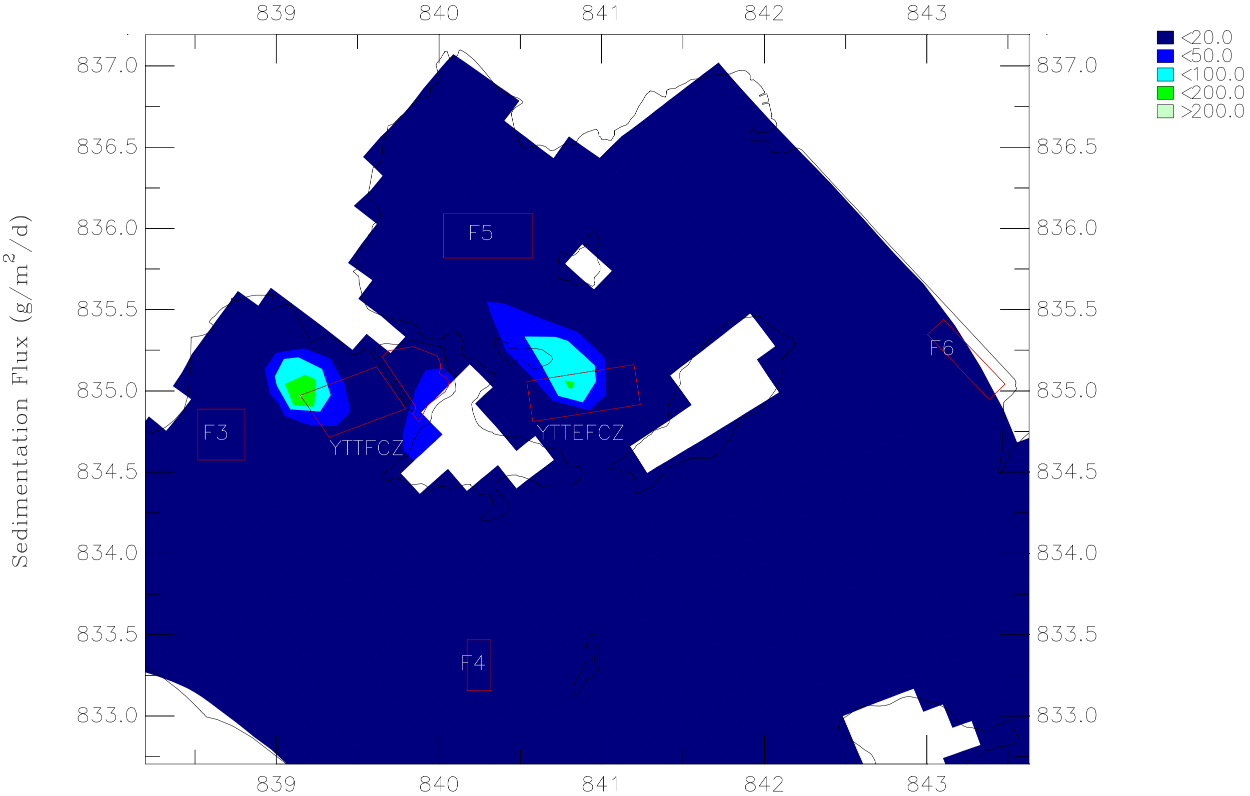
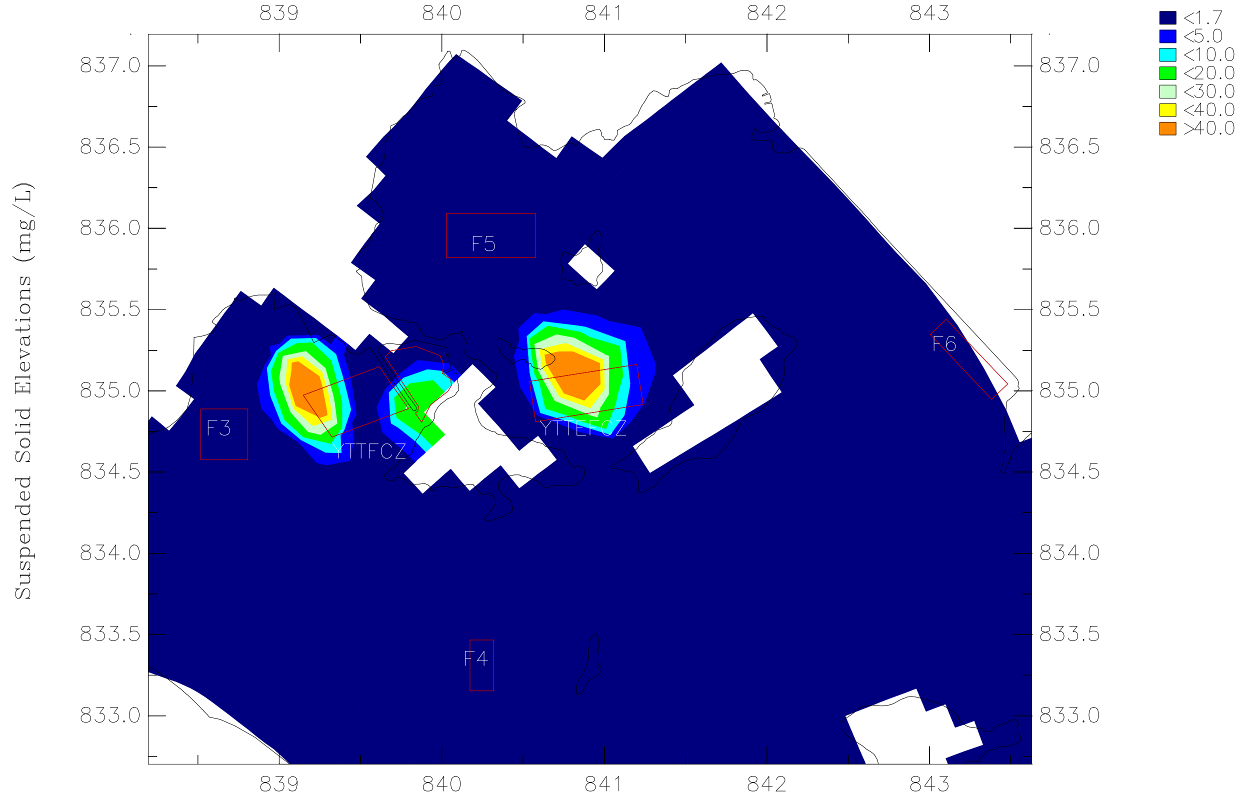
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–wet.ssn

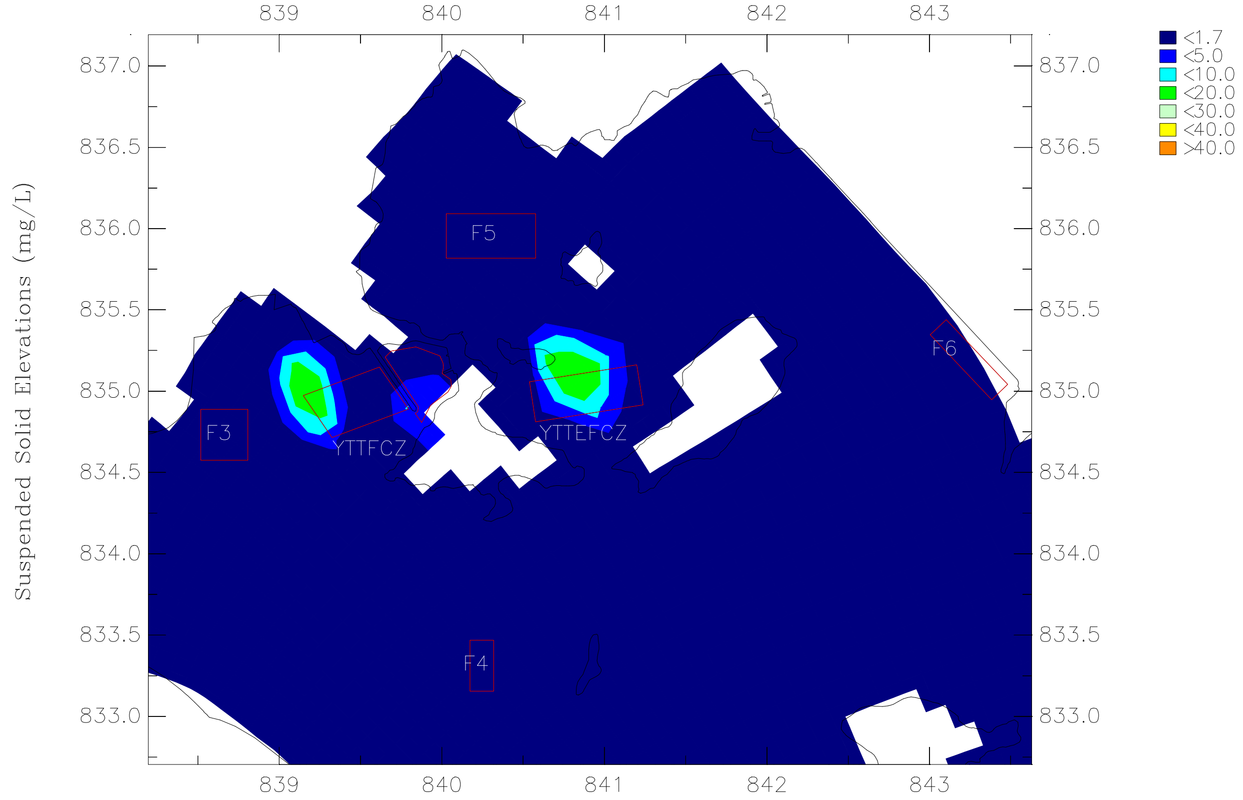




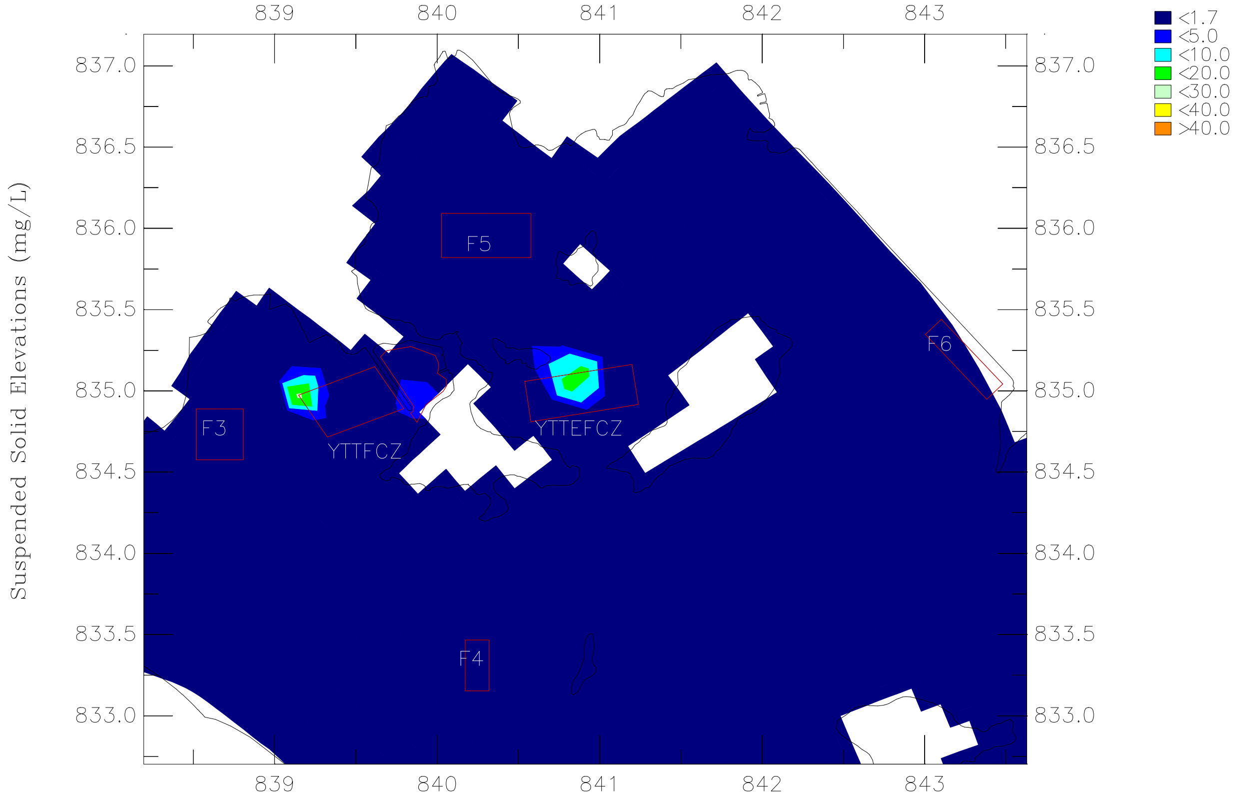
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Sedimentation Flux under Year 2010 Wet Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Wet Season
	Annex B2–8	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–wet.ssn

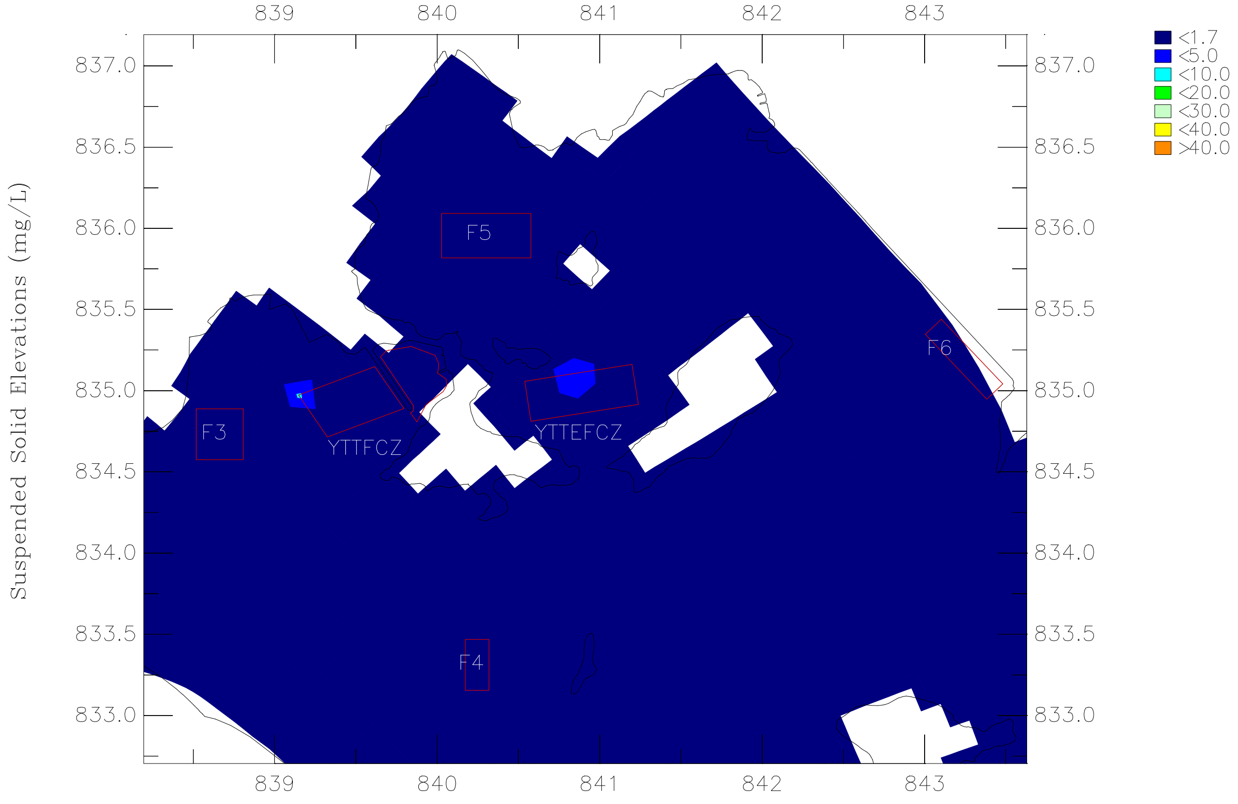
ANNEX B3
SEDIMENT PLUME MODELLING RESULTS – DRY SEASON FOR SCENARIO 1



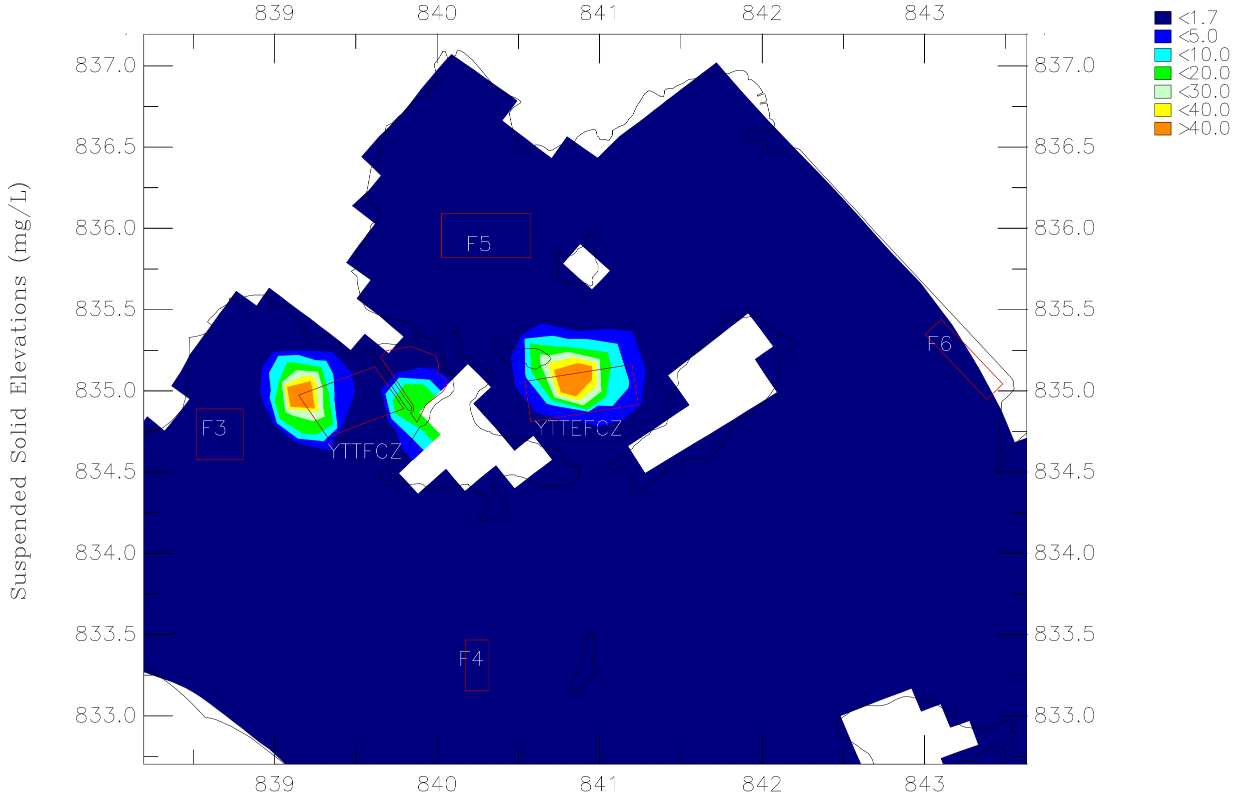


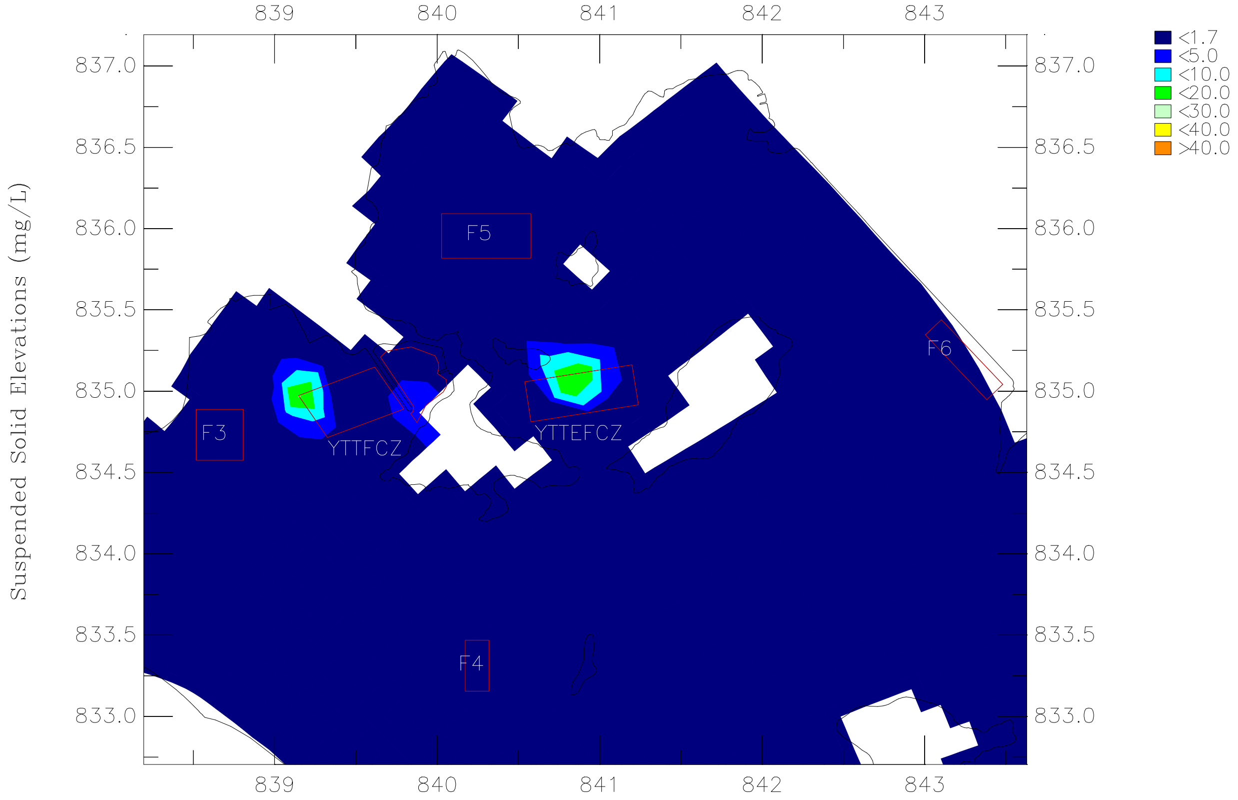
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Surface SS Elevations under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
	Annex B3–1	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn



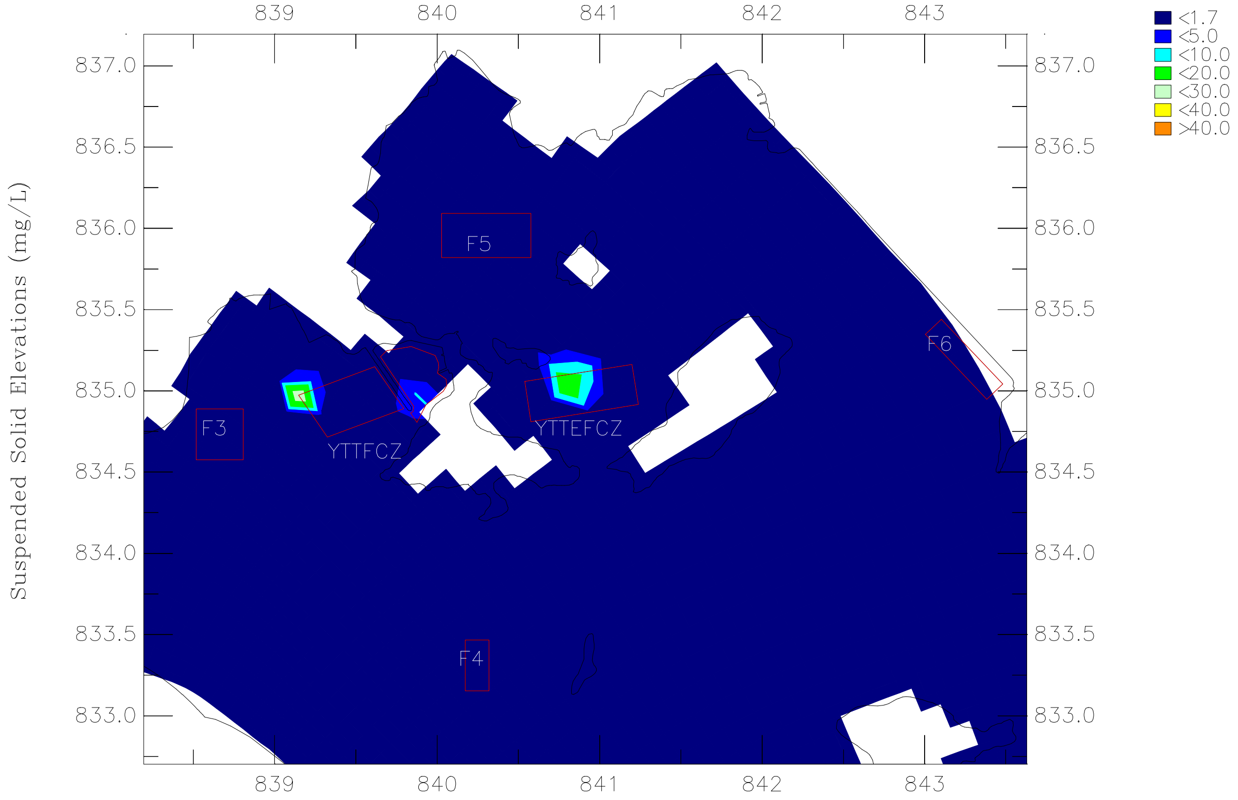


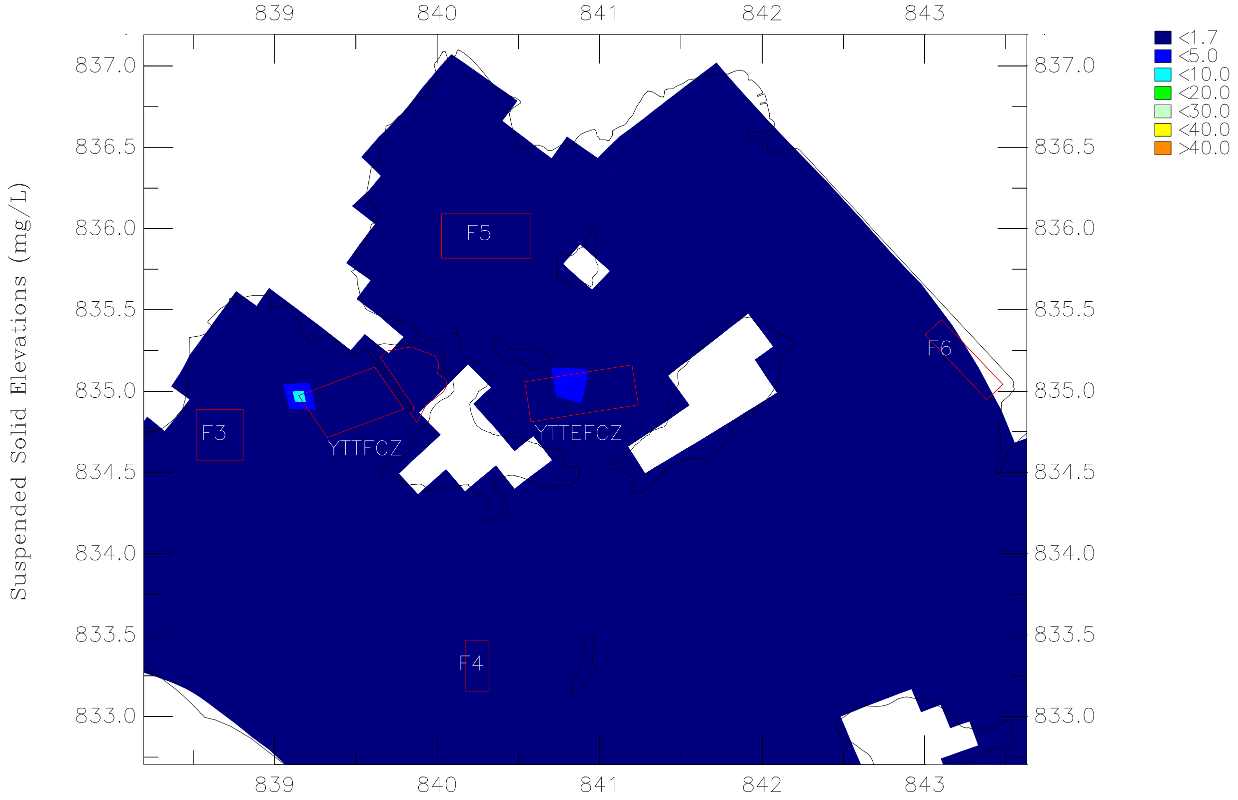
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Surface SS Elevations under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
	Annex B3–2	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation	Scenario 1	Dry Season
Maximum Mid–Depth SS Elevations under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Annex B3–3	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Mid–Depth SS Elevations under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
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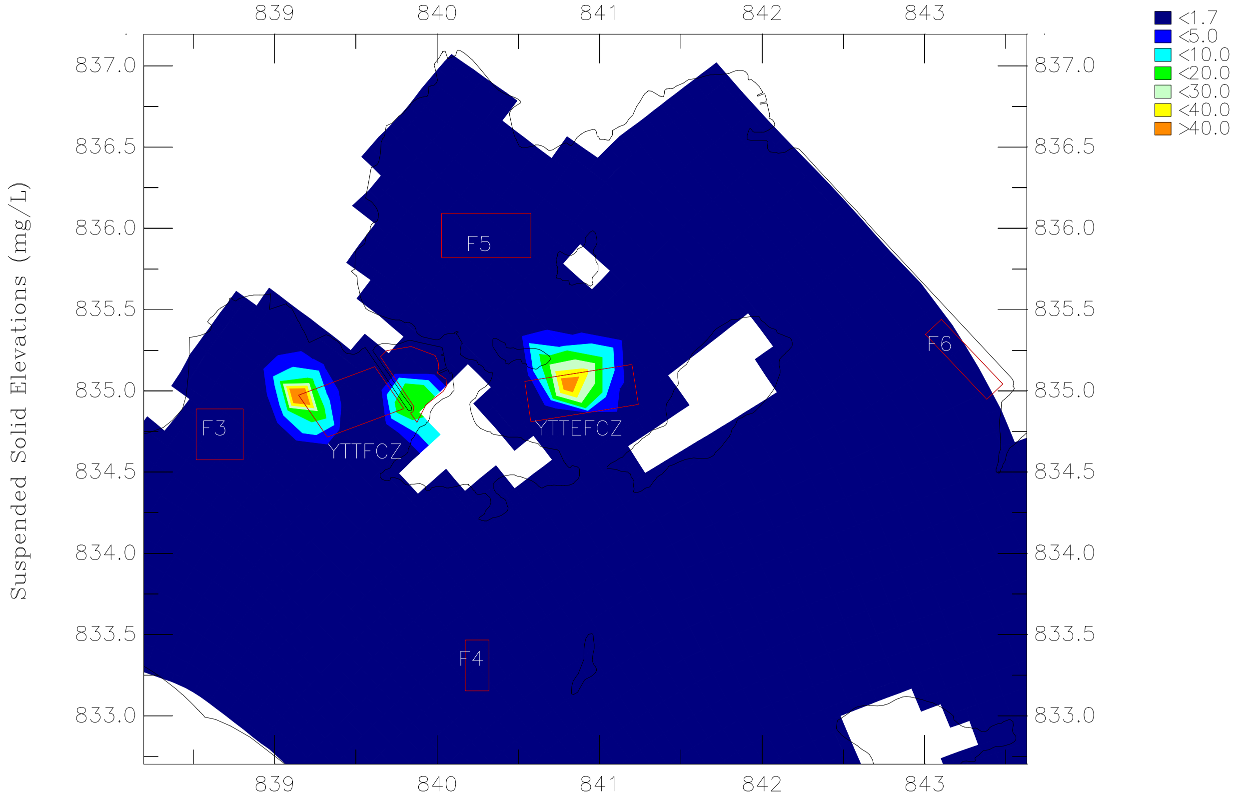
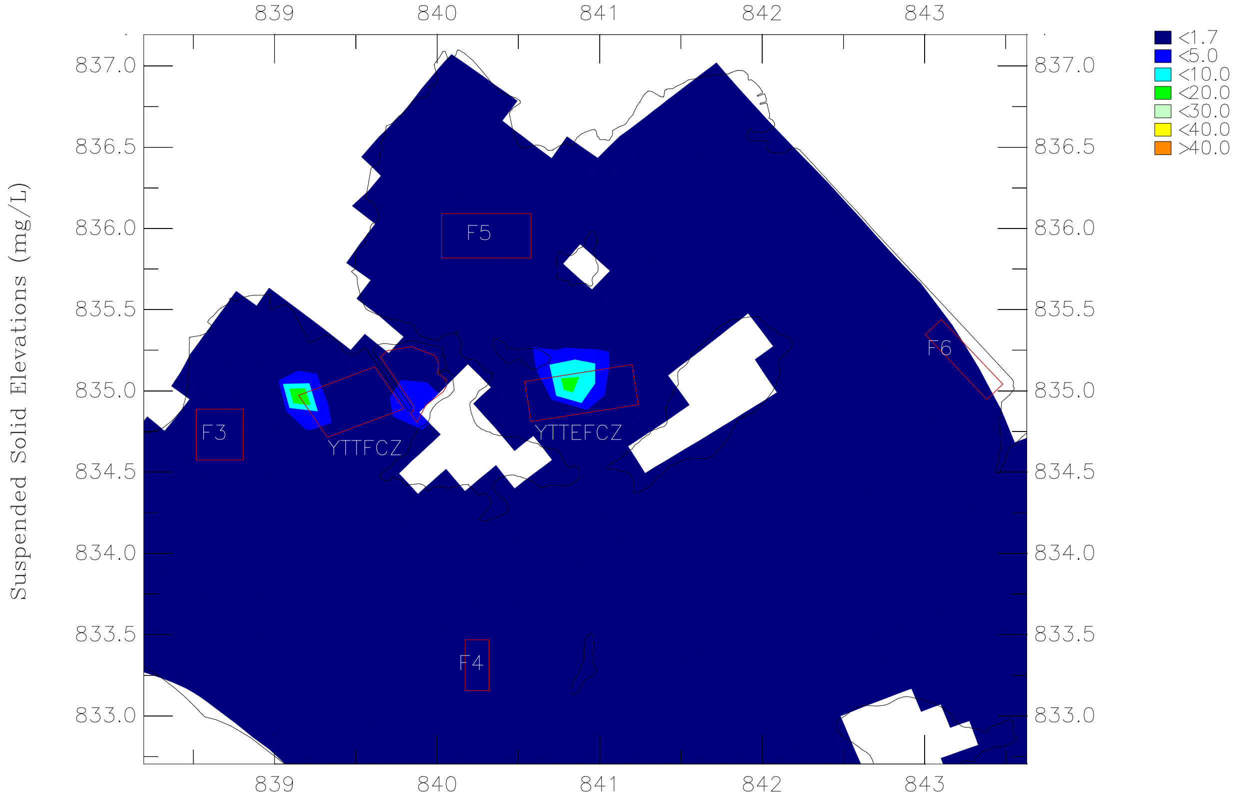
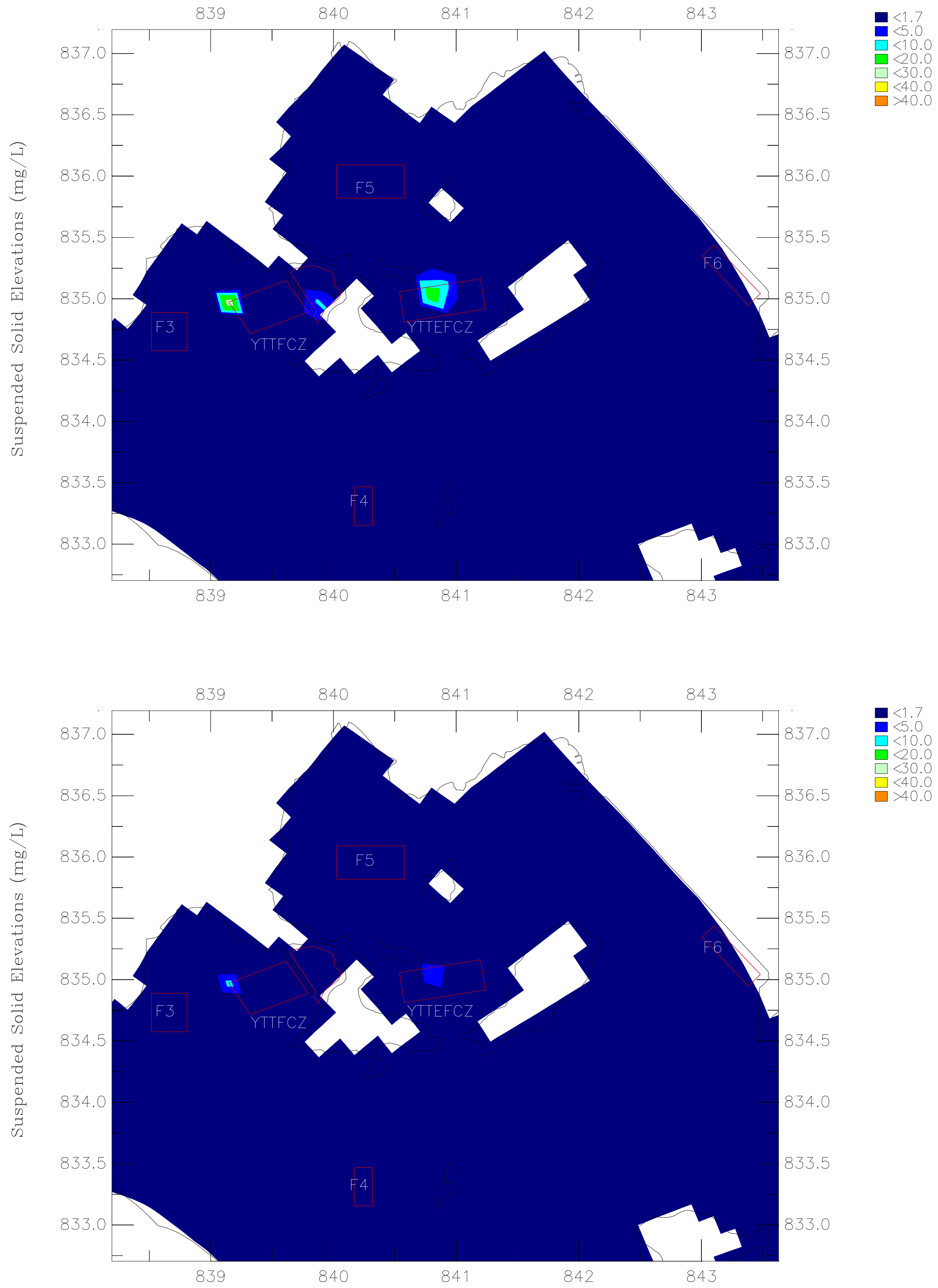
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn

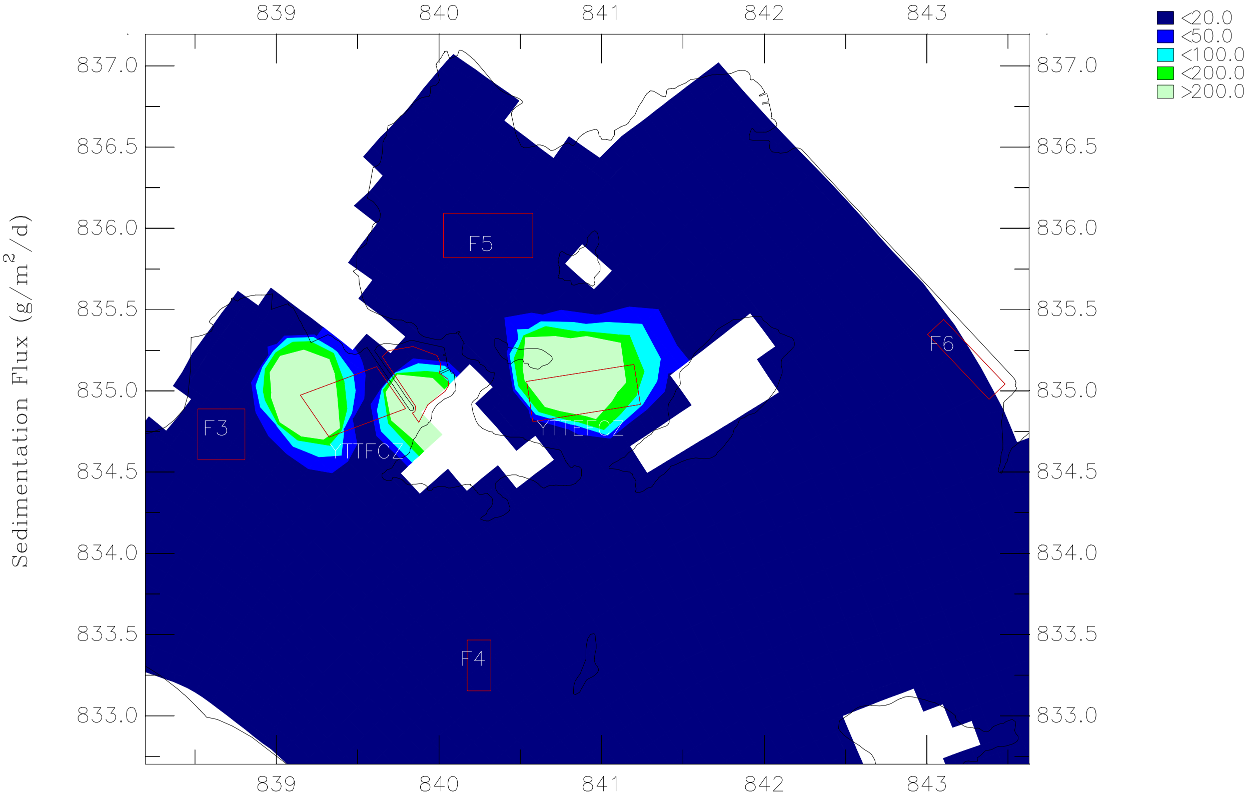


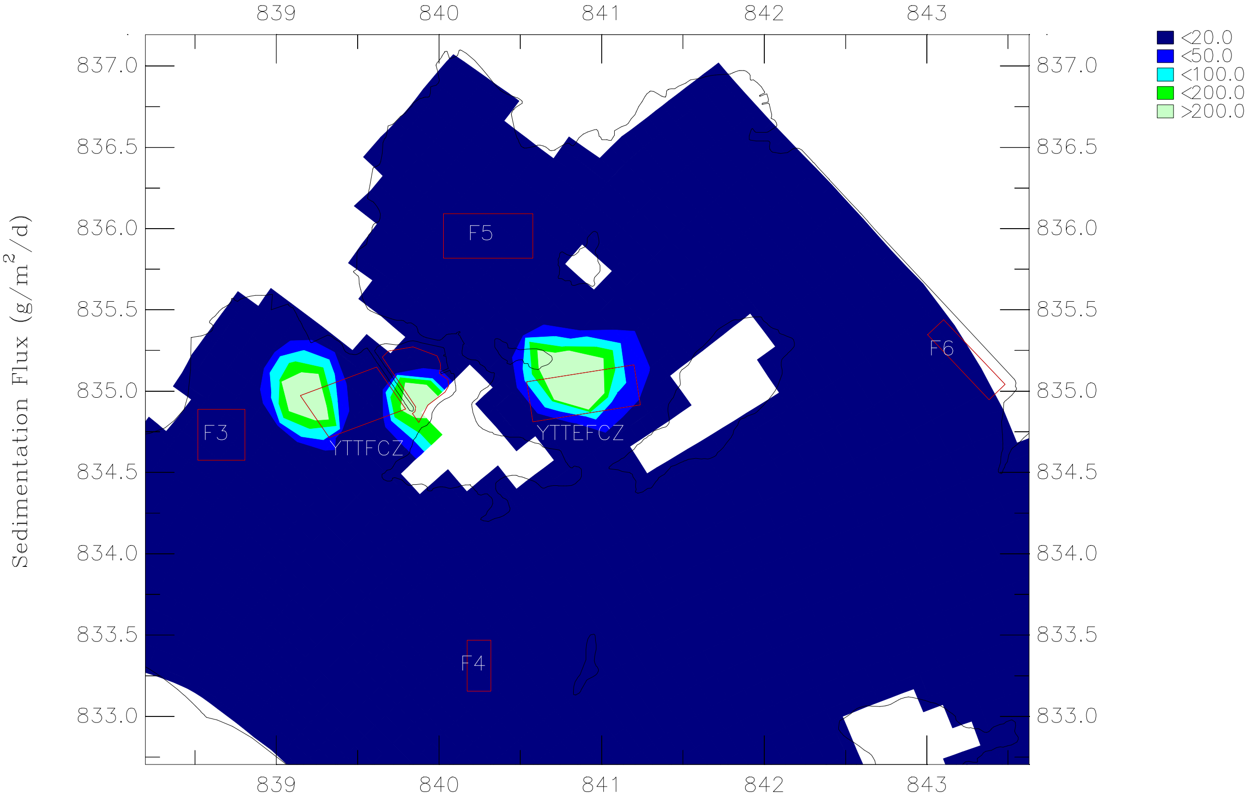


Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Bottom SS Elevations under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
	Annex B3–5	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn

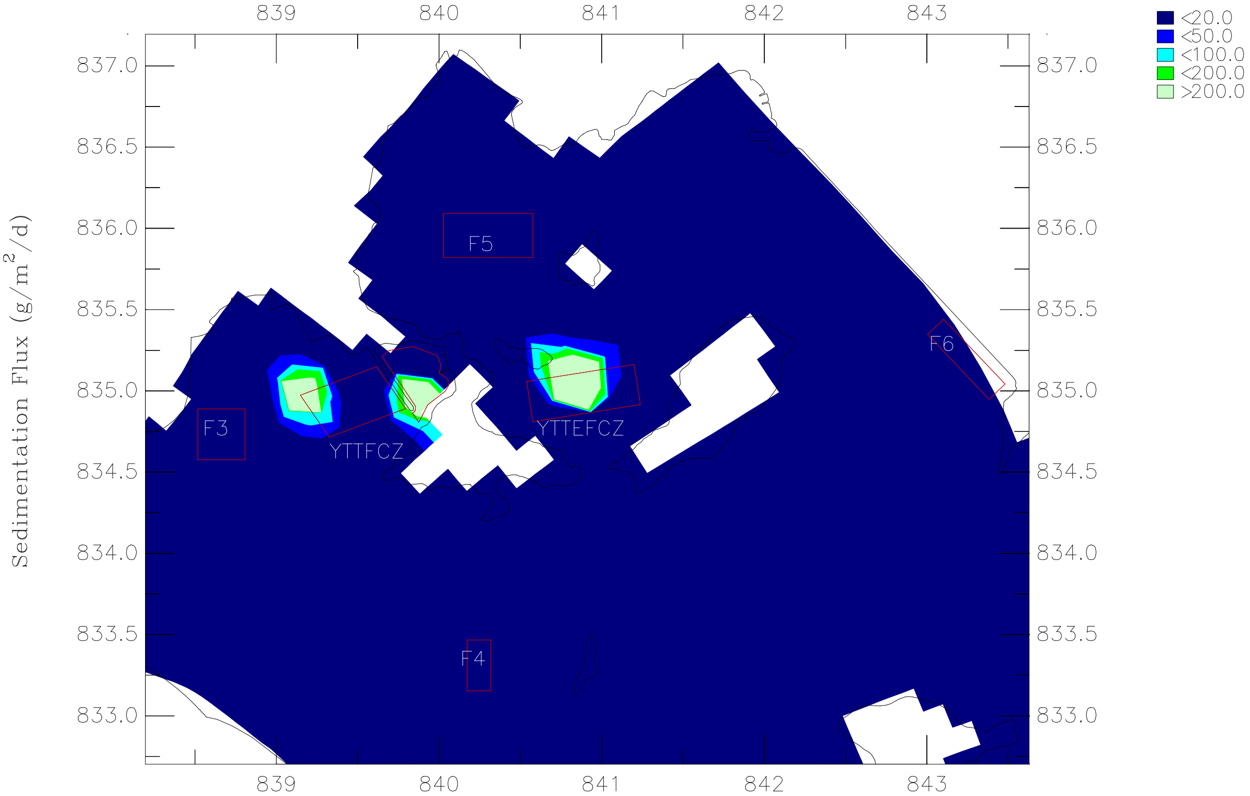


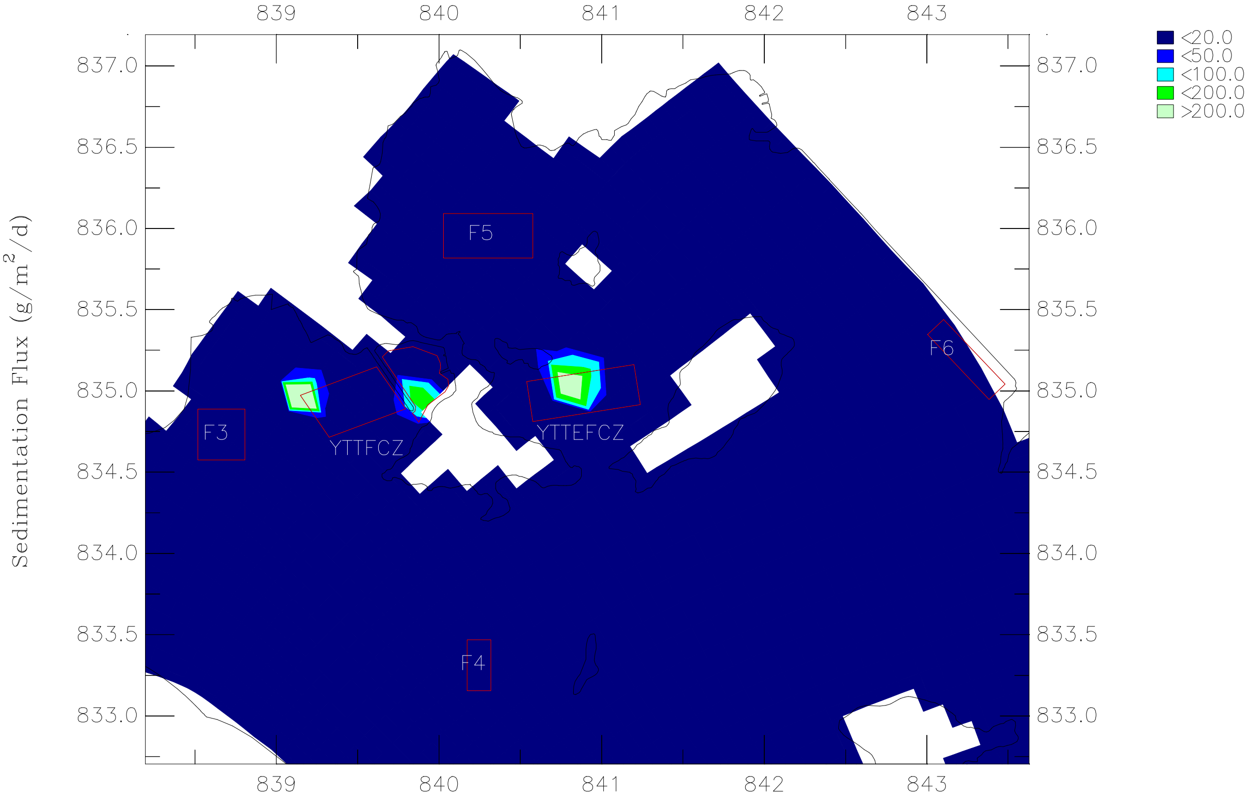
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Bottom SS Elevations under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
	Annex B3–6	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn





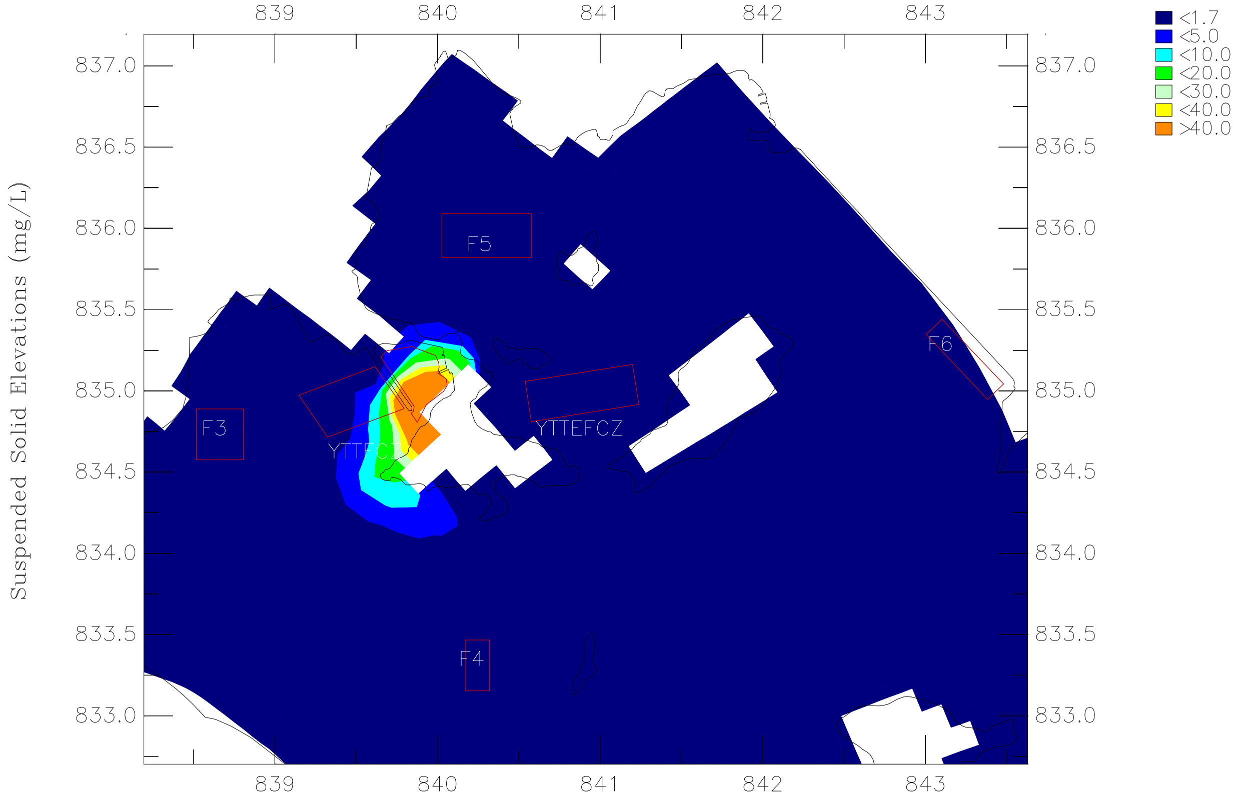
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Sedimentation Flux under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
	Annex B3–7	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn

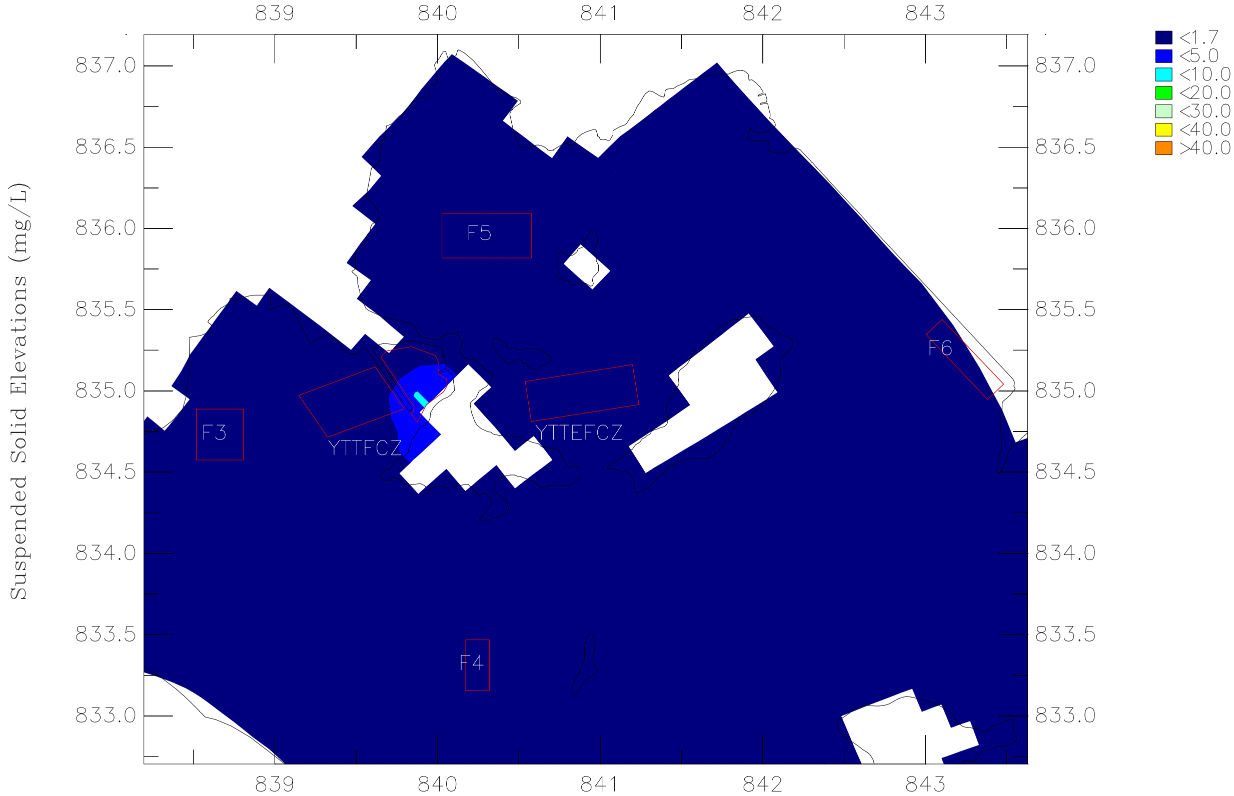




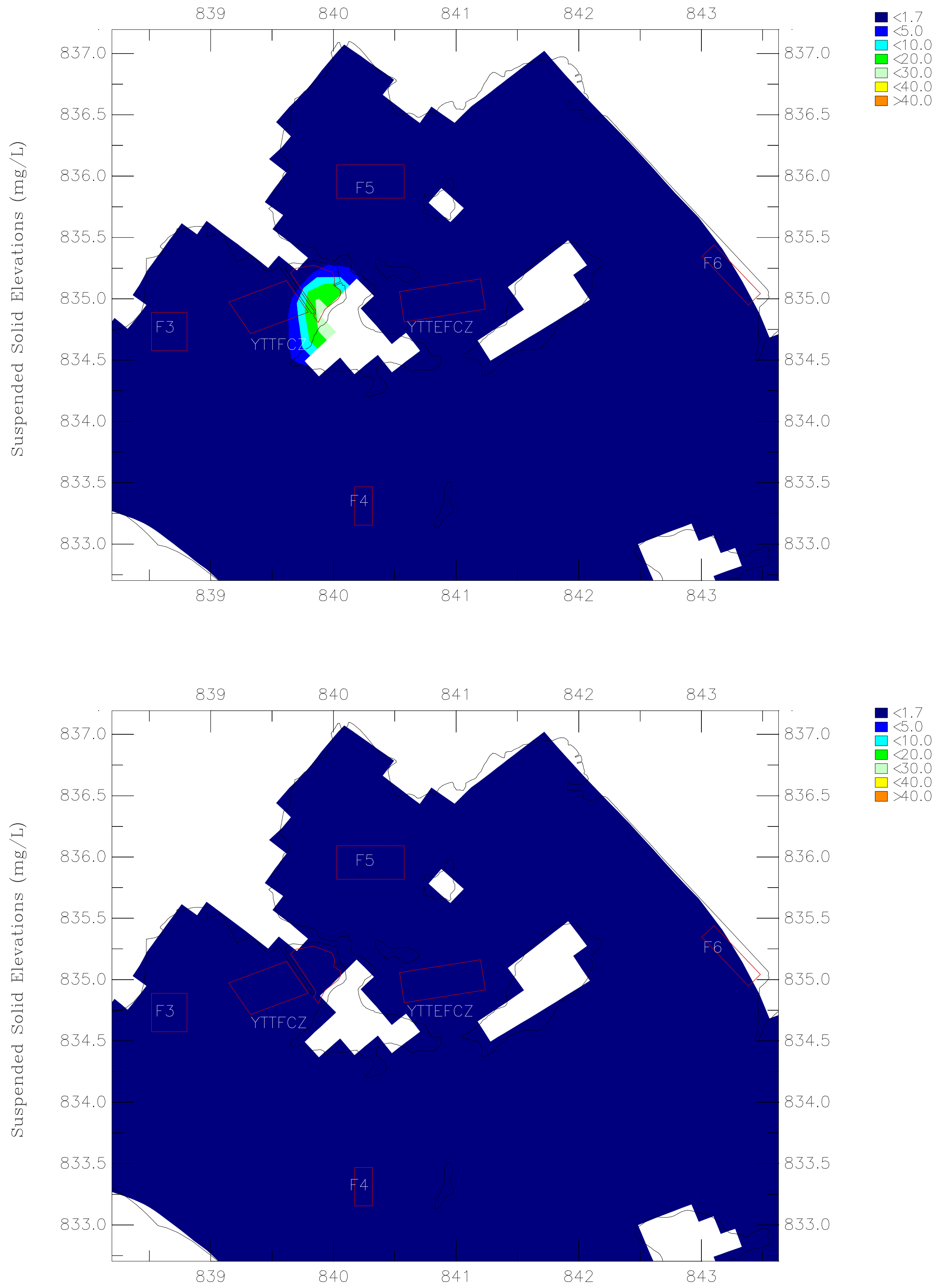
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Sedimentation Flux under Year 2010 Dry Season for Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario (with Silt Curtain only)	Scenario 1	Dry Season
	Annex B3–8	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry.ssn

ANNEX B4
SEDIMENT PLUME MODELLING RESULTS – WET SEASON FOR SCENARIO 2





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Depth-averaged SS Elevations under Year 2010 Wet Season for Scenario 2 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 2	Wet Season
	Annex B4-1	
AECOM ASIA COMPANY LTD	/GPP/	YTT-PT-wet-Scn2.ssn



Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation

Mean Depth–averaged SS Elevations under Year 2010 Wet Season for Scenario 2

Upper: Unmitigated Scenario; Lower: Mitigated Scenario

Scenario 2 | Wet Season

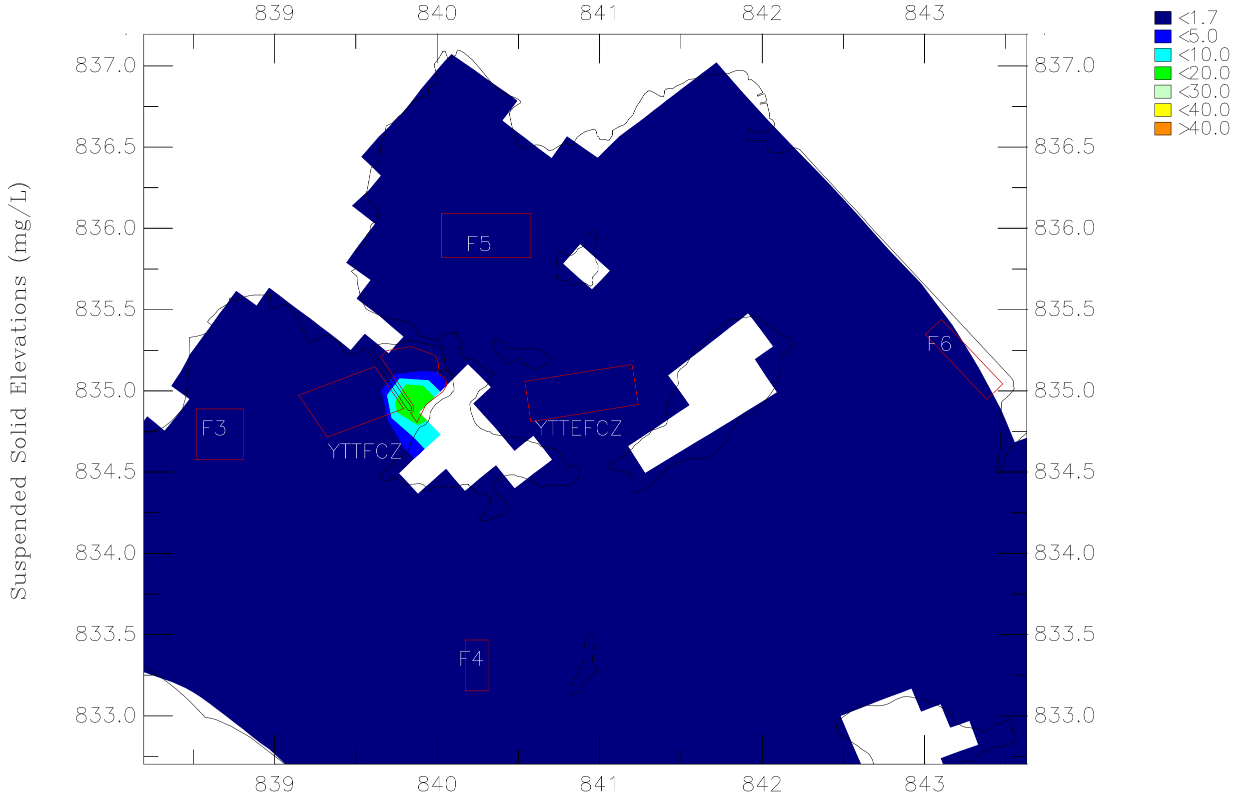
Annex B4–2

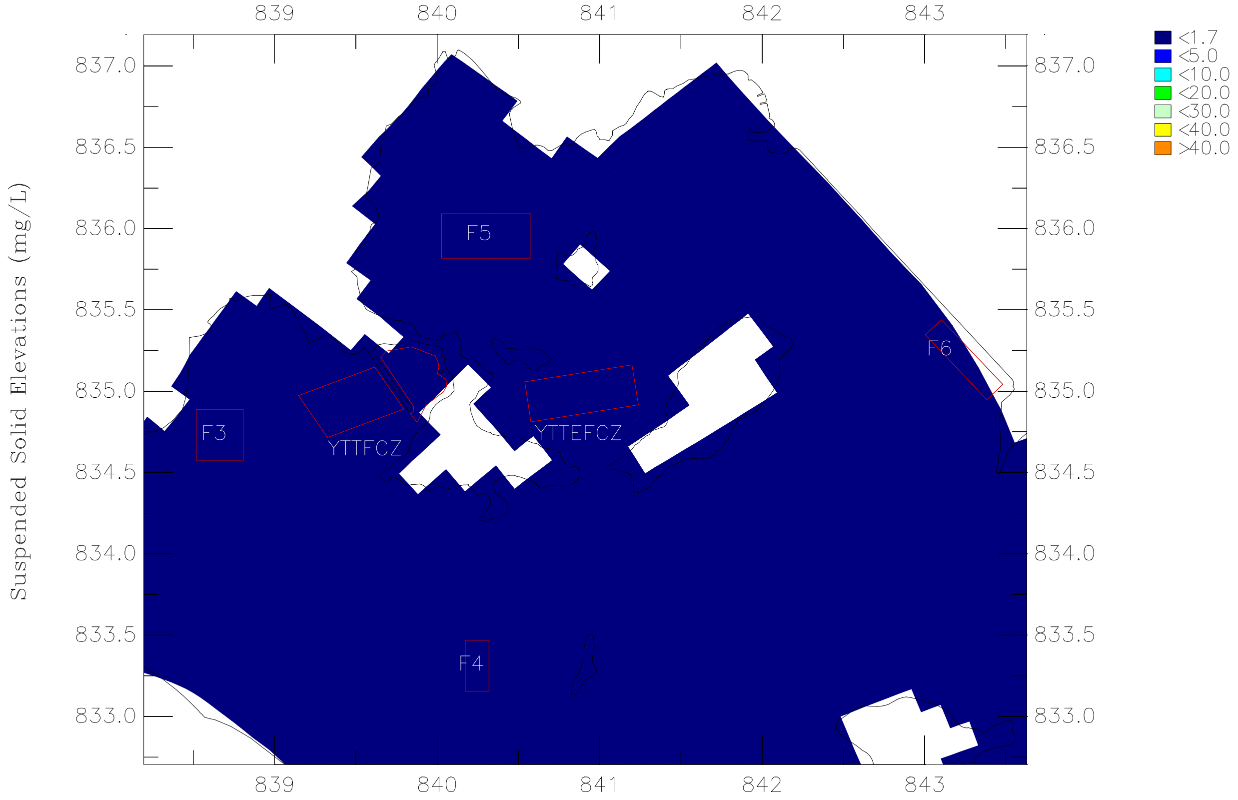
AECOM ASIA COMPANY LTD

/GPP/

YTT–PT–wet–Scn2.ssn

ANNEX B5
SEDIMENT PLUME MODELLING RESULTS – DRY SEASON FOR SCENARIO 2





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Maximum Depth-averaged SS Elevations under Year 2010 Dry Season for Scenario 2 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 2	Dry Season
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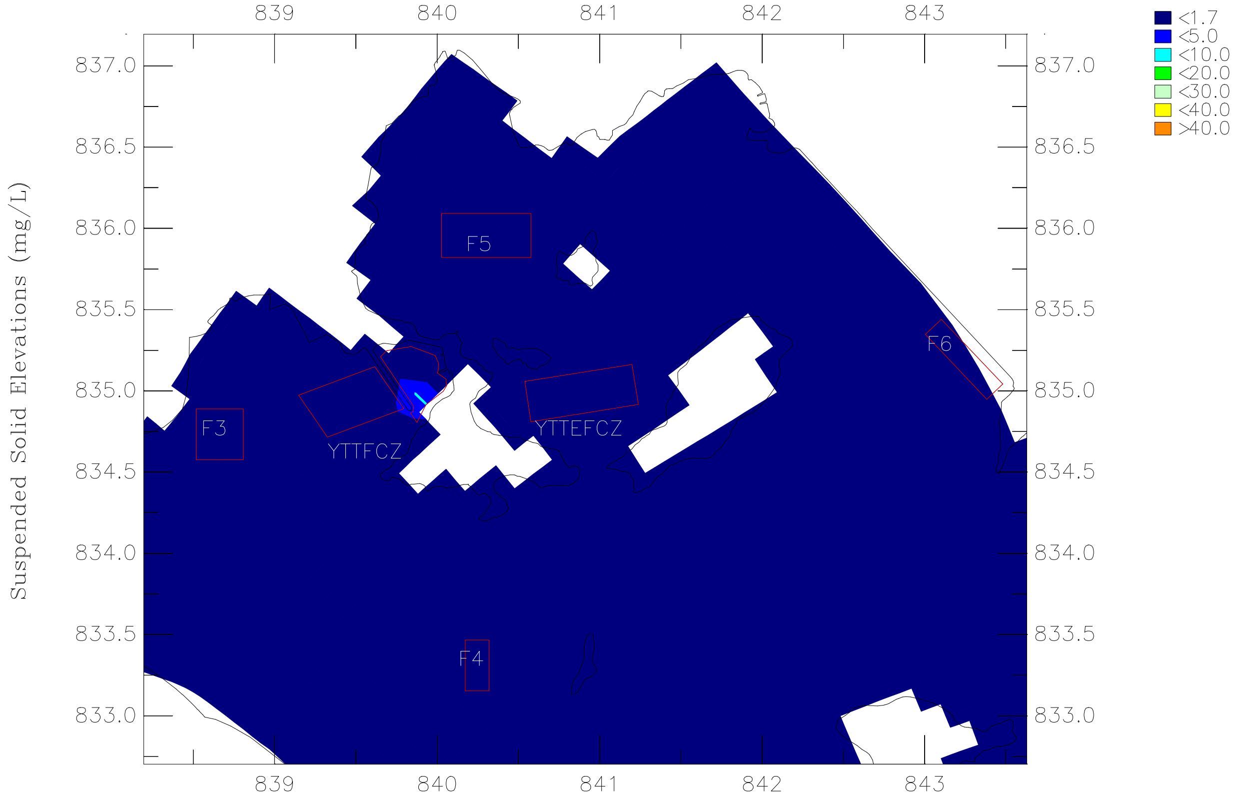
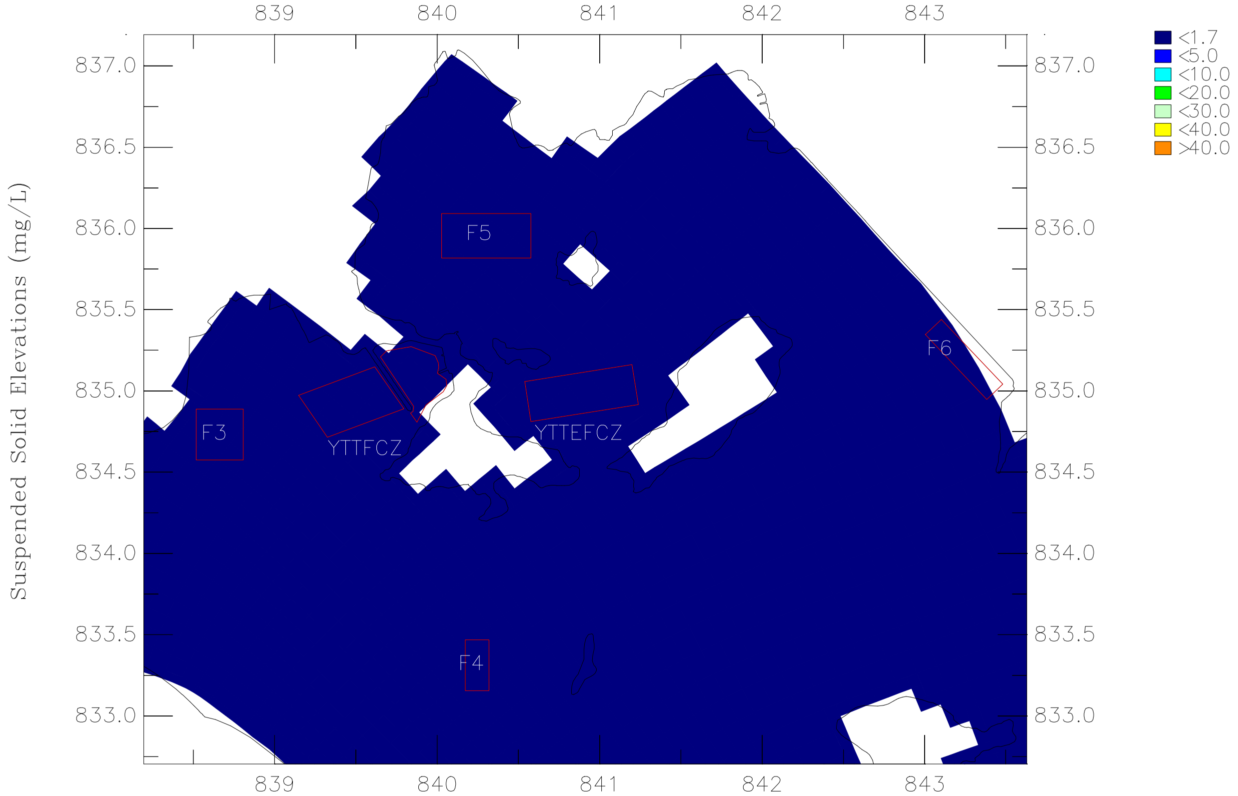
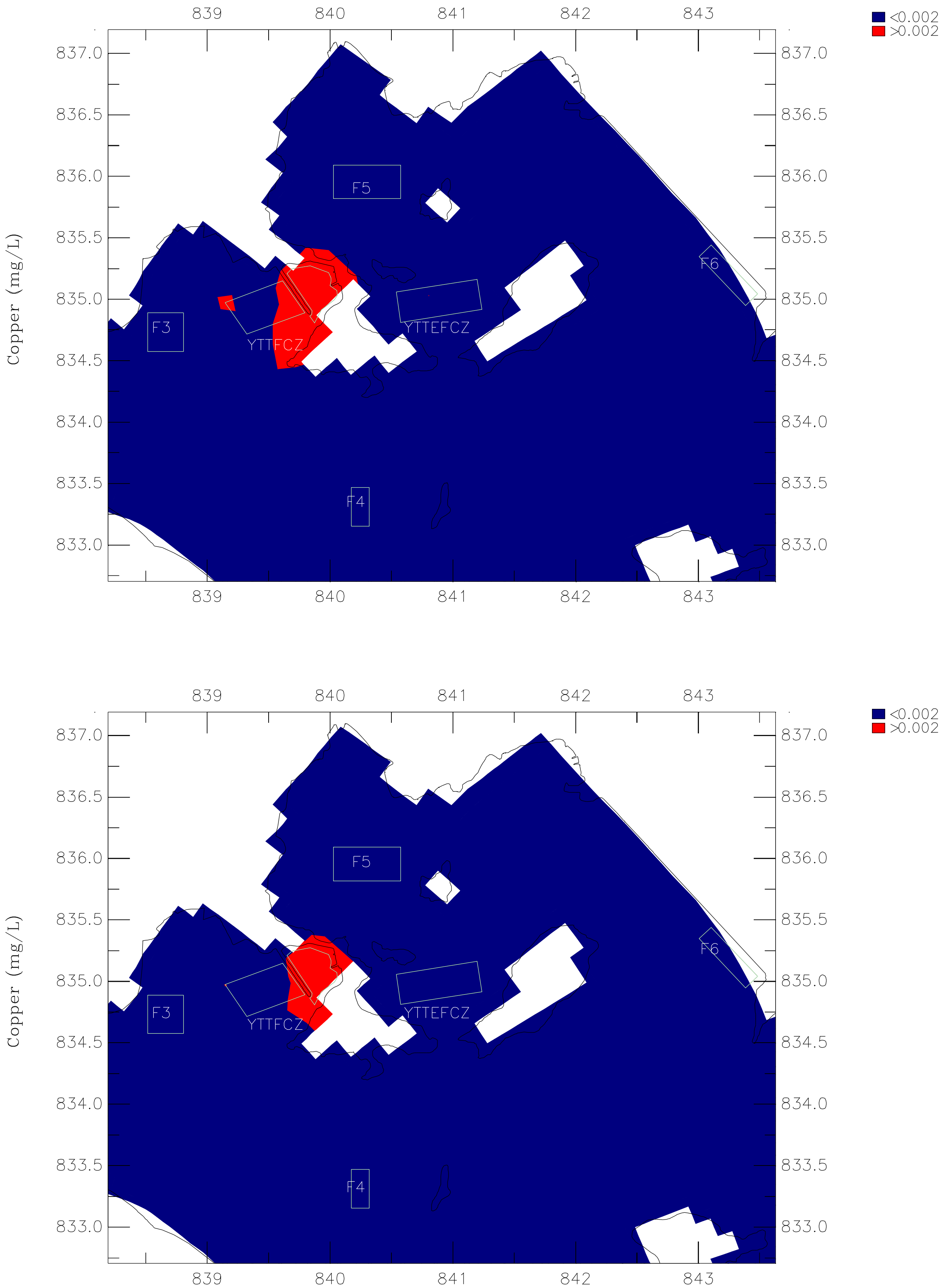
AECOM ASIA COMPANY LTD	/GPP/	YTT-PT-dry-Scn2.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Mean Depth–averaged SS Elevations under Year 2010 Dry Season for Scenario 2 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 2	Dry Season
	Annex B5–2	
AECOM ASIA COMPANY LTD	/GPP/	YTT–PT–dry–Scn2.ssn

ANNEX B6
TRACER MODELLING RESULTS FOR METALS - SCENARIO 1



Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation

Tracer Modelling Results for Copper under Year 2010 Scenario 1

Upper: Unmitigated Scenario; Lower: Mitigated Scenario

Scenario 1

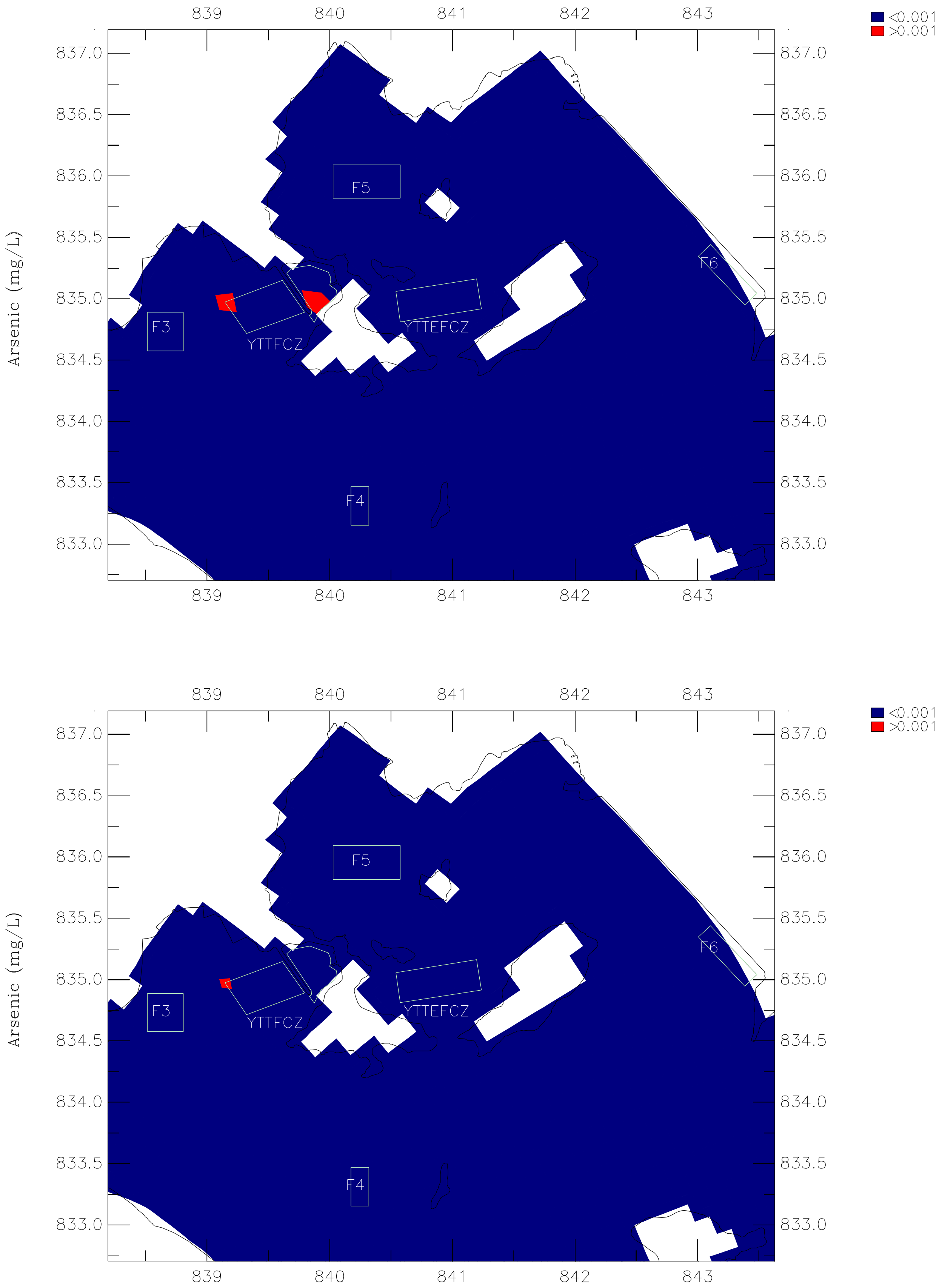
Wet Season

Annex B6–2

AECOM ASIA COMPANY LTD

/GPP/

YTT–Metal·v2.ssn

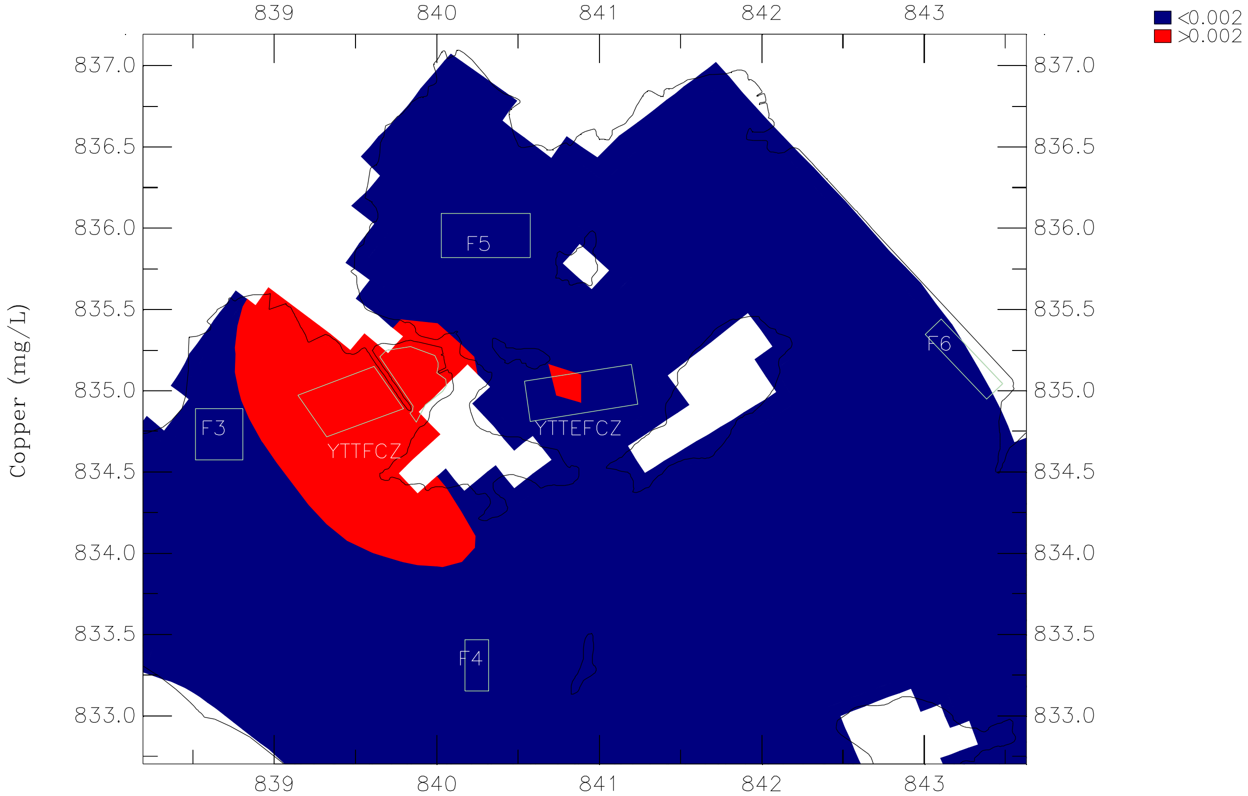


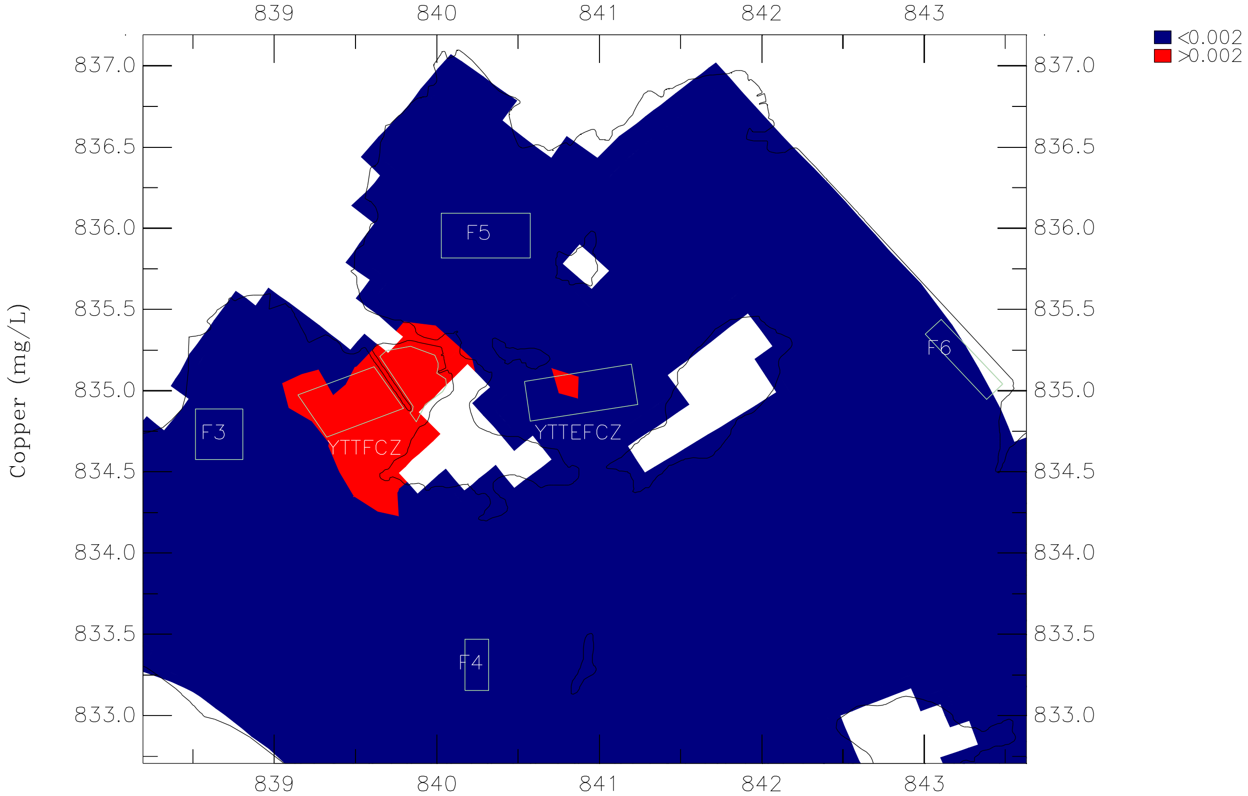
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation

Tracer Modelling Results for Arsenic under Year 2010 Scenario 1

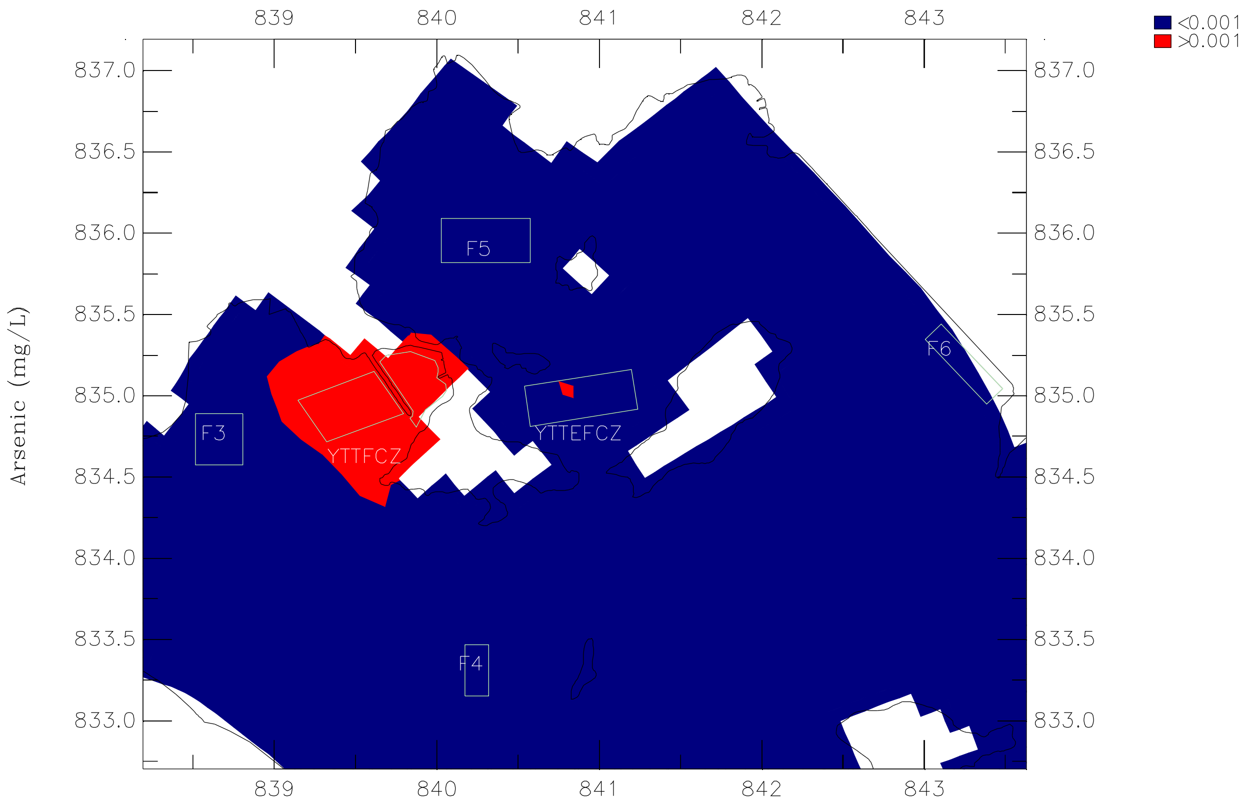
Upper: Unmitigated Scenario; Lower: Mitigated Scenario

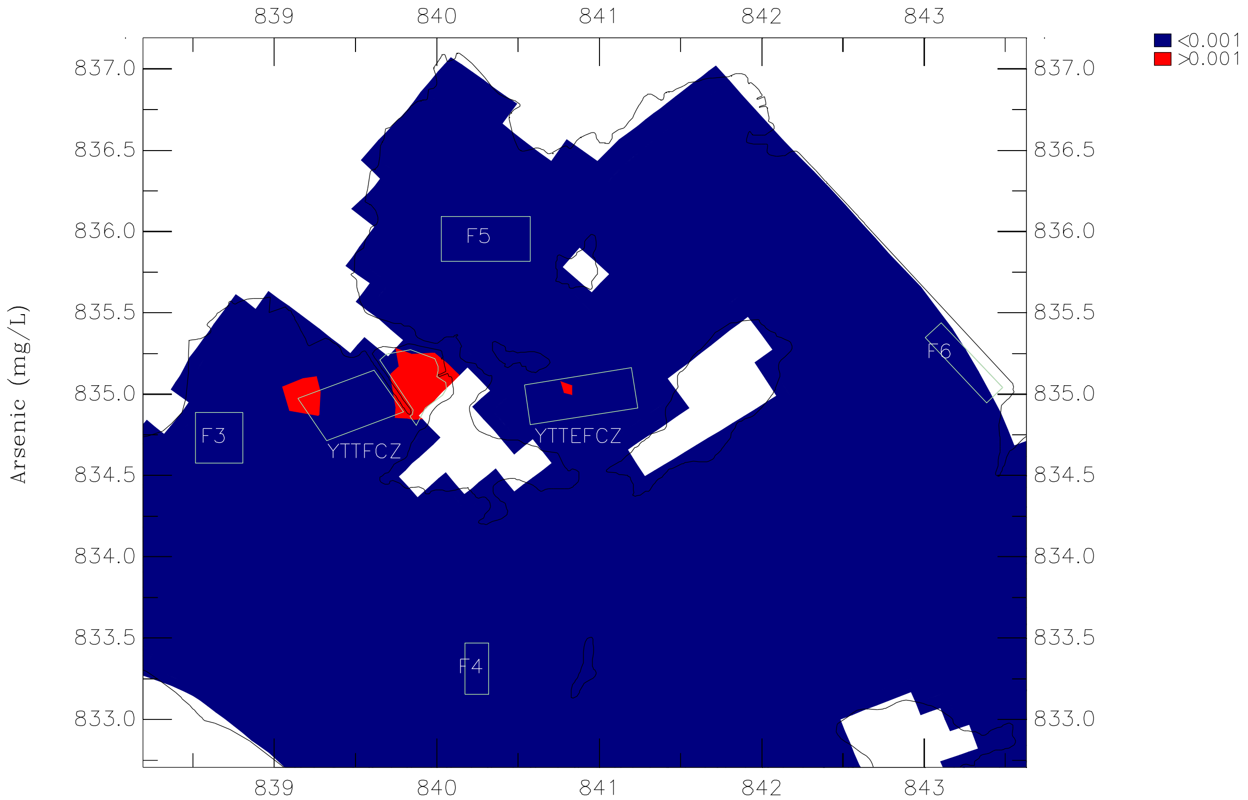
Scenario 1	Wet Season	
Annex B6–3		
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn





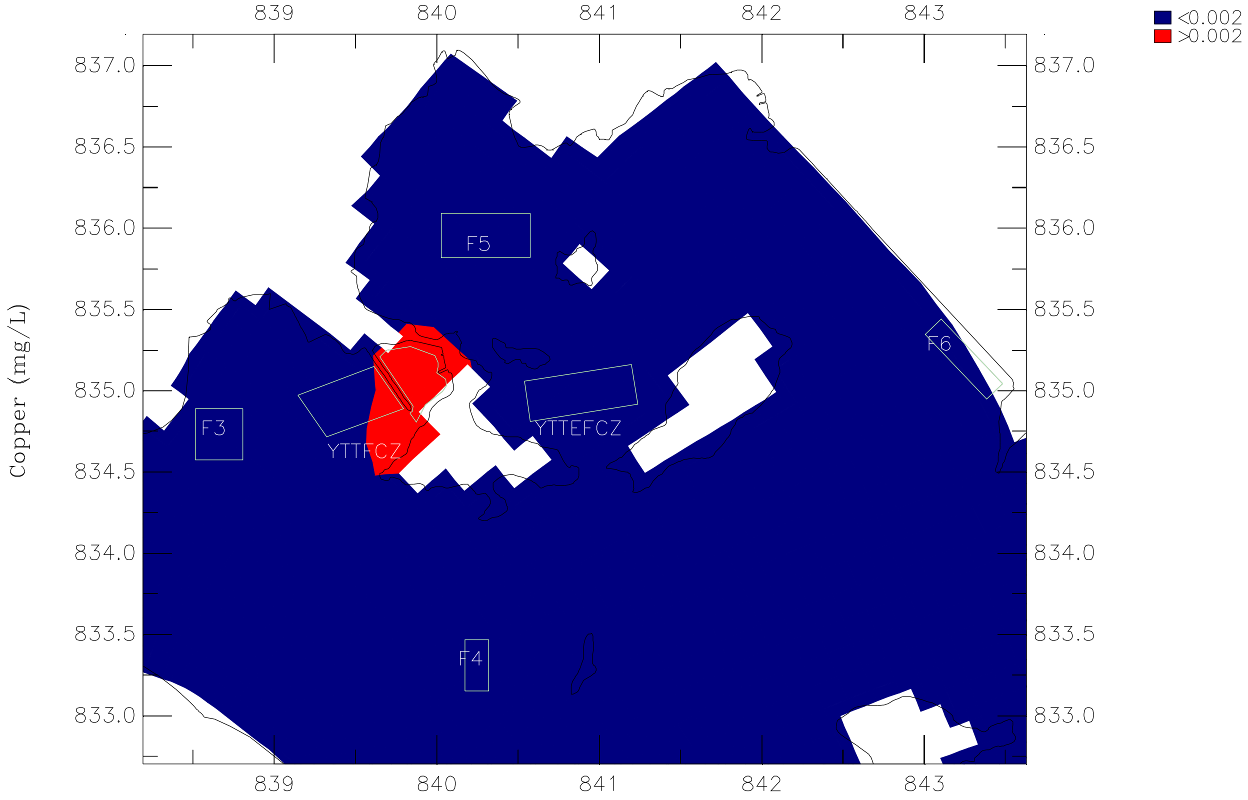
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Tracer Modelling Results for Copper under Year 2010 Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 1	Dry Season
	Annex B6–6	
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn

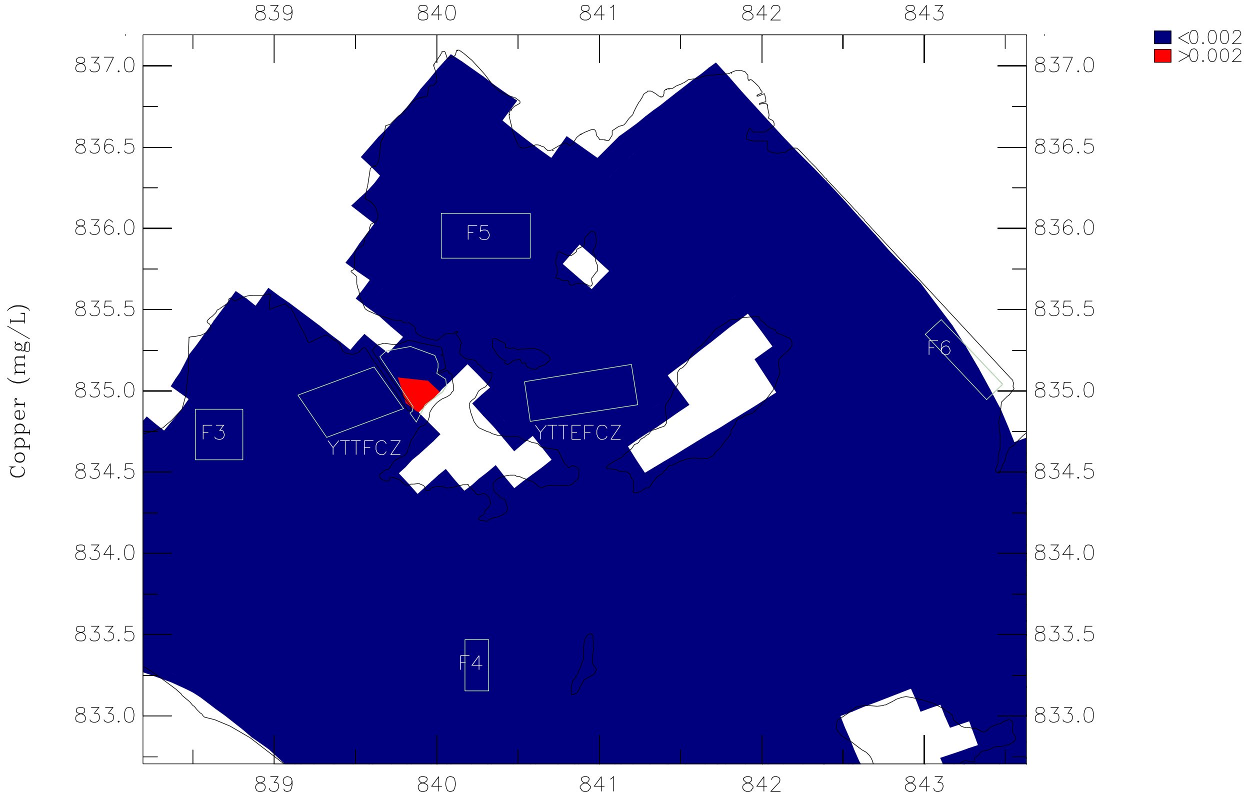




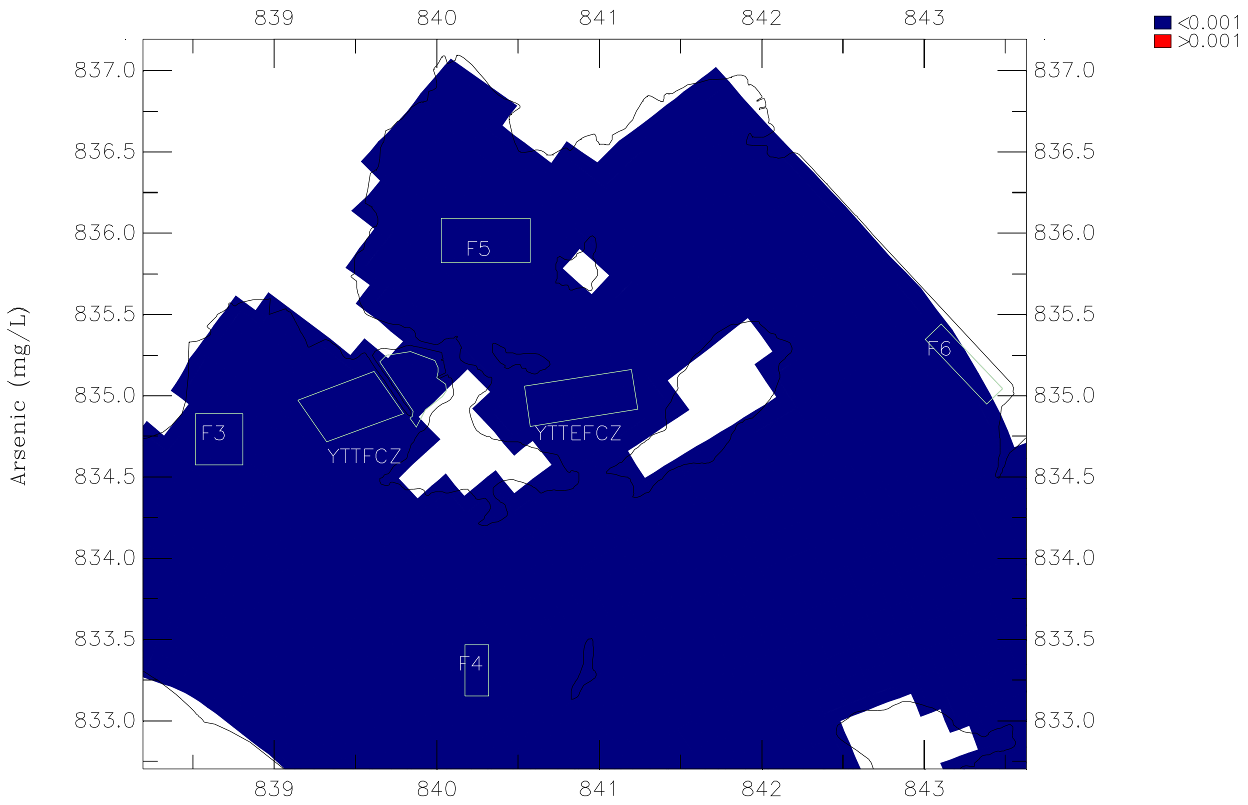
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Tracer Modelling Results for Arsenic under Year 2010 Scenario 1 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 1	Dry Season
	Annex B6–7	
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn

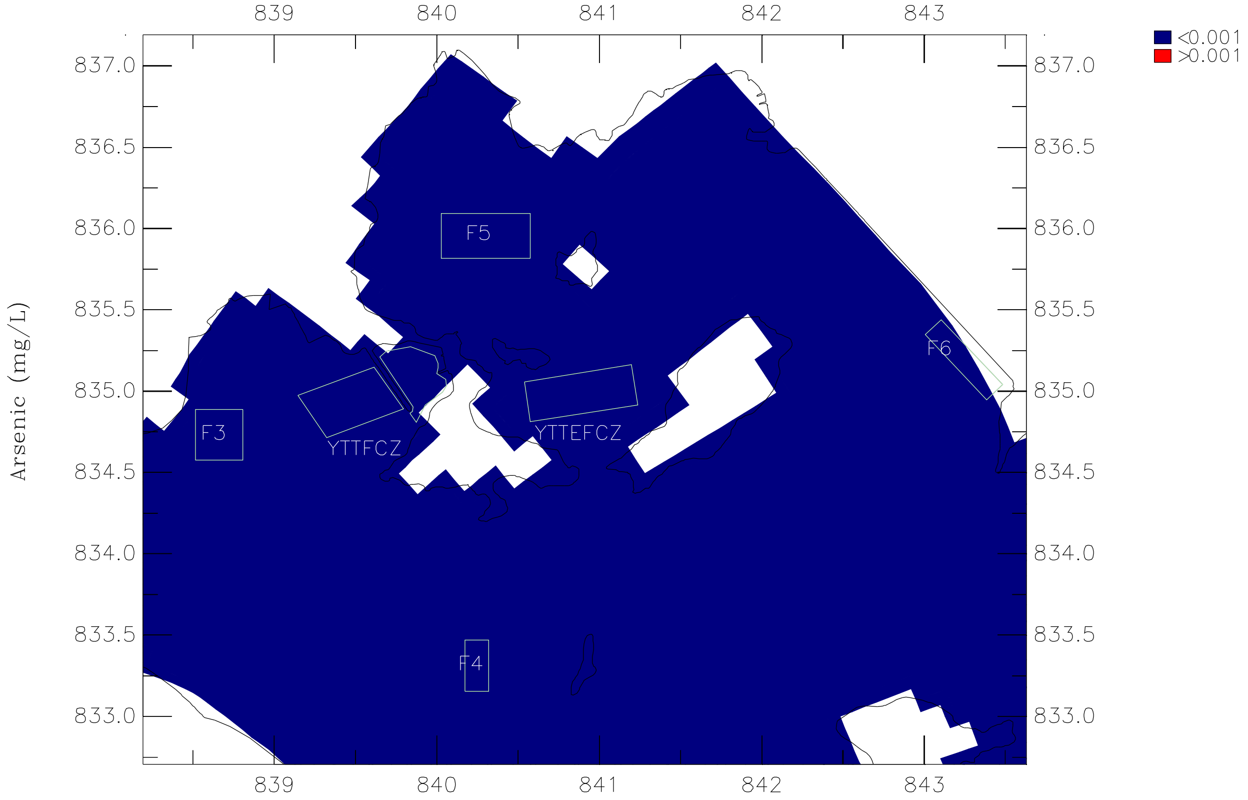
ANNEX B7
TRACER MODELLING RESULTS FOR METALS - SCENARIO 2



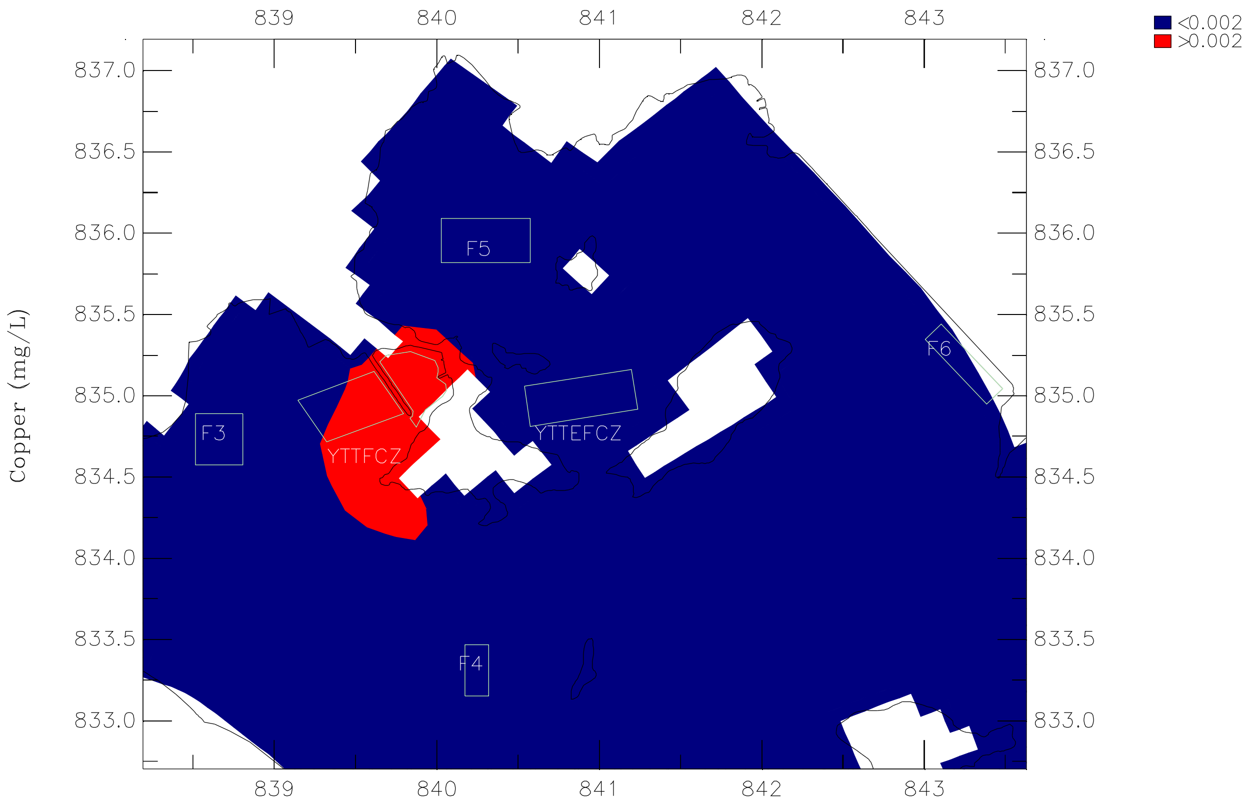


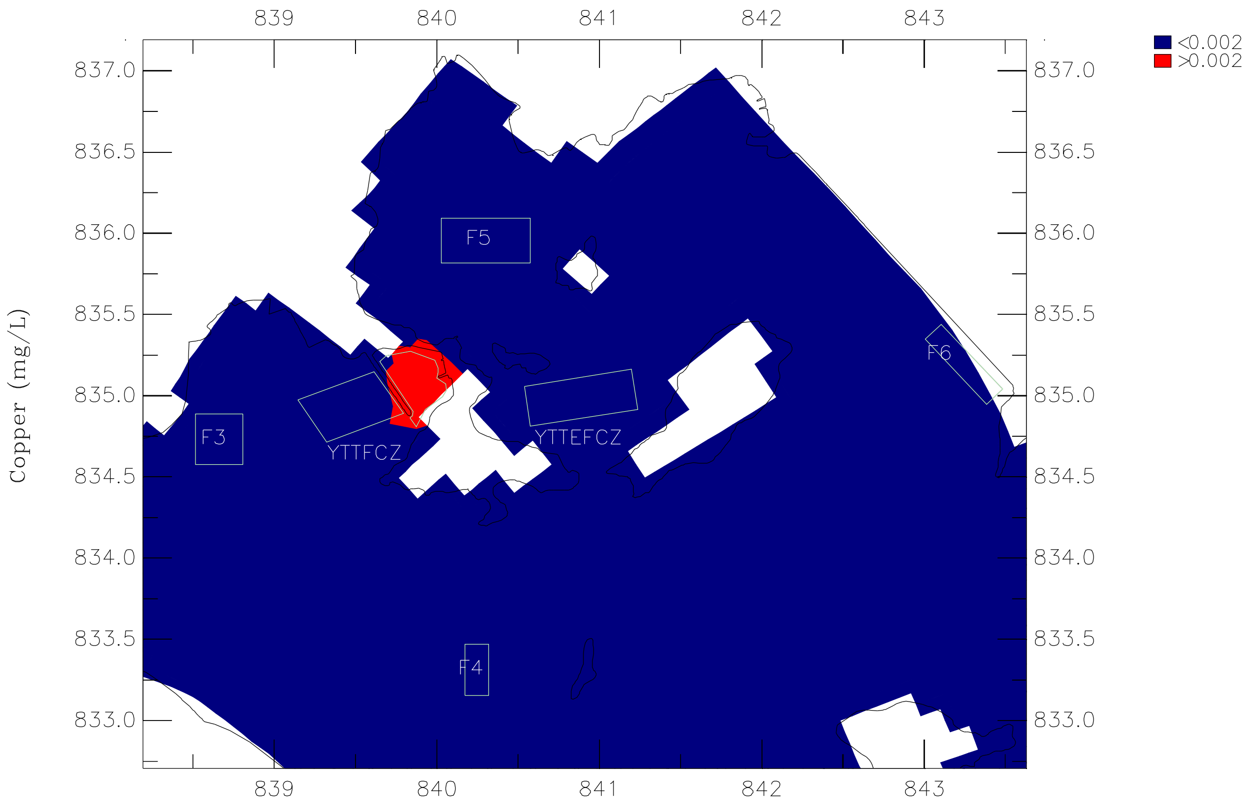
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Tracer Modelling Results for Copper under Year 2010 Scenario 2 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 2	Wet Season
	Annex B7–2	
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Tracer Modelling Results for Arsenic under Year 2010 Scenario 2 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 2	Wet Season
	Annex B7–3	
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn



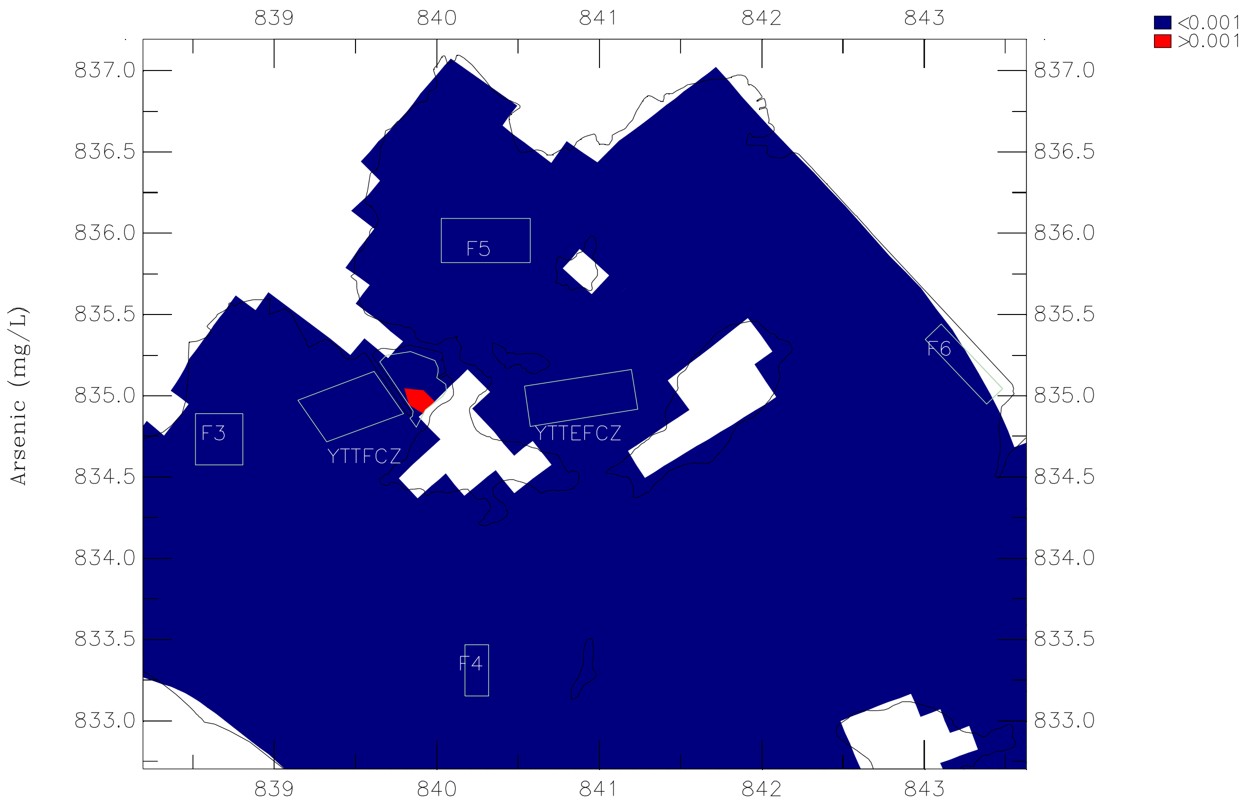


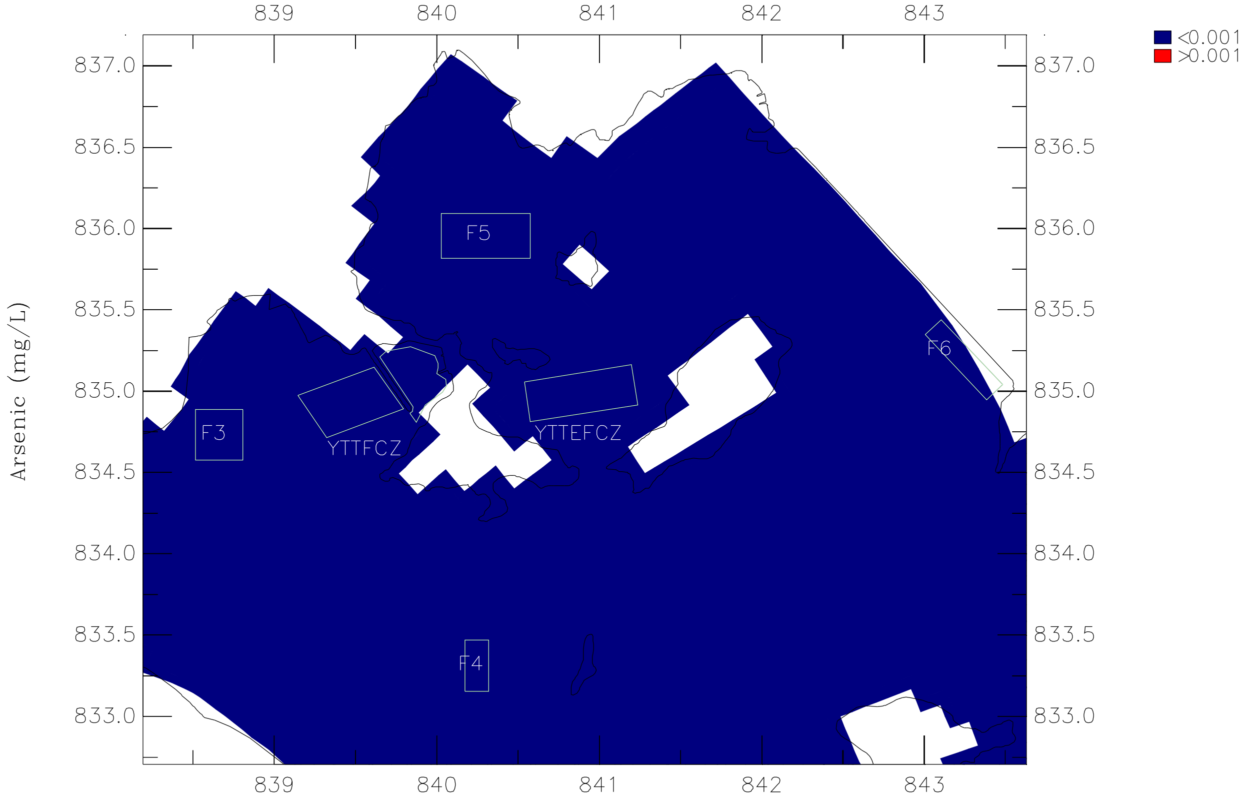
Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation

Tracer Modelling Results for Copper under Year 2010 Scenario 2

Upper: Unmitigated Scenario; Lower: Mitigated Scenario

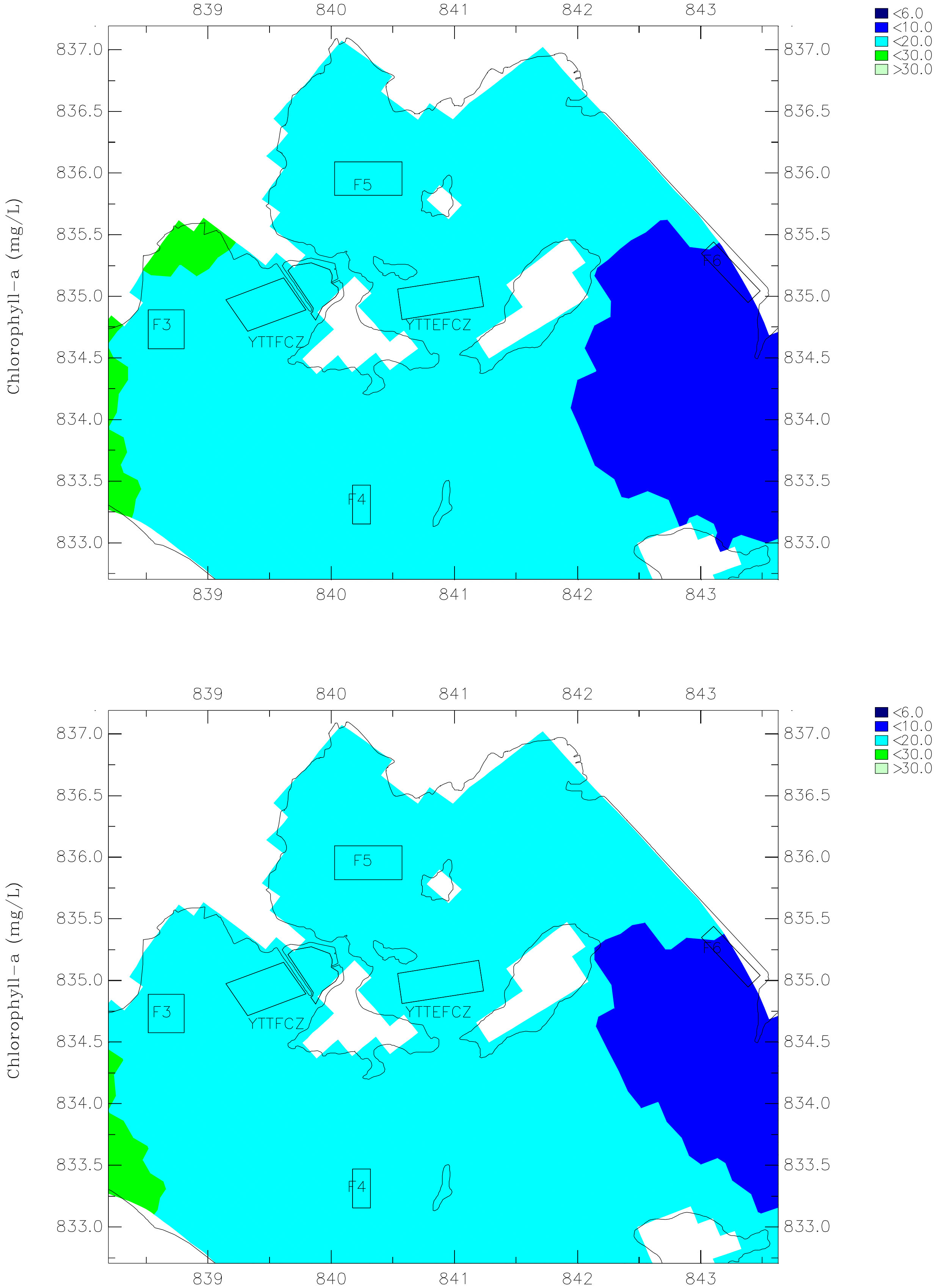
Scenario 2	Dry Season	
Annex B7–6		
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Tracer Modelling Results for Arsenic under Year 2010 Scenario 2 Upper: Unmitigated Scenario; Lower: Mitigated Scenario	Scenario 2	Dry Season
	Annex B7–7	
AECOM ASIA COMPANY LTD	/GPP/	YTT–Metal·v2.ssn

ANNEX B8
WATER QUALITY MODELLING RESULTS
FOR CHLOROPHYLL-A



Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation

Annual Depth–Averaged Maximum 5–day moving average Chlorophyll–a Concentration in Tolo Harbour

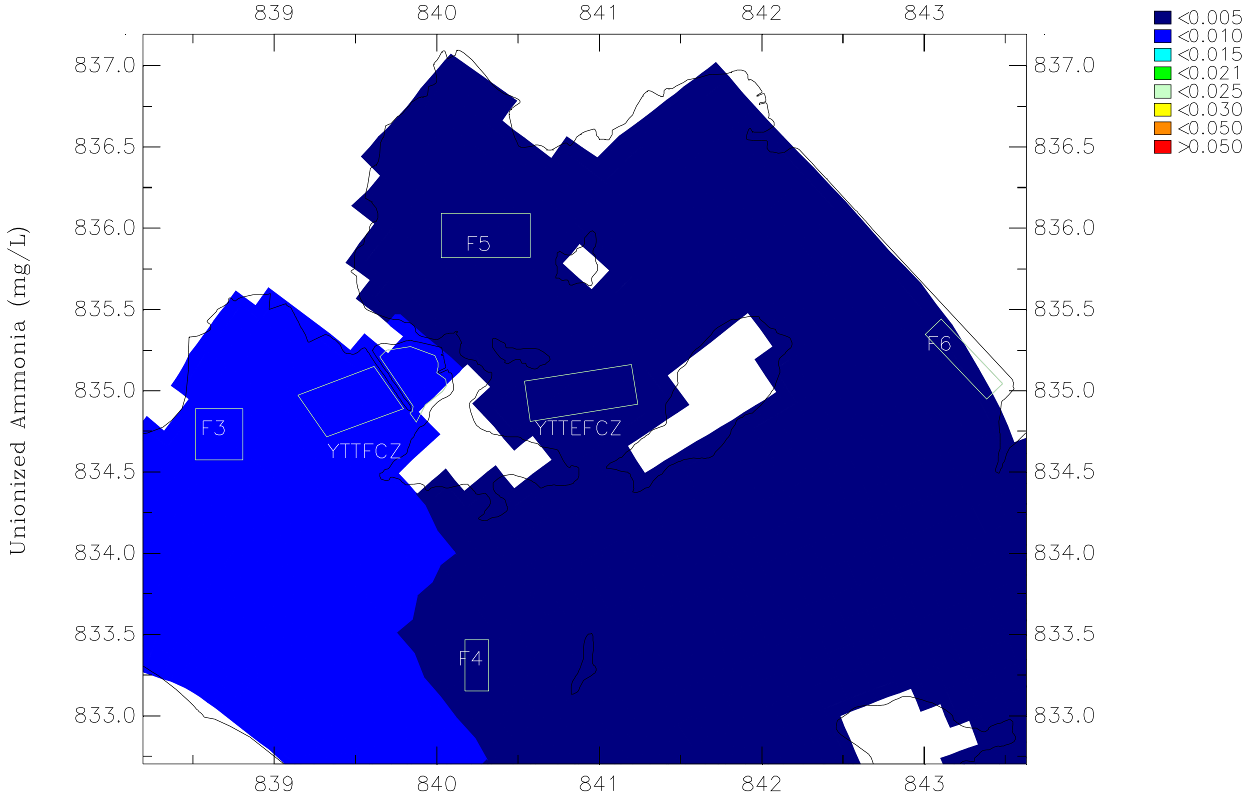
under – Upper: Baseline; Lower: Scenario 1

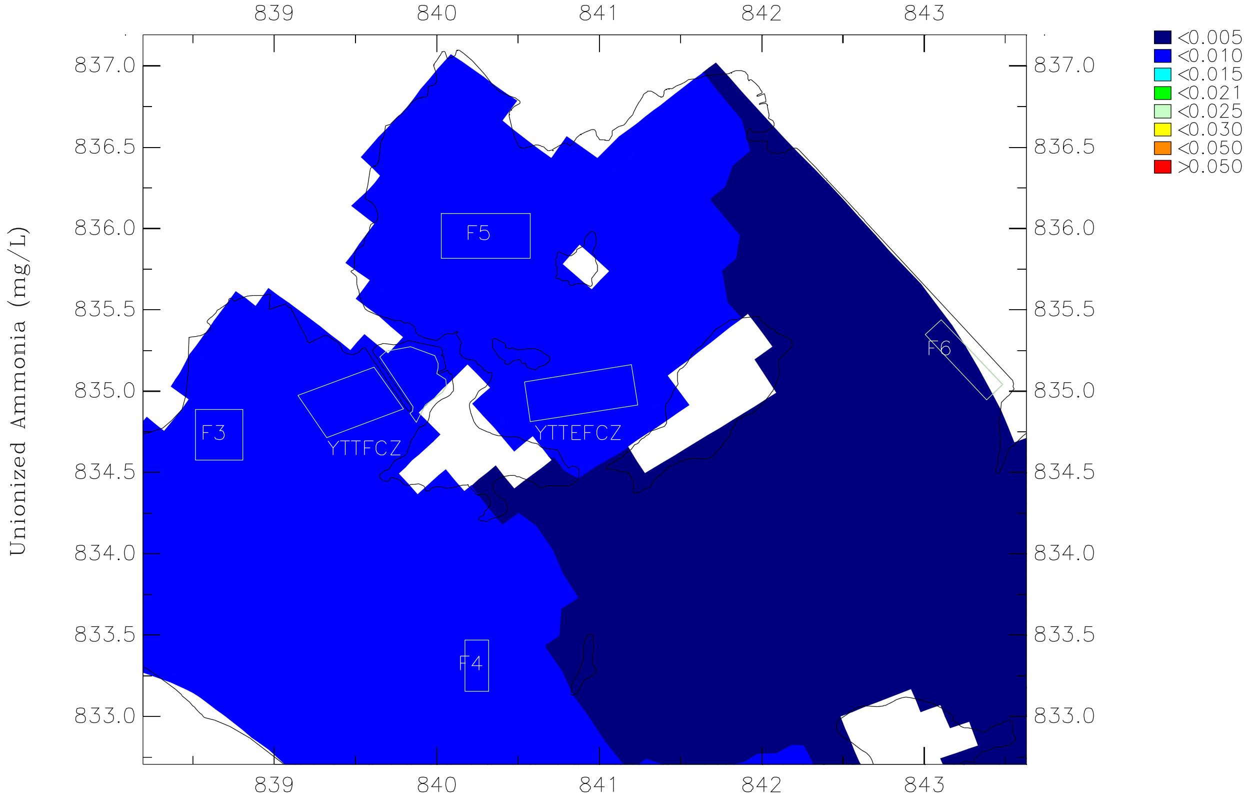
Scenario 1	Annual
Annex B8–1	

AECOM ASIA COMPANY LTD

/GPP/ YTT–waq2.ssn

ANNEX B9
WATER QUALITY MODELLING RESULTS
FOR UNIONIZED AMMONIA





Agreement No. CE 26/2008 (EP) EIA Study for Dredging at 5 FCZs and 2 Boat/TSs – Investigation Annual Depth–Averaged Unionized Ammonia Concentration in Tolo Harbour under Upper: Baseline; Lower: Scenario 1	Scenario 1	Annual
	Annex B9–1	
AECOM ASIA COMPANY LTD	/GPP/	YTT–waq2.ssn

ANNEX B10
SEDIMENT SAMPLING AND TESTING RESULTS FOR ADDITIONAL SEDIMENT QUALITY PARAMETERS

Annex B10 Sediment Sampling and Testing Results for Additional Sediment Quality Parameters

1.1 Besides the requirements outlined in the ETWB TCW No. 34/2002 "Management of dredged/excavated sediment", the sediment testing and sampling exercise conducted under this EIA also covered additional parameters to determine the levels of nutrient pollution, organic pollution and odour potential of the sediment samples.

1.2 Testing for additional parameters is proposed at selected stations to determine the levels of nutrient pollution, organic pollution and odour potential of the sediment samples as indicated in **Table B10-1**. Locations of these stations are indicated in Figure 3.1 attached in the main text of this Project Profile. The sampling types and depths of the sampling stations are given in Appendix C1 of this Project Profile.

Table B10-1 Additional Testing Parameters and Sediment Sampling Stations

Items	Additional Parameters	Dredging Area	Stations Selected for Additional Testing (Ref: Figure 3.1)
Group A parameters	**To Assess Nutrient Pollution** Ammoniacal Nitrogen Total Kjeldahl Nitrogen Nitrate Nitrogen Nitrite Nitrogen	Yim Tin Tsai FCZ	YTT/MI 7; YTT/MI 19
		Yim Tin Tsai East FCZ	YTTE/MI 6; YTTE/MI 15; YTTE/MI 10
		Shuen Wan Typhoon Shelter	SWTS/MI 4; SWTS/MI 13
Group B parameter	**To Assess Organic Pollution:** Sediment Oxygen Demand Electrochemical Potential Total Organic Carbon	Yim Tin Tsai FCZ	YTT/MI9; YTT/MI12
		Yim Tin Tsai East FCZ	YTTE/MI1; TYYE/MI11; YTTE/MI21
Group C parameter	**To Assess Odour Potential/Bioavailability / Physicochemical Properties** Total Sulphide Acid Volatile Sulphide Moisture Content Particle Size Distribution	Yim Tin Tsai FCZ	YTT/MI8; YTT/MI14
		Yim Tin Tsai East FCZ	YTTE/MI9; YTTE/MI13
		Shuen Wan Typhoon Shelter	SWTS/MI2; SWTS/MI10

1.3 Details of the testing methods, QA/QC (such as the number of blank, duplicate, spike/control samples to be adopted) and reporting limits are presented in Appendix C5 of this Project Profile. The relevant testing results are tabulated in **Table B10-2** to **Table B10-4** in this Appendix.

Table B10-2 Testing Results for Nutrient

Site	Location	Sampling Depth	Total Nitrogen (TN)			
			Ammonia Nitrogen (NH_3) mg/kg	Organic Nitrogen (Org-N) mg/kg	Nitrate Nitrogen (NO_3) mg/kg	Nitrite Nitrogen (NO_2) mg/kg
Yim Tin Tsai FCZ	YTT/MI 7	0.0-0.9m	18	782	<0.5	0.45
	YTT/MI 7	1.0-2.0m	20	690	<0.5	0.51
	YTT/MI 19	0.0-0.9m	5.2	425	1.3	0.28
	YTT/MI 19	1.0-2.0m	13.0	757	0.6	0.09
Yim Tin Tsai (East) FCZ	YTTE/MI 6	0.0-0.9m	12	788	<0.5	0.93
	YTTE/MI 6	1.0-2.0m	12	788	<0.5	2.2
	YTTE/MI 10	0.0-0.9m	14	686	<0.5	1.7
	YTTE/MI 10	1.0-2.0m	12	728	<0.5	2.1
	YTTE/MI 15	0.0-0.9m	32	708	2.0	<0.1
	YTTE/MI 15	1.0-2.0m	29	871	<0.5	<0.1
Shuen Wan Typhoon Shelter	SWTS/MI 4	0.0-0.9m	7.6	762	7.1	0.14
	SWTS/MI 13	0.0-0.9m	11	609	7.0	0.2

Annex B10 Sediment Sampling and Testing Results for Additional Sediment Quality Parameters

Table B10-3 Testing Results for Organic Condition

Site	Location	Sampling Depth	Sediment Oxygen Demand (SOD) mg/kg	Redox Potential (mV)	Total Organic Carbon (TOC) %
Yim Tin Tsai FCZ	YTT/MI 9	0.0-0.9m	1500	-250	0.30
	YTT/MI 9	1.0-2.0m	1800	-200	0.41
	YTT/MI 12	0.0-0.9m	2300	-240	0.48
	YTT/MI 12	1.0-2.0m	1600	-240	0.35
Yim Tin Tsai (East) FCZ	YTTE/MI 1	0.0-0.9m	3300	-210	0.70
	YTTE/MI 1	1.0-2.0m	3100	-260	0.60
	YTTE/MI 11	0.0-0.9m	2100	-270	0.50
	YTTE/MI 11	1.0-2.0m	2000	-220	0.40
	YTTE/MI 21	0.0-0.9m	1800	-230	0.40
	YTTE/MI 21	1.0-2.0m	2900	-200	0.70

Table B10-4 Testing Results for Sulphide and Acid Volatile Sulphide

Site	Station	Sampling Depth	Sulphide mg/kg	Acid Volatile Sulphides mg/kg
Yim Tin Tsai FCZ	YTT/MI 8	0.0-0.9m	<5	26
	YTT/MI 8	1.0-2.0m	<5	30
	YTT/MI 14	0.0-0.9m	<5	31
	YTTMI 14	1.0-2.0m	<5	33
Tim Tin Tsai (East) FCZ	YTTE/MI 9	0.0-0.9m	<5	26
	YTTE/MI 9	1.0-2.0m	<5	19
	YTE/MI 13	0.0-0.9m	<5	19
	YTE/MI 13	1.0-2.0m	<5	25
Shuen Wan Typhoon Shelter	SWTS/MI2	0.0-0.9m	<5	150
	SWTS/MI10	0.0-0.9m	<5	160

ANNEX B11
RED TIDE MONITORING PROGRAMME AND ACTION PLAN

1 RED TIDE MONITORING PROGRAMME AND ACTION PLAN

1.1.1 The potential impacts from red tide or harmful algal blooms (HABs) that may arise in the Tolo Harbour during the sediment removal works will be managed and responded under the routine red tide monitoring and management protocol and response plan currently adopted by the government in Hong Kong. AFCD shall be acting as the coordinator of the Red Tide Reporting Network, to receive reports of red tide, conduct investigation and provide warning of the risk associated and appropriate mitigation measures. The objectives of this red tide monitoring programme are to provide coordination of monitoring and response to red tides/HABs and fish kills and to compile and synthesize data necessary to effectively manage fisheries resources, protect human health and the marine ecosystems. Details of the existing red tide monitoring and management plan are provided in the website (http://www.hkredtide.org/). An outline of the red tide monitoring and management framework is highlighted in the subsequent sections for reference.

1.2 Information Network

1.2.1 Red Tide Reporting Network: Following any sighting of seawater discoloration in the Tolo Harbour waters as reported by staff of government departments working at sea as well as the public and stakeholders of this Project, AFCD shall conduct investigation to assess the risk involved, issue warnings to marine fish farmer as necessary and forward the information to concerned departments such as EPD, Food and Environmental Hygiene Department (FEHD), Leisure and Cultural Services Department (LCSD) and Department of Health (DH) for appropriate actions.

1.2.2 Phytoplankton Monitoring Programme: Routine phytoplankton monitoring is currently carried out by EPD to monitor the phytoplankton populations at 25 stations across the Hong Kong water including 3 EPD stations, namely TM3, TM4 and TM6 respectively, close to the Project sites. Under the phytoplankton monitoring programme, monthly samples are collected from one metre below the surface of the water for laboratory analysis to identify and count the phytoplankton species in each sample, and compare the results geographically between stations and over time. The aim of the phytoplankton monitoring programme is to identify changes in the phytoplankton community and to detect the presence of any toxic species of phytoplankton.

1.2.3 Routine phytoplankton monitoring is also carried out by AFCD to detect presence of toxic algae or development of harmful red tides, in order to provide early warning to mariculturists and other concerned parties. Phytoplankton samples are collected by AFCD weekly from six core stations (i.e. 1 in Western Buffer WCZ near Ma Wan, 1 in Southern WCZ near Lama Island, 1 in Port Shelter, 1 in Tolo Harbour and 2 in Mirs Bay) and fortnightly from five more offshore stations (1 in North Western WCZ, 2 in Southern WCZ, 1 in Port Shelter and 1 in Mirs Bay) year round, as well as five seasonal stations (at Lamma Island, Tung Lung Chau, Tolo Harbour, Port Shelter and Mirs Bay respectively) during red tide peak season. Sampling frequency would be stepped up when harmful algal species or abnormally high phytoplankton population was detected.

1.2.4 Seafood Surveillance and Report of Human Intoxication: Routine surveillance for biotoxins in seafood at import control, wholesale and retailed markets is carried out by FEHD. In addition, FEHD will step up the surveillance in response to the presence of toxic algae from AFCD's phytoplankton monitoring programme. Shellfish containing algal toxins exceeding the safety limit will be confiscated. Cases of human intoxication by shellfish poisons will be reported to DH. DH with assistance from FEHD will trace the source of incriminated shellfish and stop the sale of these shellfish.

1.3 Departmental Action Plans

1.3.1 The action plans include the Mariculture Action Plan to be implemented by AFCD, the Algal Biotoxin Action Plan by FEHD and DH and the Beach Action Plan by LCSD. The actions taken and monitoring results are forwarded to AFCD for coordination. Joined press release or conference will be arranged as needed.

1.4 Other Activities

1.4.1 Public Communication and Education: To inform the public and mariculturists about the latest red tide situation, the webpage (http://www.hkredtide.org/) is updated weekly and press release is issued upon occurrence of red tide. A set of posters and leaflets on red tide is produced and distributed to public including understanding of red tide/HAB, impacts of fish culture, implication on seafood safety and swimming at beach. Webpages and leaflets on shellfish toxins are published by FEHD.

APPENDIX C1
COORDINATE, TYPE, DREDGING DEPTH, SAMPLING DEPTH AND NUMBER OF SUB-SAMPLES FOR EACH SEDIMENT SAMPLING LOCATION

Appendix C1 Coordinate, Type, Dredging Depth, Sampling Depth and Number of Sub-samples for Each Sediment Sampling Location

Dredging Area	ID	Coordinate		Existing Water Depth (m)	Sampling Type	Required minimum Seabed Level (mCD)	Dredged Sediment Thickness (m)	Sub-sample Depth (m)		Number of Sub-Samples	Total Number of Samples
		X	Y					0 - 0.9	1.0 - 2.0		
Yim Tin Tsai FCZ	YTT/MI 1	839224.453	834975.149	-5.67	Vibrating Coring	-6.5	0.83	1	1	2	38
	YTT/MI 2	839293.069	834991.773	-5.30	Vibrating Coring	-6.5	1.20	1	1	2	
	YTT/MI 3	839401.136	835039.780	-5.10	Vibrating Coring	-5.5	0.40	1	1	2	
	YTT/MI 4	839497.196	835074.867	-3.33	Grab Sample	-3.5	0.17	1	-	1	
	YTT/MI 5	839581.248	835108.106	-1.36	Grab Sample	-1.5	0.14	1	-	1	
	YTT/MI 6	839243.339	834893.946	-5.62	Vibrating Coring	-6.5	0.88	1	1	2	
	YTT/MI 7	839334.251	834941.950	-5.30	Vibrating Coring	-6.5	1.20	1	1	2	
	YTT/MI 8	839435.460	834969.654	-5.10	Vibrating Coring	-5.5	0.40	1	1	2	
	YTT/MI 9	839528.041	835010.299	-4.28	Vibrating Coring	-5.5	1.22	1	1	2	
	YTT/MI 10	839629.294	835052.748	-3.30	Vibrating Coring	-3.5	0.20	1	1	2	
	YTT/MI 11	839310.259	834818.289	-5.50	Vibrating Coring	-6.5	1.00	1	1	2	
	YTT/MI 12	839392.595	834860.755	-5.55	Vibrating Coring	-6.5	0.95	1	1	2	
	YTT/MI 13	839502.381	834892.153	-5.40	Vibrating Coring	-6.5	1.10	1	1	2	
	YTT/MI 14	839591.583	834914.319	-5.17	Vibrating Coring	-5.5	0.33	1	1	2	
	YTT/MI 15	839685.926	834960.480	-4.69	Vibrating Coring	-5.5	0.81	1	1	2	
	YTT/MI 16	839349.728	834753.701	-6.00	Vibrating Coring	-6.5	0.50	1	1	2	
	YTT/MI 17	839433.783	834783.248	-5.55	Vibrating Coring	-6.5	0.95	1	1	2	
	YTT/MI 18	839546.997	834833.103	-5.70	Vibrating Coring	-6.5	0.80	1	1	2	
	YTT/MI 19	839625.904	834862.649	-5.60	Vibrating Coring	-6.5	0.90	1	1	2	
	YTT/MI 20	839735.688	834903.277	-5.00	Vibrating Coring	-6.5	1.50	1	1	2	

Appendix C1 Coordinate, Type, Dredging Depth, Sampling Depth and Number of Sub-samples for Each Sediment Sampling Location

Dredging Area	ID	Coordinate		Existing Water Depth (m)	Sampling Type	Required minimum Seabed Level (mCD)	Dredged Sediment Thickness (m)	Sub-sample Depth (m)		Number of Sub-Samples	Total Number of Samples
		X	Y					0 - 0.9	1.0 - 2.0		
Yim Tin Tsai (East) FCZ	YTTE/MI 1	840586.546	835027.148	-1.90	Vibrating Coring	-3.5	1.60	1	1	2	42
	YTTE/MI 2	840660.311	835032.705	-3.68	Vibrating Coring	-5.0	1.32	1	1	2	
	YTTE/MI 3	840778.673	835056.732	-4.30	Vibrating Coring	-4.5	0.20	1	1	2	
	YTTE/MI 4	840876.451	835073.372	-3.20	Vibrating Coring	-4.5	1.30	1	1	2	
	YTTE/MI 5	840975.945	835088.167	-3.40	Vibrating Coring	-4.5	1.10	1	1	2	
	YTTE/MI 6	841073.722	835104.807	-3.30	Vibrating Coring	-5.0	1.70	1	1	2	
	YTTE/MI 7	841164.639	835117.755	-4.30	Vibrating Coring	-5.0	0.70	1	1	2	
	YTTE/MI 8	840600.294	834942.253	-3.20	Vibrating Coring	-4.5	1.30	1	1	2	
	YTTE/MI 9	840706.651	834957.049	-4.00	Vibrating Coring	-5.0	1.00	1	1	2	
	YTTE/MI 10	840790.706	834973.683	-3.30	Vibrating Coring	-4.5	1.20	1	1	2	
	YTTE/MI 11	840890.200	834988.478	-3.20	Vibrating Coring	-4.5	1.30	1	1	2	
	YTTE/MI 12	840987.979	835005.118	-3.30	Vibrating Coring	-4.5	1.20	1	1	2	
	YTTE/MI 13	841094.335	835019.916	-3.90	Vibrating Coring	-5.0	1.10	1	1	2	
	YTTE/MI 14	841186.971	835023.636	-3.80	Vibrating Coring	-5.0	1.20	1	1	2	
	YTTE/MI 15	840614.043	834853.668	-3.60	Vibrating Coring	-5.0	1.40	1	1	2	
	YTTE/MI 16	840691.237	834868.455	-4.00	Vibrating Coring	-5.0	1.00	1	1	2	
	YTTE/MI 17	840804.456	834885.098	-3.60	Vibrating Coring	-4.5	0.90	1	1	2	
	YTTE/MI 18	840902.235	834899.892	-3.14	Vibrating Coring	-4.5	1.36	1	1	2	
	YTTE/MI 19	841003.445	834916.533	-3.60	Vibrating Coring	-4.5	0.90	1	1	2	
	YTTE/MI 20	841101.225	834931.329	-3.90	Vibrating Coring	-5.0	1.10	1	1	2	
	YTTE/MI 21	841192.142	834946.122	-3.75	Vibrating Coring	-5.0	1.25	1	1	2	

Appendix C1 Coordinate, Type, Dredging Depth, Sampling Depth and Number of Sub-samples for Each Sediment Sampling Location

Dredging Area	ID	Coordinate		Existing Water Depth (m)	Sampling Type	Required minimum Seabed Level (mCD)	Dredged Sediment Thickness (m)	Sub-sample Depth (m)		Number of Sub-Samples	Total Number of Samples
		X	Y					0 - 0.9	1.0 - 2.0		
Shuen Wan Typhoon Shelter	SWTS/MI 1	839665.279	835237.316	-0.82	Grab Sample	Outside dredging area	NA	1	-	1	18
	SWTS/MI 2	839721.907	835157.968	-4.44	Grab Sample	-5.0	0.56	1	-	1	
	SWTS/MI 3	839778.537	835073.083	-5.00	Grab Sample	-5.0	0.00	1	-	1	
	SWTS/MI 4	839836.883	834991.889	-5.32	Grab Sample	-5.0	0.00	1	-	1	
	SWTS/MI 5	839874.646	834895.927	-4.40	Grab Sample	-5.0	0.60	1	-	1	
	SWTS/MI 6	839915.834	834831.340	-0.20	Grab Sample	Outside dredging area	NA	1	-	1	
	SWTS/MI 7	839771.632	835261.333	-0.15	Grab Sample	-0.15	0.00	1	-	1	
	SWTS/MI 8	839819.682	835189.365	-4.53	Grab Sample	-5.0	0.47	1	-	1	
	SWTS/MI 9	839878.027	835108.172	-5.10	Grab Sample	-5.0	0.00	1	-	1	
	SWTS/MI 10	839934.658	835025.133	-5.30	Grab Sample	Outside dredging area	NA	1	-	1	
	SWTS/MI 11	839956.977	834953.160	-2.43	Grab Sample	-3.0	0.57	1	-	1	
	SWTS/MI 12	839883.135	835274.278	-0.20	Grab Sample	Outside dredging area	NA	1	-	1	
	SWTS/MI 13	839939.765	835193.085	-3.10	Grab Sample	-4.0	0.90	1	-	1	
	SWTS/MI 14	839996.395	835110.046	-2.47	Grab Sample	-2.47	0.00	1	-	1	
	SWTS/MI 15	840035.875	835015.930	-0.97	Grab Sample	-1.0	0.03	1	-	1	
	SWTS/MI 16	839998.078	835246.621	-0.02	Grab Sample	Outside dredging area	NA	1	-	1	
	SWTS/MI 17	840028.979	835152.503	-0.23	Grab Sample	Outside dredging area	NA	1	-	1	
	SWTS/MI 18	840070.175	835054.696	-0.43	Grab Sample	Outside dredging area	NA	1	-	1	
Reference Sample (Ngau Mei Hoi)		820057.690	850234.274	-	Grab Sample	Outside dredging area	NA	1	-	1	1

APPENDIX C2
SEDIMENT CHEMICAL SCREENING RESULTS

Appendix C2: Sediment Chemical Screening Results

Dredging Site	Stations	Sample Depth	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg	Hg mg/kg	PCBs µg/kg	LPAH µg/kg	HPAHs µg/kg	TBT µg/L	Overall Category	Disposal Option
		LCEL	12	1.5	80	65	40	75	200	1	0.5	23	550	1700	0.15		
		UCEL	42	4	160	110	40	110	270	2	1	180	3160	9600	0.15		
Yim Tin Tsai FCZ	YTT/MI 1	0.0-0.9m	6.5	0.28	16	9.6	9.5	62	96	0.1	**1.7**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 1	1.0-2.0m	7.6	0.24	19	9.6	12	69	120	0.2	**3.9**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 2	0.0-0.9m	8.9	0.27	18	9.4	11	60	100	<0.1	0.54	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTT/MI 2	1.0-2.0m	8.8	0.26	17	8.8	10	59	99	<0.1	**1.5**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 3	0.0-0.9m	6.7	0.24	17	9.4	10	60	99	<0.1	0.07	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 3	1.0-2.0m	3.8	0.27	18	7.4	11	52	100	<0.1	0.34	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 4	0.0-0.9m	5.2	0.19	7.6	9.7	4.2	25	60	<0.1	0.92	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTT/MI 5	0.0-0.9m	3.1	0.08	2.5	12	1.4	6	47	<0.1	0.16	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 6	0.0-0.9m	7.9	0.27	17	9.5	11	58	97	<0.1	0.07	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 6	1.0-2.0m	5.2	0.29	21	7.7	13	60	120	<0.1	0.41	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 7	0.0-0.9m	9.2	0.1	16	10	9.8	66	93	<0.1	<0.05	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 7	1.0-2.0m	8.8	0.11	19	9.3	12	68	110	<0.1	0.1	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 8	0.0-0.9m	6.4	0.34	19	11	12	55	110	<0.1	0.51	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTT/MI 8	1.0-2.0m	5.7	0.31	21	9.8	13	58	120	<0.1	<0.05	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 9	0.0-0.9m	8.3	0.28	17	9.7	10	59	98	<0.1	0.91	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTT/MI 9	1.0-2.0m	7.2	0.28	22	8.1	14	59	120	<0.1	<0.05	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 10	0.0-0.9m	10	0.3	15	15	8.2	80	130	<0.1	<0.05	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTT/MI 10	1.0-2.0m	9.8	0.24	17	10	10	64	96	<0.1	0.13	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 11	0.0-0.9m	6.7	0.26	18	11	10	64	98	<0.1	**1.3**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 11	1.0-2.0m	8.1	0.27	17	9.8	10	60	92	<0.1	**1.3**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 12	0.0-0.9m	5.9	0.22	19	9.1	12	58	103	<0.1	**1.1**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 12	1.0-2.0m	7.2	0.27	20	9	12	70	120	<0.1	**3.1**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 13	0.0-0.9m	9.2	0.26	18	10	11	63	100	<0.1	0.13	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 13	1.0-2.0m	7.8	0.23	19	8	11	58	100	<0.1	**5.1**#	<3.0	<55	<170	<0.015	H	Type 3 - Special Treatment Disposal
	YTT/MI 14	0.0-0.9m	9.5	0.15	16	11	9.1	83	130	<0.1	0.15	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTT/MI 14	1.0-2.0m	8.9	0.15	16	13	9	85	130	<0.1	0.22	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTT/MI 15	0.0-0.9m	9.7	0.13	15	9.4	8.8	66	100	<0.1	0.16	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 15	1.0-2.0m	11	0.21	17	11	9.1	**120**	210	<0.1	0.19	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 16	0.0-0.9m	8.2	0.27	20	8.7	13	62	110	<0.1	**3.3**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 16	1.0-2.0m	7	0.22	22	8.8	13	59	120	<0.1	0.17	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 17	0.0-0.9m	7.5	0.3	14	14	7.6	100	180	<0.1	**4.1**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 17	1.0-2.0m	8.9	0.31	17	11	9.1	99	180	<0.1	0.99	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTT/MI 18	0.0-0.9m	10	<0.05	16	10	9.2	67	100	<0.1	<0.05	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 18	1.0-2.0m	7.7	0.06	20	8.6	12	59	110	<0.1	<0.05	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 19	0.0-0.9m	5.4	0.17	9.6	11	4.6	63	150	<0.1	0.33	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 19	1.0-2.0m	4.5	0.18	18	8.6	11	53	120	<0.1	0.28	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTT/MI 20	0.0-0.9m	10	0.34	15	17	5.9	58	120	<0.1	**1.4**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTT/MI 20	1.0-2.0m	8.7	0.27	15	12	7.6	98	160	<0.1	**1.1**	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal

Appendix C2: Sediment Chemical Screening Results

Dredging Site	Stations	Sample Depth	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg	Hg mg/kg	PCBs µg/kg	LPAH µg/kg	HPAHs µg/kg	TBT µg/L	Overall Category	Disposal Option
		LCEL	12	1.5	80	65	40	75	200	1	0.5	23	550	1700	0.15		
		UCEL	42	4	160	110	40	110	270	2	1	180	3160	9600	0.15		
Yim Tin Tsai (East) FCZ	YTTE/MI 1	0.0-0.9m	3.4	0.19	21	9.8	14	31	96	<0.1	0.41	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 1	1.0-2.0m	3.9	0.25	20	13	13	33	96	<0.1	0.21	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 2	0.0-0.9m	5.6	0.52	21	32	14	31	73	<0.1	0.75	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 2	1.0-2.0m	3.9	0.6	22	8.9	15	34	82	<0.1	0.94	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 3	0.0-0.9m	5.2	0.26	15	20	11	37	96	<0.1	0.88	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 3	1.0-2.0m	3.1	0.11	22	7.3	15	32	73	<0.1	0.43	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 4	0.0-0.9m	4	0.24	20	9.4	13	32	76	<0.1	0.4	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 4	1.0-2.0m	5	0.08	22	8.5	13	40	65	<0.1	0.3	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 5	0.0-0.9m	3.5	0.15	22	7.8	15	26	80	<0.1	0.53	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 5	1.0-2.0m	1.9	0.39	25	8.1	17	29	79	<0.1	0.94	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 6	0.0-0.9m	2.2	0.24	24	7.4	16	29	74	<0.1	0.26	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 6	1.0-2.0m	1.9	0.22	25	7.3	16	32	77	<0.1	<0.05	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 7	0.0-0.9m	7.1	0.08	24	24	8.9	93	190	<0.1	0.62	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 7	1.0-2.0m	2.6	0.2	29	8.3	19	37	90	<0.1	0.3	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 8	0.0-0.9m	4.7	0.25	18	14	12	33	79	<0.1	0.99	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 8	1.0-2.0m	2.8	0.16	24	8.7	16	32	86	<0.1	0.3	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 9	0.0-0.9m	5.8	0.16	21	9.4	13	41	71	<0.1	0.82	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 9	1.0-2.0m	3.2	0.15	24	7.4	16	32	77	<0.1	0.39	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 10	0.0-0.9m	6.1	0.24	17	7	11	29	57	<0.1	0.18	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 10	1.0-2.0m	5.8	0.2	21	7.2	14	33	70	<0.1	0.13	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 11	0.0-0.9m	2.8	0.12	23	8.7	16	30	77	<0.1	0.29	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 11	1.0-2.0m	4	0.17	24	12	16	42	85	<0.1	0.58	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 12	0.0-0.9m	3.4	0.42	25	7.8	17	33	82	0.1	0.28	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 12	1.0-2.0m	9.2	0.3	14	13	8.7	32	49	0.2	0.18	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 13	0.0-0.9m	3.7	0.28	23	8.9	16	30	76	<0.1	0.86	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 13	1.0-2.0m	4.1	0.17	24	10	17	34	80	<0.1	0.43	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 14	0.0-0.9m	6.4	0.14	21	9.5	13	56	73	<0.1	0.26	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 14	1.0-2.0m	9.2	<0.05	16	21	7.5	**140**	210	<0.1	0.19	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	YTTE/MI 15	0.0-0.9m	4.3	0.22	19	11	12	36	81	<0.1	0.53	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 15	1.0-2.0m	3.6	0.15	23	8.3	16	32	75	<0.1	0.76	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 16	0.0-0.9m	4.2	0.19	21	10	13	36	76	<0.1	0.32	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 16	1.0-2.0m	2.4	0.13	24	8	16	31	77	<0.1	0.22	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 17	0.0-0.9m	4.8	0.14	23	9.4	14	48	76	<0.1	0.79	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 17	1.0-2.0m	5	0.14	20	7.6	13	34	64	<0.1	0.61	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	YTTE/MI 18	0.0-0.9m	5.8	0.19	20	7.8	12	39	60	<0.1	0.55	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	YTTE/MI 18	1.0-2.0m	5.9	0.19	21	8.2	12	40	62	0.1	0.15	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 19	0.0-0.9m	2.9	0.12	23	7.3	15	33	76	0.1	0.43	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 19	1.0-2.0m	3.7	0.18	24	8.7	16	33	77	<0.1	0.39	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 20	0.0-0.9m	5.8	0.19	19	10	13	42	70	<0.1	0.48	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 20	1.0-2.0m	7.4	0.12	20	8.3	13	38	62	<0.1	0.4	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 21	0.0-0.9m	5.8	0.12	19	9.7	11	52	73	<0.1	0.18	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	YTTE/MI 21	1.0-2.0m	6.5	0.14	18	10	10	54	80	<0.1	0.34	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal

Appendix C2: Sediment Chemical Screening Results

Dredging Site	Stations	Sample Depth	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg	Hg mg/kg	PCBs µg/kg	LPAH µg/kg	HPAHs µg/kg	TBT µg/L	Overall Category	Disposal Option
		LCEL	12	1.5	80	65	40	75	200	1	0.5	23	550	1700	0.15		
		UCEL	42	4	160	110	40	110	270	2	1	180	3160	9600	0.15		
Shuen Wan Typhoon Shelter	SWTS/MI 1	0.0-0.9m	4.3	0.04	5.7	20	2.5	21	76	<0.1	0.21	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	SWTS/MI 2	0.0-0.9m	5.4	0.86	9.5	95	5.5	44	210	<0.1	0.78	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 3	0.0-0.9m	8	0.65	15	96	9.1	60	140	<0.1	0.45	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 4	0.0-0.9m	5.6	**4.3**	11	80	5.3	46	240	<0.1	0.84	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	SWTS/MI 5	0.0-0.9m	6	0.13	7.8	51	4.1	52	130	<0.1	0.3	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	SWTS/MI 6	0.0-0.9m	3.9	0.02	2.6	34	1.3	11	37	<0.1	0.6	<3.0	<55	<170	<0.015	M	Type 2 - Confine Marine Disposal
	SWTS/MI 7	0.0-0.9m	6	0.17	8.6	59	3.9	35	130	<0.1	0.33	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	SWTS/MI 8	0.0-0.9m	5.9	0.78	14	96	8.2	67	130	<0.1	0.9	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 9	0.0-0.9m	6.7	0.29	12	67	6.7	52	140	<0.1	0.58	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 10	0.0-0.9m	5.2	0.67	12	76	5.6	48	190	<0.1	0.31	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 11	0.0-0.9m	4.9	0.04	3.3	51	1.6	14	42	<0.1	0.51	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 12	0.0-0.9m	5.3	0.28	8	79	4.5	31	110	<0.1	0.6	<3.0	<55	<170	<0.015	M	Type 1 - Open Sea Disposal (Dedicated Sites)
	SWTS/MI 13	0.0-0.9m	6.2	0.42	13	**120**	9	54	170	<0.1	0.32	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	SWTS/MI 14	0.0-0.9m	9.7	0.16	8	51	4.3	28	150	<0.1	0.46	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	SWTS/MI 15	0.0-0.9m	4.7	0.11	6.9	52	2.9	25	98	<0.1	0.41	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	SWTS/MI 16	0.0-0.9m	5.9	0.12	6.7	39	3	40	100	<0.1	0.29	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
	SWTS/MI 17	0.0-0.9m	4.8	0.56	11	**140**	4.7	47	230	<0.1	0.56	<3.0	<55	<170	<0.015	H	Type 2 - Confine Marine Disposal
	SWTS/MI 18	0.0-0.9m	2	0.04	6.1	25	2.3	15	52	<0.1	0.22	<3.0	<55	<170	<0.015	L	Type 1 - Open Sea Disposal
Reference Sample (Ngau Mei Hoi)		0.0-0.9m	2.1	0.05	17	8.8	13	26	57	<0.1	0.35	<3.0	<55	<170	<0.015	L	N/A

Note:

Shaded value: contaminant concentration exceed LCEL but less than UCEL

Shaded and bold value: contaminant concentration exceed UCEL but less than 10 times of LCEL

Contaminant concentration exceed 10 times of LCEL (10x LCEL)

LPAH: Low Molecular Weight PAH

HPAH: High Molecular Weight PAH

APPENDIX C3
SEDIMENT CHEMISTRY EXCEEDANCE SUMMARY AND BIOLOGICAL SCREENING RESULTS

Appendix C3 – Sediment Chemistry Exceedance Summary and Biological Screening Results

Table C3.1 Sediment Chemistry Results Showing Exceedances

	Stations	Sample Depth	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg	Hg mg/kg	PCBs µg/kg	LPAH µg/kg	HPAHs µg/kg	TBT µg/L	Category	Disposal Option
		LCEL	12	1.5	80	65	40	75	200	1	0.5	23	550	1700	0.15	-	-
		UCEL	42	4	160	110	40	110	270	2	1	180	3160	9600	0.15	-	-
Yim Tin Tsai FCZ	YTT/MI 1	0.0-0.9m	6.5	0.28	16	9.6	9.5	62	96	0.1	**1.7**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 1	1.0-2.0m	7.6	0.24	19	9.6	12	69	120	0.2	**3.9**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 2	0.0-0.9m	8.9	0.27	18	9.4	11	60	100	<0.1	0.54	<3.0	<55	<170	<0.015	M	**
	YTT/MI 2	1.0-2.0m	8.8	0.26	17	8.8	10	59	99	<0.1	**1.5**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 4	0.0-0.9m	5.2	0.19	7.6	9.7	4.2	25	60	<0.1	0.92	<3.0	<55	<170	<0.015	M	**
	YTT/MI 8	0.0-0.9m	6.4	0.34	19	11	12	55	110	<0.1	0.51	<3.0	<55	<170	<0.015	M	**
	YTT/MI 9	0.0-0.9m	8.3	0.28	17	9.7	10	59	98	<0.1	0.91	<3.0	<55	<170	<0.015	M	**
	YTT/MI 10	0.0-0.9m	10	0.30	15	15	8.2	80	130	<0.1	<0.05	<3.0	<55	<170	<0.015	M	**
	YTT/MI 11	0.0-0.9m	6.7	0.26	18	11	10	64	98	<0.1	**1.3**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 11	1.0-2.0m	8.1	0.27	17	9.8	10	60	92	<0.1	**1.3**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 12	0.0-0.9m	5.9	0.22	19	9.1	12	58	103	<0.1	**1.1**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 12	1.0-2.0m	7.2	0.27	20	9.0	12	70	120	<0.1	**3.1**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 13	1.0-2.0m	7.8	0.23	19	8.0	11	58	100	<0.1	**5.1**#	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 14	0.0-0.9m	9.5	0.15	16	11	9.1	83	130	<0.1	0.15	<3.0	<55	<170	<0.015	M	**
	YTT/MI 14	1.0-2.0m	8.9	0.15	16	13	9.0	85	130	<0.1	0.22	<3.0	<55	<170	<0.015	M	**
	YTT/MI 15	1.0-2.0m	11	0.21	17	11	9.1	**120**	210	<0.1	0.19	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 16	0.0-0.9m	8.2	0.27	20	8.7	13	62	110	<0.1	**3.3**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 17	0.0-0.9m	7.5	0.30	14	14	7.6	100	180	<0.1	**4.1**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 17	1.0-2.0m	8.9	0.31	17	11	9.1	99	180	<0.1	0.99	<3.0	<55	<170	<0.015	M	**
	YTT/MI 20	0.0-0.9m	10	0.34	15	17	5.9	58	120	<0.1	**1.4**	<3.0	<55	<170	<0.015	H	Type 2
	YTT/MI 20	1.0-2.0m	8.7	0.27	15	12	7.6	98	160	<0.1	**1.1**	<3.0	<55	<170	<0.015	H	Type 2
Yim Tin Tsai East FCZ	YTTE/MI 2	0.0-0.9m	5.6	0.52	21	32	14	31	73	<0.1	0.75	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 2	1.0-2.0m	3.9	0.60	22	8.9	15	34	82	<0.1	0.94	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 3	0.0-0.9m	5.2	0.26	15	20	11	37	96	<0.1	0.88	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 5	0.0-0.9m	3.5	0.15	22	7.8	15	26	80	<0.1	0.53	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 5	1.0-2.0m	1.9	0.39	25	8.1	17	29	79	<0.1	0.94	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 7	0.0-0.9m	7.1	0.08	24	24	8.9	93	190	<0.1	0.62	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 8	0.0-0.9m	4.7	0.25	18	14	12	33	79	<0.1	0.99	<3.0	<55	<170	<0.015	M	**

Appendix C3 – Sediment Chemistry Exceedance Summary and Biological Screening Results

	Stations	Sample Depth	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg	Hg mg/kg	PCBs µg/kg	LPAH µg/kg	HPAHs µg/kg	TBT µg/L	Category	Disposal Option
		LCEL	12	1.5	80	65	40	75	200	1	0.5	23	550	1700	0.15	-	-
		UCEL	42	4	160	110	40	110	270	2	1	180	3160	9600	0.15	-	-
	YTTE/MI 9	0.0-0.9m	5.8	0.16	21	9.4	13	41	71	<0.1	0.82	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 11	1.0-2.0m	4.0	0.17	24	12	16	42	85	<0.1	0.58	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 13	0.0-0.9m	3.7	0.28	23	8.9	16	30	76	<0.1	0.86	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 14	1.0-2.0m	9.2	<0.05	16	21	7.5	**140**	210	<0.1	0.19	<3.0	<55	<170	<0.015	H	Type 2
	YTTE/MI 15	0.0-0.9m	4.3	0.22	19	11	12	36	81	<0.1	0.53	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 15	1.0-2.0m	3.6	0.15	23	8.3	16	32	75	<0.1	0.76	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 17	0.0-0.9m	4.8	0.14	23	9.4	14	48	76	<0.1	0.79	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 17	1.0-2.0m	5.0	0.14	20	7.6	13	34	64	<0.1	0.61	<3.0	<55	<170	<0.015	M	**
	YTTE/MI 18	0.0-0.9m	5.8	0.19	20	7.8	12	39	60	<0.1	0.55	<3.0	<55	<170	<0.015	M	**
Shuen Wan Typhoon Shelter	SWTS/MI 2	0.0-0.9m	5.4	0.86	9.5	95	5.5	44	210	<0.1	0.78	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 3	0.0-0.9m	8.0	0.65	15	96	9.1	60	140	<0.1	0.45	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 4	0.0-0.9m	5.6	**4.30**	11	80	5.3	46	240	<0.1	0.84	<3.0	<55	<170	<0.015	H	Type 2
	SWTS/MI 6	0.0-0.9m	3.9	0.02	2.6	34	1.3	11	37	<0.1	0.60	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 8	0.0-0.9m	5.9	0.78	14	96	8.2	67	130	<0.1	0.90	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 9	0.0-0.9m	6.7	0.29	12	67	6.7	52	140	<0.1	0.58	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 10	0.0-0.9m	5.2	0.67	12	76	5.6	48	190	<0.1	0.31	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 11	0.0-0.9m	4.9	0.04	3.3	51	1.6	14	42	<0.1	0.51	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 12	0.0-0.9m	5.3	0.28	8.0	79	4.5	31	110	<0.1	0.60	<3.0	<55	<170	<0.015	M	**
	SWTS/MI 13	0.0-0.9m	6.2	0.42	13	**120**	9.0	54	170	<0.1	0.32	<3.0	<55	<170	<0.015	H	Type 2
	SWTS/MI 17	0.0-0.9m	4.8	0.56	11	**140**	4.7	47	230	<0.1	0.56	<3.0	<55	<170	<0.015	H	Type 2

Note:

Shaded value: contaminant concentration exceed LCEL but less than UCEL

Shaded and bold value: contaminant concentration exceed UCEL but less than 10 times of LCEL

[#] Contaminant concentration exceed 10 times of LCEL (10x LCEL)

***: To be determined upon completion of biological screening

LPAH: Low Molecular Weight PAH

HPAH: High Molecular Weight PAH

Table C3.2 Results of Biological Screening of Category M or Category H (10 X LCEL) Samples

Dredging Area	Sampling Stations	Sampling Depth	Amphipod Test	Polychaete Test	Bivalve Test	Result of Biological Screening
Yim Tin Tsai FCZ	YTT/MI 2	0.0-0.9m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	YTT/MI 4	0.0-0.9m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	Composite from YTT/MI 8 to YTT/MI 10	0.0-0.9m	X	√	√	Type 2 – Confined Marine Disposal
	YTT/MI 13 (dilution test)	1.0-2.0m	X	√	√	Type 3 – Special Treatment / Disposal
	Depth composite from YTT/MI 14	0.0-2.0m	X	√	√	Type 2 – Confined Marine Disposal
	YTT/MI 17	1.0-2.0m	X	√	√	Type 2 – Confined Marine Disposal
Yim Tin Tsai East FCZ	Depth composite from YTTE/MI 2	0.0-2.0m	X	√	√	Type 2 – Confined Marine Disposal
	YTTE/MI 3	0.0-0.9m	X	√	X	Type 2 – Confined Marine Disposal
	Depth composite from YTTE/MI 5	0.0-2.0m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	YTTE/MI 7	0.0-0.9m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	Composite from YTTE/MI 8 & YTTE/MI 9	0.0-0.9m	√	X	√	Type 2 – Confined Marine Disposal
	YTTE/MI 11	1.0-2.0m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	YTTE/MI 13	0.0-0.9m	X	√	√	Type 2 – Confined Marine Disposal
	Depth composite from YTTE/MI 15	0.0-2.0m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	Depth composite from YTTE/MI 17	0.0-2.0m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	YTTE/MI 18	0.0-0.9m	X	√	X	Type 2 – Confined Marine Disposal
Shuen Wan Typhoon Shelter	Composite from SWTS/MI 2 & SWTS/MI 3	0.0-0.9m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	SWTS/MI 6	0.0-0.9m	√	X	X	Type 2 – Confined Marine Disposal
	Composite from SWTS/MI 8 to SWTS/MI 11	0.0-0.9m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)
	SWTS/MI 12	0.0-0.9m	√	√	√	Type 1 – Open Sea Disposal (Dedicated Sites)

Notes:
√ = pass biological test
X = fail biological test

APPENDIX C4
ENVIRONMENT, TRANSPORT AND WORKS BUREAU TECHNICAL CIRCULAR (WORKS) (ETWB TCW) NO. 34/2002 – MANAGENMENT OF DREDGED / EXCAVED SEDIMENT

Ref. : ETWB(W) 209/32/96

Group : 5, 12

15 August 2002

Environment, Transport and Works Bureau
Technical Circular (Works) No. 34/2002

Management of Dredged/Excavated Sediment

Scope

This Circular sets out the procedure for seeking approval to dredge/excavate sediment and the management framework for marine disposal of such sediment.

2. The Secretary for Economic Development and Labour, the Director of Environmental Protection (DEP), the Director of Housing and the Director of Home Affairs have agreed to the content of this Circular.

Effective Date

3. With respect to seeking approval to dredge/excavate sediment, this Circular applies with immediate effect to all projects or portions of projects which involve the marine disposal of dredged/excavated sediment, for which mud dredging/excavation proposals have not already been agreed by the Marine Fill Committee (MFC).

Effect on Existing Circulars

4. This Circular should be read in conjunction with WBTC No. 12/2000 "Fill Management".

5. WBTC No. 22/92 and 3/2000 become obsolete with immediate effect. For dredged/excavated sediment disposal proposals previously approved in accordance with WBTC No. 22/92 or 3/2000, re-testing of sediment in accordance with this Circular will be required for projects if the time lapse between commencement of sampling and commencement of construction works is more than 3 years, unless the re-testing requirement is waived by DEP.

Introduction

6. In 1996, Contracting Parties to the London Convention 1972 agreed to adopt a new protocol for the assessment of waste and other matter that may be considered for marine dumping, including dredged material. The protocol sets out generic guidelines for considering waste management options, waste characterization, dump site selection, assessment of potential effects of disposal options, permit issue and monitoring. A new framework based on the protocol was developed for Hong Kong and this was introduced in WBTC No. 3/2000. It has since been reviewed further and the details are set out in this Circular.

7. This Circular covers the approval of dredging/excavation proposals and marine disposal of dredged/excavated sediment. It does not cover the use of dredged/excavated sediment to form land but the carrying out of such dredging and reclamation works must satisfy the requirements of the Environmental Impact Assessment Ordinance. This Circular shall be brought to the attention of all consultants engaged in Government and quasi-Government projects which involve the dredging/excavation and marine disposal of sediment. Applications for approval of dredging/excavation proposals and allocation of marine disposal space shall be made to the Secretary of MFC.

Rationale for Dredging

8. The allocation of sediment disposal space at sea <u>will not be considered</u> until the need for removal of the sediment has first been satisfactorily demonstrated. The rationale for sediment removal must therefore be provided to the Secretary of MFC for agreement, as early as possible, preferably at the Environmental Impact Assessment Stage, if one is conducted. Volumes of Category L sediment (see Appendix A) below 50,000 m^3 are exempted from this requirement.

9. Dredging of sediment will be allowed without justification in the following cases:

(a) emergency dredging for safety reasons or averting environmental hazards;

(b) maintenance/deepening of the harbour fairways, berths, anchorages, navigation channels or approaches; and

(c) maintenance (but not construction) of watercourses, rivers, stream courses, drainage channels or outfalls.

10. In all other cases, project proponents shall plan their projects on the assumption of keeping the mud in place. Time for consolidation of mud, with treatment if necessary, and consequential programme constraints shall be allowed for in programming. Additional time required for consolidation of mud left in place will not be accepted as justification for mud dredging. MFC will scrutinise applications for exemption taking into account factors including the practicality of performance specifications, completeness of risk management strategies, and comprehensiveness of option assessments including consideration of new technology. Where cost is considered, the estimation must include a fair and complete estimate of all cost components, including the actual cost of mud disposal (obtainable from MFC Secretariat) and necessary dredging and transportation, disposal management, monitoring and other associated activities.

Classification of Sediment

11. DEP, as the Authority under the Dumping at Sea Ordinance Cap. 466 (DASO), will classify sediments based on their contaminant levels with reference to the Chemical Exceedance Levels (CEL) laid down in Appendix A.

Determination of Sediment Quality

12. Guidelines on the initial data assessment, the sampling and testing procedures, the biological test criteria, and the submission requirements are set out in Appendix B. DEP may waive the sediment sampling and testing requirements in cases of:

(a) emergency dredging for reasons of safety or averting environmental hazards; and

(b) for small scale dredging works of maintenance nature and involving dredging volumes of less than 5,000 m^3 in situ.

Previously obtained data or known history of the sediment in the vicinity should be submitted to DEP for consideration of the most appropriate arrangements for handling these materials.

13. Upon agreement of the rationale for sediment removal by the Secretary of MFC, the project proponent (government department or office) or its consultant shall, in consultation with DEP, assess whether the existing data can conclusively demonstrate that the sediment[1] is suitable for open sea disposal. If no such conclusion can be drawn, the project proponent must submit proposals for sampling and chemical testing of the sediment to DEP for approval. The proposals shall be copied to the Secretary of MFC, together with details of the anticipated disposal requirements.

14. Upon completion of the sampling and chemical testing, the project proponent shall submit a Preliminary Sediment Quality Report (PSQR) to DEP with a copy to the Secretary of MFC. This report shall include the sampling details, the chemical testing results, quality control records, proposed classification and delineation of sediment according to Appendix A, and the information and/or records as specified by DEP in his approval of sediment sampling and testing plan.

15. If Category M sediment and/or certain Category H sediment are found in the sediment, the project proponent will be required to carry out a biological screening in accordance with Section 3 of Appendix B, and submit a formal Sediment Quality Report (SQR) to DEP for approval. This must be done at least 3 months prior to the dredging contract being tendered or at least 2 months prior to the works order for maintenance dredging being issued. In cases where biological screening is not required, subject to the approval of DEP, the PSQR will be deemed to be the formal SQR.

16. At the time of approval of the SQR, DEP will specify the period beyond which the reliability of the SQR data must be reviewed. This period starts on the actual date of commencement of sampling and will be not less than three years. The project proponent shall obtain DEP's prior agreement to the review methodology and sampling locations.

[1] "The sediment" in paragraph 13 and subsequent paragraphs refers to the dredged/excavated sediment for disposal under a project/contract as proposed by the project proponent.

Depending on the review finding, further sampling and testing to update the data of the SQR may be required.

17. The project proponent must schedule the preparation of the SQR or its subsequent review in such a way that the SQR will still be reliable for a reasonable period of time after the award of the contract, to allow the contractor to apply for a dumping permit. The project proponent should also include a particular specification clause in the contract to draw the contractor's attention to the requirement that the SQR must still be reliable at the time of applying for a dumping permit under the DASO. The clause should also state the expiry date of the reliability period of the current SQR and that it is the contractor's responsibility for carrying out, at his own expense, any work required to extend the reliability period of the SQR should he fail to apply for a dumping permit before the expiry date.

Allocation of Sediment Disposal Site

18. MFC will determine the most appropriate open sea or confined marine disposal site on the basis of the chemical and biological test results and formally allocate disposal space in accordance with the flow chart in Appendix C. For projects with disposal requirements of less than 50,000 m^3 Category L sediment, the allocation of disposal space has been delegated to DEP. The project proponent may request the Secretariat of MFC to *provisionally* indicate an appropriate marine disposal site or sites after the rationale for sediment removal has been agreed. An estimate of the volume and quality of sediment to be dredged, supported by available ground investigation and testing data, should be provided to the Secretary of MFC at the time of submission of the request. The contract document should include the disposal requirements from MFC & DEP, and relevant guidelines given under Notes (1) to (6) in Appendix C.

Application for Marine Dumping Permit

19. DEP controls dumping at sea by means of DASO permits which are issued to contractors or other parties responsible for the disposal of dredged/excavated sediment. The contractor who will be undertaking the works must make a formal application to DEP for a dumping permit, and if the permit is granted, it will be the contractor's responsibility to ensure that the permit conditions are met to DEP's satisfaction.

20. Any queries regarding this Circular or related issues should be directed to the MFC Secretariat (Tel. no.: 2762 5397) or the Waste and Water Management Group (WMG) of EPD (Tel. no.: 2835 1287).

(W S Chan)
Deputy Secretary for the Environment,
Transport and Works (Transport and Works) W2

Sediment Quality Criteria for the Classification of Sediment

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metals ***(mg/kg dry wt.)***		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni)*	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Metalloid ***(mg/kg dry wt.)***		
Arsenic (As)	12	42
Organic-PAHs ***(μg/kg dry wt.)***		
Low Molecular Weight PAHs	550	3160
High Molecular Weight PAHs	1700	9600
Organic-non-PAHs ***(μg/kg dry wt.)***		
Total PCBs	23	180
Organometallics ***(μg TBT/L in Interstitial water)***		
Tributyltin*	0.15	0.15

**** The contaminant level is considered to have exceeded the UCEL if it is greater than the value shown.***

The sediment is classified into 3 categories based on its contaminant levels :

Category L: Sediment with all contaminant levels not exceeding the Lower Chemical Exceedance Level (LCEL). The material must be dredged, transported and disposed of in a manner which minimizes the loss of contaminants either into solution or by resuspension.

Category M: Sediment with any one or more contaminant levels exceeding the Lower Chemical Exceedance Level (LCEL) and none exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.

Category H: Sediment with any one or more contaminant levels exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

Guidelines for Sediment Assessment

The purpose of these guidelines is to set out the requirements for assessing, sampling, testing and categorising the sediment. The sampling and testing procedures are critical to the accurate evaluation of the sediment contamination, and close supervision by the project proponent is therefore necessary. All project departments/offices, consultants, developers or contractors (hereinafter called the "project proponent") must comply with these requirements when notifying Director of Environmental Protection (DEP) and Marine Fill Committee (MFC) of an intention to dredge/excavate and dispose of the sediment.

The sampling and testing procedures and the subsequent submission of a Sediment Quality Report normally require 8 months to complete.

A list of accredited laboratories capable of carrying out biological testing stipulated under these guidelines is kept and updated by DEP.

1. TIER 1 - Review of Existing Information for Site Contamination Assessment

The purpose of Tier I screening is to review available information to determine whether the sediment belongs to Category L material suitable for open sea disposal. If the project proponent considers that there is insufficient information to arrive at such a conclusion, the project proponent may proceed directly to Tier II screening.

(a) Submission requirements

The project proponent shall submit a formal proposal to DEP and copy to the Secretary of MFC in the Civil Engineering Department. The proposal should contain the following information:

(i) project name;

(ii) plan showing detailed location and boundary of the dredging/excavation site;

(iii) estimated volume of dredged/excavated sediment requiring disposal;

(iv) timetable for dredging/excavation operation and the corresponding disposal space required;

(v) previous dredging/excavation history of the site;

(vi) previous use of the site; and

(vii) other available site specific information (e.g. sediment grain size, total organic carbon (TOC), geotechnical data and previous testing results).

(b) Necessity to proceed to Tier II - chemical screening

DEP will examine the submission and advise whether :

(i) the information is sufficient to conclude that the sediment is suitable for open sea disposal and the submission can be accepted as a formal Sediment Quality Report; or

(ii) Tier II - chemical screening is required.

2. TIER II - Chemical Screening

Tier II screening is designed to categorise the sediment based on its chemical contaminant levels, and to determine whether the sediment is suitable for open sea disposal without further testing.

(a) Submission requirements

The project proponent shall submit for approval a test proposal to DEP and copy to the Secretary of MFC. The proposal should contain the following information :

(i) project name;

(ii) plan showing detailed location and boundary of the dredging/excavation site;

(iii) estimated volume of dredged/excavated sediment requiring disposal;

(iv) the anticipated timetable for taking the sample, carrying out the tests, and producing the Sediment Quality Report for chemical & biological screening;

(v) a plan showing the area to be dredged, the locations to be sampled and their Hong Kong metric grid coordinates;

In general, the following sampling arrangement should be adopted:

Expected contamination level	**Recommended Sampling Arrangement**
Low	200 x 200 m grid, surface sample only
High	100 x 100 m grid, vertical profile of samples
Very high (e.g. near outfalls, or nullahs)	50 x 50 m grid, vertical profile of samples

When biological screening is anticipated, samples of reference sediment should also be taken. Reference sediment required for the test may be collected from reference sites in Hong Kong waters designated by DEP from time to time. Alternative reference sites may be used. However, these alternative sites should be outside the influence of previous disposal operations but close enough to reflect similar natural environmental characteristics (e.g. grain size and TOC) of potential disposal sites. The project proponent should furnish information on these alternative sites to show that their sediments are clean and are of similar natural characteristics to that of the disposal sites.

(vi) a schedule of the types of samples to be taken (e.g. grab samples, gravity coring, piston samples, vibrocores, etc.) with their locations and depths;

Where vertical profiles of samples are to be taken, samples should be continuous, and the top level of the sub-samples should be the seabed, 0.9m down, 1.9m down, 2.9m down, and then every 3m to the bottom of the dredged layers.

The size of samples collected should be adequate for this tier of chemical testing as well as the next tier of biological testing described in subsequent sections.

Parameters to be tested	**Sample size***
Metals and metalloid	0.5 litre
Organic	0.5 litre
Biological response	6 litres

* Quantity to be confirmed by testing laboratory. The quantity of reference sediment to be collected needs to be separately worked out for each case, especially if biological dilution tests are anticipated.

(vii) a schedule of tests to be carried out on the samples.

Unless otherwise specified, all samples shall be tested for all the contaminants (except Tributytin (TBT)) stated in Table 1 - Analytical Methodology at the end of this Appendix. Analysis for other contaminants, such as TBT, Dichloro-diphenyl-trichloroethane (DDT), other organo-chlorine compounds, and other hazardous chemicals which arise from specific industrial discharge or spillage, may also be required by DEP in areas where contamination by such compounds is suspected. The composite samples for biological testing should also be tested for moisture content, grain size (% <63μm), TOC and ammonia (as mgN/L) and salinity in porewater.

(b) Sampling and testing requirements

(i) Sampling practice and sample storage

All sampling bottles should be labelled with the station number, sample length, diameter and depth, sampling date and time, together with a full description of the sample.

The recommended types of sampling bottle and pretreatment methods are:

Parameters to be tested	**Sampling bottle**	**Pretreatment Procedure#**
Metals and metalloid	High density polyethylene bottles*	USEPA SW-846+ Chapter 3
Organic	Wide mouth Borosilicate glass bottles with Teflon lined lid	USEPA SW-846 Chapter 4
Biological response	Wide mouth Borosilicate glass bottles with Teflon lined lid or high density polyethylene bottles *	USEPA SW-846 Chapter 3 or Chapter 4 as appropriate.

* Heavy duty plastic bags may be used for the storage of sediment sample for testing metals, metalloid and biological response.

\# Other equivalent methods may be used subject to the approval of DEP.

\+ Test methods for evaluating solid waste: physical/chemical methods, SW-846, 3rd edition, United States Environmental Protection Agency.

The samples should be kept at 4°C in the dark and should not be frozen. All samples should be promptly analysed. If this is impractical, the recommended maximum holding time is:

Sample type	**Maximum holding time**
Chemical test	2 weeks
Biological test	8 weeks

(ii) Analytical methodologies for chemical screening

The analytical method used for detecting each contaminant should be in accordance with the methodology described in Table 1 - Analytical Methodology at the end of this Appendix.

(c) Quality assurance/quality control (QA/QC) requirements

All tests must be conducted by laboratories accredited by Hong Kong Laboratory Accreditation Scheme (HOKLAS) or, in case of overseas laboratories, by equivalent national accreditation for these tests.

(d) Necessity to proceed to Tier III - biological screening

There is no need to proceed to Tier III for Category L sediment. However, the project proponent must proceed to Tier III for further analysis of Category M and certain Category H sediment. For the latter, Tier III screening is only required if one or more contaminant levels exceed 10 times the Lower Chemical Exceedence Level (LCEL).

3. TIER III - Biological Screening

The purpose of Tier III screening is to identify the most appropriate disposal option for Category M and certain Category H sediments.

(a) Submission requirements

The project proponent shall submit for approval a test proposal to DEP and copy to the Secretary of MFC. The proposal should contain the following information :

(i) the number of biological tests;

(ii) the arrangement for preparing the composite samples; and

(iii) the test species and test conditions.

In general, all biological tests should be conducted on composite samples. Composite sample is prepared by mixing up to 5 samples of the same category (M or H) which are continuous in vertical or horizontal profile.

Sediment classified as Category M shall be subjected to the following three toxicity tests (to be considered as one set) on each composite sample:

a 10-day burrowing amphipod toxicity test ; and

a 20-day burrowing polychaete toxicity test; and

a 48-96 hour larvae (bivalve or echinoderm) toxicity test.

Sediment classified as Category H and with one or more contaminant levels exceeding 10 times LCEL shall also be subjected to the above three toxicity tests but in a diluted manner (dilution test). The samples shall be prepared prior to toxicity testing as follows:

Sediment characteristics	**Preparation method**
Category H sediment (> 10 x LCEL)	Sample to be mixed with 9 portions of reference sediment
Category M sediment or Category H sediment (> 10 x LCEL) suspected of ammonia contamination	Additional set of sample (after dilution for Cat. H sediment) to be purged# for ammonia removal (for amphipod test only).

\# If the ammonia concentration in the overlying water of the test system is ≥ 20 mg/L, purging of sediment is required. This is performed by replacing the overlying water at a rate of 6 volume replacements/24 h for 24 hours, and repeated once only if the ammonia level still exceeds 20 mg/L.

(b) Testing requirements

The test endpoints and decision criteria are summarized in Table 2 at the end of this Appendix. The sediment is deemed to have failed the biological test if it fails in any one of the three toxicity tests.

Only ecologically relevant species should be used for carrying out the biological screening tests. The species to be used for each type of test can be selected from the following:

Test Types	**Species**	**Reference Test Conditions***
10-day burrowing amphipod toxicity test	*Ampelisca abdita* *Leptocheirus plumulosus* *Eohaustorius estuarius*	U.S.EPA(1994)/PSEP(1995) U.S.EPA(1994) U.S.EPA(1994)/PSEP(1995)
20-day burrowing polychaete toxicity test	*Neanthes arenaceodentata*	PSEP(1995)
48-96 hour larvae (bivalve or echinoderm) toxicity test	Bivalve: *Mytilus* spp. *Crassostrea gigas* Echinoderm : *Dendraster excentricus* *Strongylocentrotus* spp.	 PSEP(1995) PSEP(1995) PSEP(1995) PSEP(1995)

*U.S.EPA (U.S. Environmental Protection Agency) 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. Office of Research and Development. U.S. Environmental Protection Agency, Cincinnati, OH. EPA/600/R94/025.

PSEP (Puget Sound Estuary Program) 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments.

(c) Quality assurance/quality control (QA/QC) requirements

All biological tests must be conducted by laboratories with appropriate accreditation.

The biological test shall include appropriate quality assurance/quality control such as:

(i) Negative Control

(ii) Positive Control

4. Reporting Requirement after Completion of Chemical & Biological Screening

Submission requirements

Upon completion of each stage of screening (chemical and biological), the project proponent shall submit to DEP and copy to the Secretary of MFC a report on the results covering all tests conducted so far. The report should include the following information where appropriate:

(i) plans showing the delineation of each of the 3 categories of dredged/excavated material and the corresponding types of disposal required based on the chemical and biological screening results, and

(ii) the following information :

- Name and location of the testing laboratory
- Location of samples and source of reference sediments, method of collection, handling, preservation and storage, dates and times of sample collection and receipt at the testing laboratory

(For chemical screening)

- Dates of analysis
- Analytical methods and detection limits
- Tabulated sample results with units, including reporting basis (e.g., wet, dry, TOC normalized)
- QA/QC results
- Explanations for all departures from the standard protocols and discussion of possible effects on the data

(For biological screening)

- Test species information such as the source, size, history and age of test organisms
- Source of control seawater and control sediment used, including any pretreatment
- Preparation procedures for test sediment sample and test organisms
- Test conditions for each test including any deviation from standard procedures and discussion of possible effects on the data
- Water quality measurement during testing
- QA/QC results
- Effect measurements, end point results and their statistical significance

Table 1 - Analytical Methodology

Parameters	Preparation Method *US EPA Method*	Determination Method *US EPA Method*	Reporting Limit
Metals ***(mg/kg dry wt.)***			
Cadmium (Cd)	3050B	6020A or 7000A or 7131A	0.2
Chromium (Cr)	3050B	6010C or 7000A or 7190	8
Copper (Cu)	3050B	6010C or 7000A or 7210	7
Mercury (Hg)	7471A	7471A	0.05
Nickel (Ni)	3050B	6010C or 7000A or 7520	4
Lead (Pb)	3050B	6010C or 7000A or 7420	8
Silver (Ag)	3050B	6020A or 7000A or 7761	0.1
Zinc (Zn)	3050B	6010C or 7000A or 7950	20
Metalloid ***(mg/kg dry wt.)***			
Arsenic (As)	3050B	6020A or 7000A or 7061A	1
Organic-PAHs ***(µg/kg dry wt.)***			
Low Molecular Weight PAHs+	3550B or 3540C and 3630C	8260B or 8270C	55
High Molecular Weight PAHs++	3550B or 3540C and 3630C	8260B or 8270C	170
Organic-non-PAHs ***(µg/kg dry wt.)***			
Total PCBs+++	3550B or 3540C and 3665A	8082	3
Organometallics ***(µg TBT/L in interstitial water)***			
Tributyltin	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**	0.015

Footnotes: (i) The reporting limits shown in this table are the most stringent limits which will be specified by DEP. Project proponents should consult DEP on the required limits in the preparation of proposals for sampling and chemical testing of the sediment.

(ii) Other equivalent methods may be used subject to the approval of DEP.

+ Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene

++ High molecular weight PAHs include benzo[a]anthracene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, fluoranthene, pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene and benzo[g,h,i]perylene

+++ The reporting limit is for individual PCB congeners. Total PCBs include 2,4' diCB, 2,2',5 triCB, 2,4,4' triCB, 2,2',3,5' tetraCB, 2,2',5,5' tetraCB, 2,3',4,4' tetraCB, 3,3',4,4' tetraCB, 2,2',4,5,5' pentaCB, 2,3,3',4,4' pentaCB, 2,3',4,4',5 pentaCB, 3,3',4,4',5 pentaCB, 2,2',3,3',4,4' hexaCB, 2,2',3,4,4',5' hexaCB, 2,2',4,4',5,5' hexaCB, 3,3',4,4',5,5' hexaCB, 2,2',3,3',4,4',5 heptaCB, 2,2',3,4,4',5,5' heptaCB, 2,2',3,4',5,5',6 heptaCB (ref: the "summation" column of Table 9.3 of *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (The Inland Testing Manual)* published by USEPA).

* Krone et al. (1989), A method for analysis of butyltin species and measurement of butyltins in sediment and English Sole livers from Puget Sound, Marine Environmental Research 27 (1989) 1-18. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

** UNEP/ICO/IAEA refers to IAEA's Marine Environment Laboratory reference methods. These methods are available free of charge from UNEP/Water or Marine Environmental Studies Laboratory at IAEA's Marine Environment Laboratory. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

Table 2 - Test Endpoints and Decision Criteria for Tier III Biological Screening

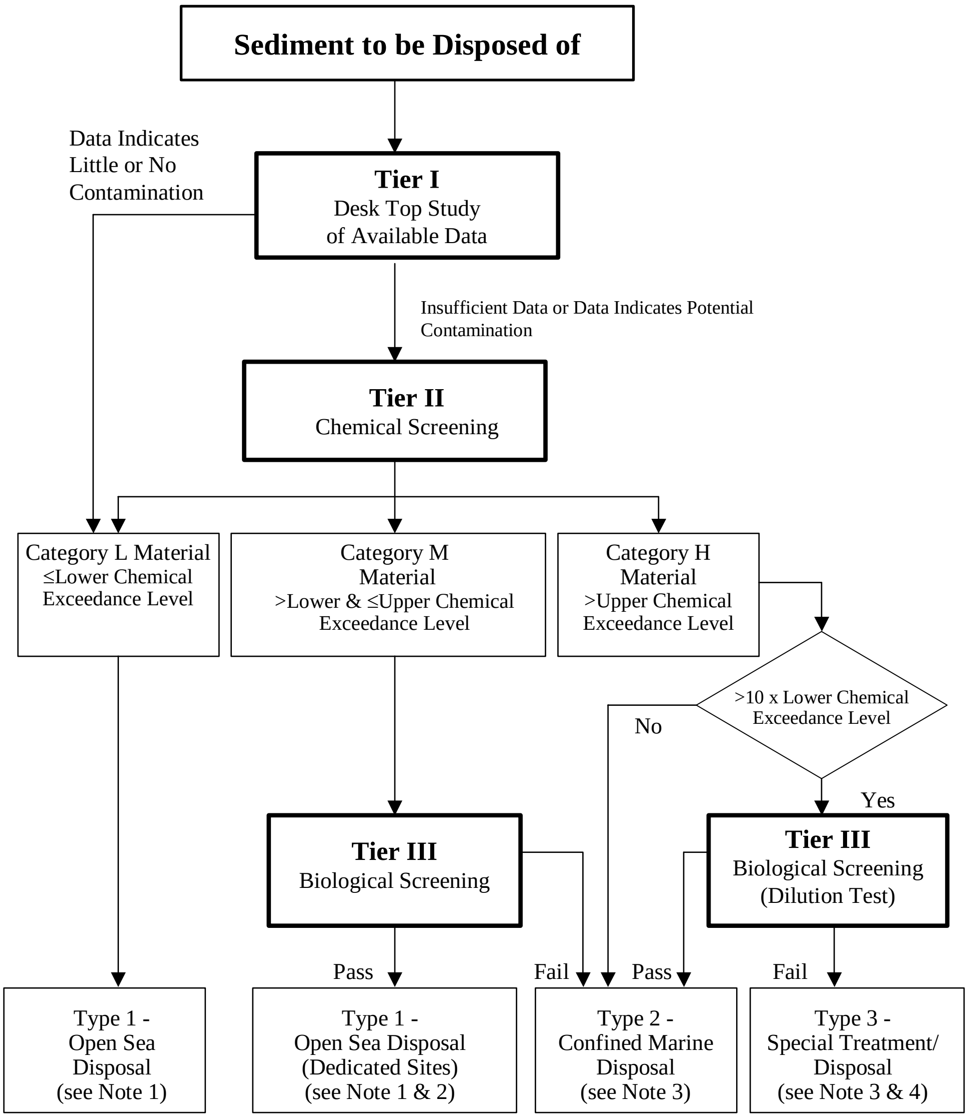
Toxicity test	**Endpoints measured**	**Failure criteria**
10-day amphipod	Survival	Mean survival in test sediment is significantly different ($p \leq 0.05$)[1] from mean survival in reference sediment **and** mean survival in test sediment < 80% of mean survival in reference sediment.
20-day polychaete worm	Dry Weight[2]	Mean dry weight in test sediment is significantly different ($p \leq 0.05$)[1] from mean dry weight in reference sediment **and** mean dry weight in test sediment < 90% of mean dry weight in reference sediment.
48-96 hour larvae (bivalve or echinoderm)	Normality Survival[3]	Mean normality survival in test sediment is significantly different ($p \leq 0.05$)[1] from mean normality survival in reference sediment **and** mean normality survival in test sediment < 80% of mean normality survival in reference sediment.

1 Statistically significant differences should be determined using appropriate two-sample comparisons (e.g., *t-tests*) at a probability of $p \leq 0.05$.

2 Dry weight means total dry weight after deducting dead and missing worms.

3 Normality survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

Management Framework for Dredged/Excavated Sediment



Notes

(1) Most open sea disposal sites are multi-user facilities and as a consequence their management involves a flexibility to accommodate varying and unpredictable circumstances. Contract documents should include provisions to allow the same degree of flexibility should it be necessary to divert from one disposal site to another during the construction period of a contract.

(2) Dedicated Sites will be monitored to confirm that there is no adverse impact.

(3) For sediment requiring Type 2 or Type 3 disposal, contract documents should state the allocation conditions of MFC and DEP. At present, East Sha Chau mud pits are designated for confined marine disposal.

(4) If any sediment suitable for Type 3 disposal (Category H sediment failing the biological dilution test) is identified, it is the responsibility of the project proponent, in consultation with DEP, to identify and agree with him/her, the most appropriate treatment and/or disposal arrangement. Such a proposal is likely to be very site and project specific and therefore cannot be prescribed. This will not preclude treatment of this sediment to render it suitable for confined marine disposal.

(5) The allocation of disposal space may carry a requirement for the project proponent to arrange for chemical analysis of the sediment sampled from 5% of the vessels en-route to the disposal site. For Category M and certain Category H sediment, the chemical tests will be augmented by biological tests. Vessel sampling will normally entail mixing five samples to form a composite sample from the vessel and undertaking laboratory tests on this composite sample. All marine disposal sites will be monitored under the general direction of the Civil Engineering Department. However, exceptionally large allocations might require some additional disposal site monitoring. These will be stipulated at the time of allocation.

(6) Trailer suction hopper dredgers disposing of sediment at East Sha Chau must use a down-a-pipe disposal method, the design of which must be approved in advance by DCE. The dredging contractor must provide equipment for such disposal.

APPENDIX C5
SEDIMENT TESTING PARAMETERS
AND ANALYICAL METHDOS

Appendix B: Testing Methods, Detection Limit, Reporting Limits and QA/QC Procedures

Parameters for Sediment Quality Testing

Parameter	Sample Preparation / Detemination Method	HOKLAS Accreditation	Lowest Detection Limit	Reporting Limit	QA/QC Procedures
Cadmium	APHA 19ed 3030F 3b# In-house method SOP053, SOP093 & 094 based on USEPA Method 6010B (ICP-ES) and 6020A (IPC-MS)*	Yes	0.01 mg/kg	0.05 mg/kg	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
Chromium			0.02 mg/kg	0.1 mg/kg	
Copper			0.04 mg/kg	0.2 mg/kg	
Mercury			0.01 mg/kg	0.05 mg/kg	
Nickel			0.04 mg/kg	0.2 mg/kg	
Lead			0.02 mg/kg	0.1 mg/kg	
Silver			0.02 mg/kg	0.1 mg/kg	
Zinc			0.04 mg/kg	0.2 mg/kg	
Metalloid (Arsenic)			0.02 mg/kg	0.1 mg/kg	
Low Molecular Weight PAHs Naphthalene Acenaphtylene Acenaphtene Fluorene Phenanthrene Anthracene	3550B# 8270C*	Yes	N/A	55µg/kg	5% QC Samples, including Blank, Duplicate, Spike/Control Sample
High Molecular Weitht PAHs Benzo(a)anthracene Benzo(a)pyrene Chrysene Dibenzo(ah)anthracene Fluoranthene Pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Indeno(1,2,3-cd)pyrene Benzo(ghi)perylene	3550B# 8270C*	Yes	N/A	170µg/kg	5% QC Samples, including Blank, Duplicate, Spike/Control Sample
Total PCBs (for each PCB congener) 2,4' dichlorobiphenyl (PCB 8) 2,2',5 trichlorobiphenyl (PCB 18) 2,4,4' trichlorobiphenyl (PCB 28) 2,2',3,5' tetrachlorobiphenyl (PCB 44) 2,2',5,5' tetrachlorobiphenyl (PCB 52) 2,3',4,4' tetrachlorobiphenyl (PCB 66) 3,3',4,4' tetrachlorobiphenyl PCB 77) 2,2',4,5,5' pentachlorobiphenyl (PCB 101) 2,3,3',4,4' pentachlorobiphenyl (PCB 105) 2,3',4,4',5 pentachlorobiphenyl (PCB 118) 3,3',4,4,5 pentachlorobiphenyl (PCB 126) 2,2',3,3',4,4' hexachlorobiphenyl (PCB 128) 2,2',3,4,4',5' hexachlorobiphenyl (PCB 138) 2,2',4,4',5,5' hexachlorobiphenyl (PCB 153) 3,3',4,4',5,5' hexachlorobiphenyl (PCB 169) 2,2',3,3',4,4',5 heptachlorobiphenyl (PCB 170) 2,2',3,4,4',5,5' heptachlorobiphenyl (PCB 180) 2,2',3,4',5,5',6 heptachlorobiphenyl (PCB 187)	3550B, 3620B, 3660B & 3665A# 8270C*	Yes	N/A	3 µg /kg	5% QC Samples, including Blank, Duplicate, Spike/Control Sample
Tributyltin (TBT)	UNEP/IOC/IAEA**	Yes	N/A	0.015µg TBT/L[Note 1]	5% QC Samples, including Blank, Duplicate, Spike/Control Sample
Ammoniaical Nitrogen	In-house method based on APHA 20e 4500 NH3- H (FIA)**	No	0.05mg NH_3-N/kg	0.25mg NH_3-N/kg	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
TKN	In-house method based on APHA 20e 4500 Norg A,B,D	No	20mg N/kg	100mg N/kg	
Nitrate Nitrogen	In-house method based on APHA 20e 4500 NO3- F (FIA)**	No	0.05 mg NO_3^--N/kg	0.25 mg NO_3^--N/kg	
Nitrite Nitrogen	In-house method based on APHA 20e 4500 NO2- B (FIA)**	No	0.01mg NO_2^--N/kg	0.05mg NO_2^--N/kg	
Total Phosphorus	In-house method based on APHA 20e 4500 P B,E,F,H	No	2 mg P/kg	10 mg P/kg	
Sediment Oxygen Demand	In-house method based on APHA 19e 5210B**	No	60 mg-O_2/kg	300 mg-O_2/kg	
Electrochemical Potential	In House Method based on APHA 20e 2510**	No	2 µS/cm	10 µS/cm	
Total Organic Carbon	EPA SW-846 Method 9060**	No	0.02%	0.10%	
Total Sulphide	EPA 821/R-91-100**	No	0.2mg/kg	1 mg/kg	
Acid Volatile Sulphide	EPA 821/R-91-100**	No	0.2mg/kg	1 mg/kg	
Moisture Content	APHA 19e 2540G**	Yes	0.20%	1%	
Particle Size Distribution	GEOSPEC 3:2001 Test 8.1**	No	0.02%	0.10%	

Note 1: For 1L sample for 100mL reported at MDL.

* Method for sample preparation

Method for sample determination

** Method for both sample preparation and determination

APPENDIX D
ECOLOGICAL IMPACT ASSESSMENT

TABLE OF CONTENTS

List of Tables

List of Annex

D1 INTRODUCTION

D1.1 The proposed works under the Project include marine sediment removal at Yim Tin Tsai and Yim Tin Tsai (East) Fish Culture Zones (FCZs), and maintenance dredging at Shuen Wan Typhoon Shelter. The Project also involves relocation of existing fish rafts at temporary sites (without dredging) for fish rafts. This section presents the potential ecological impacts generated from the proposed marine work of the Project. All figures referred in this appendix are attached in the main text of this Project Profile.

D2 ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA

D2.1 Guidelines, standards, documents and ordinances / regulations listed in the following sections were referred to during the course of the ecological impact assessment.

- Country Parks Ordinance (Cap. 208);
- Marine Parks Ordinance (Cap. 476) and Subsidiary Legislation;
- Marine Fish Culture Ordinance (Cap. 353);
- Wild Animals Protection Ordinance (Cap. 170);
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586);
- Town Planning Ordinance (Cap. 131);
- Chapter 10 of the Hong Kong Planning Standard and Guidelines (HKPSG);
- Annex 8 and 16 of the Environmental Impact Assessment Ordinance – Technical Memorandum (EIAO-TM);
- Environmental Impact Assessment Ordinance (EIAO) Guidance Note No. 3/2002, 6/2002, 7/2002, 10/2004 & 11/2004;
- IUCN Red List of Threatened Species;
- PRC's Wild Animal Protection Law.

D3 ASSESSMENT METHODOLOGY

D3.1 The Assessment Area for terrestrial ecological assessment included areas within 500 m distance from the Project Site boundary, while that for marine ecological assessment was the same as the water quality impact assessment, i.e. the Tolo Harbour and Channel Water Control Zone (WCZ).

D3.2 Relevant available studies and information regarding the ecological characters of the Assessment Area were collated and reviewed. The information collected was then evaluated to identify any information gap relating to the assessment of potential ecological impacts to the terrestrial and marine environments.

Ecological Surveys

Survey Area

Terrestrial Ecology

D3.3 Since the proposed work is marine-based, no direct impact to existing terrestrial habitats will result under the Project. The only potential impact would be confined to construction phase indirect impacts (i.e. noise and human disturbance, loss of feeding ground, etc.) in particular the nesting area of ardeids at Shuen Wan Egretry SSSI. Updated baseline information on ardeid populations in this SSSI and nearby Yeung Chau is available from the Egretry Counts undertaken by the Hong Kong Bird Watching Society (HKBWS). Nevertheless, site-specific field surveys on the ardeid populations and their use of habitats within the Assessment Area were conducted.

D3.4 Since no land-based works will be conducted under the Project, no direct impacts on flora and other major terrestrial faunal groups are expected. Therefore, ecological survey on other terrestrial biota groups is considered not necessary.

Marine Ecology

D3.5 There is limited literature describing the existing baseline condition of the benthos, coral and intertidal communities within the Project Site. Ecological surveys on these communities are necessary to fill information gaps to assess the potential impacts to marine environment resulting from the Project.

Survey Programme

D3.6 An eight-month ecological survey was conducted from February to October 2009 covering dry and wet seasons. The details of the survey programme are summarized in **Table D1**.

Table D1 Ecological Survey Programme

Season	**Dry**		**Wet**					
Ecological Surveys	**Feb 09**	**Mar 09**	**Apr 09**	**May 09**	**Jun 09**	**Jul 09**	**Aug 09**	**Sept 09**
Ardeid Surveys	✓			✓		✓		
Intertidal Surveys	✓				✓			
Dive Surveys			✓		✓ REA			✓
Benthos Surveys	✓				✓			✓

Note: The ticks (✓) denote the time of different faunal or floral groups surveyed under the Project.

Ardeid Surveys

D3.7 Representative areas, particularly coastal areas, within the Assessment Area were surveyed to record species and number of ardeid population by direct observation and hearing. The ardeid surveys were surveyed three times in February, May and July 2009, covering the breeding season of ardeids. Particular attention was paid on the use of habitats by ardeids, with its important habitats and notable behaviour being identified and recorded during the surveys.

Intertidal Surveys

D3.8 Intertidal communities at three sampling sites, (Sites R1 to R3) (**Figure 4.4**) were surveyed twice in February and June 2009. Line transects were deployed, starting from the high water mark down to low water mark during low tide period, when tidal level was below 1 m. Along each transect, standard quadrats (0.5 m x 0.5 m) were laid at 1 m intervals. Intertidal fauna and flora within each quadrat were then identified and enumerated. Approximately one-hour walk-through survey was then conducted by 3 surveyors. Intertidal fauna and flora found in the walk-through surveys were identified and recorded in relative abundance.

Dive Surveys

D3.9 Twenty-one spot-check dive routes (Sites C1 to C21) (**Figure 4.4**) were conducted once in April and September 2009. Subtidal substrata along the spot-check dive routes were surveyed for the presence of coral communities, including hard corals (order Scleractinia), octocorals (sub-class Octocorallia) and black corals (order Antipatharia).

D3.10 Five sites with signs of corals observed in the spot-check dives were further surveyed by a more detailed Rapid Ecological Assessment (REA) in June 2009. Seven 100 m REA transects (**Figure 4.5**) were laid according to the contour of seabed at the 5 sites. Benthic cover, taxon abundance and ecological attributes within a swathe of 2 m wide, with 1 m of either side of the transects, were recorded following the REA technique as described in DeVantier *et al.* (1998).

Benthos Surveys

D3.11 Seabed at 11 sampling sites (Sites B1 to B11) (**Figure 4.4**) was surveyed in February, June and September 2009, covering dry and wet seasons. At each sampling site, three replicates of grab samples over 0.1 m^2 area of seabed substrate were collected using a van Veen grab and samples were sieved through 0.5 mm sieves and stained with Rose Bengal. Collected organisms were then counted, weighed and identified to the lowest practicable taxon as possible. Abundance, biomass, species diversity *H'* and evenness *J* were calculated for pooled data.

D4 BASELINE CONDITIONS

Areas of Conservation Interest

Terrestrial Ecology

D4.1 Areas of conservation interest identified within the terrestrial Assessmen*t* Area (500 m distance from the Project Site boundary) are summarized in **Table D2** and discussed in the following sections. The locations of recognized areas of conservation interest in Assessment Area are shown in **Figure 4.3**.

Table D2 Summary of the Areas of Conservation Interest within the Assessment Area

Areas of Conservation Interest	Distance from the Nearest Project Site
Ma Shi Chau Special Area	Approximately 200 m east of the Project Site (dredging site)
Ting Kok SSSI	Approximately 250 m north of the Project Site (relocation site)
Shuen Wan Egretry SSSI	Approximately 300 m west of the Project Site (relocation site)
Yim Tin Tsai & Ma Shi Chau SSSI	Approximately 200 m east of the Project Site (dredging site)
Centre Island SSSI	Approximately 500 m east of the Project Site (relocation site)
Sam Mun Tsai Egretry SSSI	Approximately 300-350 m west of the Project Site (dredging site)
Yeung Chau Egretry	Approximately 150 m east of the Project Site (relocation site)

Special Area (SA)

D4.2 Ma Shi Chau SA encompasses 61 ha, comprising 4 islands in Tolo Harbour, Ma Shi Chau, Centre Island, Yeung Chau and an unnamed island. It provides significant geological features and fossil records of ancient organisms, such as plants, corals and bivalves.

Site of Special Scientific Interest (SSSI)

D4.3 Ting Kok SSSI of 38 ha was established in 1985 to protect the significant mangrove resources found on the site (Planning Department, 1995). It provides important nursery and foraging habitat to a range of important native species.

D4.4 Shuen Wan Egretry SSSI of 2 ha was established in 1994 to protect ardeid nesting habitats.

This egretry has been used cyclically by Little Egrets, Great Egrets, Cattle Egrets, Night Herons and Chinese Pond Herons (Planning Department, 1995). It was abandoned in the 1990's and recently Chinese Pond Herons have started to use the site for nesting, with two nests recorded in 2008 (Anon, 2008; Lee *et al.*, 2007).

D4.5 Yim Tin Tsai & Ma Shi Chau SSSI was designed in 1982 because of rare geological features and numerous fossils. The rocky coasts are characteristic land formations which are of landscape value (Planning Department, 1995).

D4.6 Central Island SSSI was established in 1982. Previously, it was an important site for ardeid nesting (Anon, 2006, 2007 & 2008), however, was abandoned in 2007. This SSSI is also of geological interest and landscape value. It contains the oldest rock formation known in Hong Kong and plant fossils of Permian age found on the island (Planning Department, 1995).

D4.7 Sam Mun Tsai Egretry SSSI was founded in 1994 to preserve egret and heron nesting habitats. The site was used by a colony of Little Egrets, Great Egrets, Cattle Egrets, Night Herons and Chinese Pond Herons as nesting site during the breeding season. However, it has been abandoned since 1991 (Planning Department, 1995).

<u>Egretry</u>

D4.8 Yeung Chau Egretry had 40 nests of Little Egrets, Great Egrets, Cattle Egrets, and Chinese Pond Herons in 2008. The number of nests at this site has varied from 16 nests in 2005 to 91 nests in 2007 (Anon, 2008).

D4.9 Shuen Wan Egretry has been used cyclically by Little Egrets, Great Egrets, Cattle Egrets, Night Herons and Chinese Pond Herons. It was abandoned in the 1990's and recently Chinese Pond Herons have started to use the site for nesting, with two nests recorded in 2008 (Anon, 2008; Lee *et al.*, 2007).

<u>Marine Ecology</u>

D4.10 The areas of conservation interest identified within the marine Assessment Area include mangrove stands, coral communities and seagrass beds scattered in Tolo Harbour and Tolo Channel areas and are shown in **Figure 4.3**.

<u>Terrestrial Environment</u>

D4.11 Within the Assessment Area, there are two active egretries, the Yeung Chau Egretry and Shuen Wan Egretry. The HKBWS Egretry Counts in Summer 2008 recorded 2 nests of Chinese Pond Heron in Yeung Chau Egretry, whilst 40 nests of Great Egret, Little Egret, Black-crowned Night Heron and Cattle Egret were recorded in Yeung Chau Egretry (Anon, 2008). Both egretries showed a sharp decrease in nest number in 2008 compared with that in 2007 (Anon, 2007 & 2008).

D4.12 The coastal areas in the vicinity of these significant egretries are potential feeding grounds for the ardeids. The coastal areas, particularly soft shores support an abundance of invertebrates which in turn attract shorebirds and waterbirds for feeding during low tide period.

Tolo Harbour

D4.13 In the northern Tolo Harbour, 2 ardeid species, Chinese Pond Heron and Little Egret, were recorded at sandy shore, shrubland and modified area in Lung Mei, located approximately 1.7 km at north of the Project Site (CEDD, 2007a). While in the western Tolo Harbour, 5 ardeid species of Chinese Pond Heron, Great Egret, Intermediate Egret, Grey Heron, and Little Egret were recorded (DSD, 2007). Moreover, Black-crowned Night Heron were also previously observed in the western Tolo Harbour (HyD, 2000).

Project Site

D4.14 Five ardeid species of Black-crowned Night Heron, Grey Heron, Great Egret, Little Egret, and Chinese Pond Heron were recorded in the Assessment Area during the current surveys. The population was dominated by Great Egret, followed by Little Egret. At the southern Yeung Chau (Yeung Chau Egretry), Great Egret, Little Egret and Black-crowned Night Heron were also recorded, with active nestings of Great Egret, Black-crowned Night Heron and White-bellied Sea Eagle observed. While Great Egret was observed at the western Centre Island, however, no nesting was observed.

D4.15 All the ardeid species were of conservation interest. Black-crowned Night Heron is considered of Local Concern, while the large, fairly secure populations of Grey Heron, Great Egret, Little Egret and Chinese Pond Heron occurring in Hong Kong are considered as of Potential Regional Concern (Fellowes *et al.*, 2002). Indicative locations of these species are shown in **Figure 4.6**. **Annex D1** details the list of avifaunal species and their corresponding habitats recorded during the current surveys.

D4.16 Most of the ardeids were recorded on/in the nearby coastal areas, i.e. natural soft and rocky shores, with limited observation within the Project Site. Within the dredging areas, only 3 ardeid species of Little Egret, Great Egret and Grey Heron were recorded in the currents surveys, with the former species also observed in the vicinity of the relocation site for fish rafts (**Table D3**).

Table D3 Ardeids Recorded in the Project Site in the Current Surveys

Project Site	**Average Number of Ardeids (ind./survey)**		
	Little Egret	**Great Egret**	**Grey Heron**
Dredging Areas			
Shuen Wan Typhoon Shelter	-	0.7	0.7
Yim Tin Tsai FCZ	4.0	0.3	-
Yim Tin Tsai (East) FCZ	0.3	1.7	-
Proposed Relocation Site			
Coasts of the Shuen Wan Golf Centre	0.7	-	-

Marine Environment

D4.17 Marine habitats in Tolo Harbour and Tolo Channel included intertidal habitats, subtidal soft bottom habitat and subtidal hard bottom habitat. The locations of the key ecological resources are shown in **Figure 4.3**.

Water

D4.18 The Tolo Harbour and Channel WCZ is a nearly land-locked body of water, with just a narrow exit out into Mirs Bay to the east (EPD, 2006). The harbour occasionally experiences temperature and salinity stratification in summer, leading to hypoxia at the sea bottom. According to 2007 Marine Water Quality Report (EPD, 2008), inner Tolo Harbour had a very low compliance for Dissolved Oxygen (DO) (29%), while the water quality of Shuen Wan Typhoon Shelter was considered as poor.

Sediment

D4.19 The seabed in the inner Tolo Harbour area was mainly composed of soft bottom sediment, with 40-80% of silt. Sediment in the harbour was highly anoxic (-331 to -351 mV), with levels of lead higher than the Lower Chemical Exceedance Level (LCEL) (EPD, 2006 & 2008). This suggests historical contamination, most likely from the use of leaded petrol before its ban in 1992. Meanwhile, Shuen Wan Typhoon Shelter had poor sediment quality amongst the typhoon shelters in Hong Kong (EPD, 2008).

<u>Intertidal Habitat</u>

D4.20 Tolo Harbour is characterized by a diversity of intertidal habitats including soft shores, rocky shores (natural rocky shores and artificial seawalls), mangroves and seagrass beds. Baseline condition of these habitats is described below:

<u>Soft Shore</u>

D4.21 Soft shores are scattered along the coastline of Tolo Harbour, while only two small sandy shores occur in close proximity to the dredging sites in Yim Tin Tsai and Yim Tin Tsai (East) areas.

Tolo Harbour and Channel

D4.22 In general, the soft shore habitat in Tolo Harbour supports intertidal communities with low biodiversity and species evenness. In the northern Tolo Harbour, sandy shores in Lung Mei (~1.7 km away from the Project Site) were dominated by common and widespread intertidal organisms such as snails and graspid crabs (CEDD, 2007a & 2007b). Similar intertidal communities were also recorded in the mudflat / sandy shore at Shuen Wan, Pak Shek Kok and Starfish Bay at the southern Tolo Harbour (~1.3 km, 1.7 km and 3.0 km away respectively) (DSD, 2007; MCAL, 1998; TDD, 2002), with low biodiversity of intertidal fauna.

D4.23 Apart from intertidal fauna, 3 fish species of conservation interest, Sleepy Goby (*Psammogobius biocellatus*), Tropical Sand Goby (*Favonigobius reichei*), and Grassy Pufferfish (*Takifugu niphobles*) were occasionally observed in the subtidal zone at Ting Kok, Yung Shue O and Lai Chi Chong (CEDD, 2007b).

Project Site

D4.24 No sandy shore and mudflat was recorded within the Project Site, while small scaled sandy shores were found in the vicinity of the two FCZs. A small sandy shore was observed 100 m at north of Yim Tin Tsai FCZ, adjacent to the existing breakwater of Shuen Wan Typhoon Shelter. Another sandy shore was recorded 300 m at west of Yim Tin Tsai (East) FCZ. The two sandy shores were both with the horizontal length of approximately 100-130 m, mainly composed of fine sand with cobbles.

D4.25 Soft shore habitat in the vicinity of the Project Site is similar to that in other parts of Tolo Harbour. The ecological value of this habitat within and in the vicinity of the Project Site is considered of low due to the small size and the degree of human disturbance observed.

<u>Rocky Shore</u>

D4.26 Rocky shore habitat is the predominant habitat in the Assessment Area, comprising both artificial seawalls and natural rocky shores. The coastline within and in the vicinity of the Project Site is also mainly made of the rocky shore habitat.

Tolo Harbour and Channel

D4.27 In the northern Tolo Harbour, the intertidal assemblage at Lung Mei comprised of similar species composition and abundance to other manmade rocky shores in Hong Kong (CEDD, 2007a). Biota mainly included snails, barnacle, and bivalves, with dominant species of snail *Planaxis sulcatus* and rock oyster. While the artificial seawalls in Shatin and Tai Po, and other areas in Tolo Harbour (DSD, 2007; The Hong Kong and China Gas Company Limited, 2003) also had similar assemblages of common intertidal organisms, mainly dominated by rock oyster, snails and barnacles.

D4.28 In addition to artificial seawalls, the intertidal assemblage of natural rocky shores at Pak Shek Kok and Whitehead Peninsula (~1.7 km and 2.2 km away from the Project Site respectively) reflected the typical sheltered rocky shores in Hong Kong. Fauna recorded including crabs, barnacles, bivalves, snails, periwinkles, limpets and sea slaters (MCAL, 1998; TDD, 2002).

Project Site

D4.29 In the current surveys, a total of 72 intertidal species of flora and fauna were recorded in the 3 sampling rocky shores (Sites R1 to R3) (**Figure 4.4**). The biotic assemblage was similar to those in the rest of the Tolo Harbour, with no records of rare species. The results of the current intertidal surveys are summarised in **Table D4**. Detailed results and representative photographs are shown in **Annex D3** and **Annex D2** respectively.

Table D4 Number of Intertidal Species and Abundance Recorded in the Current Surveys in Dry and Wet Seasons

		Sampling Site		
	Season	**R1 (YTT (East))**	**R2 (Typhoon Shelter)**	**R3 (Shuen Wan Golf Centre)**
No. of Floral Species Recorded in Transect study	Dry	2	4	4
	Wet	3	6	2
No. of Faunal Species Recorded in Transect surveys	Dry	14	16	14
	Wet	20	26	10
No. of Mobile Animal Recorded in Transect surveys (ind./m^2)	Dry	252.8	236.4	68.0
	Wet	320.8	83.7	30.7
Total No. of Species Recorded	Dry	30	25	35
	Wet	35	43	36
Total No. of Species	**TOTAL**	**45**	**47**	**45**

D4.30 Natural boulder shores along the coastline of Yim Tin Tsai (East) FCZ (Site R1) and Shuen Wan Typhoon Shelter (Site R2) had similar intertidal assemblage. Common intertidal faunal species were found in these two sites, including whelks, snails, limpets, periwinkles, barnacles, bivalves, tube-worms, crabs, chiton, sea squirt, sea slater and amphipod. Common sheltered rocky shore and mudflat associated fauna, such as shrimps, common rock anemone, turbellaria, isopods and *Ceratonereis* spp were also recorded. Snails *Lunella coronata* and *Monodonta labio* were the dominated fauna in these two natural boulder shores. While pipefish and squid were also recorded in the coastal waters of Site R1.

D4.31 Site R3, an artificial sloping boulder-mounted seawall, recorded the least number of mobile animals among the 3 sampling sites (**Table D5**). This is typical of this kind of habitat mainly due to the lack of variation in substratum. Fauna found in this artificial rocky shore included the common intertidal species recorded in the natural rocky shores in Sites R1 and R2, dominated by oyster *Saccostrea cucullata*, whelk *Thais clavigera* and limpet *Nipponacmea concinna*. Anemone and sea urchin were also found in the subtidal zone of this artificial sloping shore.

D4.32 In summary, the rocky shore communities on the natural shoreline of Yim Tin Tsai (East) FCZ (Site R1) and Shuen Wan Typhoon Shelter (Site R2) were similar to those previously surveyed at Whitehead Peninsula and Pak Shek Kok. The two sites' natural community structures reflected the sheltered nature of rocky shore at Tolo Harbour, while Site R3 reflected typical artificial and exposed rocky shore communities in Hong Kong. None of the recorded species at the 3 sites was rare or considered of conservation interest.

Mangrove

D4.33 Mangrove habitat was recorded along the shoreline of the Assessment Area. The Assessment Area had 15 mangrove stands (**Figure 4.3**), including those in Ting Kok, Shuen Wan, Sam Mun Tsai, Yuen Chau Tsai, Tolo Pond, Starfish Bay, Nai Chung, Sai Keng, Kei

Ling Ha Lo Wai, Kei Ling Ha Hoi, Sham Chung, Lai Chi Chong, Hoi Ha Wan, Lo Fu Wat, and Fung Wong Wat (AFCD, 2006; DSD, 2004 & 2007; HyD, 2000; Tam and Wong, 1997, 2000; TDD, 2002). In which, two mangrove stands at Sam Mun Tsai and Shuen Wan are in the vicinity of the Project Site. As stipulated in the EIAO TM Annex 8, established mangrove stand of any size is considered as important habitat in Hong Kong.

Tolo Harbour and Channel

D4.34 The most extensive mangrove stands are located in the northern Tolo Harbour, within Ting Kok SSSI (**Figure 4.3**). The diversity of mangal species in Ting Kok SSSI was relatively high, including *Kandelia obovata*, *Excoecaria agallocha*, *Aegiceras corniculatum*, *Bruguiera gymnorrhiza*, *Avicennia marina*, *Lumnitzera racemosa*, and *Acanthus ilicifolius* (DSD, 2007).

D4.35 Details of the size and species composition of Ting Kok SSSI and other 8 significant mangrove stands in the Assessment Area were investigated previously (Tam and Wong, 1997) and are presented in **Table D6**. Moderate to high diversity of mangal species were recorded at the 9 stands. For the two small mangrove stands at Yuen Chau Tsai (near Island House) and Starfish Bay, mangroves were limited to occasional small trees at backshore, with low abundance and species diversity, mainly consisted of *Kandelia obovata* and *Bruguiera gymnorrhiza* (HyD, 2000; TDD, 2002).

D4.36 Detailed study on the mangrove-associated macrofauna was also previously conducted at 6 of the mangrove stands in Ting Kok, Tolo Pond, Sai Keng, Kei Ling Ha Lo Wai, Kei Ling Ha Ho and Hoi Ha Wan (Tam and Wong, 1997 & 2000). The mangrove-associated macrofauna was sparse and not diverse. It mainly consisted of mud snails, shrimps, crabs and fish. Some uncommon macrofauna were also recorded in these mangrove stands, such as gastropods *Assiminea lutea japonica* and *Pythia cecillei*, crab *Nanosesarma batavicum*, and bivalve *Trapezium liratum*, however, none was rare or considered of conservation interest.

Project Site

D4.37 Two mangrove stands were recorded in the vicinity of the Project Site. The mangrove stand at Sam Mun Tsai is approximately 0.2 km away from the Project Site. While the smaller mangrove stand at Shuen Wan is approximately 1.4 km away from the dredging area.

D4.38 Sam Mun Tsai mangrove stand was previously investigated by Tam and Wong (1997). Sam Mun Tsai stand had an area of 1.83 ha, with three extremely polluted freshwater streams running into it. The stand was also under pressure from pollution and human disturbance by clam collection activities (Tam and Wong, 1997).

D4.39 Twelve species of mangrove and associated flora were recorded at the stand at Sam Mun Tsai, including uncommon species of *Bruguiera gymnorrhiza* and *Lumnitzera racemosa*, and was dominated by *Avicennia marina* with patches of *Kandelia candel* and *Aegiceras corniculatum*. Summary of the flora species in Sam Mun Tsai stand is shown in **Table D5**. Thirty-one mangrove-associated macrofauna was recorded at Sam Mun Tsai stand, dominated by mud snails (Tam and Wong, 1997 & 2000). None of the faunal species was rare or considered of conservation interest.

Table D5 Location and Characteristics of Mangrove Stands in the Assessment Area

Mangrove Stand	Area (ha)	True Mangrove Species						Mangrove Associate Species						Other Species					
		KO	AC	AM	BG	EA	LR	HL	AI	HT	TP	CI	CM	AH	DT	SC	PT	SA	LS
Ting Kok	8.77	+	+	+	+	+	+		+	+		+			+		+	+	+
Sam Mun Tsai	1.83	+	+	+	+	+	+			+		+	+				+	+	+
Tolo Pond	1.41	+	+	+		+		+		+		+					+		
Nai Chung	0.40	+	+	+		+	+			+		+	+			+	+		+
Sai Keng	3.84	+	+	+	+	+	+		+	+	+	+	+		+		+		
Kei Ling Ha Lo Wai	2.45	+	+	+		+	+			+	+	+				+	+	+	
Kei Ling Ha Hoi	0.83	+	+	+	+	+	+	+	+	+		+	+			+	+	+	+
Sham Chung	1.90	+	+						+	+			+	+			+		
Lai Chi Chong	0.31	+	+			+	+					+						+	
Hoi Ha Wan	0.53	+	+			+			+	+		+	+				+		

(Source: Tam and Wong, 2000 & 1997)

Note:

Species codes: KO = *Kandelia obovata* AC = *Aegiceras corniculatum*, AM = *Avicennia marina*, BG = *Bruguiera gymnorrhiza*, EA =*Excoecaria agallocha*, LR = *Lumnitzera racemosa*, HL = *Heritiera littoralis*, AI = *Acanthus ilicifolius*, HT = *Hibiscus tiliaceus*, TP = *Thespesia populnea*, CI = *Clerodendrum inerme*, CM = *Cerbera manghas*, AH = *Acrostichum aureum*, DT = *Derris trifoliata*, SC = *Scaevola* spp., PT = *Pandanus tectorius*, SA = *Suaeda australis*, LS = *Limonium sinense*.

Seagrass Beds

D4.40 Seagrass beds in Hong Kong are rare / uncommon habitat and there are only five seagrass species recorded, including *Halophila beccarii*, *H. ovalis*, *H. minor*, *Ruppia maritime* and *Zostera japonica*. One patch of seagrass bed of *Halophila ovalis* was found in Hoi Ha, while a small patch of seagrass was also recorded in Lai Chi Chong in the Assessment Area (AFCD, 2005a & 2005b; CEDD, 2007b) (**Figure 4.3**). As stipulated in the EIAO TM Annex 8, established seagrass bed of any size is considered as important habitat in Hong Kong. No seagrass bed was recorded within or in the vicinity of the Project Site.

<u>Subtidal Hard Bottom Habitat</u>

Coral Communities

D4.41 Marine waters within the Assessment Area is known to serve as a more stable and suitable environment for coral growth in Hong Kong and support patches of coral communities in shallow coastal area (Chan *et al.*, 2005). The coral sites in the Assessment Area identified from the previous literature and EIA studies are shown in **Figure 4.3**.

Tolo Channel

D4.42 Literature review indicates coral communities of medium to high ecological significance in Tolo Channel of the Assessment Area. A total of 51 hard coral species were found at Wong Wan Tsui, Fung Wong Wat, Wong Chuk Kok Tsui, South Wong Chuk Kok Tsui and Gruff Head (all > 8.0 km away from the Project Site), with a high coral cover (The Hong Kong and China Gas Company Ltd, 2003) (**Figure 4.3**). While Hoi Ha Wan is another location with high coral coverage (35-72%) (AFCD, 2004 & 2008). Moderate to high diversity of hard coral species were recorded at Hoi Ha Wan Pier, Hoi Ha Wan Coral Beach and Hoi Ha Wan Moon Island (all >11.0 km away) (**Figure 4.3**).

D4.43 The recorded species in Tolo Channel area included some dominant / abundant species, such as *Favites* spp. and *Favia* spp. as well as some common hard corals such as *Turbinaria peltata* and *Goniastrea* spp. Uncommon hard coral species such as *Micromussa minuta* and *Acanthastrea subechinata* were also recorded (AFCD, 2004). Apart from hard hermatypic corals, ahermatypic corals (i.e. *Balanophyllia* sp.), soft corals and black corals were also recorded.

D4.44 Moreover, seahorse *Hippocampus kuda* was recorded in Wong Chuk Kok Tsui and South Wong Chuk Kok Tsui (both > 12.0 km away) (The Hong Kong and China Gas Company Ltd, 2003) (**Figure 4.3**). *Hippocampus kuda* is still found in reasonable numbers in Hong Kong's eastern waters. It is categorized as "Vulnerable" in the IUCN Red List due to the observation of a global population decreasing trend (IUCN, 2009), however, not protected under the local legislation.

Tolo Harbour

D4.45 Coral communities were recorded in 5 sites in Tolo Harbour, at Pak Sha Tau, Whitehead Peninsula, Tai Po, Tai Mei Tuk and Ma Shi Chau, however, with relatively low species diversity (1-3 species) and coral coverage (<5%) compared with those in Tolo Channel.

D4.46 A total of three common hard corals (*Oulastrea crispata*, *Cyphastrea serailia* and *Psammocora superficialis*) were recorded at the northern coast of Mai Shi Chau and Tai Mei Tuk (~1.0 km and 1.8 km away from the Project Site respectively) (CEDD, 2007a). While only *Oulastrea crispata* with a low coverage (<5%) was recorded in the coasts of Tai Po Industrial Estate and Pak Sha Tau (~1.3 km and 2.2 km away respectively) (The Hong Kong and China Gas Company Limited, 2003). Apart from hard corals, soft coral *Euplexaura* sp. and black corals *Anthipathes* sp. were also recorded (The Hong Kong and China Gas Company Limited, 2003; TDD, 2002).

D4.47 While five individuals of seahorses *Hippocampus kuda* were also found at the coasts of Tai Po Industrial Estate *Hippocampus kuda* is still found in reasonable number in Hong Kong eastern waters. It is categorized as “Vulnerable” in the IUCN Red List due to the observation of a global population decreasing trend (IUCN, 2009), however, not protected under the local legislation.

Project Site

D4.48 In the vicinity of the Project Site, dive surveys were previously conducted in Shuen Wan (0.4 km away from the Project Site) (DSD, 2007), however, with no coral records. While a low coverage (<5%) of hard coral *Oulastrea crispata* was observed at the northern coast of Yeung Chau, with the distance of 0.8 km away from the dredging area (CEDD, 2007a).

D4.49 In the current spot-check dive surveys, 21 sampling sites (Sites C1 – C21) within and in the vicinity of the Project Site were surveyed (**Figure 4.5**). A locally common hard coral *Oulastrea crispata* of very low coverage (<1%) were found at 5 of the sampling sites (Sites C1, C3, C4, C6 and C8), with no records of soft coral nor black coral. Whilst, locally common marine life of low abundance, such as sea anemones, green mussels and sea urchins was found in the sampling sites.

D4.50 Seven REA transects were then laid at the 5 sampling sites with the presence of corals (**Figure 4.5**). During the REA surveys, only sparse coverage (<1%) of *Oulastrea crispata* was recorded. The coral colonies were in fair health condition and ranged from 2 cm to 10 cm in diameter. Detailed information and representative photographs of the spot-check dives and REA surveys are provided in **Annex D5** and **Annex D4** respectively.

D4.51 The identified coral colonies in REA transects T2 to T5 (at Sites C3, C4 & C6) were within or very close to the dredging areas in Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ. Eighteen-eight small colonies of *Oulastrea crispata* were recorded along these four REA transects. While 101 small coral colonies were found in the REA transects T1, T6 and T7 at Sites C1 and C8, outside of the dredging areas. In general, the identified coral colonies were small in size (2–5 cm in diameter) and attached to big and irremovable boulders.

D4.52 *Oulastrea crispata* has a wide range of adaptations to different environmental conditions (including those unfavourable to other corals) and geographic locations, which is a result of its stress-tolerant ability (Chen *et al.*, 2003). *O. crispata* is able to colonise a variety of substrata and to flourish as a pioneer coloniser of newly immersed structures (Lam, 2000a & 2000b). Moreover, it can survive in waters with poor water quality, contamination and sewage pollution (Cleary *et al.*, 2006). Particularly, it is highly tolerant to turbidity and usually occurs in turbid water near river mouths (Ditlev, 1978; Hoeksema and Putra, 2002; Veron and Marsh, 1988; Yamashiro, 2000).

D4.53 *Oulastrea crispata* is also common and widespread in Hong Kong marine waters, especially those more turbid and harsh environment in the western waters (Chan *et al.*, 2005; Cope and Morton, 1988; Lam, 2000a). It was previously recorded in the polluted and turbid waters along the runway of the Kai Tak Airport in the Victoria Harbour (CEDD, 2008).

D4.54 Only sparse cover of single coral species and limited common marine life were recorded in the current spot-check and REA surveys. Apart from *O. crispata*, no rare species or species of conservation interest were recorded. The ecological value of the subtidal hard bottom habitat within or in the vicinity of the Project Site is relatively low, compared to the coral sites in Tolo Harbour and Tolo Channel.

<u>Subtidal Soft Bottom Habitat</u>

Tolo Harbour and Tolo Channel

D4.55 A comprehensive survey on composition of benthic communities in the territory was undertaken in 2001 (CityU, 2002). Benthos communities in Tolo Harbour and Channel (Stations 104-107) recorded low to moderate value of species richness (d = 1.17-5.89), species diversity (*H'* = 0.63-2.81) and evenness (*J* = 0.39-0.96). It was dominated by polychaetes, echinoderm *Amphipodia obtecta*, and sipunculan *Apionsoma trichocephalus*. No rare species or other species of conservation importance (e.g. amphioxus) were observed (CityU, 2002).

D4.56 Other recent studies from Tolo Harbour support this trend of low biomass and diversity in Tolo Harbour and Channel area. Less than 10 benthic species, with a low abundance were recorded at Tolo Channel, Ma Shi Chau and Tai Po Approach, while only 24 benthic species were found at Lung Mei (CEDD, 2007b; The Hong Kong and China Gas Company Ltd, 2003). While one individual of amphioxus *Branchiostoma belcheri* of conservation interest was collected at subtidal habitat at Lung Mei (CEDD, 2007b).

D4.57 Among the five local amphioxus species, *Branchiostoma belcheri* is the most abundant and commonly found amphioxus species in Hong Kong (Chen, 2007). In Hong Kong, distribution of amphioxus is confined to the eastern waters close to Sai Kung (CityU, 2002), while significant populations have been recorded in Tai Long Wan and Pak Lan Wan (Chen, 2007). Amphioxi are considered rare animals because they inhabit a few scattered locations (Poss and Boschung, 1996), although they can be found globally in shallow, subtidal sand flats in tropical, subtropical and temperate regions (Chen, 2007; Wang *et al.*, 1989). Amphioxus is also listed as Category II protected species in mainland China (Yang *et al.*, 1993).

Project Site

D4.58 Benthos surveys were conducted at 11 sampling sites within the dredging areas or relocation sites for fish rafts (**Figure 4.4**). Representative photographs of benthos surveys and sediment at the sampling sites are presented in **Annex D6** and **Annex D7** respectively.

D4.59 A total of 2,106 and 42 specimens were collected in the dry and wet surveys, respectively. Collected taxa included annelids, mollusks, crustaceans, echinoderms, cnidarians, amphipods, platyhelminthes and nemerteans, dominated by polychaetes and mollusks. No rare species or species of conservation importance were observed. Details results of the benthos surveys are presented in **Annex D8**.

D4.60 In Yim Tin Tsai (Sites B1-B5 & B10), the total number of species, and species diversity *H'* ranged 5-25 spp./0.3 m^2 and 1.14-2.41 among the sampling sites in dry season, and 1-3 spp./0.3 m^2 and 0.33-0.66 at Sites B4, B5 and B10 in wet season. In Yim Tin Tsai (East), the *J* ranged 0.66-0.74 among the four sampling sites (Sites B6-B9) in dry season, while *H'* and *J* were 1.14 and 0.82 respectively at Site B7 in wet season. A summary of the results of benthos surveys is shown in **Table D6**.

D4.61 In the current surveys, the areas of Yim Tin Tsai and Yim Tin Tsai (East) were nearly defaunated in wet season, with only few individuals of polychaetes and bivalves found in Sites B4, B5, B7, B8 and B10. The major cause of such an observation is the thermal stratification in summer resulting in serious hypoxia (<2.8 mg/L) in the wet season of year 2009. Similar seasonal change was also reported in territory-wide benthos surveys conducted in 2001 (CityU, 2002). The *H'* at benthos sampling station 104, nearest to Yim Tin Tsai and Yim Tin Tsai (East) dropped sharply from 2.81 in dry season to 0.63 in wet season.

Table D6 Summary Results of Benthos Surveys in Dry and Wet Seasons

	Season	Sampling Sites										
		B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**	**B10**	**B11**
Total Number of Species (spp./0.3 m^2)	dry	25	16	5	7	11	37	35	10	11	/	/
	wet	/	/	/	2	3	/	4	1	/	1	0
Total Abundance (ind./m^2)	dry	1350	673	113	173	407	1590	1747	560	407	/	/
	wet	/	/	/	33	47	/	50	3	/	7	0
Total Biomass (g/m^2)	dry	8.89	0.37	0.03	3.64	6.83	9.91	8.40	9.13	4.30	/	/
	wet	/	/	/	0.07	0.81	/	3.45	0.00	/	0.01	0
Shannon-Weaver Diversity Index *H'*	dry	2.41	1.42	1.14	1.38	1.80	2.62	2.62	1.57	1.57	/	/
	wet	/	/	/	0.33	0.66	/	1.14	X	/	X	X
Pielou's Species Evenness *J*	dry	0.75	0.51	0.71	0.71	0.75	0.73	0.74	0.68	0.66	/	/
	wet	/	/	/	0.47	0.60	/	0.82	X	/	X	X

Notes:
(1) 0.00 = value less than 0.001.
(2) X = The biological parameter cannot be calculated since only one species was found.

D4.62 According to previous local studies, the benthos community was spatially divided into four groups in Hong Kong waters (Tolo Harbour, Eastern and Southern waters, Victoria Harbour and Deep Bay) (Shin *et al.*, 2004; CityU, 2002). The species diversity of benthos community in Yim Tin Tsai and Yim Tin Tsai (East) is similar to that of "Victoria Harbour" and "Tolo Harbour" groups, while the species evenness is also similar to that of "Deep Bay" and "Tolo Harbour" group (**Table D7**). Another comparison was made between the current study and the sampling point (Station 104) of the benthos survey by CityU (2002). The values obtained in the current surveys were lower that the mean values of outer Tolo Harbour (*H'*= 1.72 and *J* = 0.65) in the previous study. In general, the benthos communities in Yim Tin Tsai and Yim Tin Tsai (East) are generally low in species diversity and evenness compared to other Hong Kong's waters, under pollution and eutrophication stress. In which a lower benthic diversity was obtained within FCZs than the nearby waters.

Table D7 Diversity Index (*H'*) and Evenness Index (*J*) of Benthos Communities in Yim Tin Tsai, Yim Tin Tsai (East) and Other Water Zones

	Season	Yim Tin Tsai	Yim Tin Tsai (East)	Tolo Harbour	Eastern and Southern Waters	Victoria Harbour	Deep Bay
		Current Surveys		Study of Shin *et al.*, 2004			
H'	Dry	1.63	2.10	1.36	2.82	1.64	2.32
	Wet	0.49	1.14	1.42	2.87	1.79	1.46
	Overall	**1.06**	**1.62**	**1.39**	**2.85**	**1.72**	**1.89**
J	Dry	0.69	0.70	0.83	0.81	0.44	0.73
	Wet	0.53	0.82	0.73	0.82	0.47	0.53
	Overall	**0.61**	**0.76**	**0.78**	**0.82**	**0.46**	**0.63**

<u>Ecological Importance</u>

D4.63 Based on the available literature and discussion presented above, the ecological values of terrestrial and marine resources within the Assessment Area and the Project Site, have been assessed and evaluated. This assessment follows EIAO-TM Annex 8 Table 2 criteria and is shown in **Tables D8 to D14**.

Table D8 Evaluation of Ecological Significance of Feeding Grounds (Coastal Areas and Fish Rafts) for Ardeids in the Assessment Area

Criteria	**Feeding Grounds for Ardeids**	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour**
Naturalness	Mainly man-made seawalls, with natural coastal shores in the vicinity of Yim Tin Tsai (East) FCZ.	Man-made seawalls at the western and southern Tolo Harbour, with natural shores at the northern and central Tolo Harbour.
Size	Low to moderate. Fish rafts in FCZs, breakwater, and nearby natural boulder shores are potential feeding grounds for ardeids.	Moderate, particularly the long natural shoreline at the northern and central Tolo Harbour.
Diversity	Low to moderate (5 ardeid species)	Moderate (7 ardeid species)
Rarity	Five ardeids were recorded, with Grey Heron, Great Egret and Little Egret found within the	Seven ardeids were previously recorded.

Criteria	Feeding Grounds for Ardeids	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour**
	Project Site.	
Re-creatability	High	Low
Fragmentation	The habitat is not fragmented.	The habitat is not fragmented.
Ecological linkage	Functionally linked to the egretries at Shuen Wan and Yeung Chau.	
Potential value	Low	Low
Nursery ground	No significant record.	No significant record.
Age	Not known.	Not known.
Abundance/ Richness of Wildlife	Low	Low to moderate
Ecological importance	**Low**	**Moderate**

Table D9 Evaluation of Ecological Significance of Intertidal Habitat (Soft Shore) in the Assessment Area

Criteria	Soft Shore	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
Naturalness	Natural, subjected to some human disturbance by recreational uses.	Natural, subjected to some human disturbance by recreational uses.
Size	Small (<0.5 ha), with only 2 small scale sandy shores recorded in the vicinity of the Project Site.	Moderate, with sandy shore / mudflat in Lung Mei, Shuen Wan, Pak Shek Kok and Starfish Bay.
Diversity	Low	Low
Rarity	No rare species recorded.	Three species of conservation interest, Sleepy Goby, Tropical Sand Goby and Grassy Pufferfish were recorded in the subtidal zone in Ting Kok, Lung Mei, Yung Shue O and Lai Chi Chong.
Re-creatability	Low	Low
Fragmentation	The habitat is not fragmented.	The habitats are scattered throughout the Assessment Area.
Ecological linkage	Not functionally linked to any highly valued habitat in close proximity.	
Potential value	Low	Low
Nursery ground	No significant record.	No significant record.
Age	Not known.	Not known.
Abundance/ Richness of Wildlife	Low	Low
Ecological importance	**Low**	**Low to Moderate**

Table D10 Evaluation of Ecological Significance of Intertidal Habitat (Rocky Shore) in the Assessment Area

Criteria	Rocky Shore	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
Naturalness	Mainly artificial seawalls, with	Artificial seawalls at the western

Criteria	Rocky Shore	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
	natural boulder shores in the vicinity of Yim Tin Tsai (East) FCZ.	and southern Tolo Harbour, with natural shores at the northern and central Tolo Harbour, and Tolo Channel area.
Size	Low to moderate	Moderate
Diversity	Moderate, with 72 intertidal species recorded in the three rocky shores in the current surveys.	Low intertidal floral and faunal diversity obtained in the past records.
Rarity	No rare species found.	No rare species found.
Re-creatability	High for artificial seawalls; moderate for natural boulder shores.	High for artificial seawalls; moderate for natural boulder shores.
Fragmentation	The habitat is not fragmented.	The habitat is not fragmented.
Ecological linkage	Not functionally linked to any highly valued habitat in close proximity.	
Potential value	Low	Low
Nursery ground	No significant record.	No significant record.
Age	Not known.	Not known.
Abundance/ Richness of Wildlife	Low to moderate, with average of 223.4 ind./m^2 of mobile intertidal fauna found in natural boulder shores.	Low
Ecological importance	**Low to Moderate**	**Low**

Table D11 Evaluation of Ecological Significance of Intertidal Habitat (Mangrove) in the Assessment Area

Criteria	Mangrove	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
Naturalness	Natural, under pressure from pollution and human disturbance by clam collection activities.	Natural, subjected to some human disturbance by clam collection activities.
Size	Small (~2 ha), with only two mangrove stands at Sam Mun Tsai and Shuen Wan.	Moderate (~21 ha). Thirteen stands were recorded throughout Tolo Harbour and Tolo Channel.
Diversity	Low to moderate floral and faunal diversity	Moderate floral diversity and low to moderate faunal diversity
Rarity	No rare floral and faunal species were recorded. As stipulated in the EIAO TM Annex 8, established mangrove stand of any size is considered as important habitat in Hong Kong.	
Re-creatability	Low	Low
Fragmentation	The habitat is not fragmented.	The habitats are scattered throughout the Assessment Area.
Ecological linkage	Not functionally linked to any highly valued habitat in close proximity.	
Potential value	Low to moderate	Moderate
Nursery ground	No significant record.	Nursery and / or breeding ground for fishes, crustaceans and other intertidal fauna, particularly Ting Kok SSSI.
Age	Not known.	Not known.

Criteria	Mangrove	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
Abundance/ Richness of Wildlife	Low to moderate	Moderate
Ecological importance	**Low to Moderate**	**Moderate**

Table D12 Evaluation of Ecological Significance of Intertidal Habitat (Seagrass) in the Assessment Area

Criteria	Seagrass
Naturalness	Natural
Size	Small, with only two patches of seagrass beds in Hoi Ha Wan and Lai Chi Chong.
Diversity	Low, with only one seagrass species *Halophila ovalis* found.
Rarity	No rare seagrass species was recorded. As stipulated in the EIAO TM Annex 8, established seagrass bed of any size is considered as important habitat in Hong Kong.
Re-creatability	Low. The habitat is not readily to be re-created.
Fragmentation	The habitat is not fragmented.
Ecological linkage	Not functionally linked to any highly valued habitat in close proximity.
Potential value	Moderate
Nursery ground	Nursery and/or breeding ground for horseshoe crabs, fishes, crustaceans and other intertidal fauna.
Age	Not known.
Abundance/ Richness of Wildlife	Low
Ecological importance	**Moderate**

Table D13 Evaluation of Ecological Significance of Subtidal Hard Bottom Habitat in the Assessment Area

Criteria	Subtidal Hard Bottom Habitat		
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour**	**Inner and Outer Tolo Channel**
Naturalness	Mainly artificial at the breakwater of Typhoon Shelter, coasts of Tai Po Shuen Wan Golf Centre, under pressure from water pollution.	Natural	Natural
Size	Low. Corals were previously recorded in the northern Yeung Chau. In the current surveys, corals were recorded adjacent to Shuen Wan Typhoon Shelter, Yim Tin Tsai FCZ and Tai Po Shuen Wan Golf	Moderate. Five coral sites were recorded in Tolo Harbour, including Pak Sha Tau, Whitehead Peninsula, Tai Po, Tai Mei Tuk and Ma Shi Chau.	Large. Eight important coral sites were recorded in Tolo Channel, including Wong Wan Tsui, Fung Wong Wat, Wong Chuk Kok Tsui, South Wong Chuk Kok Tsui, Gruff Head, Moon Island, Coral

Criteria	Subtidal Hard Bottom Habitat		
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour**	**Inner and Outer Tolo Channel**
	Centre.		Beach and Hoi Ha Wan Pier.
Diversity	Low. Only single species of hard corals was recorded.	Low. Three common hard corals, one soft coral and one black coral species were previously recorded.	Moderate to high. Over 51 hard coral species were recorded, with hermatypic corals, soft corals and black corals also found.
Rarity	Only a locally common hard coral species *Oulastrea crispata* was recorded. No rare species found.	Coral community is important habitat in Hong Kong. Three hard coral species and seahorse were previously recorded, with no records of rare species.	Coral community is important habitat in Hong Kong. Seahorse and over 51 hard coral species were previously recorded, with the presence of uncommon corals.
Re-creatability	Moderate	Low	Low
Fragmentation	Fragmented from adjacent homogeneous soft-bottom seabed.		
Ecological linkage	Not functionally linked to any highly valued habitat in close proximity.		
Potential value	Low	Low	Moderate to high
Nursery ground	No significant record.	No significant record.	Nursery and breeding grounds for reef fishes.
Age	Not known.	Not known.	Not known.
Abundance/ Richness of Wildlife	Low, with sparse coral coverage (~1%)	Low with sparse coral coverage (<5%)	Moderate to high coverage (35-72%)
Ecological importance	**Low**	**Low to Moderate**	**Moderate to High**

Table D14 Evaluation of Ecological Significance of Subtidal Soft Bottom Habitat in the Assessment Area

Criteria	Subtidal Soft Bottom Habitat	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
Naturalness	Natural, subject to organic pollution by fish culture activities and historical contamination.	Natural, subject to some human disturbance by trawling activity and organic pollution by the fish culture activities.
Size	Moderate	Large
Diversity	Low	Low to Moderate
Rarity	No rare species found in the current surveys.	*Branchiostoma belcheri* was previously found in Lung Mei.
Re-creatability	High	High
Fragmentation	The habitat is not fragmented.	The habitat is not fragmented.
Ecological linkage	Not functionally linked to any highly valued habitat in close proximity.	
Potential value	Low	Low
Nursery ground	No significant record.	No significant record.
Age	Not known.	Not known.
Abundance/ Richness of wildlife	Low. Average of 113-130 ind./m^2 of benthos species was recorded	Low to Moderate

Criteria	Subtidal Soft Bottom Habitat	
	Within or in Vicinity of the Project Site	**Remaining Part of the Tolo Harbour and Tolo Channel**
	in dry season, but nearly defaunated in wet season.	
Ecological importance	**Low**	**Low to Moderate**

D4.64 The species of conservation interest recorded within the Assessment Area are evaluated in **Table D15**.

Table D15 Species of Conservation Interest Recorded within the Assessment Area

Species/Group	Location	Protection Status	Distribution in HK
Within or In Vicinity of the Project Site			
Single species of *Oulastrea crispata*	Previously recorded in the northern Yeung Chau. Recorded at coasts of Shuen Wan Typhoon Shelter, adjacent to Yim Tin Tsai FCZ and Tai Po Shuen Wan Golf Centre in the current surveys.	Protected under the *Protection of Endangered Species of Animals and Plants Ordinance* (Cap. 586).	Wide range of adaptations to different environmental conditions as well as geographic locations due to its stress-tolerant ability. It is common and widespread in Hong Kong waters.
Tolo Harbour			
Hard coral species, *Oulastrea crispata*, *Cyphastrea serailia* and *Psammocora superficialis*	Previously recorded in Pak Sha Tau, Whitehead peninsula, Tai Po, Tai Mei Tuk and Ma Shi Chau.	Protected under Cap. 586.	Mainly distributed in the eastern or northeastern waters of Hong Kong. All the 3 species were commonly found in Hong Kong.
Amphioxus *Branchiostoma belcheri*	Previously recorded in Lung Mei area.	Class II National Key Protected Species. Categorized as “Endangered” in the China Red Data Book.	Distributed in the eastern waters near Sai Kung (Nam She Wan, Tai Long Wan, Long Ke Wan and Pak Lap Wan).
Seahorse *Hippocampus kuda*	Previously recorded off the Tai Po industrial estate.	It is categorized as “Vulnerable” in the IUCN Red List.	It can be found in reasonable number in Hong Kong eastern waters.
Tolo Channel			
Over 51 species of hard corals	Moderate to high diversity of hard coral species recorded at Wong Wan Tsui, Fung Wong Wat, Wong Chuk Kok Tsui, South Wong Chuk Kok Tsui and Gruff Head as well as Hoi Ha Wan.	Protected under Cap. 586.	Mainly distributed in the eastern or northeastern waters of Hong Kong. Uncommon hard coral species with restricted distribution such as *Micromussa minuta* and *Acanthastrea subechinata* were also recorded.
Seahorse *Hippocampus kuda*	Previously recorded in Wong Chuk Kok Tsui and South Wong Chuk Kok Tsui.	It is categorized as “Vulnerable” in the IUCN Red List.	It can be found in reasonable number in Hong Kong eastern waters.

D5 IDENTIFICATION AND EVALUATION OF ENVIRONMENTAL IMPACTS

Construction Phase

Direct Impact

D5.1 The only predicted direct impacts would be the temporary loss of approximately 40.7 ha of soft bottom and subtidal habitats and associated marine species at the dredging areas due to the dredging activities. The benthos communities found within the dredging areas is considered of low ecological value, with no rare species or species of conservation interest recorded. Moreover, it should be noted that benthos communities of the temporarily affected areas are expected to recolonise the seabed areas after the short period dredging operation (lasts <6 months). In view of the low ecological value of the subtidal soft bottom habitat and temporary nature of the impact, the ecological impact of habitat loss due to dredging activities would be considered minor.

Indirect Impact

Changes in Water Quality

Elevated Suspended Solids

D5.2 The effect of suspended solids (SS) on marine organisms depends on several factors, such as species tolerance, life mode of organisms (sessile or free-swimming), growth form or orientation of sessile organisms and water movement. Sessile filter feeders are susceptible to deleterious impacts from elevated SS in the water column through smothering and clogging of their respiratory and feeding apparatus. Increased turbidity due to elevation in SS may reduce the amount of light reaching beneath the water surface. Lethal (e.g. mortality) and sub-lethal (e.g. slow growth rate and low in reproductive success rate) impacts on marine life may occur. All these impacts may eventually cause the reduction in population size of marine communities/populations.

D5.3 Non-compliance with the SS criteria (10 mg/L) is predicted in the Tolo Harbour near the proposed dredging zones during dredging. With the implementation of silt curtains around the dredging area, the SS elevation arising from this Project could be effectively reduced (**Appendix B**).

Mangroves and Seagrass Beds

D5.4 The seagrass beds at Lai Chi Chong and Hoi Ha Wan are too remote to be affected by the proposed dredging work. Two mangrove stands at Sam Mun Tsai and Shuen Wan are 0.2 km and 1.4 km from the proposed dredging area, respectively. None of the mangrove stands would be directly affected by the proposed dredging activities. In view of the mangrove stands have been subject to high pollution pressure and human disturbance (Tam and Wong, 1997), the indirect water quality impacts arising from the proposed dredging operation to these mangrove stands are thus considered minor in nature. The results from the water quality modelling indicate that no exceedance of WQOs, including elevation of SS would be expected in these important ecological habitats.

Coral Communities

D5.5 Of particular ecological concern, hard corals may be injured by both high SS concentration and high sediment deposition rates. The reduction in light availability due to elevation in SS may kill the photosynthesising symbiotic algae associated with hard corals leading to bleaching of hard corals. Excessive sedimentation stress on the surface of hard coral can adversely affect coral's physical and biological processes, such as feeding and increasing energy expenditure to remove sediment from coral surfaces (Roger, 1990). Mean sedimentation rate and concentration of suspended solids generally tolerated by hard coral are less than 1 to 10 mg/cm^2/day and below 10 mg/ L, respectively (ibis).

D5.6 A sedimentation rate of no more than 0.1 kg/m^2/day has been adopted as the assessment criterion for protecting the corals in Hong Kong based on past relevant approved EIAs such as Tai Po Sewage Treatment Works Stage 5 EIA (DSD, 2004). This sedimentation rate criterion is considered to offer sufficient protection to marine ecological sensitive receivers and is anticipated to guard against unacceptable impacts.

D5.7 There is no marine WQO for SS within the Tolo Harbour and Channel WCZ. To assess impacts associated with SS in the Tolo Harbour, a criterion of 10 mg/L has been adopted and is considered suitable for use in this Study. Using this criterion, if SS levels exceed 10 mg/L at coral sites, adverse impacts would be predicted (and suitable mitigation would be pursued). This criterion was adopted in the approved Tai Po Sewage Treatment Works Stage 5 EIA (DSD, 2004).

▪ In the Vicinity of Project Site

D5.8 A single species of hard coral, *Oulastrea crispata*, was recorded from the coastal subtidal hard substrata in vicinity of the dredging areas in Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ, and in vicinity of the relocation site adjacent to Tai Po Shuen Wan Golf Centre.

D5.9 For the coral colonies along the coasts of the Tai Po Shuen Wan Golf Centre, the predicted SS level is below the sedimentation rate of 10 mg/cm^2/day and SS concentration of 10 mg/L based on the water quality modelling, if mitigated (**Appendix B**). No adverse impact is expected due to the dredging activities with the implementation of silt curtains around the dredging areas. While the anchoring of the fish rafts may also result in sediment plume, however, as the change in water quality impact is very low and short term, the impact of increased SS levels due to the anchoring is considered as acceptable.

D5.10 No coral was recorded within the dredging areas, however, coral colonies of *Oulastrea crispata* were observed at close vicinity, at breakwater of Shuen Wan Typhoon Shelter, southern coast of Shuen Wan Typhoon Shelter and coast at north of Yim Tin Tsai FCZ (~20m, 60m and 100m away respectively) (**Figure 4.5**). With the implementation of silt curtains and closed grab dredging, the water quality impacts due to elevated SS and sedimentation rate are highly reduced, however, still present to these nearby colonies due to a short distance. As discussed above, *Oulastrea crispata* is highly tolerant to turbidity and high sedimentation (Chen *et al.*, 2003; Cleary *et al.*, 2006). Considering its high tolerant and adaptation ability, and temporary nature of the impact, the water quality impacts to this coral species are considered acceptable under the Project. As a precautionary measure, coral monitoring programme for these nearby coral colonies is recommended to monitoring potential water quality impacts to coral colonies during construction phase.

▪ Tolo Harbour and Tolo Channel

D5.11 As discussed above, important coral sites were recorded in Tolo Harbour and Tolo Channel, with the nearest coral site at Tai Mei Tuk of 1.7 km away from the dredging areas.

D5.12 Based on the prediction of the sediment plume modelling (**Appendix B**), full compliance with the WQO for SS elevation and the criteria value for sedimentation rate would be achieved at all the identified coral sites identified in the Tolo Harbour and Channel WCZ. Hence, no adverse effect upon these far field coral sites would be expected from the proposed dredging works.

Seahorse

D5.13 Seahorse was previously recorded at the coasts of Tai Po Industrial Estate of 1.3 km at west of the dredging site. According to the results of the water quality modelling (**Appendix B**), no exceedance of WQO was obtained at the coasts of Tai Po Industrial Estate, no adverse water quality impact is hence expected due to the dredging activities. While the anchoring of the fish rafts at the relocation site may also results in sediment plume, however, as the water quality will return to normal after a short period of time. In addition, unlike sessile marine organisms, seahorse would swim away from affected area and the potential impact on seahorse is thus considered insignificant.

Amphioxus

D5.14 Amphioxus was previously recorded at Lung Mei (~1.7 km away from Project Site). It is vulnerable to increased silt deposition on substratum (Wang *et al.*, 1989; Konsulova, 1992). Its oral cirri could be damaged by elevated SS (>100 mg/L) in water and hence increased SS level has posed threat to the survival of amphioxus (Chen, 2007). Based on the water quality assessment (**Appendix B**), no exceedance of WQO was obtained in Lung Mei, no adverse water quality impact to amphioxus is hence expected due to the dredging activities. Moreover, the anchoring of the fish rafts at the nearest relocation site adjacent to Yeung Chau may also results in localised sediment plume. However, Lung Mei is approximately 1.3 km apart from the relocation site, the increased SS levels due to the anchoring to amphioxus is considered as insignificant.

Ardeids

D5.15 Potential secondary impact on ardeids may result from deterioration of feeding grounds and reduction of food availability within or in vicinity of the Project Site, resulting from deterioration of marine water quality during the dredging operation. Alternative similar habitats, such as temporary relocation sites for the FCZs, man-made seawalls and natural coastal shores within Tolo Harbour, are available and easily accessible to ardeids, which are able to move easily between foraging sites (Carey *et al.*, 2001). Secondary impacts on avifaunal species are hence expected to be minor and acceptable.

Recognised Site of Conservation Interest

D5.16 Ting Kok SSSI is the only marine site of conservation interest within the boundary of 500 m of the Project Site (~1.4 km away from the nearest dredging area). As this SSSI is of high ecological value due to presence of significant mangrove resources, it was identified as sensitive receiver in the water quality model. The results from the modelling (**Appendix B**) indicated that elevation of SS in the water of this SSSI resulting from the Project was undetectable and compliant with the relevant WQO. Hence, the water quality impact to Ting Kok SSSI and the associated ecological resources is not anticipated from the Project.

Release of Pollutants and Contaminants

D5.17 The sediments within the proposed dredging areas, particularly under the existing FCZs are contaminated by organic matters and nutrient generated from the mariculture activities such as feeding operations, excreta and faecal materials produced by fish. Dredging activities disturb the bottom sediment and cause water turbulence which may induce the release of pollutants and contaminants from the seabed sediment into the water column. Increase in level of these pollutants or contaminants could cause lethal or sub-lethal toxic effects to marine fauna within or in vicinity of the dredging areas. The toxic effects the marine fauna would depend on several factors, such as species tolerance, contaminant levels, water flow rate, etc.

D5.18 The release of pollutants and contaminants during the dredging operation was assessed by reviewing the results of elutriate tests and mathematical modelling as detailed in **Appendix B**. The assessment results indicated that elevation of contaminant levels due to the proposed dredging works would be highly localized and minor with implementation of the recommended mitigation measures. No off-site marine water quality impact would be expected and any local water quality impacts will be transient.

Decrease in Dissolved Oxygen

D5.19 With the increased SS concentration in the water column combined with other factors, the dissolved oxygen (DO) in the water column will be reduced. Elevated SS reduces light penetration and lowers the photosynthetic rate of phytoplankton, resulting lower oxygen production. Moreover, dredging activities disturb bottom sediments and cause the release of the inorganic substances from the seabed to the water column. The sudden release of inorganic substances may cause eutrophication and algal bloom. Oxidation of dead algae during decomposition may lead to further oxygen depletion within the water column. With low oxygen levels, benthic organisms unable to tolerate such conditions may suffer hypoxia-induced mortality and stress including reduced feeding and growth rate. DO depletion also has an adverse effect on eggs and larvae of fish, as higher metabolic demand for oxygen are required for the growth at these developmental stages.

D5.20 The WQO standard of not less than 2 mg/L within 2 m of the bottom, or not less than 4 mg/L in the remainder of the water column was adopted under this assessment. Based on the water quality modelling prediction (**Appendix B**), no significant DO depletion was predicted under the unmitigated scenarios. The concurrent dredging activities would cause a maximum DO depletion of less than 0.01 mg/l in Tolo Harbour. Full compliance with the WQO for depth-averaged and bottom DO was predicted in Tolo Harbour. No mixing zone for DO can therefore be identified. No adverse impacts on the DO levels in Tolo Harbour would be expected from the dredging works.

D5.21 Moreover, the temporary mariculture operations will cause increased organic loading to the water column and seabed sediment at the temporary relocation sites for fish rafts. During the mariculture operation, excess fish feeds, excreta and faecal materials produced by fish may resulted in increased organic loading and DO depletion in both the water column and seabed sediment under the fish rafts. Therefore, benthic and subtidal fauna within the relocation sites may be subject to higher stress of hypoxia resulting from the mariculture activities. However, considering the relocation of fish rafts would be temporary in nature (lasts <6 months), the impact of organic pollution due to mariculture at temporary relocation sites would be minor.

<u>Terrestrial Disturbance (Noise and Dust Disturbance)</u>

D5.22 Noise and dust disturbance will be generate during construction stage, potentially affecting the distribution and behaviour of terrestrial fauna and health condition of flora of the adjacent habitats, but will only affect areas adjacent to the Project Site. Areas adjacent to the dredging sites included mainly the developed areas and the two active egretries at Yeung Chau and Shuen Wan.

Egretries and Ardeids

D5.23 During the dredging operation, increased marine traffic and marine works may also cause disturbance impacts on ardeids at the two nearby egretries due to increased background noise. The noise impact assessment (**Appendix A**) indicated that no adverse noise impact was predicted to the noise sensitive receivers within 300 m boundary even in the unmitigated case. With the implementation of good site practice, such as use of well maintained plants, the noise impact due to dredging operation would be further ameliorated. In addition, set against the background of intense human activities in the vicinity of the Project Site and the nearby egretries (particularly Shuen Wan Egretry), the ardeids are considered already well adapted to human disturbance. Considering the high adaptation ability of ardeids, distant from the dredging site (both >500 m away from the nearest dredging site) and temporary nature of the noise impact, the noise impact to the two egretries resulting from dredging activities is considered minor and acceptable.

D5.24 For the Sam Mun Tsai Egretry, it is approximately 300 to 350 m away from the nearest dredging area. However, as discussed above, it was already abandoned since 1991. No impacts to the associated ardeids in this egretry would be expected.

D5.25 Meanwhile, increased marine traffic and marine works may also cause disturbance impacts on the coastal shoreline associated wildlife such as ardeids due to increased background noise and human activities. Set against the background of intense human activities in the Project Site, the ardeids are considered already well adapted to human disturbance. It is expected that displacement to the nearby waters for roosting and feeding area may occur temporarily but adverse impact is not anticipated. Moreover, in view of similar habitats, such as temporary relocation sites for the FCZs, man-made seawalls in the western and southern Tolo Harbour, i.e. Tai Po and the mainly natural coastal shores at the northern and central Tolo Harbour, are available in the nearby environment, the disturbance impact resulting from dredging activities is considered minor.

D5.26 Potential secondary impact to waterbirds, particularly ardeids, may result from reduced food availability within or in vicinity of the Project Site, resulting from deterioration of marine water quality during the dredging operation. As discussed above, the affected area with water quality impact is highly localized and small in scale, and alternative similar feeding grounds are available and easily accessible to the waterbirds. Hence, the potential secondary impact to waterbirds is considered minor.

White-bellied Sea Eagle

D5.27 An active nest of White-bellied Sea Eagle was recorded in Yeung Chau at appropriately 600 m at north of the nearest dredging area at Yim Tin Tsai (East) FCZ. During the dredging operation, increased marine traffic and marine works may cause noise disturbance impacts on the breeding pair of White-Bellied Sea Eagle.

D5.28 Dredging operation is a minor construction work involving less Powered Mechanical Equipment, such as dredgers, derrick lighter, tug boats and barge. The noise impact assessment (**Appendix A**) indicated that no adverse noise impact was predicted to the noise sensitive receivers within 300 m boundary even in the unmitigated case. With the implementation of good site practice, such as use of well maintained plants, the noise impact resulted from the dredging operation would be further ameliorated.

D5.29 In addition, with the records of breeding White-bellied Sea Eagles at Green Island and on Pa Tau Kwu, it is believed that the White-bellied Sea Eagles in Hong Kong have certain degree tolerance to disturbance (CEDD, 2002). In which, the breeding White-bellied Sea Eagles recorded on Green Island can be tolerant to background disturbance from helicopter, boats travelling pass, and the urban development at Kennedy Town approximately 600 m away. While the breeding pair at the Pa Tau Kwu woodland can be tolerant to the surrounding disturbance from motor boats, ships, helicopter and aircraft, and the reclamation and construction works of Theme Park at Penny Bay approximately 500 m away. Considering the tolerance ability of local White-bellied Sea Eagle, long distance from the dredging site (>600 m away from the nearest dredging site), and temporary and small scaled disturbance, the noise impact to the breeding White-bellied Sea Eagle at Yeung Chau is considered minor and acceptable.

Other Terrestrial Wildlife

D5.30 Apart from ardeids and waterbirds, other wildlife may also impacted by the noise and dust impacts. As mentioned above, the area in the vicinity of the Project Site is mainly highly disturbed developed area of low ecological value, with no previous record of floral and faunal species of conservation interest. The disturbance impact to the nearby terrestrial habitat and the associated wildlife is considered as minimal. In addition, set against the background of intense human activities in the Project Site, the wildlife is considered already well adapted to human disturbance. Adverse disturbance impact to terrestrial wildlife is not anticipated.

Recognised Site of Conservation Interest

D5.31 The terrestrial disturbance impact at recognised sites of conservation interest within the terrestrial Assessment Area (500 m boundary) and the associated ecological resources, such as mammals and terrestrial invertebrates, is also a concern. Apart from the Yeung Chau and Shuen Wan Egretries, and the abandoned egretry at Sam Mun Tsai, the remaining three sites of conservation interest, Ma Shi Chau Special Area, Yim Tin Tsai and Ma Shi Chau SSSI, and Centre Island SSSI, are mainly of geological interest and landscape value. Since no land-based works will be conducted under the Project, no direct impact would be expected, while disturbance impact to these sites of conservation interest is considered insignificant.

Operation Phase

D5.32 After the construction of the Project, temporary relocated fish rafts will be moved back to the existing FCZs and the mariculture will be re-operated within the boundary of the Yim Tin Tsai and Yim Tin Tsai (East) FCZs. The subtidal habitat of the works areas will be self-restored and no maintenance works would be required under the Project.

D5.33 Nevertheless, the sediment removal of the dredging sites would cause long term positive impacts to the marine environment. There are several localized benefits in this Project in ecological view. They include:

- Improvement of the local water quality and sediment condition to be more suitable for benthic colonization.
- Removal of the anoxic sediments to enable fast recovery of bottom environment within weeks rather than years through decomposition by natural process.
- Removal of the bulk of nutrient trapped in the sediment in the dredging sites can help to reduce the risks of local red tide.
- Removal of trapped nutrient which may be released gradually, affecting the water quality at the dredging sites and the surrounding environment.

Cumulative Impact

D5.34 For terrestrial environment, no major project was identified to be carried out concurrently in the vicinity of the Project Site and within 500 m from the Project Site boundary.

D5.35 For marine environments, two projects involving dredging activities are possibly concurrent to the Project, including:

- Development of a Bathing Beach at Lung Mei, Tai Po (2010 – 2012); and
- Sediment Removal at Yung Shue Au Fish Culture Zone (2010/2011).

D5.36 The project sites of the two possible concurrent projects above are 1.7 km and >5 km away from this Project Site, respectively. Cumulative impact on water quality change due to the Project and the two concurrent projects has been considered in the Water Quality Impact Assessment (**Appendix B**). The assessment results indicated that the water quality influence zones for this Project would be highly localized and would not contribute any significant cumulative water quality impacts with the two possible concurrent projects (details refer to Sections B5.56 to B5.57 of **Appendix B**).

Overall Impact

D5.37 Based upon the above discussion, the ecological impacts associated with the Project are considered to be low to low to moderate in construction phase, while no adverse impact would be expected in operation phase. A summary of impact evaluation in construction phase is presented in **Tables D16 to D20**.

Table D16 Evaluation of Ecological Impacts on Feeding Grounds for Ardeids within or in Vicinity of the Project Site

Criteria	**Feeding Grounds for Ardeids**
Habitat quality	Low
Species	Five ardeid species were recorded in the current surveys, with Grey Heron, Great Egret and Little Egret found within the Project Site.
Size/ Abundance	Small. Relocation of fish rafts results in temporary relocation of potential feeding grounds in construction phase. The coastal areas in the vicinity of the Project Site may be impacted by indirect water quality and noise disturbance impacts in construction phase.
Duration	Temporary (lasts <6 months). The fish rafts will be relocated back to the FCZs after dredging activities.
Reversibility	Reversible
Magnitude	Low. In the worst scenario, ardeids are readily to move between foraging sites to nearby alternative feeding grounds.
Overall Impact Conclusion	**Low**

Table D17 Evaluation of Ecological Impacts on Intertidal Habitats (Soft Shore and Rocky Shore) within or in Vicinity of the Project Site

Criteria	**Soft Shore**	**Rocky Shore**
Habitat quality	Low	Low to moderate
Species	Low species diversity, with no rare species.	Low to moderate species diversity, with no rare species.
Size/ Abundance	Small. No direct impact would be anticipated in both construction and operation phases. The soft and rocky shores may be impacted by indirect water quality impact in construction phase.	
Duration	Temporary (lasts <6 months)	Temporary (lasts <6 months)
Reversibility	Reversible	Reversible
Magnitude	Low	Low
Overall Impact Conclusion	**Low**	**Low**

Table D18 Ecological Impacts on Intertidal Habitats (Mangrove and Seagrass) within or in Vicinity of the Project Site

Criteria	**Mangrove**	**Seagrass**
Habitat quality	Low to moderate	Moderate
Species	Low to moderate floral and faunal diversity, with no rare species recorded.	One seagrass species *Halophila ovalis* was recorded.
Size/ Abundance	Small. No direct impact would be anticipated in both construction and operation phases. The mangrove habitat may be impacted by indirect water quality impact in construction phase.	Small. No direct and indirect impact would be anticipated in both construction and operation phases due to the vast distance.
Duration	Temporary (lasts <6 months)	No impact
Reversibility	Reversible	No impact

Criteria	Mangrove	Seagrass
Magnitude	Very low	No impact
Overall Impact Conclusion	**Insignificant**	**Insignificant**

Table D19 Evaluation of Ecological Impacts on Subtidal Hard Bottom Habitat within or in Vicinity of the Project Site

Criteria	Subtidal Hard Bottom Habitat
Habitat quality	Low
Species	Only small and isolated colonies of single hard coral species (*Oulastrea crispata*) was recorded in the current surveys.
Size/ Abundance	Small. No direct impacts would be anticipated in both construction and operation phases. The coral communities in the vicinity of the Project Site may be impacted by increased SS levels due to dredging activities and anchoring of fish rafts in the construction phase.
Duration	Temporary (lasts <6 months)
Reversibility	Reversible
Magnitude	Low
Overall Impact Conclusion	**Low to moderate**

Table D20 Evaluation of Ecological Impacts on Subtidal Soft Bottom Habitat within or in Vicinity of the Project Site

Criteria	Subtidal Soft Bottom Habitat
Habitat quality	Low
Species	Low species diversity, with no rare species recorded.
Size / Abundance	Small. Temporary loss of 40.6 ha of soft bottom seabed in the construction phase. The benthos communities in the vicinity of the Project Site may also be impacted by water quality change due to dredging activities and anchoring of fish rafts in the construction phase.
Duration	Temporary (lasts <6 months)
Reversibility	Reversible. The subtidal habitat within the dredging areas will be self-restored after the construction phase.
Magnitude	Low
Overall Impact Conclusion	**Low**

D5.38 Only one species of conservation interest, hard coral *Oulastrea crispata* was recorded in the vicinity of the Project Site. No direct or indirect impacts would be anticipated in operation phase, while ecological impact to this species of conservation interest in construction phase are evaluated and summarised in **Table D21**.

Table D21 Evaluation of Ecological Impacts on Species of Conservation Interest within or in Vicinity of the Project Site

Species/Group	Construction Phase Impact	
	Description	**Evaluation**
Hard coral *Oulastrea crispata* recorded along coasts of Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ (at REA transects T1 to T5)	Dredging activities results in increased SS levels and sediment deposition rates of the adjacent waters. With the implementation of silt curtains, indirect water quality impact on the coral colonies is highly reduced. Moreover, *Oulastrea crispata* is tolerant to high SS levels, the impact is	**Low to moderate**

Species/Group	Construction Phase Impact	
	Description	**Evaluation**
	considered as acceptable.	
Hard coral *Oulastrea crispata* recorded along coasts of the Shuen Wan Golf Centre (at REA transects T6 to T7)	If migrated, no adverse impact is expected due to the dredging activities. While the anchoring of the fish rafts at the nearby relocation site may also result in sediment plume, however, as the change in water quality impact is very low and short term, the impact of increased SS levels to these coral colonies is considered as acceptable.	**Low**

D6 MITIGATION OF ENVIRONMENTAL IMPACTS

D6.1 Following EIAO-TM Annex 16 and EIAO Guidance Note No. 3/2002, mitigation measures are discussed in this section to avoid, minimize, and compensate for the identified ecological impacts, in the order of priority. All figures referred in this appendix are attached in the main text of this Project Profile.

Avoidance

D6.2 Refer to the results of the current REA surveys, coral colonies within the Project Site (at REA transects T2 to T5) were mainly recorded at rocks / boulders of the edge structures along the southeastern shore and breakwater of Shuen Wan Typhoon Shelter. To avoid direct impact on the coral colonies and impact to stability of the edge structures, the dredging area in Shuen Wan Typhoon Shelter is reduced in size with a reasonable distance away from the existing structures (**Figure 1.7**).

D6.3 To avoid the potential direct impact to coral colonies due to the anchoring of barges, anchoring should be prohibited at the edges of Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ. Anchoring point of the barges should be restricted within the dredging area.

D6.4 The dredging areas are proposed to be as minimum as possible in order to avoid extensive direct impact on existing benthos communities and adjacent intertidal communities within the Project Site.

Minimization

Change in Water Quality

D6.5 To confine sediment plume within the proposed dredging area and minimise indirect impact to the nearby intertidal and subtidal flora and fauna, recommended water quality mitigation measures include:

- Control of production rate for dredging in Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ and Shuen Wan Typhoon Shelter as described in Section B6 of **Appendix B**;
- Dredging will be carried out by closed grab to minimize release of sediment and other contaminants during dredging; and
- Silt curtains will be deployed around the dredging operation to minimise the potential impact from dredging.

D6.6 Standard good site practice and management proposed in the water quality impact assessment (**Appendix B**), such as tight fitting seals to bottom openings of barges / dredgers, effective site drainage, and provision of chemical toilets would be implemented to minimise any impacts to the marine environment resulting from dredging operations, transportation and disposal of dredged sediment in construction phase.

Indirect Impacts to Ardeids, Waterbirds and White-bellied Sea Eagle

D6.7 To minimize potential disturbance impacts on the foraging ardeid population in the Project Site, appropriate good site practices on noise control shall be adopted during the dredging works to reduce noise generated from the Project as suggested in the noise impact assessment (**Appendix A**).

Indirect Impacts to Corals

D6.8 Coral colonies in close proximity to the proposed dredging sites, Yim Tin Tsai FCZ and Shuen Wan Typhoon Shelter, would be indirectly impacted by elevated SS resulting from the dredging operation. Apart from implementation of silt curtains around the dredgers, a coral monitoring programme is recommended to ensure no adverse and unacceptable impacts to the nearby coral colonies.

D6.9 The coral monitoring programme comprise a Baseline Survey, Impact Monitoring Surveys and a Post-Project Monitoring Survey. The health status of coral colonies would be carefully recorded in each monitoring, including information on sediment cover, coral mortality and bleaching. Coral monitoring results would be evaluated against Action and Limit Levels.

D6.10 To further monitor the potential water quality impact to the nearby coral colonies, a water quality monitoring and audit programme is recommended to ensure that all the recommended water quality mitigation measures are implemented properly (**Appendix B & Annex G**).

D7 EVALUATION OF RESIDUAL ENVIRONMENTAL IMPACTS

D7.1 With the effective implementation of mitigation measures proposed in Section D6, residual impacts to marine ecology are expected to be relatively minor. The residual impact would be the unavoidable temporary loss of soft bottom benthic habitat of 40.6 ha within the proposed dredging areas. However, this habitat and the associated fauna are not considered of particular important in ecological value. Therefore, the temporary loss of soft bottom habitat as a residual impact resulting from the proposed works is considered as minimal and acceptable.

D7.2 The water quality impacts to the 5 nearby coral colonies would be considered as a residual impact after the implementation of mitigation measures. Considering that *Oulastrea crispata* is tolerant to turbid water and high sedimentation (Chen *et al.*, 2003), the residual impact to the nearby coral colonies would be considered acceptable.

D8 ENVIRONMENTAL MONITORING AND AUDIT

Coral Monitoring

D8.1 To monitoring potential indirect water quality impacts to coral colonies in vicinity of the proposed dredging areas, a coral monitoring programme is recommended. The coral monitoring programme comprise a Baseline Survey, Impact Monitoring Surveys and a Post-Project Monitoring Survey. The 5 nearby coral sites constitute the 5 impact monitoring stations in the coral monitoring, with the coral site at Ma Shi Chau North as the control station. At each monitoring station, a minimum of 10 hard coral colonies would be tagged and monitored. The health status of each tagged coral colony would be carefully recorded in each monitoring, including information on sediment cover, coral mortality and bleaching. Coral monitoring results would be evaluated against Action and Limit Levels. The details of coral monitoring programme are discussed in **Annex G**.

Water Quality Monitoring

D8.2 To review the effectiveness of water quality mitigation measures, a water quality monitoring and audit programme is also recommended. If unacceptable water quality impacts are detected, additional measures such as slowing down, or rescheduling of works should be implemented as necessary. Details of water monitoring programme are discussed in **Annex G**.

D9 CONCLUSIONS

D9.1 Bottom sediments at Yim Tin Tsai and Yim Tin Tsai (East) contain a certain amount of organic matter accumulated over the years. The sediment removal would results long term positive impacts to the marine environment by improving the local water quality and sediment condition. The project would reduce the risks of local red tide and provide a more suitable bottom environment for benthic colonization.

D9.2 Only approximately 40.6 ha of soft bottom benthos habitat would be temporarily affected under the Project. Considering that the benthos habitat within the dredging area is of low ecological value, the impact is minimal. With the implementation of water quality mitigation measures, no adverse water quality impact would be resulted under the Project. While the health status of the locally common hard coral, *Oulastrea crispata*, recorded near to the Project Site would be regularly monitored during construction phase.

D9.3 Other indirect impacts arising from the Project would be temporary and minimised with implementation of proper mitigation measures. No unacceptable ecological impact on ecological resources is anticipated.

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ANNEX D1
LIST OF AVIFAUNA RECORDED IN ARDEID SURVEYS

Annex D1 - List of Avifauna Recorded Within the Assessment Area

Common Name*	Scientific Name	Distribution in HK	Level of Concern[1]	Protection Status in China[2]	China Red Data Book	IUCN Red List	16/02/2009				26/05/2009					03/07/2009					TOTAL
							Developed Area	Shrubland	Coastal Area	Fish Raft	Developed Area	Shrubland	Coastal Area	Fish Raft	Egretry	Developed Area	Shrubland	Coastal Area	Fish Raft	Egretry	
Great Cormorant#	*Phalacrocorax carbo*	Common	PRC	-	-	-			1												**1**
Grey Heron#	*Ardea cinerea*	Common	PRC	-	-	-			2												**2**
Great Egret#	*Egretta alba*	Common	PRC (RC)	-	-	-			5	4			13		30			19	2	39	**112**
Little Egret#	*Egretta garzetta*	Common	PRC (RC)	-	-	-			10	12	7		10		20			6	1		**66**
Black-crowned Night Heron#	*Nycticorax nycticorax*	Common	(LC)	-	-	-														3	**3**
Black Kite*#	*Milvus migrans*	Common	(RC)	Class II	-	-	4	2				3	1								**10**
White-bellied Sea Eagle*#	*Haliaeetus leucogaster*	Uncommon	(RC)	Class II	-	-		2													**2**
White-breasted Waterhen#	*Amaurornis phoenicurus*	Common	RC	-	-	-			1												**1**
Common Sandpiper#	*Actitis hypoleucos*	Common	-	-	-	-			1												**1**
Spotted Dove	*Streptopelia chinensis*	Common	-	-	-	-	4	2			9	3	3					5			**26**
Indian Cuckoo	*Cuculus micropterus*	Uncommon	-	-	-	-						3	2								**5**
Common Koel	*Eudynamys scolopacea*	Common	-	-	-	-					4	2	1								**7**
Greater Coucal	*Centropus sinensis*	Common	-	Class II	Vulnerable	-						3									**3**
White-throated Kingfisher#	*Halcyon smyrnensis*	Common	(LC)	-	-	-												1			**1**
Barn Swallow	*Hirundo rustica*	Common	-	-	-	-					1	6	4			1	1				**13**
Red-whiskered Bulbul	*Pycnonotus jocosus*	Abundant	-	-	-	-	22				12	17	1				1				**53**
Chinese Bulbul	*Pycnonotus sinensis*	Abundant	-	-	-	-	24	3			16	11	2				6	2			**64**
Oriental Magpie Robin	*Copsychus saularis*	Abundant	-	-	-	-	3	1			4					1					**9**
Unidentified thrush	-	-	-	-	-	-		1													**1**
Masked Laughingthrush	*Garrulax perspicillatus*	Abundant	-	-	-	-		5			4	9	2				3				**23**
Russet Bush Warbler	*Bradypterus seebohmi*	Rare	-	-	-	-		1													**1**
Zitting Cisticola	*Cisticola juncidis*	Common	LC	-	-	-		2													**2**
Bright-capped Cisticola	*Cisticola exilis*	Scarce	LC	-	-	-		2													**2**
Yellow-bellied Prinia	*Prinia flaviventris*	Common	-	-	-	-		3				8	1				1				**13**
Plain Prinia	*Prinia inornata*	Common	-	-	-	-		2													**2**
Common Tailorbird	*Orthotomus sutorius*	Common	-					1				1					2				**4**
Yellow-browed Warbler	*Phylloscopus inornatus*	Common	-	-	-	-		3													**3**
Great Tit	*Parus major*	Common	-	-	-	-		1													**1**
Fork-tailed Sunbird	*Aethopyga christinae*	Common	-	-	-	-		1													**1**
Japanese White-eye	*Zosterops japonica*	Abundant	-	-	-	-		11				4				1					**16**
Unidentified bunting	-	-	-	-	-	-		2													**2**
White-rumped Munia	*Lonchura striata*	Common	-	-	-	-		2													**2**
Scaly-breasted Munia	*Lonchura punctulata*	Common	-	-	-	-	10	2													**12**
Eurasian Tree Sparrow	*Passer montanus*	Abundant	-	-	-	-	3				8										**11**
Black-collared Starling	*Sturnus nigricollis*	Common	-	-	-	-					1							14			**15**
Crested Myna	*Acridotheres cristatellus*	Common	-	-	-	-												2			**2**
Black Drongo	*Dicrurus macrocercus*	Common	-	-	-	-						1					1				**2**
Common Magpie	*Pica pica*	Common	-	-	-	-	1														**1**
Large-billed Crow	*Corvus macrorhynchus*	Common	-	-	-	-			1			1					3				**5**
Collared Crow#	*Corvus torquatus*	Uncommon	LC	-	-	Near	1		2												**3**

Remarks:
All wild birds are Protected under Wild Animal Protection Ordinance (Cap. 170)
* Protected under Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)
# Wetland-dependent species (including wetland-dependent species and waterbirds)
1. Fellowes et al. (2002); GC=Global concern; RC=Regional Concern; LC=Local Concern; PGC=Potential Global Concern; PRC=Potential Regional Concern.
2. List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989). [國家重點保護野生動物名錄(1989年1月14日林業局及農業部發佈施行)]

ANNEX D2
PHOTOGRAPHIC RECORDS OF INTERTIDAL SURVEYS

Natural boulder shore at Site R1

Natural boulder shore at Site R2

Artificial sloping boulder-mounted seawall at Site R3

Petrolisthes japonicus

Turbellaria

AECOM	Agreement No. CE 26/2008(EP) Environmental Impact Assessment Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters – Investigation	SCALE	N.T.S.	DATE	Nov-09
	Photographic Records of Intertidal Surveys	CHECK	GCCL	DRAWN	HYLI
		JOB NO.	60092461	**DRAWING No.**	Annex D2

ANNEX D3
LIST OF FAUNA AND FLORA RECORDED
IN INTERTIDAL SURVEYS

Annex D3 - List of Flora and Fauna Recorded in the Intertidal Surveys

Floral and Faunal Species Full List

Cyanobacteria
Lyngbya sp.
Chroococcus sp.
Kyrtuthrix maculans

Encrusting Algae
Hildenbrandia occidentalis
Hildenbrandia rubra
Pseudulvella applanata

Erect Algae
Endarachne binghamiae
Gelidium pusillum
Pterocladiella tenuis
Ulva lactuca
Codium sp.

Sea-anemones
Cerianthus filiformis
Haliplanella lineata

Sea-squirt
Styela plicata

Tube-worms
Hydroides spp.
Spirorbis spp.

Chitons
Acanthopleura japonica

Limpets
Cellana grata
Cellana toreuma
Nipponacmea concinna
Patelloida pygmaea
Patelloida saccharina
Siphonaria japonica
Siphonaria laciniosa

Nerita
Nerita albicilla

Periwinkles
Peasiella spp.
Echinolittorina trochoides
Echinolittorina radiata
Echinolittorina vidua
Littoraria articulata

Planaxid Snails
Planaxis sulcatus

Turban Shell/Topshell
Lunella coronata
Monodonta labio
Monodonta neritoides
Chlorostoma argyrostoma

Whelks
Thais clavigera
Thais luteostoma
Morula musiva

Ceriths
Batillaria sp.
Batillaria zonalis

Bivalves
Saccostrea cucullata
Isognomon isognomum
Barbatia virescens
Perna viridis
Septifer virgatus
Asaphis dichotoma
Ervilia sp.
Grafrarium pectinatum
Tapes philippinarum

Barnacles
Capitulum mitella
Balanus amphitrite
Tetraclita japonica

Crabs
Clibanarius virescens
Pagurus dubius
Petrolisthes japonicus
Grapsus albolineatus
Hemigrapsus sanguineus
Epixanthus frontalis
Metopograpsus frontalis
Chasmagnathus sp.
Leptodius exaratus

Sea Slater
Ligia exotica

Shrimp
Alpheus brevicristatus

Sea-urchin
Anthocidaris crassispina

Fish
Synganthidae sp. (pipefish)

Squid
Sepioteuthis lessoniana

Turbellaria
Pseudobiceros hancockanus
Turbellaria sp. 1
Turbellaria sp. 2

Others
amphipods
isopods
Ceratonereis spp.

Total Species No.: 72

Annex D3 - List of Fauna and Flora Recorded in Intertidal Surveys

Survey location: Site R1 (N 22° 27.342 E114° 13.159)
Intertidal type: Natural boulder shore
Transect Length: 6.5 m

Survey Date	**2/26/2009**					**6/5/2009**					**2/26/2009**	**6/5/2009**
Quadrat	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**Walk-through**	**Walk-through**
Cyanobacteria												
Chroococcus sp.									5%			+
Encrusting Algae												
Hildenbrandia rubra	40%	50%	50%	20%					15%`	10%	++	++
Erect Algae												
Endarachne binghamiae											+	
Gelidium pusillum				2%	3%				2%	<1%	++	++
Ulva lactuca											++	
Codium sp.												+
Sea-anemones												
Haliplanella lineata									1	2		++
Tube-worms												
Hydroides spp.									3%		+++	++
Spirorbis spp.					1%				1%		++	++
Chitons												
Acanthopleura japonica											+	
Limpets / False Limpets												
Cellana toreuma									3			++
Nipponacmea concinna			2	3	11			9	19	3	+++	+++
Patelloida pygmaea									2		+	+
Nerites												
Nerita albicilla				5				2	1	1	++	++
Periwinkles												
Peasiella spp.			28	16	3				59		+++	+++
Echinolittorina trochoides												+
Echinolittorina radiata												+
Littoraria articulata								1				+
Planaxid Snails												
Planaxis sulcatus	2	18	39	51	3		15	18	21	4	+++	+++
Turban Shells												
Lunella coronata	1	12	13	13	18		6	4	38	6	+++	+++
Topshells												
Monodonta labio	14		19	23	12	11	39	3	106	1	+++	++++
Whelks												
Thais luteostoma											+	
Morula musiva												++
Ceriths												
Batillaria sp.											++	
Batillaria zonalis											+	+++
Bivalves												
Saccostrea cucullata	1%	3%	20%	15%	40%		10%	5%	5%	5%	+++	+++
Isognomon isognomum											++	+
Barbatia virescens											++	
Septifer virgatus				1%	<1%			<1%	<1%	<1%	++	++
Asaphis dichotoma								1	1			++
Ervilla sp.											++	
Grafrarium pectinatum										1		+
Barnacles												
Balanus amphitrite		<1%	<1%		<1%				<1%	<1%	++	++
Crabs												
Clibanarius virescens											+	+
Petrolisthes japonicus					2						++	++
Grapsus albolineatus											+	++
Hemigrapsus sanguineus					1		1	1	3		+	++
Metopograpsus frontalis												+
Leptodius exaratus												+
Sea Slaters												
Ligia exotica	1	5				3	1	3	3		++	++
Fish												
Synganthidae sp. (pipefish)												++
Squids												
Sepioteuthis lessoniana												+
Turbellaria												
Turbellaria sp. 1		1									+	
Turbellaria sp. 2											+	
Others												
Amphipods							3	2	3			++
Isopods											++	

Note: high tide mark – quadrat 1
(Code for Relative Abundance / Coverage: ++++=abundant; +++=frequent; ++=occasional; +=scarce)

Annex D3 - List of Fauna and Flora Recorded in Intertidal Surveys

Survey location: Site R2 (N 22° 27.177', E 114° 12.751')
Intertidal type: Natural boulder shore
Transect Length: 13-17 m

Survey time	2/28/2009									6/5/2009												2/28/2009	6/5/2009
Quadrat	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Walk-through**	**Walk-through**
Cyanobacteria																							
Lyngbya sp.																						+	
Chroococcus sp.										1%		<1%						<1%				++	+
Kyrtuthrix maculans																							+
Encrusting Algae																							
Hildenbrandia occidentalis																		<1%					+
Hildenbrandia rubra	1%	1%	3%	1%	3%	1%	1%	1%	3%	3%	1%	10%	5%	2%	<1%	10%					<1%	++	++
Pseudulvella applanata										2%		3%		2%		<1%							++
Erect Algae																							
Gelidium pusillum				<1%		1%		5%	2%					1%		1%	5%	4%				++	++
Pterocladia tenuis									2%											<1%		+	+
Ulva lactuca		<1%	3%	10%	2%	5%	5%	5%															+
Sea-anemones																							
Haliplanella lineata																			1			+++	+
Sea-squirts																							
Styela plicata								1	1												1	++	+++
Tube-worms																							
Hydroides spp.			<1%	<1%	1%		<1%	1%	1%					1%		2%		2%		1%		++	++
Spirorbis spp.				1%		1%	2%	10%	10%					3%		2%		2%		2%		++	++
Chitons																							
Acanthopleura japonica																							+
Limpets / False Limpets																							
Cellana grata																							++
Nipponacmea concinna		1		3	3	1	10	5	20					5		1		1				+++	++
Patelloida pygmaea									1													+	
Patelloida saccharina																						+	
Periwinkles																							
Peasiella spp.					1					21				24		2						+++	+++
Echinolittorina trochoides																							++
Echinolittorina radiata																							++
Echinolittorina vidua																							++
Planaxid Snails																							
Planaxis sulcatus				1			2								1							++	++
Turban Shells																							
Lunella coronata			3	3	1	5	13	14	70				1	3	4	1	13	4	5	28	21	++++	+++
Topshells																							
Monodonta labio		2	6	9	15	17	44	33	16				2	7		1	3	10	13	1		++++	+++
Monodonta neritoides																							++
Whelks																							
Thais luteostoma																							++
Morula musiva																1							+
Ceriths																							
Batillaria zonalis																1				2	1		++
Bivalves																							
Saccostrea cucullata	1%	<1%		5%	1%	1%		20%	25%	3%	<1%	5%		5%	5%	5%	<1%	5%	5%	3%	5%	+++	++
Isognomon isognomum																			<1%			+	+
Barbatia virescens																							+
Septifer virgatus						<1%		<1%	1%	<1%	<1%			<1%		1%		<1%				+	+
Ervilla sp.																							+
Tapes philippinarum											1												+
Barnacles																							
Balanus amphitrite	<1%	<1%	2%	5%	2%	5%	3%	5%	5%	<1%		<1%		1%	<1%	<1%	<1%	2%	5%	<1%		++	++
Tetraclita japonica																							
Crabs																							
Pagurus dubius								1														+	
Hemigrapsus sanguineus						1	2	1											8			++	++
Epixanthus frontalis																							+
Metopograpsus frontalis																							+
Leptodius exaratus																							+
Sea Slaters																							
Ligia exotica											1	2	2										++
Shrimps																							
Alpheus brevicristatus																							+
Turbellaria																							
Pseudobiceros hancockanus																							+
Turbellaria sp. 1																		1					+
Others																							
Amphipods		18	19	30	40	26	26	2	62					5		20	1	11		10	6	+++	++
Isopods																				1		+	+
Ceratonereis spp.								2	1								2	1				++	++

Note: high tide mark – quadrat 1
(Code for Relative Abundance / Coverage: ++++=abundant; +++=frequent; ++=occasional; +=scarce)

Annex D3 - List of Fauna and Flora Recorded in Intertidal Surveys

Survey location: Site R3 (N 22° 27.250', E 114° 11.900')
Intertidal type: Sloping boulder-mounted seawall
Transect Length: 3.5 m

Survey Date	**2/28/2009**			**6/5/2009**			**2/28/2009**	**6/5/2009**
Quadrat	**1**	**2**	**3**	**1**	**2**	**3**	**Walk-through**	**Walk-through**
Cyanobacteria								
Chroococcus sp.							+++	
Kyrtuthrix maculans								+
Encrusting Algae								
Hildenbrandia occidentalis	10%						++	
Hildenbrandia rubra	30%	10%					++	++
Pseudulvella applanata	15%						++	+
Erect Algae								
Gelidium pusillum		10%			40%	20%	++	++
Pterocladia tenuis								+
Ulva lactuca					25%		++	++
Sea-anemones								
Cerianthus filiformis								++
Haliplanella lineata					1			
Sea-squirts								
Styela plicata							+	+++
Tube-worms								
Hydroides spp.							++	++
Spirorbis spp.			3%				++	
Chitons								
Acanthopleura japonica							++	++
Limpets / False Limpets								
Nipponacmea concinna	4	20	10		13	3	++	++
Patelloida pygmaea			2				++	++
Patelloida saccharina			2				++	
Siphonaria japonica							+	++
Siphonaria laciniosa								++
Nerites								
Nerita albicilla							+	
Periwinkles								
Peasiella spp.							+++	
Echinolittorina radiata							++	++
Echinolittorina vidua								++
Littoraria articulata							+	
Planaxid Snails								
Planaxis sulcatus		8			1		++	++
Turban Shells								
Lunella coronata							+++	+
Topshells								
Monodonta labio								++
Monodonta neritoides	1						+	
Chlorostoma argyrostoma						1		+
Whelks								
Thais clavigera							+++	++
Thais luteostoma			2				++	++
Morula musiva		1					+	+
Bivalves								
Saccostrea cucullata	40%	80%	90%		60%	90%	++++	++++
Isognomon isognomum	20%	10%	2%				++	+
Barbatia virescens			<1%				+	++
Perna viridis						5%	++	++
Septifer virgatus					<1%		++	++
Barnacles								
Capitulum mitella								+
Balanus amphitrite			3%			50%	+	++
Tetraclita japonica		<1%					++	
Crabs								
Hemigrapsus sanguineus						2	+++	++
Metopograpsus frontalis			1				+	+++
Chasmagnathus sp.								+
Sea Slaters								
Ligia exotica					2		+	++
Sea-urchins								
Anthocidaris crassispina								+
Others								
Amphipods							++	++
Isopods								
Ceratonereis spp.								

Note: high tide mark – quadrat 1
(Code for Relative Abundance / Coverage: ++++=abundant; +++=frequent; ++=occasional; +=scarce)

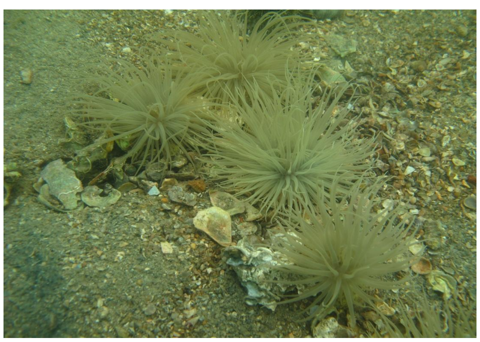
ANNEX D4
PHOTOGRAPHIC RECORDS OF SPOT-CHECK DIVE AND REA CORAL SURVEYS

The artificial sloping at Site C2

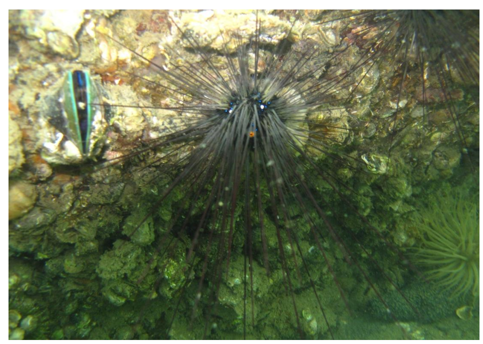
Natural coastline

Bedrocks

Muddy bottom



Actinia equine



Diadema setosum

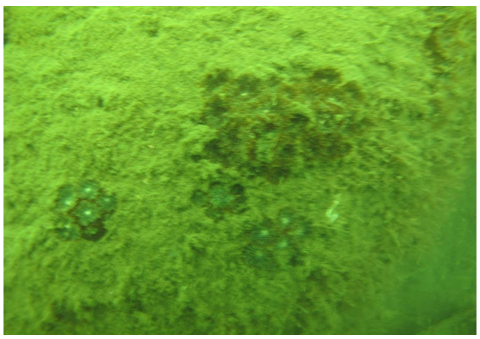
Cerianthus filiformis

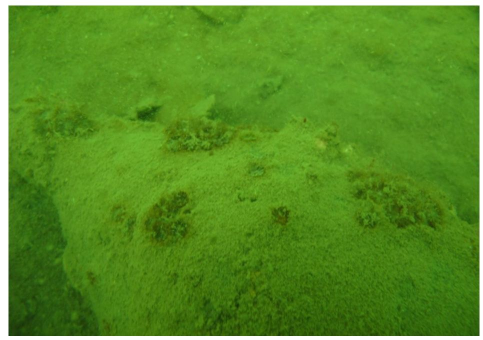
Bursatella leachii

AECOM	Agreement No. CE 26/2008(EP) Environmental Impact Assessment Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters – Investigation	SCALE	N.T.S.	DATE	Nov-09
	Photographic Records of Spot-check Dive and REA Coral Surveys	CHECK	GCCL	DRAWN	HYLI
		JOB NO.	60092461	**DRAWING No.**	Annex D4

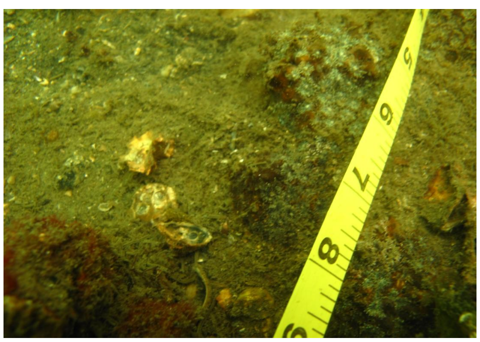
Salmacis sphaeroides

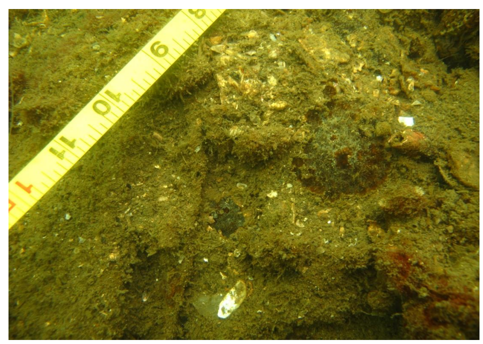
Styela plicata





Oulastrea crispata





Oulastrea crispata

AECOM	Agreement No. CE 26/2008(EP) Environmental Impact Assessment Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters – Investigation	SCALE	N.T.S.	DATE	Nov-09
	Photographic Records of Spot-check Dive and REA Coral Surveys	CHECK	GCCL	DRAWN	HYLI
		JOB NO.	60092461	**DRAWING No.**	Annex D4

ANNEX D5
DETAILED RESULTS OF SPOT-CHECK DIVE AND REA CORAL SURVEYS

1. Spot-check Dives

1.1 The spot-check dives were carried out on 9-17 April 2009 and 26-27 September 2009. The weather conditions were summarized in **Table 1**.

Table 1 Weather Condition for the Spot-Check Dives on 9-17 April 2009 and 26-27 September 2009

Date	Condition	Average Underwater Visibility
9 April 2009	- Wind Speed: East force 5, occasionally force 6 offshore, - Mainly cloudy	0.5 m
10 April 2009	- Wind Speed: East force 5, - Mainly cloudy	0.5 m
11 April 2009	- Wind Speed: East force 5, - Mainly cloudy	0.5 m
12 April 2009	- Wind Speed: East force 3 to 4, - Sunny periods	0.5-1.0 m
13 April 2009	- Wind Speed: Light winds force 2, - Sunny periods and visibility relatively low	1.0-1.5 m
14 April 2009	- Wind Speed: South force 2-3, - Cloudy with occasional rain	0.5-1.0 m
15 April 2009	- Wind Speed: South to southeast force 2-3, - Cloudy with a few showers	0.5-1.0 m
16 April 2009	- Wind Speed: South to southeast force 3-4, - Rain with a few squally thunderstorms	0.5 m
17 April 2009	- Wind Speed: East force 5, occasionally force 6 offshore, - Mainly cloudy	0.5 m
26 September 2009	- Wind Speed: East force 4 to 5 - Sunny period	0.5-1.0 m
27 September 2009	- Wind Speed: East force 5 - Sunny period	0.5-1.0 m

1.2 A total of 21 spot-check dives C1 to C21 were carried out during the 11-day surveys (**Figure 4.5**). The GPS location, maximum depth, bottom substrate and bottom visibility each surveyed sites were summarized in **Table 2**.

Table 2 GPS Location, Route Distance, Maximum Depth Bottom Substrate and Bottom Visibility of Spot-Check Dive Sites C1 to C21

Site	Location (GPS) (Starting Point)	Max. Depth (m)	Bottom Substrate	Visibility (m)
C1	E 114°12'19.7" N 22°27'25.9"	3	Vertical Seawall/Boulder/ Sandy	0.5
C2	E 114°12'33.7" N 22°27'24.3"	2	Slopping Boulder/Rocks/Sandy	0.5
C3	E 114°12'48.3" N 22°27'24.2"	2	Artificial Seawall/Rocks/Sandy	0.5
C4	E 114°12'45.2" N 22°27'10.1"	3	Artificial Seawall/Boulder/Sandy	0.5
C5	E 114°12'33.6" N 22°27'24.1"	4	Boulder/Sandy/Muddy	0.5
C6	E 114°12'32.5" N 22°27'23.6"	6	Boulder/Sandy/Muddy	1.0
C7	E 114°12'30.2" N 22°27'21.9"	7	Sandy/Muddy	1.0
C8	E 114°11'53.8" N 22°27'24.1"	9	Artificial Slopping Boulder/Rock/Muddy	1.0
C9	E 114°13'16.7" N 22°27'37.1"	3.5	Bedrocks/Scattered Boulders/Sandy	1.5
C10	E 114°13'08.9" N 22°27'40.2"	6	Sandy/Muddy	0.5
C11	E 114°13'01.0" N 22°27'39.4"	7	Sandy/Muddy	0.5
C12	E 114°13'06.2" N 22°27'21.5"	3	Bedrocks/Scattered Boulders/Sandy	1.5
C13	E 114°13'01.5" N 22°27'20.3"	2	Bedrocks/Scattered Rocks/Sandy	1.0
C14	E 114°13'09.1" N 22°27'05.5"	2	Bedrocks/Scattered Rocks/Sandy	1.0
C15	E 114°13'35.9" N 22°27'12.2"	3	Bedrocks/Scattered Rocks/Sandy	1.5
C16	E 114°13'19.7" N 22°27'08.5"	7	Muddy	0.5
C17	E 114°13'31.7" N 22°27'13.3"	7	Muddy	0.5
C18	E 114°13'20.4" N 22°26'27.8"	3	Bedrocks/Scattered Boulders/Sandy	1.5
C19	E 114°12'54.4" N 22°26'24.9"	7	Sandy/Muddy	0.5
C20	E 114°11'55.2" N 22°27'12.3"	8	Muddy	0.5
C21	E 114°14'48.9" N 22°27'17.7"	12.5	Bedrocks/Scattered Boulders/Sandy	0.5-1.0

Site C1, Site C3, Site C4, Site C5, Site C6 and Site C8

1.3 These six sites are mainly composed of vertical seawall (Site C1), artificial slopping boulders (Site C5, Site C6 and Site C8), artificial seawalls (Site C3 and Site C4) and sandy bottom. Nature bedrocks (**Annex D4**) (Site C4) and sandy beach (Site C1) were also recorded. Substrates beyond the maximum depth are all muddy (**Annex D4**) and with visibility less than 0.5 m. Sea anemone *Actinia equine*, sea urchin *Diadema setosum*, tunicate *Styela plicata,* common rock oyster *Saccostrea cucullata* and green mussel *Perna viridis* were found at all the six sites. Common tube anemone *Cerianthus filiformis* was found at the muddy bottom of Site C8. Nudibranch *Bursatella leachii* and common green sea urchin *Salmacis sphaeroides* were also recorded at Site C1, Site C3 and Site

C4 (**Annex D4**). All species are commonly found in Hong Kong waters (**Table 4**). Only one species of hard coral *Oulastrea crispata* was found in Site C1, Site C3, Site C4, Site C6 and Site C8 (**Annex D4**). This species is commonly found on Hong Kong waters especially in turbid water. All animals found in the above sites were common species, occurred in low abundance and sparsely distributed. Other than the hard corals found, no rare species or species of conservation value were recorded during the survey. Size range of the *Oulastrea crispata* found in these 5 sites was summarized in **Table 3**. The overall % cover of the corals found in both sites is less than 1.

Table 3 Species, Coverage and Size of Corals Found at Spot-Check Site C1, Site C3, Site C4, Site C6 and Site C8

Site	Coral species	Coverage	Size (Max. Diameter)
1	*Oulastrea crispata*	<1%	2 cm to 10 cm
3	*Oulastrea crispata*	<1%	2 cm to 10 cm
4	*Oulastrea crispata*	<1%	2 cm to 10 cm
6	*Oulastrea crispata*	<1%	2 cm to 10 cm
8	*Oulastrea crispata*	<1%	2 cm to 10 cm

Site C2, Site C9, Site C12, Site C13, Site C14, Site C15, and Site C18

1.4 This 7 sites are mainly composed of natural bedrock and scattered boulders at the bottom (**Annex D4**). The bottom part is mainly composed of smaller size rocks and sand along the 9 sites. Part of Site 2 is composed with artificial concrete sloping and sandy beach along the coastline. Sea anemone *Actinia equine*, Common sea urchin *Diadema setosum* and *Salmacis sphaeroides*, common rock oyster *Saccostrea cucullata*, tunicate *Styela plicata* and common green mussel *Perna viridis* (**Annex D4**) were found in all these 7 sites and they are commonly found in Hong Kong waters (**Table 4**). No hard corals or gorgonian were found in these sites. All animals found in the above sites were common species, occurred in low abundance and sparsely distributed. No rare or species of conservation value were recorded during the survey.

Site C7, Site C10, Site C11, Site C16, Site C17, Site C19, Site 20 and Site 21

1.5 These 8 sites are located inside the existing fish culture area (Site C7, Site C16 and Site C17) or the relocation area (Site C10, Site C11, Site C19, Site C20 and Site C21). The bottom substrates along these 8 sites are mainly composed of sandy and muddy with scattered rocks, except Site C21 with big boulders along the areas close to the shores. Hard substrates such as garbage and plastic buckets were found at the bottom of the fish culture cages (Site C7, Site C16 and Site C17). Sea anemone *Actinia equine*, tunicate *Styela plicata,* common green mussel *Perna viridis* and nudibranch *Bursatella leachii* were commonly found at the fisher culture area. Sea anemone *Actinia equine*, tunicate *Styela plicata,* sea urchins *Diadema setosum* and *Salmacis sphaeroides,* common green mussel *Perna viridis* and common oyster *Saccostrea cucullata* were also recorded at Site C21. Common tube anemone *Cerianthus filiformis* was also recorded at bottom. Common green algae *Ulva* sp. was also recorded (**Table 4**). No hard corals or gorgonian were found in these sites. All animals found in the above sites were common species, occurred in low abundance and sparsely distributed. No rare species or species of conservation value were recorded during the survey.

Table 4 Summary Results of Subtidal Fauna and Hard Corals Recorded in Current Spot-check Dive Surveys

Spot-check Sites	Hard Coral	Dominated Subtidal Fauna							
	Oulastrea crispata	**AE**	**DS**	**SP**	**SC**	**PV**	**SS**	**BL**	**CF**
C1	+	+	+	+	+	+			
C2		+	+	+	+	+	+		
C3	+	+	+	+	+	+	+	+	
C4	+	+	+	+	+	+	+		
C5		+	+	+	+	+			
C6	+	+	+	+	+	+			
C7		+	+	+		+		+	+
C8	+	+	+	+	+				+
C9		+	+	+	+	+	+	+	
C10		+		+					+
C11		+		+					+
C12		+	+	+	+	+	+		
C13		+	+	+	+	+	+		
C14		+	+	+	+	+	+	+	
C15		+	+	+	+	+	+	+	
C16		+	+	+		+		+	+
C17		+	+	+		+		+	+
C18		+	+	+	+	+	+		
C19				+					+
C20				+					+
C21		+	+	+	+	+	+		+

Note:
Species codes: AE = *Actinia equina*, DS = *Diadema setosum*, SP = *Styela plicata*,
SC = *Saccostrea cucullata*, PV = *Perna viridis*, SS = *Salmacis sphaeroides*,
BL = *Bursatella leachii*, CF = *Cerianthus filiformis*.

2. Rapid Ecological Assessment Surveys

2.1 The surveys were performed on 25th – 28th June 2009 for the area. The weather was mainly cloudy with showers and the sea was windy and the visibility was fair (approximately 1 m) (**Table 5**). Seven 100 m transects were laid parallel to the coastline which covered the coral area at the 5 spot-check sites (Sites C1, C3, C4, C6 and C8) (**Table 6** and **Figure 4.5**).

Table 5 Weather Condition for the REA Survey on 25th – 28th June 2009

Date	Condition	Average Underwater Visibility
25 June 2009	- Wind Speed: East force 4 - Cloudy	0.5 - 1 m
26 June 2009	- Wind Speed: East force 5-6 - Rainy and thunder storms	0.5 - 1 m
27 June 2009	- Wind Speed: East force 4-5 - Rainy and thunder storms	0.5 - 1 m
28 June 2009	- Wind Speed: Southwest force 3-4 - Sunny period with a few showers	1 m

Table 6 GPS of Transect Starting and Ending, Maximum Depth, Bottom Substrate and Bottom Visibility of the REA Transects

Transect	Location (GPS) (Starting Point)	Location (GPS) (End Point)	Corresponding Spot-check Site	Max. Depth (m)	Bottom Substrate	Visibility (m)
T1	E 114°12’19.7” N 22°27’25.8”	E 114°12’23.3” N 22°27’26.7”	1	3	Artificial Seawall /Boulders	1
T2	E 114°12’49.9” N 22°27’15.8”	E 114°12’46.4” N 22°27’13.2”	3	2	Artificial Seawall /Boulders	1
T3	E 114°12’43.9” N 22°27’09.2”	E 114°12’40.9” N 22°27’04.2”	4	3	Bedrock/Boulders	0.5
T4	E 114°12’40.6” N 22°27’12.4”	E 114°12’37.7” N 22°27’16.3”	6	6	Artificial Slopping Boulder /Boulders	1
T5	E 114°12’36.7” N 22°27’17.7”	E 114°12’32.9” N 22°27’23.1”	6	6	Artificial Slopping Boulder /Boulders	1
T6	E 114°11’53.9” N 22°27’23.9”	E 114°11’54.1” N 22°27’19.9”	8	7	Artificial Slopping Boulder /Boulders	0.5
T7	E 114°11’54.1” N 22°27’19.4”	E 114°11’53.7” N 22°27’14.4”	8	7	Artificial Seawall /Boulders	0.5

Within the Project Site

Transect T2

2.2 A 100 m transect was laid down along the coastline which covered the coral area at spot check Site C3 (**Figure 4.5**). The start point and end point laid on boulder surfaces and sandy bottom at around 2 m depth.

2.3 This site is located in front of the residential area of Yim Tin Tsai in is which the coastline is mainly built by artificial concrete seawall. The REA transect was laid at the bottom with boulders and sand (**Table 7**). Areas deeper than 2 m were all muddy with visibility less than 0.5 m. The site supported limited marine life and was dominated by some common marine animals such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 7 REA Ecological and Substratum attributes of Transect T2

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	0
Boulder Blocks (diam.>50cm)	2
Boulder Blocks (diam.<50cm)	3
Rubble	0
Other	0
Soft Substrata	0
Sand	2
Mud/Silt	1

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.4 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. 20 *Oulastrea crispata* colonies were found during the REA survey and all of them grow on the boulders and rocks surfaces (**Table 8**). They were of small size (about 2 cm to 10 cm in diameter) and in low coverage.

Table 8 Size, Health Condition and Translocation Feasibility of Coral Colonies found at Transect T2

Coral Number	Coral Species	Size (cm)	Health Condition	Distance along the REA Transect (m)	Translocation Feasibility
1	*Oulastrea crispata*	5	Fair	25.4	Yes
2	*Oulastrea crispata*	2	Fair	29.1	No
3	*Oulastrea crispata*	3	Fair	29.2	Yes
4	*Oulastrea crispata*	5	Fair	29.5	Yes
5	*Oulastrea crispata*	7	Fair	45	Yes
6	*Oulastrea crispata*	10	Fair	48	Yes
7	*Oulastrea crispata*	3	Fair	55.2	Yes
8	*Oulastrea crispata*	5	Fair	55.2	Yes
9	*Oulastrea crispata*	2	Fair	66.1	No
10	*Oulastrea crispata*	2	Fair	66.1	No
11	*Oulastrea crispata*	2	Fair	66.2	No
12	*Oulastrea crispata*	5	Fair	64	Yes
13	*Oulastrea crispata*	2	Fair	69.4	Yes
14	*Oulastrea crispata*	5	Fair	85.2	No
15	*Oulastrea crispata*	6	Fair	87.4	Yes
16	*Oulastrea crispata*	2	Fair	90.1	Yes
17	*Oulastrea crispata*	4	Fair	90.1	Yes
18	*Oulastrea crispata*	6	Fair	95	Yes
19	*Oulastrea crispata*	4	Fair	95.4	Yes
20	*Oulastrea crispata*	9	Fair	95.5	No

2.5 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

Transect T3

2.6 A 100 m transect was laid down along the coastline of Spot-check Site C4 which covered coral area (**Figure 4.5**). The transect was laid at an average depth of 3 m in which the area is mainly composed with boulders and rocks.

2.7 Along the transect area, the substrate is mainly composed of boulders and rocks (**Table 9**). Areas deeper than 4 m were all muddy and sandy with visibility less than 0.5 m. The transect was laid across the artificial seawall and natural coastline at Site C4. The first part of the transect was laid inside the dredging area in Shuen Wan Typhoon Shelter and the distances is around 35 m. The rest of the transect was laid outside the dredging area which mainly composed of natural boulders. The site supported limited marine life and was dominated by some common marine animals such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 9 REA Ecological and Substratum attributes of Transect T3

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	2
Boulder Blocks (diam.>50cm)	3
Boulder Blocks (diam.<50cm)	1
Rubble	0
Other	0
Soft Substrata	0
Sand	1
Mud/Silt	1

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.8 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. 17 *Oulastrea crispata* colonies were found during the REA survey and all of them grow on the boulders and rocks surfaces (**Table 10**). They were of small size (about 2 cm to 10 cm in diameter) and in low coverage.

Table 10 Size, Health Condition and Translocation Feasibility of Coral Colonies found at Transect T3

Coral Number	Coral Species	Size (cm)	Health Condition	Distant Along the REA Transect (m)	Translocation Feasibility
1	*Oulastrea crispata*	3	Fair	15.2	Yes
2	*Oulastrea crispata*	2	Fair	15.2	Yes
3	*Oulastrea crispata*	10	Fair	25	No
4	*Oulastrea crispata*	5	Fair	32	Yes
5	*Oulastrea crispata*	7	Fair	33	Yes
6	*Oulastrea crispata*	4	Fair	33.1	Yes
7	*Oulastrea crispata*	6	Fair	42	Yes
8	*Oulastrea crispata*	5	Fair	45	Yes
9	*Oulastrea crispata*	9	Fair	62.2	Yes
10	*Oulastrea crispata*	7	Fair	62.3	Yes
11	*Oulastrea crispata*	5	Fair	62.4	Yes
12	*Oulastrea crispata*	3	Fair	70	Yes
13	*Oulastrea crispata*	6	Fair	70.8	No
14	*Oulastrea crispata*	2	Fair	77.4	No
15	*Oulastrea crispata*	3	Fair	85.2	Yes
16	*Oulastrea crispata*	4	Fair	85.3	No
17	*Oulastrea crispata*	2	Fair	85.3	Yes

3.15 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

Transect T4

2.9 A 100 m transect was laid down along the coastline of Spot-check Site C6 which covered coral area (**Figure 4.5**). The transect was laid at around 6 m of the artificial sloping boulder-mounted seawall.

2.10 Area long the transect is mainly composed with big sloping boulders and rocks (**Table 11**). Areas deeper than 6 m were all muddy with visibility less than 0.5 m. The site supported limited marine life and was dominated by some common marine animals, such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 11 REA Ecological and Substratum attributes of Transect T4

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	0
Boulder Blocks (diam.>50cm)	4
Boulder Blocks (diam.<50cm)	1
Rubble	0
Other	0
Soft Substrata	0
Sand	0
Mud/Silt	2

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.11 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. 29 *Oulastrea crispata* colonies were found during the REA survey and all of them grow on the boulders and rocks surfaces (**Table 12**). They were of small size (about 2 cm to 10 cm in diameter) and in low coverage.

Table 12 Size, Health Condition and Translocation Feasibility of Coral Colonies found at Transect T4

Coral Number	Coral Species	Size (cm)	Health Condition	Distant Along the REA Transect	Translocation Feasibility
1	*Oulastrea crispata*	3	Fair	5.2	No
2	*Oulastrea crispata*	5	Fair	5.4	No
3	*Oulastrea crispata*	6	Fair	8	No
4	*Oulastrea crispata*	7	Fair	9.2	Yes
5	*Oulastrea crispata*	10	Fair	9.5	Yes
6	*Oulastrea crispata*	6	Fair	18.1	No
7	*Oulastrea crispata*	3	Fair	18.2	No
8	*Oulastrea crispata*	3	Fair	18.2	No
9	*Oulastrea crispata*	10	Fair	25	No
10	*Oulastrea crispata*	6	Fair	25.7	No
11	*Oulastrea crispata*	3	Fair	45.2	No
12	*Oulastrea crispata*	5	Fair	45.3	Yes
13	*Oulastrea crispata*	2	Fair	45.3	Yes
14	*Oulastrea crispata*	2	Fair	45.4	No
15	*Oulastrea crispata*	2	Fair	47.2	Yes

16	*Oulastrea crispata*	4	Fair	47.3	Yes
17	*Oulastrea crispata*	5	Fair	68	No
18	*Oulastrea crispata*	9	Fair	68.5	No
19	*Oulastrea crispata*	2	Fair	77	No
20	*Oulastrea crispata*	10	Fair	78.7	No
21	*Oulastrea crispata*	7	Fair	78.8	Yes
22	*Oulastrea crispata*	7	Fair	79.1	No
23	*Oulastrea crispata*	3	Fair	82.5	No
24	*Oulastrea crispata*	5	Fair	88	No
25	*Oulastrea crispata*	2	Fair	88.5	Yes
26	*Oulastrea crispata*	2	Fair	88.5	Yes
27	*Oulastrea crispata*	5	Fair	88.6	No
28	*Oulastrea crispata*	7	Fair	89	No
29	*Oulastrea crispata*	8	Fair	97.2	No

2.12 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

Transect T5

2.13 A 100 m transect was laid down along the coastline of Spot-check Site C6 which covered coral area (**Figure 4.5**). The transect was laid at around 6 m of the artificial sloping boulder-mounted seawall.

2.14 Similar to Transect 4, the area long the transect is mainly composed with big slopping boulders and rocks (**Table 13**). Areas deeper than 6m were all muddy with visibility less than 0.5 m. The site supported limited marine life and was dominated by some common marine animals such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 13 REA Ecological and Substratum attributes of Transect T5

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	0
Boulder Blocks (diam.>50cm)	4
Boulder Blocks (diam.<50cm)	1
Rubble	0
Other	0
Soft Substrata	0
Sand	0
Mud/Silt	2

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.15 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. 23 *Oulastrea crispata* colonies were found during the REA survey and all of them grow on the boulders and rocks surfaces (**Table 14**). They were of small size (about 2 cm to 10 cm in diameter) and in low coverage.

Table 14 Size, Health Condition and Translocation Feasibility of Coral Colonies found at Transect T5

Coral Number	Coral Species	Size (cm)	Health Condition	Distant Along the REA Transect	Translocation Feasibility
1	*Oulastrea crispata*	5	Fair	2.1	No
2	*Oulastrea crispata*	2	Fair	2.5	No
3	*Oulastrea crispata*	4	Fair	8.9	No
4	*Oulastrea crispata*	3	Fair	8.9	No
5	*Oulastrea crispata*	8	Fair	15	No
6	*Oulastrea crispata*	10	Fair	15.4	Yes
7	*Oulastrea crispata*	9	Fair	15	No
8	*Oulastrea crispata*	3	Fair	42.2	No
9	*Oulastrea crispata*	3	Fair	42.2	No
10	*Oulastrea crispata*	5	Fair	62	No
11	*Oulastrea crispata*	2	Fair	62.1	No
12	*Oulastrea crispata*	2	Fair	62.1	No
13	*Oulastrea crispata*	2	Fair	68	No
14	*Oulastrea crispata*	3	Fair	68	No
15	*Oulastrea crispata*	4	Fair	68.1	No
16	*Oulastrea crispata*	7	Fair	70.1	Yes
17	*Oulastrea crispata*	9	Fair	70.5	No
18	*Oulastrea crispata*	10	Fair	71	Yes
19	*Oulastrea crispata*	6	Fair	74	No
20	*Oulastrea crispata*	7	Fair	74.5	No
21	*Oulastrea crispata*	4	Fair	74.5	No
22	*Oulastrea crispata*	10	Fair	74.8	Yes

2.16 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

In Vicinity of the Project Site

Transect T1

2.17 A 100 m transect was laid down along the vertical seawall of Tai Po Wholesale Fish Market Pier at Spot-check Site C1 at around 3 m depth (**Figure 4.5**). The whole transect were covered the whole vertical seawall and part of the natural boulders.

2.18 This site is mainly composed of vertical seawall and boulders down to 3 m depth along the surveyed route (**Table 15**). Areas deeper than 4 m were all muddy with visibility less than 0.5 m. The site supported limited marine life and was dominated by some common marine animals such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 15 REA Ecological and Substratum attributes of Transect T1

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	0
Boulder Blocks (diam.>50cm)	3
Boulder Blocks (diam.<50cm)	2
Rubble	0
Other	0
Soft Substrata	0
Sand	0
Mud/Silt	2

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.19 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. About 27 *Oulastrea crispata* colonies were found during the REA survey and all of them are located on the boulders and rocks surfaces. They were of small size (about 2 cm to 10 cm in diameter), in low coverage. Most of the coral were found on boulders of the vertical seawall and around 10% of the colonies were attached to movable rocks (less than 50 cm in length).

2.20 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

Transect T6

2.21 A 100 m transect was laid down along the coastline of Spot-check Site C8 which cover the coral area (**Figure 4.5**). The transect was laid at an average depth of 7 m along the bottom part of the artificial sloping boulder-mounted seawall.

2.22 The transect was laid next to the proposed relocation site which is mainly composed of artificial sloping boulders down to 8 m depth along the surveyed route (**Table 16**). Areas deeper than 8 m were all muddy with visibility less than 0.5 m. The site supported limited marine life and was dominated by some common marine animals such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 16 REA Ecological and Substratum attributes of Transect T6

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	0
Boulder Blocks (diam.>50cm)	4
Boulder Blocks (diam.<50cm)	1
Rubble	0
Other	0
Soft Substrata	0
Sand	0
Mud/Silt	2

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.23 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. About 35 *Oulastrea crispata* colonies were found during the REA survey and all of them are located on the boulders and rocks surfaces. They were of small size (about 2 cm to 10 cm in diameter), in low coverage. Most of the coral were found on boulders of the vertical seawall and around 5% of the colonies were attached to movable rocks (less than 50 cm in length).

2.24 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

Transect T7

2.25 A 100 m transect was laid down along the coastline of Spot-check Site C8 which cover the coral area (**Figure 4.5**). The transect was laid at an average depth of 7 m along the bottom part of the artificial sloping boulder-mounted seawall.

2.26 Similar to Transect T6, this transect was laid next to the proposed relocation site which is mainly composed of artificial sloping boulders down to 8 m depth along the surveyed route (**Table 17**). Areas deeper than 8 m were all muddy with visibility less than 0.5 m. The site supported limited marine life and was dominated by some common marine animals such as rock oyster, sea urchin, tunicate, sea anemone and green mussel.

Table 17 REA Ecological and Substratum attributes of Transect T7

Ecological attributes	Rank
Hard coral	0.5
Octocoral (soft corals and gorgonians)	0
Black Corals	0
Dead standing corals	0
Substratum Attributes	
Bedrock/continuous pavement	0
Boulder Blocks (diam.>50cm)	4
Boulder Blocks (diam.<50cm)	1
Rubble	0
Other	0
Soft Substrata	0
Sand	0
Mud/Silt	2

* Rank of percentage cover: 0 = None recorded; 0.5 = 1-5%; 1 = 6-10%; 2 = 11-30 %; 3 = 31-50%; 4= 51-75 %; 5 = 76-100%.

2.27 The site supported a sparse and patchy cover (<1%) of hard coral *Oulastrea crispata*. About 39 *Oulastrea crispata* colonies were found during the REA survey and all of them were located on the boulders and rocks surfaces. They were of small size (about 2 cm to 10 cm in diameter), in low coverage. Most of the coral were found on boulders of the vertical seawall and around 5% of the colonies were attached to movable rocks (less than 50 cm in length).

2.28 *Oulastrea crispata* is a very common species of hard coral found in Hong Kong waters. It is especially adapted to harsh and low visibility environment and it can be found in many places in Hong Kong.

ANNEX D6
PHOTOGRAPHIC RECORDS OF BENTHO SURVEYS


Envrionment around Site B1

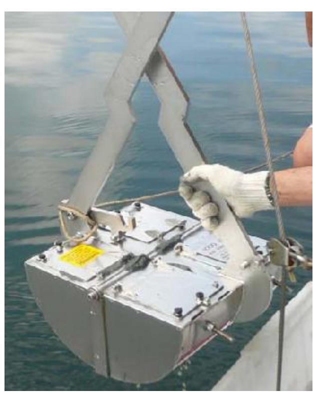

Envrionment around Site B3


Envrionment around Sites B6 & B7


Envrionment around Sites B8 & B9


Envrionment around Sites B10


Envrionment around Sites B11


0.1 m^2 van Veen grab.


The collected sediment was washed with gentle seawater through a wooden box of sieve of mesh size 0.5 mm

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AECOM	Agreement No. CE 26/2008(EP) Environmental Impact Assessment Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters – Investigation	SCALE	N.T.S.	DATE	Nov-09
	Photographic Records of Benthos Surveys	CHECK	GCCL	DRAWN	HYLI
		JOB NO.	60092461	DRAWING No.	Annex D6

The preserved macrofauna in sediment residues was sorted out in laboratory.

Taxonomic identification was undertaken with the aid of both stereoscopic and compound microscopes.

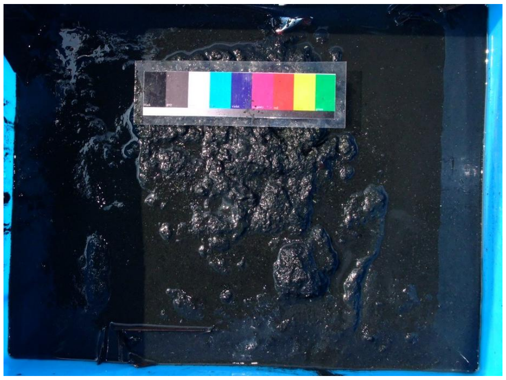
AECOM	Agreement No. CE 26/2008(EP) Environmental Impact Assessment Study for Dredging at 5 Fish Culture Zones and 2 Boat/Typhoon Shelters – Investigation	SCALE	N.T.S.	DATE	Nov-09
	Photographic Records of Benthos Surveys	CHECK	GCCL	DRAWN	HYLI
		JOB NO.	60092461	**DRAWING No.**	Annex D6

ANNEX D7
PHOTOGRAPHIC RECORDS OF SEDIMENT AT SAMPLING SITES OF BENTHOS SURVEYS

Annex D7 - Photographic Records of Sediment at Sampling Sites of Benthos Surveys. See Figure 4.4 for site locations.

Dry Season	Wet Season

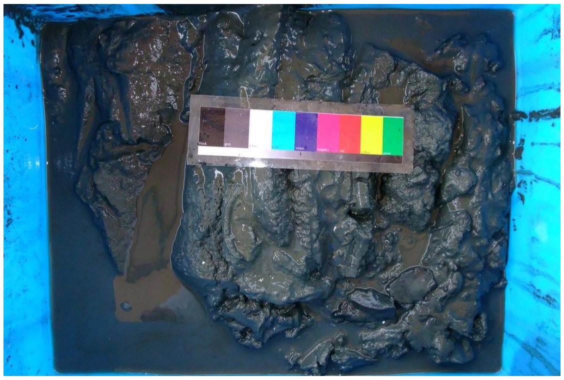
Site B1



Site B2

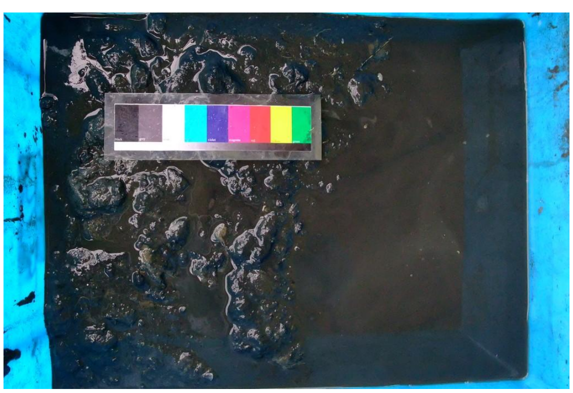
Site B3

Dry Season **Wet Season**




Site B4

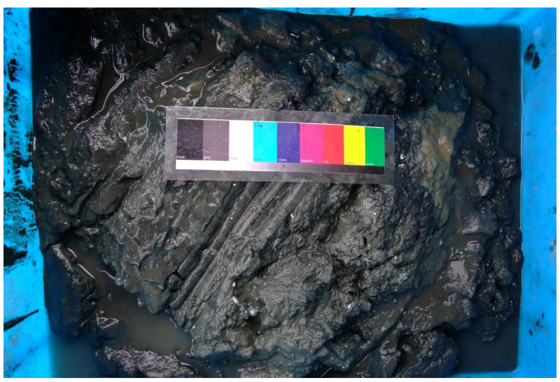

Site B5




Site B6

Dry Season | **Wet Season**


Site B7




Site B8


Site B9

Wet Season

Site B10

Wet Season

Site B11

ANNEX D8
DETAILED RESULTS OF BENTHOS SURVEYS

Annex D8 – Detailed Results of Benthos Surveys

1 Introduction

The aim of present survey is to obtain ecological baseline information on the benthic condition in Yim Tin Tsai and Yim Tin Tsai (East) before the dredging works at fish culture zone and typhoon shelter.

2 Methodologies

2.1 Field sampling

In order to collect comprehensive benthic baseline information in two survey areas Yim Tin Tsai and Yim Tin Tsai (East) in Tolo Harbour, benthos sampling was undertaken at eleven sampling sites (refer to Figure 4.4). In Yim Tin Tsai, three sampling sites were located in the proposed dredging area (B1 in typhoon shelter, B2 and B3 under fish rafts). Three sampling sites were located at vicinities for temporary relocation of fish rafts (B4, B5 & B11). In Yim Tin Tsai (East), two sampling sites were located in the proposed dredging area (B6, B7 under fish rafts). Three sampling sites were located at vicinities for temporary relocation of fish rafts (B8, B9 & B11). The coordinates of the sampling sites were fixed by Global Positioning System (GPS) on board (Table 2.1). The present sampling was conducted in dry season (21th February, 2009) and in wet season (28th June, 2009 & 26th September, 2009).

At every sampling site, three replicates of sediment samples were collected using a 0.1 m^2 van Veen grab. Collected samples were only accepted when at least two-third of grab volume was filled. A photographic record of the sediment texture and colour was taken. The samples were washed with gentle seawater through a wooden box of sieve with 0.5 mm mesh size. Large animals that were visible from the residues were hand-picked into a small plastic vial. All remains were washed and transferred into a plastic container followed by preservation with 70% ethanol solution and staining with 1% Rose Bengal.

2.2 Laboratory work

After arrival to laboratory, the samples were stored for one day to ensure sufficient preservation and staining. The animals collected were sorted out from the sediment residues. For quality assurance, the sediment residues of one-third sorted samples were randomly rechecked. No missed specimen was found in the recheck.

The collected specimens were identified to the lowest taxonomic resolution by a trained specialist. Examination of the morphological features of the specimens was undertaken with the aid of both stereoscopic and compound microscopes. The taxonomic classification was conducted in accordance to the following references: Polychaetes: Day (1967), Gallardo (1967), Fauchald (1977), Yang and Sun (1988), Wu et al. (1997), Sun (2004); Crustaceans: Dai and Yang (1991), Dong (1991); Mollusks: Qi (2004). The number of individuals of each species was recorded by counting the anterior portions of the fauna only. Total biomass of each species was determined as preserved wet weight, after blotting the animals on filter paper for 3 minutes before weighing to the nearest 0.0001 g.

2.3 Data analysis

Data collected from three replicate samples at every sampling site were pooled together for data analysis. Shannon-Weaver Diversity Index (*H'*) and Pielou's Species Evenness (*J*) were calculated using the formulae below,

$H' = -\Sigma (Ni / N) \ln (Ni / N)$ (Shannon and Weaver, 1963)

$J = H' / \ln S$, (Pielou, 1966)

where S is the total number of species in the sample, N is the total number of individuals, and Ni is the number of individuals of the i^{th} species.

Table 2.1. *The GPS coordinates and depths of the sampling sites (in WGS84 datum (ITRF96 Reference Frame))*

Sampling site	Latitude (N)	Longitude (E)	Depth (m)
Yim Tin Tsai			
B1	22° 27.311'	114° 12.711'	6.8
B2	22° 27.204'	114° 12.502'	6.3
B3	22° 27.237'	114° 12.382'	7.0
B4	22° 27.300'	114° 12.019'	7.5
B5	22° 26.354'	114° 12.933'	9.2
B10	22° 27.123'	114° 12.008'	6.6
Yim Tin Tsai (East)			
B6	22° 27.272'	114° 13.353'	6.0
B7	22° 27.218'	114° 13.245'	4.8
B8	22° 27.803'	114° 13.052'	7.2
B9	22° 27.793'	114° 12.868'	7.2
B11	22° 27.376'	114° 14.680'	11.0

3 Results

3.1 Sediment texture and colour

Table 3.1 show the sediment texture and colour at every sampling site in dry and wet seasons. In Yim Tin Tsai, the sediment in the typhoon shelter (B1) was black mud (~90% silt-clay fraction (particle diameter <64μm)) with mild smell of sulphite. The sediments under the fish rafts (B2 and B3) were deep black mud (~80% silt-clay fraction) with pungent sulphite smell. The sediments at B4, B5 and B10 were grey mud (~80% silt-clay fraction) while mild sulphite smell was noticed in wet season.

In Yim Tin Tsai (East), the sediments under the fish rafts (B6 and B7) were black mud (~80% silt-clay fraction). Mild sulphite smell was noticed in dry season and stronger sulphite smell was noticed in wet season. The sediment at B8 was grey mud (~80% silt-clay fraction). Mild sulphite smell was noticed in dry season and stronger sulphite smell was noticed in wet season. The sediment at B9 was black mud (~80% silt-clay fraction) with pungent sulphite smell across seasons. The sediment at B11 was grey mud (~80% silt-clay fraction), mild sulphite smell noticed in wet season.

Lots of mussel shells, tubeworm tubes and garbage were found in the sediment under the fish rafts. It should be the fall off of dead bio-fouler from the fish raft structure (e.g. fish cage, rope) and dumping by fishermen.

3.2 Benthic baseline

Table 3.2 lists the total abundance and total biomass of every faunal group in dry and wet seasons. A total of 2106 and 42 specimens were collected in dry and wet seasons respectively. Fifty one of 55 taxa were identified to genus or species levels. The most diverse phylum was polychaetes (36 species + Aiciopidae spp.) followed by 9 species of mollusk, 4 species of crustacean, 1 species of echinoderm and 1 species of cnidarian. Amphipods, platyhelminthes and nemerteans were classified into three general taxa due to limited taxonomic references. In dry season, 71%, 18%, 9% and 2% of total abundance were polychaetes, mollusks, crustaceans and other phyla respectively. The total biomass was 15.45g, in which 76%, 15% and 9% of total biomass were accounted by mollusks, polychaetes and other phyla respectively. In wet season, 79% and 21% of total abundance were polychaetes and mollusks respectively. The total biomass was 1.30 g, in which 87% and 13% of total biomass were accounted by mollusks and polychaetes respectively. No fauna was collected at B1, B2, B3, B6, B9 and B11.

Table 3.3 shows the percent proportion of each faunal group (in total abundance) at every sampling site in dry and wet seasons. In dry season, polychaete was the most abundant group at all sampling sites except B8 that accounted for 54 to 97% of total abundance. Mollusk was the most abundant group at B8 (52% of total abundance) and was the second abundant group (15-46% of total abundance) at B4, B5, B6 and B9. The crustacean was the second abundant group (11-15% of total abundance) at B1 and B7. Other phyla occupied less than 4% of total abundance at every sampling site. In wet season, polychaete and mollusk were the most and second abundant groups respectively at B4, B5, B7, B8 and B10, although the total abundances were very low. No fauna was collected at other sampling sites.

Table 3.4 shows the total number of species, total abundance, total biomass, *H'* and *J* at all sampling sites in dry and wet seasons. In Yim Tin Tsai, the total number of species, total abundance, total biomass and *H'* ranged 5-25 spp. 0.3 m^{-2}, 113-1350 ind. m^{-2}, 0.03-8.89 g m^{-2} and 1.14-2.41 among the sampling sites n dry season. The *J* at B2 was obviously lower than other four sampling sites. In wet season, the total number of species, total abundance, total biomass, *H'* and *J* ranged 2-3 spp. 0.3 m^{-2}, 33-47 ind. m^{-2}, 0.07-0.81 g m^{-2}, 0.33-0.66 and 0.47-0.60 respectively among B4 and B5. Only 1 species was recorded in B10, while no biological parameter of B1, B2 and B3 could be obtained.

In Yim Tin Tsai (East), the total number of species, total abundance, *H'* at B6 and B7 (mean values: 36 spp. 0.3m^{-2}, 1669 ind. m^{-2}, 2.62 respectively) were obviously higher than that at B8 and B9 (mean values: 10 spp. 0.3m^{-2}, 484 ind. m^{-2}, 1.57 respectively) in dry season. The total biomass and *J* ranged 4.30-8.9.91 g m^{-2} and 0.66-0.74 among the sampling sites and no spatial pattern was noticed. In wet season, the total number of species, total abundance and total biomass ranged 1-4 spp. 0.3 m^{-2}, 3-50 ind. m^{-2} and 0.00-3.45 g m^{-2} respectively among B7 and B8. The *H'* and *J* were 1.14 and 0.82 respectively at B7. The *H'* and *J* of B8 could not be calculated since only one species was found. No biological parameter of B6, B9 and B11 could be obtained.

Table 3.5 lists out the five most abundant species at every sampling site in dry season. In Yim Tin Tsai, B1 was dominated by polychaete *Minuspio cirrifera* (29%), bivalve *Theora lata* (13%) and amphipods (12%). B2 and B3 were dominated by polychaetes *Minuspio cirrifera* (53%) and *Capitella* sp. (mean 31%). B4 was dominated by bivalve *Theora lata* (46%), polychaetes *Otopsis* sp. (23%) and *Rhynchospio* sp. (21%). B5 was dominated by bivalve *Theora lata* (29%), polychaetes *Rhynchospio* sp. (23%) and *Sigambra hanaokai* (23%). In Yim Tin Tsai (East), B6 and B7 were generally dominated by polychaetes *Minuspio cirrifera* (mean 27%), *Sigambra hanaokai* (mean 10%), *Ophelina acuminata* (mean 9%) and bivalve *Theora lata* (mean 11%). B8 and B9 were mainly dominated by bivalve *Theora lata* (mean 48%) while other less dominant species were polychaetes *Rhynchospio* sp. (mean 18%) and *Capitella* sp. (14% at B8). Only polychaete *Sigambra hanaokai* was recorded at B10, while no benthos was found at B11.

Table 3.6 lists out the species at every sampling site in wet season. Polychaete *Sigambra hanaokai* was the major dominant species at B4, B5, B7, B8 and B10 (53-100%). Other fauna were actually low in abundance (<14 ind. m^{-2}) that could not be regarded as dominant species. The complete list of collected specimens is provided in Appendix I.

Table 3.1 *Summary Results of the Sediment Texture and Colour at Benthos Sampling Sites*

	Sampling Sites	% of Silt – Clay Fraction	Sediment Color	Level of Sulphite Smell
Yim Tin Tsai	B1 (typhoon shelter)	~90%	Black	Mild to Strong
	B2 (fish raft)	~80%	Deep black	Strong
	B3 (fish raft)	~80%	Deep black	Strong
	B4 (proposed relocation site)	~80%	Grey	Odourless to Mild
	B5 (proposed relocation site)	~80%	Grey	Odourless to Mild
	B10 (proposed relocation site)	~80%	Grey	Odourless to Mild
Yim Tin Tsai (East)	B6 (fish raft)	~80%	Black	Mild to Strong
	B7 (fish raft)	~80%	Black	Mild to Strong
	B8 (proposed relocation site)	~80%	Grey	Mild to Strong
	B9 (proposed relocation site)	~80%	Grey	Strong
	B11 (proposed relocation site)	~80%	Grey	Odourless to Mild

Table 3.2 Total abundance and total biomass of every faunal group in dry and wet seasons

Faunal group	Total ind.	%	Total biomass (g)	%
Dry season				
Polychaeta	1502	71	2.3389	15
Mollusca	385	18	11.7811	76
Crustacea	181	9	0.5571	4
Nemertea	21	1	0.0823	1
Platyhelminthes	10	0	0.0373	0
Cnidaria	4	0	0.5531	4
Echinodermata	3	0	0.0953	1
Total	2106		15.4451	
Wet season				
Polychaeta	33	79	0.1689	13
Mollusca	9	21	1.1315	87
Total	42		1.3004	

0 %: total individual / biomass of the faunal group is less than 1% of that of all specimens

Table 3.3 The percent proportion of faunal groups (in total abundance) at every sampling site in dry and wet seasons

% proportion of faunal groups	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Dry season											
Polychaeta	69	94	97	54	70	69	78	48	54		
Crustacea	15	2	3			12	11				
Mollusca	15	0		46	30	16	9	52	46		
Nemertea	1				1	2	2				
Cnidaria	0	1				0					
Platyhelminthes		1				1	1				
Echinodermata		0				0	0				
Wet season											
Polychaeta				90	79		67	100		100	
Mollusca				10	21		33	0			

0 %: Percent proportion of the faunal group is less than 1% of total abundance at the sampling site

Table 3.4 Number of species, total abundance, total biomass, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) at every sampling site in dry and wet seasons

		Sampling sites										
	Season	**B 1**	**B 2**	**B 3**	**B 4**	**B 5**	**B 6**	**B 7**	**B 8**	**B 9**	**B 10**	**B 11**
Total number of species (spp. 0.3 m^{-2})	Dry	25	16	5	7	11	37	35	10	11	\	\
	Wet	\	\	\	2	3	\	4	1	\	1	\
Total abundance (ind. m^{-2})	Dry	1350	673	113	173	407	1590	1747	560	407	\	\
	Wet	\	\	\	33	47	\	50	3	\	7	\
Total biomass (g m^{-2})	Dry	8.8903	0.3663	0.0253	3.6393	6.8300	9.9120	8.3977	9.1250	4.2977	\	\
	Wet	\	\	\	0.0683	0.8093	\	3.4477	0.0013	\	0.0080	\
Shannon-Weaver Diversity Index *H'*	Dry	2.41	1.42	1.14	1.38	1.80	2.62	2.62	1.57	1.57	\	\
	Wet	\	\	\	0.33	0.66	\	1.14	X	\	X	\
Pielou's Species Evenness *J*	Dry	0.75	0.51	0.71	0.71	0.75	0.73	0.74	0.68	0.66	\	\
	Wet	\	\	\	0.47	0.60	\	0.82	X	\	X	\

X. The biological parameter cannot be calculated since only one species was found

Table 3.5. **The five most abundant species at every sampling site in dry season**

Sampling site	Group	Species	mean density (ind. m^{-2})	mean biomass (g m^{-2})	relative abundance (%)
B1	P	*Minuspio cirrifera*	390	0.0383	29
	M	*Theora lata*	180	3.8643	13
	C	Amphipod spp.	163	0.0297	12
	P	*Capitella* sp.	130	0.0190	10
	P	*Rhynchospio* sp.	113	0.0367	8
B2	P	*Minuspio cirrifera*	357	0.0480	53
	P	*Capitella* sp.	197	0.0647	29
	P	*Ophiodromus obscura*	30	0.0053	5
	C	Amphipod spp.	17	0.0083	3
	P	*Laonice cirrata*	13	0.0020	2
B3	P	*Minuspio cirrifera*	60	0.0067	53
	P	*Capitella* sp.	37	0.0090	32
	P	*Rhynchospio* sp.	7	0.0087	6
	P	*Ophelina acuminata*	7	0.0007	6
	C	Amphipod spp.	3	0.0003	3
B4	M	*Theora lata*	80	3.5963	46
	P	*Otopsis* sp.	40	0.0187	23
	P	*Rhynchospio* sp.	37	0.0190	21
	P	*Micronephtys sphaerocirrata*	7	0.0010	4
	P	*Capitella* sp.	3	0.0003	2
B5	M	*Theora lata*	117	6.5360	29
	P	*Rhynchospio* sp.	93	0.0883	23
	P	*Sigambra hanaokai*	93	0.1000	23
	P	*Prionospio malmgreni*	37	0.0190	9
	P	*Otopsis* sp.	23	0.0130	6

P = Polychaeta, C = Crustacea, M = Mollusca

Table 3.5 (cont'd). **The five most abundant species at every sampling site in dry season**

Sampling site	Group	Species	mean density (ind. m^{-2})	mean biomass (g m^{-2})	relative abundance (%)
B6	P	*Minuspio cirrifera*	350	0.0477	22
	M	*Theora lata*	237	4.3583	15
	P	*Sigambra hanaokai*	173	0.2657	11
	C	Amphipod spp.	160	0.2007	10
	P	*Ophelina acuminata*	140	0.3193	9
B7	P	*Minuspio cirrifera*	543	0.0550	31
	P	*Ophelina acuminata*	157	0.2767	9
	P	*Sigambra hanaokai*	153	0.2160	9
	M	*Theora lata*	133	2.2963	8
	P	*Rhynchospio* sp.	103	0.0620	6
B8	M	*Theora lata*	290	8.7880	52
	P	*Capitella* sp.	80	0.0770	14
	P	*Minuspio cirrifera*	57	0.0053	10
	P	*Rhynchospio* sp.	53	0.0117	10
	P	*Aglaophamus dibranchis*	27	0.1423	5
B9	M	*Theora lata*	183	3.7713	45
	P	*Rhynchospio* sp.	110	0.0250	27
	P	*Sigambra hanaokai*	43	0.0490	11
	P	*Aglaophamus dibranchis*	20	0.1220	5
	P	*Minuspio cirrifera*	17	0.0017	4

P = Polychaeta, C = Crustacea, M = Mollusca

Table 3.6. **The five most abundant species at every sampling site in wet season**

Sampling site	Group	Species	mean density (ind. m^{-2})	mean biomass (g m^{-2})	relative abundance (%)
B1		N.A.			
B2		N.A.			
B3		N.A.			
B4	P	*Sigambra hanaokai*	30	0.0160	90
	M	*Theora lata*	3	0.0523	10
B5	P	*Sigambra hanaokai*	37	0.0273	79
	M	*Didimacar tenebrica*	7	0.6693	14
	M	*Moerella* sp. 1	3	0.1127	7
B6		N.A.			
B7	P	*Sigambra hanaokai*	27	0.0447	53
	M	*Moerella* sp. 1	13	2.0933	27
	P	*Naineris* sp.	7	0.4657	13
	M	*Anodontia stearnsiana*	3	0.8440	7
B8	P	*Sigambra hanaokai*	3	0.0013	100
B9		N.A.			
B10	P	*Sigambra hanaokai*	7	0.0080	100
B11		N.A.			

P = Polychaeta, M = Mollusca

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Annex D8

Appendix I *List of collected specimens at every sampling site*

Sampling site: B1 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Capitella* sp.	19	0.00	5	0.00	15	0.00	39	0.01
2	P	*Glycinde gurjanovae*	4	0.01	1	0.01			5	0.02
3	P	*Hydroides elegans*					1	0.00	1	0.00
4	P	*Laonome indica*	1	0.00	1	0.00	4	0.01	6	0.01
5	P	*Loimia medusa*					4	0.01	4	0.01
6	P	*Lygdamis* sp.					3	0.00	3	0.00
7	P	*Lysidice ninetta*					6	0.01	6	0.01
8	P	*Micronephtys sphaerocirrata*	18	0.03	2	0.01	6	0.00	26	0.05
9	P	*Minuspio cirrifera*	86	0.01	7	0.00	24	0.00	117	0.01
10	P	*Naineris* sp.	1	0.00			1	0.00	2	0.00
11	P	*Ophiodromus obscura*	2	0.00			5	0.00	7	0.00
12	P	*Phyllodoce* sp. 1	2	0.00	1	0.00			3	0.00
13	P	*Poecilochaetus hystricosus*	6	0.00			2	0.01	8	0.01
14	P	*Prionospio ehlersi*	6	0.00	1	0.00			7	0.00
15	P	*Rhynchospio* sp.	29	0.01	1	0.00	4	0.00	34	0.01

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B1 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
16	P	*Serpula vermicularis*					1	0.00	1	0.00
17	P	*Sigambra hanaokai*	5	0.01			4	0.00	9	0.01
18	P	*Strellospio* sp.	1	0.02			1	0.02	2	0.04
19	C	Amphipod spp.	19	0.00	3	0.00	27	0.01	49	0.01
20	C	*Caprella* sp.	1	0.00			9	0.04	10	0.04
21	C	*Processa japonica*	2	0.05					2	0.05
22	M	*Fulvia aperta*	2	0.34			3	0.62	5	0.96
23	M	*Theora lata*	18	0.21	3	0.14	33	0.82	54	1.16
24	N	Nemertean spp.	4	0.01					4	0.01
25	Cn	*Anthopleura* sp.					1	0.26	1	0.26
Total			226	0.6973	25	0.1661	154	1.8037	405	2.67

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B2 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.3m^2$)	Wet wt. ($g/0.3m^2$)
1	p	Aiciopidae spp.					1	0.00	1	0.00
2	P	*Capitella* sp.	32	0.01	12	0.01	15	0.00	59	0.02
3	P	*Ceratonereis marmorata*	1	0.00	2	0.00			3	0.00
4	P	*Cirriformia* sp.	1	0.00					1	0.00
5	P	*Harmothoe minuta*	1	0.03					1	0.03
6	P	*Laonice cirrata*	4	0.00					4	0.00
7	P	*Lysidice ninetta*	1	0.00					1	0.00
8	P	*Minuspio cirrifera*	84	0.01	13	0.00	10	0.00	107	0.01
9	P	*Naineris* sp.	1	0.00					1	0.00
10	P	*Ophiodromus obscura*	9	0.00					9	0.00
11	P	*Schistomeringos rudolphi*	2	0.00			1	0.01	3	0.01
12	C	Amphipod spp.	2	0.00	2	0.00	1	0.00	5	0.00
13	M	*Theora lata*			1	0.00			1	0.00
14	Pl	Platyhelminthes spp.	3	0.01					3	0.01
15	Cn	*Anthopleura* sp.	2	0.01					2	0.01

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B2 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			($/0.1m^2$)	($g/0.1m^2$)	($/0.1m^2$)	($g/0.1m^2$)	($/0.1m^2$)	($g/0.1m^2$)	($/0.3m^2$)	($g/0.3m^2$)
16	Ec	*Amphioplus lucidus*	1	0.00					1	0.00
Total			144	0.0802	30	0.0152	28	0.0145	202	0.11

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B3 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Capitella* sp.	2	0.00	9	0.00			11	0.00
2	P	*Minuspio cirrifera*			6	0.00	12	0.00	18	0.00
3	P	*Ophelina acuminata*					2	0.00	2	0.00
4	P	*Rhynchospio* sp.					2	0.00	2	0.00
5	C	Amphipod spp.					1	0.00	1	0.00
Total			2	0.0002	15	0.0028	17	0.0046	34	0.01

P = Polychaeta, C = Crustacea

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B4 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Capitella* sp.	1	0.00					1	0.00
2	P	*Lygdamis* sp.			1	0.00			1	0.00
3	P	*Micronephtys sphaerocirrata*					2	0.00	2	0.00
4	P	*Otopsis* sp.	2	0.00	5	0.00	5	0.00	12	0.01
5	P	*Prionospio malmgreni*					1	0.00	1	0.00
6	P	*Rhynchospio* sp.	3	0.00	5	0.00	3	0.00	11	0.01
7	M	*Theora lata*	8	0.47	6	0.19	10	0.41	24	1.08
Total			14	0.4748	17	0.1966	21	0.4204	52	1.09

P = Polychaeta, M = Mollusca

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B5 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.3m^2$)	Wet wt. ($g/0.3m^2$)
1	P	*Laonome indica*			1	0.00			1	0.00
2	P	*Minuspio cirrifera*	3	0.00	4	0.00			7	0.00
3	P	*Otopsis* sp.			5	0.00	2	0.00	7	0.00
4	P	*Paraprionospio pinnata*	1	0.00					1	0.00
5	P	*Prionospio ehlersi*	1	0.00			1	0.00	2	0.00
6	P	*Prionospio malmgreni*			6	0.00	5	0.00	11	0.01
7	P	*Rhynchospio* sp.	8	0.00	11	0.01	9	0.01	28	0.03
8	P	*Sigambra hanaokai*	8	0.01	13	0.00	7	0.02	28	0.03
9	M	*Carditella hanzawai*			1	0.02			1	0.02
10	M	*Theora lata*	9	0.34	17	0.81	9	0.81	35	1.96
11	N	Nemertean spp.	1	0.00					1	0.00
Total			31	0.3524	58	0.8531	33	0.8435	122	2.05

P = Polychaeta, M = Mollusca, N = Nemertea

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B6 Sampling date: 21/02/2009

No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Branchiomma cingulata*			1	0.00			1	0.00
2	P	*Capitella* sp.	4	0.00					4	0.00
3	P	*Ceratonereis marmorata*					1	0.17	1	0.17
4	P	*Cirriformia* sp.					1	0.00	1	0.00
5	P	*Glycinde gurjanovae*	3	0.03	9	0.06	5	0.03	17	0.12
6	P	*Hydroides elegans*			1	0.00			1	0.00
7	P	*Loimia bandera*			1	0.00			1	0.00
8	P	*Loimia medusa*					1	0.02	1	0.02
9	P	*Lysidice ninetta*					1	0.02	1	0.02
10	P	*Micronephtys sphaerocirrata*	1	0.00	1	0.00	2	0.00	4	0.01
11	P	*Minuspio cirrifera*	1	0.00	31	0.00	73	0.01	105	0.01
12	P	*Naineris* sp.					3	0.08	3	0.08
13	P	*Nectoneanthes alatopalpis*	1	0.01			1	0.00	2	0.01
14	P	*Notomastus* sp.	1	0.00	3	0.00	9	0.01	13	0.01
15	P	*Ophelina acuminata*	13	0.03	11	0.01	18	0.06	42	0.10

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B6 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
16	P	*Ophiodromus obscura*			3	0.00	7	0.00	10	0.00
17	P	*Phyllodoce* sp. 1					2	0.00	2	0.00
18	P	*Poecilochaetus hystricosus*	10	0.04	2	0.00	1	0.00	13	0.05
19	P	*Prionospio malmgreni*			5	0.00	16	0.01	21	0.01
20	P	*Pseudopolydora* sp.					1	0.00	1	0.00
21	P	*Rhynchospio* sp.			17	0.01	6	0.00	23	0.02
22	P	*Schistomeringos rudolphi*					1	0.00	1	0.00
23	P	*Sigambra hanaokai*	3	0.01	8	0.01	41	0.06	52	0.08
24	P	*Strellospio* sp.			10	0.17	1	0.04	11	0.21
25	C	*Alpheus* sp. 1					1	0.01	1	0.01
26	C	Amphipod spp.	1	0.00	12	0.02	35	0.04	48	0.06
27	C	*Caprella* sp.			2	0.00	3	0.00	5	0.00
28	C	*Eucrate* sp. 1			1	0.08			1	0.08
29	C	*Processa japonica*	1	0.04	2	0.04			3	0.08
30	M	*Eocylichna musashiensis*					1	0.05	1	0.05

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B6 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
31	M	*Moerella* sp. 1					1	0.01	1	0.01
32	M	*Theora lata*	3	0.12	34	0.57	34	0.62	71	1.31
33	M	*Paphia* sp. 1	1	0.02					1	0.02
34	N	Nemertean spp.	1	0.00	2	0.01	5	0.03	8	0.04
35	Pl	Platyhelminthes spp.			1	0.02	3	0.00	4	0.02
36	Cn	*Anthopleura* sp.			1	0.28			1	0.28
37	Ec	*Amphioplus lucidus*			1	0.09			1	0.09
Total			44	0.3231	159	1.38	274	1.2706	477	2.97

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Cn = Cnidaria, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B7 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.3m^2$)	Wet wt. ($g/0.3m^2$)
1	P	*Branchiomma cingulata*			3	0.01			3	0.01
2	P	*Capitella* sp.	8	0.00	19	0.00	1	0.00	28	0.01
3	P	*Ceratonereis marmorata*			6	0.10	1	0.04	7	0.14
4	P	*Glycinde gurjanovae*	1	0.00	4	0.04	4	0.03	9	0.07
5	P	*Loimia bandera*			4	0.04			4	0.04
6	P	*Loimia medusa*			1	0.01			1	0.01
7	P	*Lysidice ninetta*			2	0.00			2	0.00
8	P	*Mediomastus* sp.			7	0.01			7	0.01
9	P	*Micronephtys sphaerocirrata*	1	0.00	2	0.00			3	0.01
10	P	*Minuspio cirrifera*	20	0.00	129	0.01	14	0.00	163	0.02
11	P	*Naineris* sp.	3	0.02	8	0.04			11	0.06
12	P	*Nectoneanthes alatopalpis*					1	0.00	1	0.00
13	P	*Notomastus* sp.	2	0.00			4	0.00	6	0.00
14	P	*Onuphis eremita*	1	0.00					1	0.00
15	P	*Ophelina acuminata*	2	0.00	39	0.07	6	0.01	47	0.08

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B7 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
16	P	*Ophiodromus obscura*	1	0.00	9	0.03	3	0.00	13	0.03
17	P	*Phyllodoce* sp. 1			2	0.01			2	0.01
18	P	*Poecilochaetus hystricosus*	2	0.00	3	0.00	1	0.00	6	0.01
19	P	*Prionospio malmgreni*	1	0.00	2	0.00	1	0.00	4	0.00
20	P	*Pseudopolydora* sp.					1	0.00	1	0.00
21	P	*Rhynchospio* sp.	1	0.00	29	0.02	1	0.00	31	0.02
22	P	*Schistomeringos rudolphi*			3	0.01			3	0.01
23	P	*Scolelepis squamata*			1	0.00			1	0.00
24	P	*Sigambra hanaokai*	12	0.02	26	0.04	8	0.01	46	0.06
25	P	*Strellospio* sp.			3	0.04	6	0.16	9	0.20
26	C	Amphipod spp.	1	0.00	21	0.03	1	0.00	23	0.03
27	C	*Caprella* sp.			28	0.05			28	0.05
28	C	*Processa japonica*	1	0.02			4	0.12	5	0.14
29	M	*Cultellus scalprum*					1	0.07	1	0.07
30	M	*Fulvia aperta*					1	0.24	1	0.24

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B7 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
31	M	*Moerella* sp. 1			2	0.35	3	0.09	5	0.43
32	M	*Theora lata*	4	0.07	23	0.42	13	0.20	40	0.69
33	N	Nemertean spp.	1	0.01	5	0.03	2	0.01	8	0.04
34	Pl	Platyhelminthes spp.					3	0.01	3	0.01
35	Ec	*Amphioplus lucidus*			1	0.00			1	0.00
Total			62	0.1607	382	1.3672	80	0.9914	524	2.52

P = Polychaeta, C = Crustacea, M = Mollusca, N = Nemertea, Pl = Platyhelminthes, Ec = Echinodermata

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B8 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.3m^2$)	Wet wt. ($g/0.3m^2$)
1	P	*Aglaophamus dibranchis*	3	0.02	2	0.01	3	0.01	8	0.04
2	P	*Capitella* sp.	4	0.01	20	0.02			24	0.02
3	P	*Glycinde gurjanovae*			3	0.01	1	0.01	4	0.01
4	P	*Minuspio cirrifera*	1	0.00	16	0.00			17	0.00
5	P	*Otopsis* sp.	1	0.00					1	0.00
6	P	*Poecilochaetus hystricosus*	2	0.00			1	0.00	3	0.00
7	P	*Rhynchospio* sp.	6	0.00	10	0.00			16	0.00
8	P	*Sigambra hanaokai*	2	0.00	5	0.00			7	0.00
9	M	*Moerella* sp. 1					1	0.01	1	0.01
10	M	*Theora lata*	10	0.36	44	1.32	33	0.97	87	2.64
Total			29	0.3901	100	1.3527	39	0.9947	168	2.74

P = Polychaeta, M = Mollusca

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B9 Sampling date: 21/02/2009										
No	Groups	Species	1		2		3		Total	
			Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.3m^2$)	Wet wt. ($g/0.3m^2$)
1	P	*Aglaophamus dibranchis*	2	0.01	4	0.03			6	0.04
2	P	*Capitella* sp.			2	0.00			2	0.00
3	P	*Ceratonereis marmorata*					1	0.02	1	0.02
4	P	*Minuspio cirrifera*			5	0.00			5	0.00
5	P	*Poecilochaetus hystricosus*			2	0.01	1	0.00	3	0.01
6	P	*Pseudopolydora* sp.			2	0.00			2	0.00
7	P	*Rhynchospio* sp.			31	0.01	2	0.00	33	0.01
8	P	*Sigambra hanaokai*			6	0.01	7	0.00	13	0.01
9	P	*Strellospio* sp.			1	0.07			1	0.07
10	M	*Moerella* sp. 1			1	0.00			1	0.00
11	M	*Theora lata*	4	0.19	37	0.67	14	0.27	55	1.13
Total			6	0.1974	91	0.804	25	0.2879	122	1.29

P = Polychaeta, M = Mollusca

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B1			Sampling date: 28/06/2009							
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
									0	0.00
Total			0	0	0	0	0	0	0	0.00

No specimen was collected.

Sampling site: B2			Sampling date: 28/06/2009							
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
									0	0.00
Total			0	0	0	0	0	0	0	0.00

No specimen was collected.

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B3 Sampling date: 28/06/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
									0	0.00
Total			0	0	0	0	0	0	0	0.00

No specimen was collected.

Sampling site: B4 Sampling date: 28/06/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Sigambra hanaokai*	8	0.00	1	0.00			9	0.00
2	M	*Theora lata*					1	0.02	1	0.02
Total			8	0.0044	1	0.0004	1	0.0157	10	0.02

P = Polychaeta, M = Mollusca

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B5 Sampling date: 28/06/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Sigambra hanaokai*	2	0.00	2	0.00	7	0.01	11	0.01
2	M	*Didimacar tenebrica*	1	0.18			1	0.03	2	0.20
3	M	*Moerella* sp. 1					1	0.03	1	0.03
Total			3	0.1763	2	0.0009	9	0.0656	14	0.24

P = Polychaeta, M = Mollusca

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Sampling site: B6 Sampling date: 28/06/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
									0	0.00
Total			0	0	0	0	0	0	0	0.00

No specimen was collected.

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B7			Sampling date: 28/06/2009							
No	Groups	Species	1		2		3		Total	
			Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.1m^2$)	Wet wt. ($g/0.1m^2$)	Ind. ($/0.3m^2$)	Wet wt. ($g/0.3m^2$)
1	P	*Naineris* sp.					2	0.14	2	0.14
2	P	*Sigambra hanaokai*			2	0.00	6	0.01	8	0.01
3	M	*Anodontia stearnsiana*					1	0.25	1	0.25
4	M	*Moerella* sp. 1	1	0.11	3	0.52			4	0.63
Total			1	0.1104	5	0.5213	9	0.4026	15	1.03

P = Polychaeta, M = Mollusca

Biomass = 0.00 g / $0.1m^2$: The specimen with total biomass less than 0.01 g / $0.1m^2$

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B8 Sampling date: 28/06/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Sigambra hanaokai*	1	0.00					1	0.00
Total			1	0.0004	0	0	0	0	1	0.00

P = Polychaeta

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Sampling site: B9 Sampling date: 28/06/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
									0	0.00
Total			0	0	0	0	0	0	0	0.00

No specimen was collected.

Appendix I (cont'd) *List of collected specimens at every sampling site*

Sampling site: B10 Sampling date: 26/09/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
1	P	*Sigambra hanaokai*			2	0.00			2	0.00
Total			0	0	2	0.0024	0	0	2	0.00

P = Polychaeta

Biomass = 0.00 g / 0.1m^2 : The specimen with total biomass less than 0.01 g / 0.1m^2

Sampling site: B11 Sampling date: 26/09/2009										
No	Groups	Species	1		2		3		Total	
			Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.	Ind.	Wet wt.
			(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.1m^2)	(g/0.1m^2)	(/0.3m^2)	(g/0.3m^2)
									0	0.00
Total			0	0	0	0	0	0	0	0.00

No specimen was collected.

APPENDIX E
FISHERIES IMPACT ASSESSMENT

TABLE OF CONTENTS

List of Tables

E1. INTRODUCTION

E1.1 The proposed works under the Project include marine sediment removal at Yim Tin Tsai and Yim Tin Tsai (East) Fish Culture Zones (FCZs), and maintenance dredging at Shuen Wan Typhoon Shelter. The Project also involves relocation of existing fish rafts at temporary sites (without dredging) for fish rafts. This section presents the potential fisheries impacts generated from the proposed marine work of the Project. All figures referred in this appendix are attached in the main text of this Project Profile.

E2. ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA

E2.1 This fisheries impact assessment is conducted according to criteria and guidelines set out in the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM) Annex 9 and Annex 17 to provide a more complete and objective identification, prediction and evaluation of potential fisheries impacts arising from the Project. EIAO-TM Annex 17 describes the methodology for assessment of fisheries impacts and Annex 9 provides the evaluation criteria.

E2.2 Other local legislation that relevant to fisheries and this fisheries impact assessment includes:

- Fisheries Protection Ordinance (Cap. 171) – aims to promote the conservation of fish and other forms of aquatic life within Hong Kong waters by regulating fishing practises to prevent detrimental activities to the fisheries industry. The Ordinance came into effect on 30 June 1997.
- Marine Fish Culture Ordinance (Cap. 353) – regulates and protects marine fish culture by designating areas as fish culture zones, granting licenses, prohibiting unauthorized vessels, and deposition of chemicals or other substance which are likely to cause injury to fish in a fish culture zone. The list of designated fish culture zones was last revised in January 2000.
- The Water Pollution Control Ordinance (Cap.358) – aims to control water pollution in the waters of Hong Kong. Water control zones are designated with individual water quality objectives to promote conservation and best use of those waters in the public interest. The most updated water quality objectives for the Tolo Harbour and Channel Control Zone were revised in June 1997.

E3. ASSESSMENT METHODOLOGY

E3.1 This impact assessment included relevant fisheries baseline data presented in the Agriculture, Fisheries and Conservation Department (AFCD) Port Survey 2006 (AFCD, 2009b) and incorporated the most recent information available in other reports and publications. The information available was comprehensive and no information gaps were identified, therefore no field surveys were necessary.

E3.2 The impact assessment on capture and culture fisheries resources followed the criteria and guidelines stated in Annexes 9 and 17 of the EIAO-TM. Results of water quality modelling (**Appendix B**) were used to assess the extent and severity of indirect impacts during the dredging works. The water quality model was also used to formulate mitigation measures, if required.

E4. DESCRIPTION OF THE ENVIRONMENT AND BASELINE CONDITIONS

E4.1 The Assessment Area for this fisheries impact assessment is the same as the water quality impact assessment for this Project and includes area within the Tolo Harbour and Channel Water Control Zone (WCZ) (**Figure 1.1**). Based on the review on the available literature, important nursery grounds of commercial fisheries resources were identified within the Assessment Area. While there are four mariculture areas identified in the Assessment Area, with Yim Tin Tsai Fish Culture Zone (FCZ) and Yim Tin Tsai (East) FCZ within the Project Site, and Lo Fu Wat FCZ and Yung Shue Au FCZ, approximately 4 km and 5 km at east of the Project Site, respectively. The locations of the fisheries resources are given in **Figure 4.7**.

Capture Fisheries

E4.2 In 2008, the capture fishing industry landed approximately 158,000 tonnes of fish valued at $1,780 million (AFCD, 2009b). The industry consists of 3,800 fishing vessels and nearly 7,900 fishermen. Fishing activities are mainly conducted in the waters of the continental shelf in South China Sea. The majority of the fishing vessels are manned by family members with the assistance of hired crew. Main fishing methods include trawling, long-lining, gill-netting and purse-seining, with the majority of the catch obtained through trawling. Recent data on local capture fisheries industry are summarized in **Table E1**.

Table E1 Recent Figures on Hong Kong Capture Fisheries Industry

Parameter	2008	2007	2006	2005	2004	2003	2002	2001
Fishing fleet size (No. of vessels)	3,800	4,000	3,950	4,150	4,300	4,600	4,470	5,100
Local fishermen engaged in capture fisheries	7,900	8,500	8,500	9,170	9,700	10,100	10,860	11,560
Production (tonnes)	158,000	154,000	155,000	162,000	167,500	157,400	169,790	174,000
Value of produce (HK$ million)	1,780	1,530	1,600	1,600	1,600	1,500	1,600	1,700

Source: AFCD Departmental Annual Reports, 2001-2008 and AFCD (2009b)

E4.3 The latest AFCD Port Survey 2006 (AFCD, 2009b) provides the most updated and detailed information on capture fisheries in Hong Kong waters, including both fishing operation and fisheries production (adult fish and fry). In general, the highest fishing yields in Hong Kong were obtained in the eastern waters (e.g. Tolo Harbour, Crooked Haven, Port Shelter, and Po Toi) and the southern waters (e.g. Lamma Island, Cheung Chau, and Soko Islands). The areas around Three Fathoms Cove and Sham Chung Wan within the Assessment Area also supported high fisheries resources.

E4.4 The fishing operations within the Assessment Area were mainly conducted by vessels less than 15 m in length. Sampans were the dominant fishing vessels but other vessels, including gill netters, purse seiners, stern trawlers, pair trawlers, shrimp trawlers and long liners were also operated within the Assessment Area. The capture fisheries data for the Assessment Area are summarized in **Table E2**.

Table E2 Summary of Capture Fisheries Data in the Assessment Area

Parameter	Tolo Harbour	Inner Tolo Channel	Outer Tolo Channel	Yim Tin Tsai (dredging sites & relocation sites P1 – P3)	Pak Sha Tau (relocation site P4)
No. of vessels	10 – 400	10 – 400	100 – 400	10 – 400	100 – 400
Adult fish production in terms of weight (kg/ha)	0 – 400	0 – 400	100 – 400	0 – 200	200 – 400
Fish fry production in terms of density (tails/ha)	0 – 50	0 – 500	0 – 100	0 – 50	0 – 50
Fisheries production (adult and fry) in terms of value (HK$/ha)	0 – 5,000	2,000 – 10,000	2,000 – 10,000	500 – 5,000	2,000 – 5,000

Source: Port Survey 2006 (AFCD, 2009b)

E4.5 Compared to other fishing grounds in Hong Kong, the scale of fishing activities, in terms of number of fishing vessels, operating in Yim Tin Tsai and Pak Sha Tau were considered to be moderate (10 – 400 vessels), with similar scale of fishing activities in other parts in the Tolo Harbour and Tolo Channel (10 – 400 vessels).

E4.6 Fisheries production for adult fish in the Tolo Harbour and Channel WCZ was moderate with maximum yield of 200 – 400 kg/ha near Three Fathoms Cove, Sham Chung Wan, and Hoi Ha Wan Marine Park. The Project Site at Pak Sha Tau (relocation site P4, **Figure 4.7**) produced similar yield of 200 - 400 kg/ha, while the Project Site (including the 3 dredging areas and other 3 relocation sites P1 to P3, **Figure 4.7**) at Yim Tin Tsai supported low fisheries production with yield of 0 – 100 kg/ha.

E4.7 The capture fisheries yields of the top 10 taxa within the Assessment Area are tabulated in **Table E3**. The fish production in the Project Site at Yim Tin Tsai was lower than other waters within the Assessment Area, while a higher production was obtained in Pak Sha Tau, the proposed relocation site P1 for the existing fish rafts.

Table E3 Production of the Top 10 Taxa of Fisheries Resources within the Assessment Area

Fish Family	Fish Production – Adult Weight (kg/ha)				
	Tolo Harbour	Inner Tolo Channel	Outer Tolo Channel	Yim Tin Tsai (dredging sites & relocation sites P1 – P3)	Pak Sha Tau (relocation site P4)
Carangidae	0 – 40	10 – 40	0 – 20	< 5	20 – 40
Shrimp (All Families)	< 5	< 5	< 5	< 5	< 5
Siganidae	0 – 40	10 – 40	10 – 60	0 – 20	20 – 40
Squid (All Families)	0 – 20	0 – 20	0 – 20	< 5	10 – 20
Sciaenidae	0 – 20	10 – 20	0 – 20	< 5	10 – 20
Crab (All Families)	0 – 20	10 – 60	0 – 40	0 – 20	10 – 20
Mugilidae	0 – 20	0 – 40	0 – 20	0 – 10	10 – 20
Clupeidae	0 - 20	10 – 20	5 – 20	< 5	10 – 20
Sparidae	0 – 40	10 – 40	10 – 40	0 – 10	20 – 40
Engraulidae	< 5	< 5	< 5	< 5	< 5

Source: Port Survey 2006 (AFCD, 2009b)

E4.8 The most common capture fish in the Project Site and the rest of the Assessment Area was Rabbitfish (Siganidae) (**Table E3**). High production of 40 – 60 kg/ha of this species was recorded in Hoi Ha Wan in outer Tolo Channel, while moderate production (20 - 40 kg/ha) of this species was recorded in Three Fathoms Cove. For the Project Site, moderate yield of 20 – 40 kg/ha was recorded in Pak Sha Tau, while only low yield of 0 – 20 kg/ha was recorded in Yim Tin Tsai area. This species is of relatively low commercial value.

E4.9 The annual capture fisheries production values within the Assessment Area ranged from HK$ 0 – 500/ha to HK$5,000 – 10,000 /ha with the highest production values recorded in Three Fathoms Cove, Sham Chung Wan and Hoi Ha Wan (**Table E2**). While in the Project Site, low to moderate and moderate value of capture fishery production of HK$500 – 5,000 /ha and HK$2,000 – 5,000 /ha were obtained in Yim Tin Tsai and Pak Sha Tau, respectively.

E4.10 Important nursery grounds can be identified from the main areas of fry collection for the mariculture industry. Fry collection in Hong Kong has been much reduced in scale in recent years. The latest interview studies (AFCD, 2008a) reported that fry collection only occurred in a few areas in Hong Kong. Based on the 1989-1991 AFCD Port Survey Data, the whole Assessment Area was important nursery grounds for commercial fisheries resources. However, the Tolo Harbour area (including Yim Tin Tsai and Pak Sha Tau) was no longer important based on an interview programme (ERM, 1998), while only Three Fathoms Cove and Hoi Ha Wan (both >5 km away from the Project Site) in the Assessment Area remained as important nursery grounds of fry collection of >4,000 tails/ha and 3,000 – 4,000 tails/ha, respectively. In the latest AFCD Port Survey 2006 (AFCD, 2009b), high fry collection was also found in Three Fathoms Cove and Hoi Ha Wan, however, the fry production dropped to 50 – 500 tails/ha.

E4.11 According to the “Fisheries Resources and Fishing Operations in Hong Kong Waters” (ERM, 1998), spawning grounds of commercial fisheries resources were identified in the northeast and eastern waters, southeast Hong Kong, south Lamma, south Cheung Chau, and northeast and south Lantau. The Assessment Area is not considered important spawning grounds for capture fisheries.

Culture Fisheries

E4.12 Marine culture fisheries include marine fish culture and oyster culture. Mariculture areas for marine fish included 26 FCZs located in various sheltered coastal areas throughout Hong Kong's marine waters and occupied about 209 ha of marine areas with about 1,060 licensed operators in 2008 (AFCD, 2009a). Most of the licensed farms are small, family-based operations and consist of one to two rafts with average total area of around 280 m^2.

E4.13 Oyster culture has been practiced on the Deep Bay mudflats for at least 200 years. Production from oyster culture in 2008 was about 211 tonnes (meat only) valued at $11 million (AFCD, 2009a). The Deep Bay WCZ is more than 20 km away and separated by the land of the New Territories.

E4.14 There are four FCZs but no oyster culture present in the Assessment Area. Two FCZs at Yim Tin Tsai and Yim Tin Tsai (East) were recorded within the Project Site. While another two FCZs located in Lo Fu Wat (4 km away from the Project Site) and Yung Shue Au (5 km away from the Project Site). The locations of these four FCZs are shown in **Figure 4.7**.

E4.15 Although no figures are available on the individual production of these FCZs, it was estimated that culture fisheries of marine fish production in 2008 was about 1,370 tonnes valued at $82 million which contributed about 10% of local demand for live marine fish (AFCD, 2009a). Recent figures on marine fish culture fisheries are presented in **Table E4**.

Table E4 Recent Figures on Hong Kong Marine Culture Fisheries Industry

	2008	2007	2006	2005	2004	2003	2002	2001
Licensed operator	1,060	1,070	1,078	1,092	1,125	1,155	1,240	1,370
Production (tonnes)	1,370	1,530	1,490	1,540	1,540	1,490	1,211	2,470
Value (HK$ million)	82	99	89	76	79	76	57	136

Source: AFCD Departmental Annual Reports, 2001-2008 and AFCD (2009a)

E4.16 The species cultured in FCZs changed gradually in the recent years depending on the availability of imported fry. Common species include green grouper, brown-spotted grouper, giant grouper, Russell's snapper, mangrove snapper, red snapper, star snapper, and pompano (AFCD, 2009a).

Proposed Fisheries Protection Area

E4.17 A fisheries protection area has been proposed under the Fisheries Protection Ordinance (Cap. 171), covering Tolo Harbour (including the Project Site) and most of Tolo Channel. Designated to provide specific controls on fishing activities, the area would be regarded as a sensitive water body and any impacts should be minimized as far as possible during construction to achieve compliance with the Water Quality Objectives.

Fisheries Importance

E4.18 The importance of fisheries resources within the Assessment Area are addressed based on the baseline information provided above. Fishing areas within Tolo Harbour and Tolo Channel are of moderate to high commercial value generally when compared with other waters in Hong Kong. Whilst, the fishing grounds in the Project Site at Yim Tin Tsai and Pak Sha Tau are of low to moderate commercial values as the fisheries production is dominated by moderate-yield of low-valued Rabbitfish.

Fisheries Sensitive Receivers

E4.19 Based on the fisheries resources in the Assessment Area, the sensitive receivers which may be affected by the proposed dredging works associated with the Project Site are identified (**Figure**

4.7 and **Table E5**).

Table E5 Fisheries Sensitive Receivers within the Assessment Area

Fisheries Sensitive Receiver	**Approximate Distance**	
	From Project Site (dredging and relocation sites)	**From Dredging Area**
Yim Tin Tsai FCZ	Within the Project Site	Within the Dredging Area
Yim Tin Tsai (East) FCZ	Within the Project Site	Within the Dredging Area
Lo Fu Wat FCZ	3.5 km	5.5 km
Yung Shue Au FCZ	4.5 km	6.5 km
Three Fathoms Cove (important nursery grounds for commercial fish resources)	3 km	5 km
Hoi Ha Wan (important nursery grounds for commercial fish resources)	9 km	11 km

E5. IDENTIFICATION, PREDICTION AND EVALUATION OF FISHERIES IMPACTS

Construction Phase

E5.1 The dredging at Yim Tin Tsai and Yim Tin Tsai (East) FCZs, and maintenance dredging at Shuen Wan Typhoon Shelter would involve an approximately 40.6 ha of seabed. Approximately 36 ha would be required for temporary relocation of the existing fish rafts to the waters near Tai Po Shuen Wan Golf Centre, A Chau, Yeung Chau and Pak Sha Tau. The proposed works is tentatively scheduled to commence in March 2010 for completion in July 2010. The potential impacts to the fisheries resources and fish operators within the Assessment Area may include:

- Temporary closure of culture fisheries areas;
- Temporary loss of fishing grounds; and
- Indirect impact on fisheries resources and the livelihood of fisheries operators due to changes in water quality.

Direct Impact

<u>Temporary Closure of Culture Fisheries Areas</u>

E5.2 During the construction phase, dredging activities would be taken place at Yim Tin Tsai FCZ and Yim Tin Tsai (East) FCZ. This results in a temporary closure of about 28.6 ha of marine culture fisheries areas, constituting 13.7% of the total area of marine culture fisheries in Hong Kong. No figures are available on the individual production of these two FCZs, it was estimated that the marine culture fish production of these two affected FCZs was 187.4 tonnes valued at $11.2 million annually, with the average production of 6.6 tonnes valued at $0.39 million per hectares of the local FCZs in 2008 (AFCD, 2009a).

E5.3 However, the closure of culture fisheries areas is temporary and short term. These two FCZ areas would be re-opened for fish culture after construction, while the dredging activities would only last for less than 6 months. Moreover, the mariculture activities can be continuously operated in the existing fish rafts in the relocation sites. In view of the small size of the affected area, the temporary impacts to culture fisheries production due to the proposed dredging activities are considered minor and acceptable. Yet, the water quality of the FCZs would be improved after the Project. This would provide a better environment for the fish culture business, increase fisheries production and improve the livelihood of the fish operators in long term.

Temporary Loss of Fishing Grounds

E5.4 During construction phase, dredging activities would also be taken place at Shuen Wan Typhoon Shelter. This results in a direct loss of area of about 8.7 ha, however no fishing operation is expected within the typhoon shelter. Hence, no adverse impact to the fishing grounds would be anticipated in the dredging sites.

E5.5 Apart from the dredging areas, the four relocation sites P1 to P4 are potential fishing grounds for capture fisheries. During the construction phase, these four areas of about 36 ha will be used for locating the affected fish rafts, no capture fishing can be carried out in these four areas. Based on the Port Survey 2006 (AFCD, 2009b), the directly impacted fisheries area in Yim Tin Tsai (28.6 ha) and Pak Sha Tau (7.48 ha) supported low to moderate fisheries production. The affected fisheries area constitutes an insignificant portion of the total fishing areas in Hong Kong. The loss of fisheries production would be insignificant in comparison to the total fisheries production in Hong Kong.

E5.6 Moreover, the loss of fishing grounds is temporary and in short term (less than 6 months), as the fish rafts would be relocated back to the two FCZ areas and these four relocation sites would be re-opened for fishing operations after construction. The impact of loss of fishing grounds due to the dredging activities under this Project is hence considered to be temporary, reversible and short term.

E5.7 In view of the small size of the affected area, and temporary and insignificant loss of fisheries production, the impacts to the capture fisheries production are considered minor and acceptable under the Project.

Indirect Impact

Changes in Water Quality

E5.8 Potential indirect impacts to the fisheries resources would include changes in water quality due to dredging activities for sediment removal and maintenance.

Elevation of Suspended Solids (SS)

E5.9 Dredging activities would temporarily elevate the suspended solids (SS) level, and create sediment plumes. Possible indirect impacts to fisheries resources may result from elevated SS in the water column. High SS levels may clog gill structure of fish, cause physical damage and reduce survival, reproductive potential, and growth rates. These effects may be lethal or sub-lethal. Fish egg and larval fish (fry) are more susceptible to deleterious impacts from sedimentation through smothering and clogging of their respiratory systems. Adult fish are generally less sensitive to effects from suspended sediments.

E5.10 Sediment plumes occur naturally in the marine environment from wave action and vertical flux of water currents. Fish have evolved behavioural adaptations to turbid water, including clearing their gills by flushing water or simply avoiding turbid waters.

E5.11 According to the sediment plume modelling results in water quality impact assessment (**Appendix B**), only the proposed temporary relocation site for Yim Tin Tsai FCZ (P1 of **Figure 4.7**) marginally exceeded the assessment criteria (<10 mg/L) with maximum SS concentration of 10.47 mg/L, if unmitigated. If maintenance dredging at Shuen Wan Typhoon Shelter is to be undertaken alone with no relocation of fish rafts, the water quality at the existing Yim Tin Tsai FCZ would also be adversely affected by the SS elevations caused by the maintenance dredging, if unmitigated. However, with the deployment of silt curtains around the dredging operations and reduction of dredging rates as recommended under the water quality impact assessment, the SS concentrations of all water sensitive receivers would fully comply with the assessment criteria.

E5.12 Important nursery grounds for commercial fish species were identified in the Assessment Area, in Three Fathoms Cove and Hoi Ha Wan, however, they are distant from the proposed dredging areas (5 km and 11 km away, respectively). According to the results of the water quality modelling (**Appendix B**), SS levels at these two important nursery grounds remains unchanged, hence no adverse water quality impact to the important nursery grounds is expected under this Project.

E5.13 Impacts to far-field fisheries sensitive receivers (i.e. Lo Fu Wat FCZ and Yung Shue Au FCZ) are not expected as these FCZs are located outside the influence zone of the predicted sediment plumes (**Appendix B Water Quality Impact Assessment**). Therefore, no adverse impacts on these sensitive fisheries receivers would be expected from the proposed dredging works.

Contaminant Release During Dredging Activities

E5.14 Dredging activities can cause the release of contaminants from marine sediments. Potential impacts on fisheries resources include the accumulation of contaminants in fish tissues, resulting in sub-lethal effects which may alter behaviour, reproduction and increase susceptibility to disease. Eggs, larvae and juveniles are particularly susceptible to the sub-lethal effects of contaminants, and elevated levels may lead to increased mortality. Bioaccumulation in commercially important fish species may ultimately impact human health. The toxic effects the marine fauna would depend on several factors (e.g. species tolerance, contaminant levels, water flow rate, etc.).

E5.15 The release of pollutants and contaminants during the dredging operation was assessed by reviewing the results of elutriate tests conducted under the marine sediment investigation works for this Project as well as by means of mathematical modelling as detailed in the Water Quality Impact Assessment Section (**Appendix B**). The assessment results indicated that the maximum influence zone of contaminants (including metals) released from the dredging works would be highly localized and no fisheries sensitive receivers (i.e. important nursery grounds for commercial fisheries resources and far-field FCZs) would be affected by the contaminant release.

Decrease of Dissolved Oxygen (DO)

E5.16 With the increased SS concentration in the water column combined with other factors, the dissolve oxygen (DO) in the water column will be reduced. Elevated SS reduces light penetration and lowers the photosynthetic rate of phytoplankton, resulting lower oxygen production. Moreover, dredging activities disturb bottom sediments and cause the release of the inorganic substances from the seabed to the water column. The sudden release of inorganic substances may cause eutrophication and algal bloom. Oxidation of dead algae during decomposition may lead to further oxygen depletion within the water column. If oxygen levels fall to low levels, fish, especially those in early life stages may be unable to tolerate such conditions and suffer from hypoxia-induced mortality and stress, including reduced feeding and growth rate, as higher metabolic demand for oxygen are required for the growth at these developmental stages.

E5.17 No significant DO depletion was predicted under the unmitigated scenarios (**Table B5.12 of Appendix B**). The concurrent dredging activities would cause a maximum DO depletion of less than 0.01 mg/L at the nearby sensitive receivers. Full compliance with the WQO for depth-averaged and bottom DO was predicted in the Tolo Harbour. No adverse impacts on the DO levels in Tolo Harbour would be expected from the dredging works.

Impact to Livelihood of Fisheries Operators

Culture Fisheries Operators

E5.18 During the construction phase, dredging activities would be taken place at Yim Tin Tsai FCZ and Yim Tin Tsai (East) FCZs. The closure of these two FCZs may affect the livelihood of the mariculture operators in these two FCZs. However, the closure of these culture fisheries areas is temporary and short term. These two FCZ areas would be re-opened for fish culture after construction, while the dredging activities would only last for less than 6 months. Meanwhile the mariculture activities can be continuously operated in the existing fish rafts in the 4 proposed relocation sites, P1 to P4 in construction phase. In view of the temporary nature of impacts to culture fisheries production and availability of alterative mariculture areas during construction phase, the constructional impact to the livelihood of mariculture fish operators is considered minor and acceptable.

E5.19 Moreover, the aim of the Project is to remove the contaminated sediment within the FCZs to improve the fish farming environment. The project has the following benefits to mariculture operation:

- Improvement of the seabed conditions under the FCZs - it will encourage colonization of bottom-dwelling marine organisms and helps provide a healthy marine ecological environment conducive to fish culture;
- Lowering the risks of fish kills due to anoxic condition and upwelling of toxic gas from the bottom sediment; and
- Removal of the bulk nutrient trapped in the sediment in the FCZ and lowering the risks of local red tide.

E5.20 Therefore, the Project enhances the quality of mariculture environment in Yim Tin Tsai FCZ and Yim Yin Tsai (East) FCZ, and may further improve the livelihood of the mariculture fish operators in long term.

Capture Fisheries Operators

E5.21 During construction phase, dredging activities would result in deterioration in water quality and affect the quality of marine waters in the vicinity of the Project Site. It may impact the fisheries resources in the vicinity of Project Site and hence affect the livelihood of the capture fishers operating in the waters adjacent to the Project Site. However, with proper implementation of the mitigation measures proposed in water quality impact assessment (**Appendix B**), the deterioration of water quality is highly reduced. The maximum influence zone of water quality change would be localised, the water quality change to the important nursery grounds for commercial fisheries resources (in Three Fathoms Cove and Hoi Ha Wan) is insignificant, hence no adverse water quality impact to the important fisheries resources is expected under this Project.

E5.22 Apart from the indirect water quality impact, temporary closure of the 4 proposed relocation sites for fishing would be resulted in construction phase. However, these 4 relocation sites of 36.08 ha support generally low to moderate fisheries production, constituting an insignificant portion of the total fishing areas in Hong Kong. While the loss of fishing grounds is temporary and short term (less than 6 months), as these four relocation sites would be re-opened for fishing operations after construction. The impact of temporary closure of fishing grounds to the livelihood of capture fisheries operators would be insignificant.

E5.23 Moreover, removal of the contaminated sediment by dredging operation will improve the anoxic conditions in Yim Tin Tsai and Yim Tin Tsai (East) areas, lower the risks of upwelling of toxic gas from the bottom sediment and local red tide. Therefore, the Project enhances the quality of marine environment in Tolo Harbour, and may further enhance the fisheries resources, improve the capture fisheries production and livelihood of the capture fishers operating in Tolo Harbour in long term.

E5.24 The overall evaluation of construction phase fisheries impacts for the proposed marine works are summarized in **Table E6**.

Table E6 Potential Fisheries Impact during Construction Phase

Criteria	Construction Phase Impact
Nature of impact	Closure of fishing ground (for both capture and culture fisheries) due to dredging works are temporary, reversible and short term. The fish culture area and fishing grounds would be re-opened after a period of less than 6 months. Indirect water quality changes due to dredging works are temporary, reversible and short term. No unacceptable residual water quality impact due to the proposed dredging works is expected to the important fisheries resources.
Size of affected area	<u>Culture Fisheries</u> Small. About 28.6 ha of the two affected FCZs (Yim Tin Tsai and Yim Tin Tsai (East)) would be temporarily closed due to the dredging works. No direct impact to Lo Fu Wat FCZ and Yung Shue Au FCZ would be expected. <u>Capture Fisheries</u> Small. About 36 ha of fishing grounds at the four relocation sites P1 to P4 for fish rafts would be temporarily occupied during the construction phase.
Loss of fisheries resources / production	<u>Culture Fisheries</u> Small. Temporary loss of small proportion (~13.7%) of the total fisheries production in Hong Kong is expected. However, the impact would only last for <6 months and culture activities can be operated in the relocation sites. <u>Capture Fisheries</u> Small. Temporary loss of small proportion of the total fisheries production in Hong Kong is expected. However, the impact would only last for <6 months.
Destruction and disturbance of nursery and spawning grounds	Important nursery grounds for commercial fisheries resources are identified in the Assessment Area (Three Fathoms Cove and Hoi Ha Wan), however, they are distant from the dredging areas (5 km and 11 km away). No adverse impact to these nursery grounds would be anticipated.
Impact on fishing activity	Low impact. The maximum influence zone of water quality change would be localised, no adverse water quality impact to the important fisheries resources (i.e. important nursery grounds in Three Fathoms Cove and Hoi Ha Wan is expected under this Project. The 4 relocation sites of 36.08 ha support generally low to moderate fisheries production, constituting an insignificant portion of the total fishing areas in Hong Kong, the impact to the livelihood of capture fisheries operators would be insignificant. These two impacts to fishing activity is temporary and short term (lasts <6 months). In long term, the Project enhances the quality of marine environment in Tolo Harbour, and may further enhance the fisheries resources, improve the capture fisheries production and livelihood of the capture fishers operating in Tolo Harbour.
Impact on aquaculture activity	Low impact. The closure of the two culture fisheries areas in Yim Tin Tsai and Yim Tin Tsai (East) is temporary and short term (lasts for <6

Criteria	Construction Phase Impact
	months). The mariculture activities can be continuously operated in the existing fish rafts in the 4 proposed relocation sites in construction phase. In view of the temporary nature of impacts to culture fisheries production and availability of alterative mariculture areas during construction phase, the constructional impact to the mariculture operation and the livelihood of mariculture fish operators is considered minor and acceptable. No indirect water quality impact to the far-field FCZs (Lo Fu Wat FCZ and Yung Shue Au FCZ) is expected. Moreover, the Project removes the contaminated sediment within the FCZs and enhances the mariculture environment by improving the seabed conditions, lowering the risks of fish kills and algal bloom. In long term, the Project enhances the quality of the two FCZs, and may further improve the livelihood of the mariculture fish operators in these FCZs.
Overall fisheries impact	**Low**

Operation Phase

E5.25 No direct loss of mariculture area and fishing ground are expected during operation phase as the fish rafts would be relocated back to the original areas at Yim Tin Tsai and Yim Tin Tsai (East) FCZs.

E5.26 In addition, the Project has positive impacts to the local culture and capture fisheries in Tolo Harbour. It improves the seabed conditions under the two FCZs, providing a healthy marine ecological environment conducive to fish culture. Moreover, it removes the contaminated sediment, improving the anoxic condition and lowering the risks of upwelling of toxic gas from the bottom sediment and the occurrence of algal bloom in Tolo Harbour. It may further improve the livelihood of the culture and capture fisheries operators in Tolo Harbour in long term.

E6. MITIGATION MEASURES OF FISHERIES IMPACTS

E6.1 Following EIAO-TM Annex 17, mitigation measures are discussed in this section to avoid, minimize, and compensate for identified fisheries impacts.

<u>Change in Water Quality</u>

E6.2 During dredging operations, a number of mitigation measures to control water quality would be adopted to confine sediment plume within the proposed dredging area and to minimize indirect impact to the nearby fisheries resources. Refer to the water quality impact assessment (**Appendix B**), recommended mitigation measures include the following:

- Control of production rate for dredging in Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ and Shuen Wan Typhoon Shelter as described in Section B6 of **Appendix B** (water quality impact assessment);
- Dredging will be carried out by closed grab to minimize release of sediment and other contaminants during dredging; and
- Silt curtains will be deployed around the dredging operation to minimise the potential impact from dredging.

E6.3 Standard good site practice and management proposed in the water quality impact assessment (**Appendix B**), such as tight fitting seals to bottom openings of barges / dredgers, effective site drainage, and provision of chemical toilets would minimize any impacts to the marine environment and associated fisheries resources resulting from dredging operations, transportation and disposal of dredged sediment in construction phase.

Impact to Livelihood of Fisheries Operators

E6.4 To minimise the impact to mariculture operation due to the temporary closure of FCZs during construction phase, the mariculture activities can be continuously operated in the existing fish rafts in the 4 proposed relocation sites, P1 to P4 in construction phase.

E7. EVALUATION OF RESIDUAL FISHERIES IMPACTS

E7.1 The only residual impact would be the temporary loss of 28.6 ha of the two FCZs and 36.08 ha of capture fishing area for less than 6 months in construction phase. In view of the small size of affected area, temporary loss of fisheries production, low impact on culture and capture fisheries activities, and long term benefits to both culture and capture fisheries, the residual impact is considered minor and acceptable.

E8. EVALUATION OF CUMULATIVE FISHERIES IMPACTS

E8.1 Two projects involving dredging activities are possibly concurrent to the Project, including:

- Development of a Bathing Beach at Lung Mei, Tai Po (2008 – 2010); and
- Sediment Removal at Yung Shue Au Fish Culture Zone (2010).

E8.2 The project sites of the two possible concurrent projects above are 1.7 km and >5 km away from this Project Site, respectively. Cumulative impact on water quality change due to the Project and the two concurrent projects has been considered in the Water Quality Impact Assessment (**Appendix B**). The assessment results indicated that the water quality influence zones for this Project would be highly localized and would not contribute any significant cumulative water quality impacts with the two possible concurrent projects (details refer to Sections B5.56 to B5.57 of **Appendix B**).

E9. ENVIRONMENTAL MONITORING AND AUDIT

E9.1 No unacceptable fisheries impacts are expected from the Project. No monitoring programme specific for fisheries is required.

E10. CONCLUSIONS

E10.1 Fishing areas in Yim Tin Tsai and Pak Sha Tau within the Project Site are of low to moderate fisheries values. Two FCZs (Yim Tin Tsai and Yim Tin Tsai (East)) of 28.6 ha were identified within the Project Site. No important nursery grounds for commercial fisheries resources would be affected.

E10.2 The temporary (<6 months) closure of mariculture area (28.6 ha) and temporary (<6 months) loss of fishing grounds (36.08 ha) in where resulted from the Project is considered minor and acceptable. Indirect impacts to water quality arising from the Project would be temporary and insignificant based on the predictions from water quality modelling. Mitigation measures recommended in the water quality impact assessment to control water quality would protect fisheries resources from indirect impacts during construction.

E10.3 Upon completion of the Project, the water quality of the FCZs and Tolo Harbour would be improved, and thus providing a better environment for the fish culture and capture operations, increasing fisheries production and improving the livelihood of the fish operators in long term.

E11. REFERENCES

Agriculture, Fisheries and Conservation Department, 2001 – 2008. Departmental Annual Report. http://www.afcd.gov.hk/english/publications/publications_dep/publications_dep.html

Agriculture, Fisheries and Conservation Department, 2009a. Fisheries: Aquaculture. http://www.afcd.gov.hk/english/fisheries/fish_aqu/fish_aqu_mpo/fish_aqu_mpo.html

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APPENDIX F
MARINE ARCHAEOLOGICAL REVIEW

TABLE OF CONTENTS

F1. THE APPROACH

F1.1 The approach of this review followed the Guidelines for Marine Archaeological Investigation, devised by the Antiquities and Monuments Office (AMO) of Leisure and Cultural Service Department of HK SAR Government.

F1.2 The review was conducted through a desk-top review of existing available information such as past relevant seabed survey data, EIA or MAI studies, hydrographic data and other relevant historic records. Different factors influencing the identification of the marine archaeological potential were also considered in the review. These factors include the presence of any historic records of settlement, and ship wreck nearby and the presence of any historic ship navigation and vessel traffic route nearby.

F2. POTENTIAL MARINE ARCHAEOLOGICAL IMPACT

F2.1 Yim Tin Tsai is located in Tai Po, Yim Tin Tsai in Chinese means “little salt field”. However, there is no evidence showing that there was any salt farm present at the Yim Tin Tsai before. The aboriginal people whom settled in the western coast of Yim Tin Tsai between early and middle 19th century were Chan’s clan of Hakka people. The Chans of Yim Tin Tsai in Tai Po came from Yantian (鹽田) of Shenzhen; their settlements were thus named as “Yim Tin Tsai” in the memory of their homeland in Shenzhen.

F2.2 The village of “Yim Tin Tsai” near the existing Yim Tin Tsai village at the western coast of Yim Tin Tsai was marked in a historic map of 1868 Sun –On- District. An existing fishing people village namely Sam Mun Tsai in Yim Tin Tsai was established in the 1960s. This village was originally settled within the Plover Cove but was later moved to Yim Tin Tsai due to the construction of Plover Cove Reservoir.

F2.3 Since Taipo Market was established in 1691, Tolo Harbour was used as a marine route connected with other areas of the region. However, Yim Tin Tsai FCZ, Shuen Wan Typhoon Shelter and Yim Tin Tsai East FCZ are all located within the embayed areas with very shallow water and would therefore lie outside or away from the main historic marine transportation route, and therefore their marine archaeological potential would be very low.

F2.4 The operation of existing fish culture zones of Yim Tin Tsai and Yim Tin Tsai East since 1988 and 1986 respectively due to the decrease of fish supply of South China Sea. To the south of the FCZs are a known terrestrial archaeological site, Yim Tin Tsai Archaeological Site, Tai Po, with a large buffer distance of over 700m and 1,000m from the two FCZs respectively.

F2.5 No shipwreck was marked on the marine chart of Yim Tin Tsai (Marine Department 2007 [4]) and also with reference to Draper-Sarah 1998 [5], no shipwreck was recorded in Yim Tin Tsai East FCZ. The northern seabed of the Yim Tin Tsai East FCZ was also used as a historic spoil ground (Marine Department 2007 [4]) which indicated that regular dredging work was carried out. Furthermore, no human settlement of historic period was established in the northern coast of Ma Shi Chau Island and eastern coast of Yim Tin Tsai Island indicated that the archaeological potential of Yim Tin Tsai East FCZ was very low.

F2.6 Based on the review of the as-built drawings for Shuen Wan Typhoon Shelter (Public Works Department, 1967 [6]), the seabed of the Typhoon Shelter and part of the Yim Tin Tsai FCZ is considered to be significantly disturbed during the construction of the Typhoon Shelter. In addition, all the proposed dredging areas were covered under the surveyed areas of past

[4] Marine Department 2007, Hong Kong, China: Mirs Bay Chart - Yim Tin Tsai (1:30,000), HKSAR Government. Coverage of the Mirs Bay Chart includes the whole Tolo Harbour

[5] Draper-Sarah 1998 *Potential for Maritime Archaeology in Hong Kong SAR: Survey, Assessment, Management and Conservation of Underwater Heritage*.

[6] Public Works Department 1967 *Armouring for Shuen Wan Typhoon Shelter Breakwater, Tolo Harbour Typical Section (Design B)*, Drawing No. P.3785-19, Hong Kong, Public Works Department Hong Kong.

relevant seabed investigations [7, 8, 9, 10, 11, 12], and based on the review of these past seabed data, no evidence of shipwreck or anomaly object was identified within the Project sites.

F2.7 In view of the above, the marine archaeological potential at Shuen Wan Typhoon Shelter, Yim Tin Tsai and Yim Tin Tsai East FCZs would be very low. However, the Contractor is recommended to inform Antiquities and Monuments Office in case of any discovery of antiquities or supposed antiquities in the dredging work at all the Project sites in accordance with the Antiquities and Monuments Ordinance.

[7] Public Works Department 1966, Armouring for Shuen Wan Typhoon Shelter Breakwater, Tolo Harbour - Layout and Sounding Plan.
[8] CEDD 2005, Preliminary Sounding Data - Shuen Wan Typhoon Shelter for Maintenance Dredging (2005 – 2008), Reference no. SP01269, Hong Kong, Civil Engineering and Development Department.
[9] CEDD 2002 *Preliminary Sounding Survey to Fish Culture Zone (Yim Tin Tsai East)*, Reference no. SP00778, Hong Kong, Port Works Division, Civil Engineering and Development Department.
[10] CEDD 2002 *Preliminary Sounding Survey to Fish Culture Zone (Yim Tin Tsai)*, Reference no. SP00777, Hong Kong, Port Works Division, Civil Engineering and Development Department.
[11] Hydrographic Office 2002, Sounding Survey—Tolo Harbour for Chart HK 3001, Hong Kong, Marine Department.
[12] CEDD 2009, Digital Geophysical Survey Data: Yim Tin Tsai FCZ, Yim Tin Tsai East FCZ and Shuen Wan Typhoon Shelter, Hong Kong, Port Works Division, Civil Engineering and Development Department.

APPENDIX G
ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

Contents

1 INTRODUCTION

1.1.1 This Appendix outlines the monitoring and audit requirements for the proposed Project. It aims to provide systematic procedures for monitoring, auditing and minimising environmental impacts associated with Project activities.

2 PROJECT ORGANIZATION

2.1.1 The roles and responsibilities of the various parties involved in the EM&A process and the organizational structure of the organizations responsible for implementing the EM&A programme are outlined below.

2.2 The Contractor

2.2.1 The Contractor shall report to the Engineer. The duties and responsibilities of the Contractor are to:

- employ an Environmental Team (ET) to undertake monitoring, laboratory analysis and reporting of environmental monitoring and audit;
- provide assistance to ET in carrying out monitoring;
- submit proposals on mitigation measures in case of exceedances of Action and Limit Levels in accordance with the Event and Action Plans;
- implement measures to reduce impact where Action and Limit Levels are exceeded;
- implement the corrective actions instructed by the Engineer;
- accompany joint site inspection undertaken by the ET; and
- adhere to the procedures for carrying out complaint investigation.

2.3 Environmental Team

2.3.1 The ET Leader and the ET shall be employed to conduct the EM&A programme and to ensure the Contractor's compliance with the Project's environmental performance requirements during construction. The ET Leader shall be an independent party from the Contractor and have sufficient relevant EM&A experience subject to the approval of the Engineer's Representative (ER). The ET shall be led and managed by the ET Leader. The ET Leader shall possess at least 7 years experience in EM&A and/or environmental management.

2.3.2 The duties and responsibilities of the ET are to:

- monitor various environmental parameters as required in this EM&A Manual;
- analyse the environmental monitoring and audit data and review the success of EM&A programme to cost-effectively confirm the adequacy of mitigation measures implemented and the validity of the EIA predictions and to identify any adverse environmental impacts arising;
- carry out regular site inspection to investigate and audit the Contractors' site practice, equipment and work methodologies with respect to pollution control and environmental mitigation, and initiate proactive action to pre-empt problems; carry out ad hoc site inspections if significant environmental problems are identified;
- audit and prepare monitoring and audit reports on the environmental monitoring data and site environmental conditions;
- report on the environmental monitoring and audit results to the IEC, the Contractor, the ER and EPD or its delegated representative;

- recommend suitable mitigation measures to the Contractor in the case of exceedance of Action and Limit Levels in accordance with the Event and Action Plans; and
- adhere to the procedures for carrying out complaint investigation.

2.4 Engineer or Engineer's Representative

2.4.1 The Engineer is responsible for overseeing the construction works and for ensuring that the works undertaken by the Contractor are in accordance with the specification and contractual requirements. The duties and responsibilities of the Engineer with respect to EM&A may include:

- supervise the Contractor's activities and ensure that the requirements in the EM&A Manual are fully complied with;
- inform the Contractor when action is required to reduce impacts in accordance with the Event and Action Plans;
- employ an IEC to audit the results of the EM&A works carried out by the ET;
- participate in joint site inspection undertaken by the ET; and
- adhere to the procedures for carrying out complaint investigation.

2.5 Independent Environmental Checker

2.5.1 The Independent Environmental Checker (IEC) shall be an independent party from the Contractor and the ET and shall advise the Engineer's Representative on environmental issues related to the Project. The IEC shall possess at least 7 years experience in EM&A and/or environmental management.

2.5.2 The duties and responsibilities of the IEC are to:

- review the EM&A works performed by the ET (at least at monthly intervals);
- carry out random sample check and audit the monitoring activities and results (at least at monthly intervals);
- review the EM&A reports submitted by the ET;
- review the effectiveness of environmental mitigation measures and project environmental performance;
- review the proposal on mitigation measures submitted by the Contractor in accordance with the Event and Action Plans; and
- adhere to the procedures for carrying out complaint investigation.

2.5.3 Sufficient and suitably qualified professional and technical staff shall be employed by the respective parties to ensure full compliance with their duties and responsibilities, as required under the EM&A programme for the duration of the Project.

3 MONITORING REQUIRMENTS

3.1.1 Based on the assessment findings of this Project Profile, a water quality monitoring and audit programme is recommended for the proposed dredging works. Coral monitoring is also recommended to be carried out at the coral sites in the vicinity of the dredging areas. No monitoring programme specific for other environmental aspects would be required.

3.2 Water Quality Monitoring

3.2.1 Water quality monitoring will be carried out before, during and after the dredging works at the following monitoring locations:

- The existing Yim Tin Tsai and Yim Tin Tsai (East) FCZs (namely F7 and F8 respectively);
- The temporary fish rafts relocation sites proposed for Yim Tin Tsai and Yim Tin Tsai (East) FCZs (namely F3, F4, F5 and F6 respectively);
- Four gradient stations located in the water bodies between the existing and temporary relocated FCZs (namely G1, G2 and G3 respectively);
- The WSD flushing water intake at Tai Po (namely WSD1).

3.2.2 Locations of these monitoring stations are shown in Figure 4.2 attached in the main text of this Project Profile. Monitoring parameters shall include turbidity, dissolved oxygen (DO) and suspended solids (SS) and metal levels. The baseline monitoring should be taken at all designated monitoring stations for at least 4 weeks prior to the commencement of dredging works. Impact monitoring shall then be carried out at all the designated monitoring stations during the entire dredging period. The impact monitoring at the existing Yim Tin Tsai and Yim Tsai (East) FCZs shall be ceased during the time when the dredging works are being undertaken within these FCZs (after the proposed relocation of fish rafts) and shall be resumed after the dredging works for the FCZ are completed. Post-project monitoring shall be carried out at all the designated stations for at least 1 week after completion of all the dredging activities.

3.2.3 If the water quality monitoring data indicate that the proposed dredging works result in unacceptable water quality impacts in the receiving water, appropriate actions should be taken to review the dredging operation and additional measures such as slowing down, or rescheduling of works should be implemented as necessary. Details of the water quality monitoring programme are described in **Annex G1** .

3.3 Coral Monitoring

3.3.1 It is proposed to monitor the coral colonies at the 5 coral sites (at REA transects T1 to T5) along coasts of Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ near the Project Sites. These coral sites are within the potential water quality influence zone of the dredging works as demonstrated from the water modelling studies conducted under this Project Profile. Locations of the 5 impact monitoring stations (at REA transects T1 to T5) are shown on Figure 4.5 attached in the main text of this Project Profile.

3.3.2 In order to identify background environmental perturbations during the monitoring that are not associated with the Project, coral monitoring should also be conducted at a Control Site (Site C) at Mai Shi Chau North, which is located at a sufficient distance from the works areas where no water quality impact associated with Project would be likely. Comparison of monitoring data from Impact Monitoring Sites and the Control Site would be used to confirm the source of impacts.

3.3.3 The coral monitoring programme shall comprise a baseline survey (prior to the dredging work), impact monitoring surveys (during the dredging period) and a post-project monitoring survey (after completion all the dredging works). The health status of coral colonies would be carefully recorded in each monitoring, including information on sediment cover, coral mortality and bleaching. Coral monitoring work should be conducted by a qualified marine biologist with specialist knowledge of corals and sound experience at identifying corals in the field. To ensure consistency, it is recommended that the same coral specialist should be used on each dive survey. The details of coral monitoring programme are discussed in **Annex G2**.

4 AUDIT REQUIREMENTS

4.1.1 Implementation of regular site audits is to ensure that the recommended mitigation measures (refer to Section 6 of the Project Profile) are to be properly undertaken. It can also provide an effective control of any malpractices and therefore achieve continual improvement of environmental performance on site.

4.1.2 Site inspections shall be carried out by the ET and shall be based on the mitigation measures for environmental pollution control recommended in Section 6 of this Project Profile. In the event that the recommended mitigation measures are not fully or properly implemented, deficiency shall be recorded and reported to the site management. Suitable actions are to be carried out to:

- Investigate the problems and the causes;
- Issue action notes to the Contractor which is responsible for the works;
- Implement remedial and corrective actions immediately;
- Re-inspect the site conditions upon completion of the remedial and corrective actions; and
- Record the event and discuss with the Contractor for preventive actions.

ANNEX G1
WATER QUALITY MONITORING REQUIREMENTS

Contents

Lists of Tables

1 INTRODUCTION

1.1.1 Marine water quality monitoring is recommended to be carried out at selected water quality receivers (WSRs). The monitoring should include baseline, impact and post-Project monitoring.

2 MONITORING SCHEDULE AND STATIONS

2.1.1 It is proposed to monitor the water quality at 2 existing FCZs, 4 temporary fish raft relocation sites and 4 gradient stations (located in the water bodies between the existing FCZs and the temporary relocated fish rafts) as well as 1 WSD flushing water intake near the Project sites as shown in **Table G1.2.1**. These WSRs are closest to the potential water quality influence zone of the dredging works as demonstrated from the modelling studies conducted under this Project Profile. Locations of these monitoring stations are shown on Figure 4.2 in the main text of this Project Profile.

Table G1.2.1 Proposed Marine Water Quality Stations for Baseline, Impact and Post Project Monitoring

Station	Marine Water Quality Stations	Easting	Northing
F3	Temporary Fish Raft Relocation site for Yim Tin Tsai FCZ	838807	834803
F4	Temporary Fish Raft Relocation site for Yim Tin Tsai FCZ	840174	833468
F5	Temporary Fish Raft Relocation site for Yim Tin Tsai East FCZ	840303	835819
F6	Temporary Fish Raft Relocation site for Yim Tin Tsai Fish East FCZ	843004	835347
F7	Existing Yim Tin Tsai FCZ	839720	834870
F8	Existing Yim Tin Tsai East FCZ	840871	835101
G1	Gradient Station	839025	834828
G2	Gradient Station	839760	834165
G3	Gradient Station	840637	835503
G4	Gradient Station	842184	835872
WSD1	WSD Flushing Water Intake at Tai Po	837750	834624

3 MONITORING FREQUENCY

3.1 Baseline Monitoring

3.1.1 Baseline conditions for marine water quality should be established and agreed with EPD prior to the commencement of marine works. The purpose of the baseline monitoring is to establish ambient conditions prior to the commencement of the dredging works and to demonstrate the suitability of the proposed monitoring stations.

3.1.2 The baseline conditions should be established by measuring turbidity, dissolved oxygen (DO), suspended solids (SS) and metal levels at the eleven selected monitoring stations. **Table G1.3.1** below shows the proposed monitoring frequency and water quality parameters.

3.1.3 The measurements should be taken at all designated monitoring stations, 3 days per week, at mid-flood and mid-ebb tides, for at least 4 weeks prior to the commencement of dredging works. There should not be any marine construction activities in the vicinity of the stations during the baseline monitoring. The interval between 2 sets of monitoring should not be less than 36 hours.

3.1.4 The baseline monitoring report should be submitted to EPD at least 4 weeks before the commencement of the dredging works for agreement.

3.2 Impact Monitoring

3.2.1 During the period of dredging, monitoring should be undertaken three days per week, at mid-flood and mid-ebb tides, with sampling / measurement at the designated monitoring stations as shown in **Table G1.2.1**. The impact monitoring at the existing Yim Tin Tsai and Yim Tsai (East) FCZs (namely F7 and F8) shall be ceased during the time when the dredging works are being undertaken within the FCZ (after the proposed relocation of fish rafts) and shall be resumed after the dredging works for the FCZ are fully completed.

3.2.2 The interval between two sets of monitoring should not be less than 36 hours except where there are exceedances of Action and/or Limit Levels, in which case the monitoring frequency will be increased. **Table G1.3.1** shows the proposed monitoring frequency and water quality parameters.

3.3 Post-Project Monitoring

3.3.1 Post-Project Monitoring will comprise sampling on three occasions (days) within one week after completion of the sediment removal works at the same stations as Baseline and Impact Monitoring, during mid-flood and mid-ebb tides. The interval between two sets of monitoring shall not be less than 36 hours. The post-project monitoring data should also be used to determine whether the baseline water quality conditions at the existing FCZs (namely F7 and F8) are restored before resuming the marine culture activities at the FCZs. **Table G1.3.1** shows the proposed monitoring frequency and water quality parameters.

Table G1.3.1 Proposed Marine Water Quality Monitoring Frequency and Parameters

Activities	Monitoring Frequency [Note 1]	Monitoring Station (refer to Table G1.2.1)	Key Parameters [Notes 2 and 3]
During the 4-week baseline monitoring period	Three days per week, at mid-flood and mid-ebb tides	F3, F4, F5, F6, F7, F8, G1, G2, G3, G4, WSD1	Turbidity, Suspended Solids (SS) and Dissolved Oxygen (DO)
		F3, F4, F5, F6, F7, F8, G1, G2, G3, G4	Copper (Cu), Lead (Pb), Zinc (Zn) and Arsenic (As)
During the proposed sediment removal works	Three days per week, at mid-flood and mid-ebb tides	F3, F4, F5, F6, F7, F8, G1, G2, G3, G4, WSD1	Turbidity, Suspended Solids (SS) and Dissolved Oxygen (DO)
		F3, F4, F5, F6, F7, F8, G1, G2, G3, G4	Copper (Cu), Lead (Pb), Zinc (Zn) and Arsenic (As)
During a 1-week period after completion of the sediment removal works	Three occasions (days), at mid-flood and mid-ebb tides	F3, F4, F5, F6, F7, F8, G1, G2, G3, G4, WSD1	Turbidity, Suspended Solids (SS) and Dissolved Oxygen (DO)
		F3, F4, F5, F6, F7, F8, G1, G2, G3, G4	Copper (Cu), Lead (Pb), Zinc (Zn) and Arsenic (As)

Notes:
1. For selection of tides for *in-situ* measurement and water sampling, tidal range of individual flood and ebb tides should be not less than 0.5 m.
2. Turbidity and DO should be measured *in situ* whereas SS and metals should be determined by laboratory.
3. Elutriate tests were conducted under the water quality impact assessment (refer to Appendix B) to assess the potential release of contaminants from dredging. Parameters tested include copper (Cu), nickel (Ni), mercury (Hg), silver (Ag), lead (Pb), zinc (Zn), arsenic (As), cadmium (Cd), chromium (Cr), total polychlorinated biphenyl (PCBs), polycyclic aromatic hydrocarbons (PAHs) and tributyltin (TBT). The elutriate test results indicated that the instantaneous concentrations for four parameters (namely Cu, Pb, Zn and As respectively) in the marine waters surrounding the dredging site would exceed the assessment criteria. The monitoring of these four metals in the water column is therefore considered necessary.

3.4 Monitoring Schedule

3.4.1 The proposed water quality monitoring schedule for Baseline, Impact and Post Project Monitoring should be submitted to EPD at least 1 week before the first day of the monitoring. EPD should also be notified immediately for any changes in schedule. If the monitoring data collected at the fish culture zones and the flushing water intake indicate that the Action or Limit Levels as shown in **Table G1.6.1** are exceeded, appropriate actions should be taken in accordance with the Event and Action Plan in **Table G1.6.2**.

3.5 Sampling Method

3.5.1 During monitoring at the WSD flushing water intake, water samples and *in-situ* measurement shall be taken at appropriate vertical level of the abstraction point of the intake.

3.5.2 For monitoring at FCZs, sampling shall be taken at three water depths, namely, 1m below water surface, mid-depth and 1m above sea bed, except where the water depth is less than 6m, in which case the mid-depth station may be omitted. Shall the water depth be less than 3m, only the mid-depth station will be monitored.

3.5.3 Duplicate *in-situ* measurements should be carried out in each sampling event. For selection of tides for *in-situ* measurement and water sampling, tidal range of individual flood and ebb tides should be not less than 0.5 m.

3.6 Field Log

3.6.1 Other relevant data should also be recorded, including monitoring location / position, time, water depth, sampling depth, pH, salinity, DO saturation, water temperature, tidal stages, weather conditions and any special phenomena or work underway nearby.

4 MONITORING EQUIPMENT

4.1 Dissolved Oxygen and Temperature Measuring Equipment

4.1.1 The instrument should be a portable and weatherproof DO measuring instrument complete with cable and sensor, and use a DC power source. The equipment should be capable of measuring:

- a DO level in the range of 0 - 20 mg L^{-1} and 0 - 200% saturation; and
- a temperature of 0 - 45 degree Celsius.

4.1.2 It should have a membrane electrode with automatic temperature compensation complete with a cable (for example, YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument). Sufficient stocks of spare electrodes and cables should be available for replacement where necessary.

4.1.3 Should salinity compensation not be built-in to the DO equipment, in-situ salinity should be measured to calibrate the DO equipment prior to each DO measurement.

4.2 Turbidity Measurement Instrument

4.2.1 Turbidity should be measured in situ by the nephelometric method. The instrument should be portable and weatherproof using a DC power source complete with cable, sensor and comprehensive operation manuals. It should have a photoelectric sensor capable of measuring turbidity between 0 - 1000 NTU (for example, Hach model 2100P or an approved similar instrument). The cable should not be less than 25m in length. The meter should be calibrated in order to establish the relationship between NTU units and the levels of suspended solids. The turbidity measurement should be carried out on split water sample collected from the same depths of suspended solids samples.

4.3 Sampler

4.3.1 A water sampler is required. It should comprise a transparent PVC cylinder, with a capacity of not less than 2 litres, which can be effectively sealed with latex cups at both ends. The sampler should have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth (for example, Kahlsico Water Sampler or an approved similar instrument).

4.4 Water Depth Detector

4.4.1 A portable, battery-operated echo sounder should be used for the determination of water depth at each designated monitoring station. This unit can either be hand held or affixed to the bottom of the work boat, if the same vessel is to be used throughout the monitoring programme.

4.5 Salinity

4.5.1 A portable, salinometer capable of measuring salinity in the range 0 – 40 mg/L shall be provided for measuring salinity of the water at each monitoring location.

4.6 Sample Containers and Storage

4.6.1 Water samples for SS and metals should be stored in high density polythene bottles, packed in ice (cooled to 4℃ without being frozen) and delivered to the laboratory and analysed as soon as possible after collection. Sufficient volume of samples should be collected to achieve the detection limit.

4.7 Monitoring Position Equipment

4.7.1 A hand-held or boat-fixed type digital Differential Global Positioning System (DGPS) with way point bearing indication or other equipment instrument of similar accuracy, should be provided and used during water quality monitoring to ensure the monitoring vessel is at the correct location before taking measurements. DGPS or the equivalent instrument, calibrated at appropriate checkpoint (e.g. Quarry Bay Survey Nail at Easting 840683.49, Northing 816709.55) should be provided and used to ensure the monitoring station is at the correct position before taking measurement and water samples.

4.8 Calibration of *In-Situ* Instruments

4.8.1 All *in-situ* monitoring instruments should be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use and subsequently re-calibrated at three monthly intervals throughout all stages of the water quality monitoring programme. Responses of sensors and electrodes should be checked with certified standard solutions before each use. Wet bulb calibration for a DO meter should be carried out before measurement at each monitoring location.

4.8.2 For the on site calibration of field equipment, the BS 127:1993, Guide to Field and On-Site Test Methods for the Analysis of Water should be observed.

4.8.3 Sufficient stocks of spare parts should be maintained for replacements when necessary. Backup monitoring equipment should also be made available so that monitoring can proceed uninterrupted even when some equipment is under maintenance, calibration, etc.

5 LABORATORY MEASUREMENT / ANALYSIS

5.1.1 Analysis of SS and metal level should be carried out in a HOKLAS or other international accredited laboratory. Sufficient water samples should be collected at the monitoring stations for carrying out the laboratory determinations. The suggested testing method and lowest detection limit are provided in **Table G1.5.1**.

Table G1.5.1 Analytical Methods to be applied to Marine Water Quality Samples

Determinant	Suggested Method	Suggested Reporting Limit
Suspended solids	APHA 2540D	1 mg L^{-1}
Copper (Cu)	USEPA 6020A	1 µg L^{-1}
Zinc (Zn)		4 µg L^{-1}
Arsenic (As)		10 µg L^{-1}
Lead (Pb)		1 µg L^{-1}

5.1.2 The testing of SS should be HOKLAS accredited (or if not, approved by EPD) and comprehensive quality assurance and control procedures in place in order to ensure quality and consistency in results.

5.1.3 Additional duplicate samples may be required by EPD for inter laboratory calibration. Remaining samples after analysis should be kept by the laboratory for 3 months in case repeat analysis is required. If in-house or non-standard methods are proposed, details of the method verification may also be required by EPD. In any circumstance, the sample testing should have comprehensive quality assurance and quality control programmes. The laboratory should prepare to demonstrate the programmes to EPD or EPD's representatives when requested.

6 EVENT AND ACTION PLAN

6.1.1 The water quality assessment criteria, namely Action and Limit Levels are shown in **Table G1.6.1**. If the monitoring results of the water quality parameters at any designated monitoring stations indicate that the water quality assessment criteria are exceeded, the actions in accordance with the Event and Action Plan in **Table G1.6.2** should be carried out.

6.1.2 The Contractor or Environmental Monitoring Team should assess the potential dredging impacts on the WSRs based on the monitoring data. Monthly Water Quality Monitoring Report should be submitted to EPD.

Table G1.6.1 Action and Limit Levels for Marine Water Quality

Parameters	Action	Limit
SS in mg L^{-1} (See Note 1)	95 percentile of baseline data or 10 mg/l	99 percentile of baseline data or 10 mg/l
DO in mg/L (See Note 2)	**For Stations F3, F4, F7** Surface or Mid-Depth 5 percentile of baseline surface /mid-depth data or <4 mg/l Bottom 5 percentile of baseline bottom data or <2 mg/l **For Stations F5, F6, F8** Surface or Mid-Depth 5 percentile of baseline surface /mid-depth data or <4 mg/l Bottom 5 percentile of baseline bottom data or <3 mg/l	**For Stations F3, F4, F7** Surface or Mid-Depth 1 percentile of baseline surface /mid-depth data or <4 mg/l Bottom 1 percentile of baseline bottom data or <2 mg/l **For Stations F5, F6, F8** Surface or Mid-Depth 1 percentile of baseline surface /mid-depth data or <4 mg/l Bottom 1 percentile of baseline bottom data or <3 mg/l

Parameters	Action	Limit
	For WSD1 At Seawater Abstraction Level 5 percentile of baseline data or <2 mg/l	**For WSD1** At Seawater Abstraction Level 1 percentile of baseline data or <2 mg/l
Turbidity in NTU (See Note 1)	95 percentile of baseline data	99 percentile of baseline data
Copper in µg L^{-1} (See Notes 1 and 4)	95 percentile of baseline data or 4.8 µg L^{-1}	99 percentile of baseline data or 4.8 µg L^{-1}
Lead in µg L^{-1} (See Notes 1 and 4)	95 percentile of baseline data or 25 µg L^{-1}	99 percentile of baseline data or 25 µg L^{-1}
Zinc in µg $L^{-1(See}$ (See Notes 1 and 4)	95 percentile of baseline data or 40 µg L^{-1}	99 percentile of baseline data or 40 µg L^{-1}
Arsenic in µg L^{-1} (See Notes 1 and 4)	95 percentile of baseline data or 25 µg L^{-1}	99 percentile of baseline data or 25 µg L^{-1}

Remarks:
1. For turbidity, SS and metals, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.
2. For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.
3. All the figures given in the table are used for reference only and EPD may amend the figures whenever it is considered as necessary.
4. Action and limit values of metals are based on the assessment criteria adopted under the water quality impact assessment (refer to Appendix B of this Project Profile).

Table G1.6.2 Event Action Plan

EVENT	ACTION			
	ET	IEC	ER	CONTRACTOR
Action level being exceeded by one sampling day	1. Repeat in-situ measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform IEC and Contractor; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with IEC and Contractor; 6. (The above actions should be taken within 1 working day after the exceedance is identified) 7. Repeat measurement on next day of exceedance.	1. Discuss with ET and Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly; 3. Assess the effectiveness of the implemented mitigation measures. 4. (The above actions should be taken within 1 working day after the exceedance is identified)	1. Discuss with IEC on the proposed mitigation measures; 2. Make agreement on the mitigation measures to be implemented. 3. (The above actions should be taken within 1 working day after the exceedance is identified)	1. Inform the ER and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Review the working methods and consider additional measures such as slowing down, or rescheduling of works; 5. Discuss with ET and IEC and propose mitigation measures to IEC and ER; 6. Implement the agreed mitigation measures. 7. (The above actions should be taken within 1 working day after the exceedance is identified)
Action level being exceeded by more than one consecutive sampling days	1. Identify source(s) of impact; 2. Inform IEC and Contractor; 3. Check monitoring data, all plant, equipment and Contractor's working methods; 4. Discuss mitigation measures with IEC and Contractor; 5. Ensure mitigation measures are implemented; 6. Prepare to increase the monitoring	1. Discuss with ET and Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly; 3. Assess the effectiveness of the implemented mitigation	1. Discuss with IEC on the proposed mitigation measures; 2. Make agreement on the mitigation measures to be implemented; 3. Assess the effectiveness of the implemented mitigation measures. 4. (The above actions should	1. Inform the Engineer and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Review the working methods and consider

EVENT	ACTION			
	ET	**IEC**	**ER**	**CONTRACTOR**
	frequency to daily; 7. (The above actions should be taken within 1 working day after the exceedance is identified) 8. Repeat measurement on next working day of exceedance.	measures. 4. (The above actions should be taken within 1 working day after the exceedance is identified)	be taken within 1 working day after the exceedance is identified)	additional measures such as slowing down, or rescheduling of works; 5. Discuss with ET and IEC and propose mitigation measures to IEC and ER within 3 working days; 6. Implement the agreed mitigation measures. 7. (The above actions should be taken within 1 working day after the exceedance is identified)

ANNEX G2
CORAL MONITORING REQUIREMENTS

Contents

Lists of Tables

1 INTRODUCTION

1.1.1 Coral monitoring is recommended to be carried out at the 5 coral sites in the vicinity of the dredging areas. The monitoring should include baseline, impact and post-project monitoring.

2 MONITORING STATIONS

2.1.1 It is proposed to monitor the coral colonies of *Oulastrea crispata* at the 5 coral sites (at REA transects T1 to T5) along coasts of Shuen Wan Typhoon Shelter and Yim Tin Tsai FCZ near the Project Site. These coral sites are within the potential water quality influence zone of the dredging works as demonstrated from the water modelling studies conducted under this Project Profile. These 5 nearby coral sites will constitute the Impact Monitoring Sites for this coral monitoring programme.

2.1.2 In order to identify background environmental perturbations during the monitoring that are not associated with the Project, coral monitoring should also be conducted at a Control Site (Site C). Based on previous studies, corals were found at Mai Shi Chau North. It is considered that this area is a suitable coral monitoring control site, which is located at a sufficient distance from the works areas where no water quality impact associated with Project would be likely. The exact location of the Control Site is subject to the findings of Baseline Monitoring. The recommended site and the reasons for selecting the preferred Control Site should be submitted to AFCD for consideration and agreement. Comparison of monitoring data from the Impact Monitoring Sites and the Control Site would be used to confirm the source of impacts.

2.1.3 Locations of the 5 Impact Monitoring Sites (at REA transects T1 to T5) are shown on **Figure 4.5** attached in the main text of this Project Profile.

3 MONITORING REQUIREMENT

3.1.1 The construction phase coral monitoring programme should comprise a Baseline Monitoring Survey with coral tagging exercise, Impact Monitoring Surveys and a Post-project Monitoring Survey.

3.1.2 Coral monitoring work should be conducted by a qualified marine biologist with specialist knowledge of corals and sound experience at identifying corals in the field. To ensure consistency, it is recommended that the same coral specialist should be used on each dive survey. The coral specialist should be approved by AFCD prior to the commencement of the monitoring programme.

3.2 Baseline Monitoring

3.2.1 A baseline survey and coral tagging exercise at the 5 Coral Impact Sites and the Control Site should be conducted preferably no more than one month before commencement of construction works.

3.2.2 The baseline survey comprises a detailed Rapid Ecological Assessment (REA) conducted in the Impact Sites and the Control Site. The 100 m REA transects will be laid according to the contour of seabed at each of the Impact Sites and the Control Site. Benthic cover, taxon abundance and ecological attributes within a swathe of 2 m wide, with 1 m of either side of the transects, were recorded following the REA technique as described in DeVantier *et al.* (1998). In which, the size, coverage and species of the corals, health conditions, associated substratum, and locations of individual coral colonies and their translocation feasibility will be recorded.

3.2.3 Moreover, a minimum of 10 hard coral colonies at each coral monitoring site should be tagged using small brightly coloured (e.g. orange or green) stones marked with labelled tags. Coral should be tagged giving priority to the largest, undamaged colonies since damage to these colonies would be more evident compared to smaller colonies or corals with existing damage.

3.2.4 The health status of each tagged coral colony should be carefully recorded, including information on existing surface area with partial mortality and bleached area. For each tagged hard coral colony, sediment cover should be recorded including percentage cover, colouration, texture and approximate thickness of sediment on the colony itself and on adjacent hard substrate. Any contiguous patches of sediment cover >10% should be counted. The condition of each tagged coral colony should also be recorded by taking a photograph from an angle and distance that best represents the entire colony. The information of selected corals collected during the Baseline Survey should be submitted to AFCD for agreement.

3.3 Impact Monitoring

3.3.1 Impact monitoring is required to determine whether impacts are occurring on the tagged corals during the construction phase. A particular focus of the Impact Monitoring is effects due to sedimentation.

3.3.2 For the 5 Impact Monitoring Sites and the Control Site C, the corals should be monitored twice a month during the first 2 months of the construction works. If there is no exceedance recorded, the monitoring frequency would be adjusted to monthly during the rest of the construction period.

3.3.3 Dive surveys for impact monitoring should collect the same information for tagged corals as the baseline survey. Information gathered during each impact monitoring survey should include observations on the size and health status of corals, and sediment cover. It should also include condition of the tagged corals surroundings as well as water depth, weather, sea and tidal conditions. Each tagged coral should be photographed for every monitoring maintaining the same aspect and orientation as photographs taken for the baseline monitoring survey as far as possible.

3.3.4 The results of the impact monitoring surveys should be reviewed with reference to findings of the baseline monitoring survey and the data from the Control Site C collected during the impact monitoring.

3.3.5 The monthly coral survey reports should be prepared on each month during the construction phase and submitted to AFCD for comments. The reports should contain a summary of the activities, monitoring data of the health conditions of the corals with photos, exceedance of Action and Limit (AL) levels as indicated in **Table G2.4.1**, causes of exceedance and appropriate actions being taken.

3.4 Post-Project Monitoring

3.4.1 Post-project monitoring should be conducted to confirm that is no adverse impact to the coral communities due to the Project. The 5 Impact Sites and the Control Site should be surveyed once within one month after the completion of construction activities. The methodology of coral survey specified for the baseline monitoring shall in general be applied to the post-project monitoring.

3.4.2 All tags at the Impact and Control Sites should be removed / retrieved after the monitoring is completed.

3.4.3 The final coral monitoring report with photos should be submitted to AFCD for comments, within a month of completion of the post-project monitoring survey. The report should contain a summary of the activities, assessment of health conditions of the corals in the entire monitoring programme, and assessment on the effectiveness of the mitigation measures implemented.

4 EVENT AND ACTION PLAN

4.1.1 The coral monitoring criteria, namely Action and Limit Levels are shown in **Table G2.4.1**. Evaluation should be based on recorded changes in the percentage of partial mortality, sediment cover, and bleaching of the corals.

4.1.2 Upon action level being exceeded, appropriate actions should be taken to review the dredging operation and additional measures such as slowing down, or rescheduling of works should be implemented as necessary, with the agreement from the ET and AFCD. Upon limit level being exceeded, the Contractor shall suspend all works affecting the corals until an effective solution is identified. Once the solution has been identified and agreed with the ET and AFCD, construction works affecting seabed may recommence. In which, coral transplantation can be considered as one of the possible action plans.

Table G2.4.1 Action and Limit Levels for Coral Monitoring

Parameter	Action Level Definition	Limit Level Definition
Sedimentation	If during Impact Monitoring a 20% increase in the percentage of sediment cover on hard corals occurs at more than 20% of the tagged coral at any one Impact Monitoring Site that is not recorded at the Control Site, then the Action Level is exceeded.	If during the Impact Monitoring a 25% increase in the percentage of sediment cover occurs at more than 20% of the tagged coral at any one Impact Monitoring Site that is not recorded at the Control Site, then the Limit Level is exceeded.
Bleaching	If during Impact Monitoring a 15% increase in the percentage of bleaching (bleached white) on hard corals occurs at more than 20% of the tagged coral at any one Impact Monitoring Site that is not recorded at the Control Site, then the Action Level is exceeded.	If during the Impact Monitoring a 25% increase in the percentage of bleaching (bleached white) occurs at more than 20% of the tagged coral at any one Impact Monitoring Site that is not recorded at the Control Site, then the Limit Level is exceeded.
Mortality	If during Impact Monitoring a 15% increase in the percentage of partial mortality on hard corals occurs at more than 20% of the tagged coral at any one Impact Monitoring Site that is not recorded at the Control Site, then the Action Level is exceeded.	If during the Impact Monitoring a 25% increase in the percentage of partial mortality occurs at more than 20% of the tagged coral at any one Impact Monitoring Site that is not recorded at the Control Site, then the Limit Level is exceeded.