# 3. Water Quality Impact Assessment

## 3.1 Introduction

3.1.1 This section addresses all of the requirements under Clause 3.5.1 – Water Quality Impact of the EIA Study Brief issued by EPD.

3.1.2 This project involves decommissioning of the existing Dock at Yam O Wan and commissioning of the Dock at Tsing Yi. Relocation of the existing Yiu Lian floating dock No.3 at Yam O Wan to the south-western coast of Tsing Yi requires small scale dredging of marine sediment at the new site and, also at the existing site if the anchor blocks should be removed from the existing site. There is an on-going discussion between the Marine Department and Yiu Lian on if the anchor blocks should be removed from the existing site. Leaving the anchor blocks in place is preferred as it will avoid the disturbance to the seabed and therefore minimise any potential environmental impact of the decommissioning work. The reasons for conducting the dredging are discussed in Section 2. The subsequent assessment assumes that the anchor blocks at the existing site should be removed to cover the eventuality.

3.1.3 During dredging, marine sediments leaking through the dredger can be released into the water column, thus leading to an elevated level of water pollution, such as an elevation of suspended solids (SS). Coarse materials, within the released sediment such as sand and gravel, will quickly settle back to the seabed close to the dredging areas. However, fine particles, such as silt and clay together with any contaminants they may carry, may be transported away from the dredging site by currents and tides, thereby potentially leading to adverse environmental effects on sensitive receivers (WSRs). As such, environmental mitigation measures may be required.

3.1.4 During Dock operation at the new Tsing Yi site intermittent industrial wastewater will be generated from hull washing and discharged to marine waters after screening. Disposal of these effluents may have potential adverse impacts on the marine environment and WSRs and mitigation measures may therefore be required to minimise and control the impacts. Domestic wastewater generated by workers on the Dock will be collected and treated on-board and then discharged to the marine waters. A detail description of Dock operations is given in Section 2. Yiu Lian currently holds a licence to discharge both the industrial and domestic wastewater arising from Dock operations into the marine water at Yam O Wan.

3.1.5 The baseline environmental conditions are described and the relevant WSRs identified in this Section. At present, there are only descriptive Hong Kong standards for toxicants. In order to quantify the water quality effect, numerical standards for toxicants have been recommended in this report, based on a review of literature and international standards.

3.1.6 Fine sediment and associated toxicant releasing rates due to dredging and contaminant discharge rates from Dock operations have been estimated. The potential impacts on WSRs in terms of pollution levels have been quantified and assessed, and necessary mitigation measures recommended. Cumulative impacts have been discussed and assessed.

3.1.7 Detailed water quality assessment to fully address relevant requirements of the EIA Study Brief is provided in the remainder of this Section.

## 3.2 Environmental Legislation, Standards and Guidelines

3.2.1 The following legislation, standards and guidelines are applicable to the evaluation of water quality (WQ) impacts associated with the dredging of marine sediment and discharge of effluents.

- Water Pollution Control Ordinance (WPCO) (Cap. 358)
- Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (WPCO Cap. 358, S21)
- Environmental Impact Assessment Ordinance (EIAO)
- Technical Memorandum on Environmental Impact Assessment Process (EIA-TM)
- Environment, Transport and Works Bureau Technical Circular (Works) (ETWB TC(W)) No. 34/2002, Management of Dredged/Excavated Sediment
- Shipping and Port Control Ordinance
- Sewerage Manual (DSD)

3.2.2 WPCO is the primary legislation for the control of water pollution and WQ in Hong Kong. Under WPCO, Hong Kong waters are divided into 10 Water Control Zones (WCZs) and four supplementary WCZs and each zone has a designated set of statutory Water Quality Objectives (WQOs).

3.2.3 The existing dock at Yam O Wan lies within the North Western WCZ and the proposed site at Tsing Yi in the Western Buffer WCZ. The North Western WCZ covers the water body between northern Lantau and southern New Territories and adjacent waters. The Western Buffer WCZ includes the Ma Wan Channel, Kap Shui Mun Channel and other major navigation channels and anchorages in the Western Harbour. Figure 3-1 shows the coverage of the North Western WCZ and the Western Buffer WCZ.

3.2.4 The relevant WQOs for the North Western WCZ and the Western Buffer WCZ are listed in Table 3-1. These WQOs form the basis of the WQ assessment criteria in this EIA.

3.2.5 As indicted in Table 3-1, the WQOs for the North Western WCZ and the

Western Buffer WCZ only specify descriptive standards for toxicants. In order to conduct a quantitative water quality assessment in this EIA, however, numerical standards for toxicants are required. As such, a review of international standards and criteria for toxicants has been conducted and appropriate standards recommended.

| Parameters | North Western WCZ | Western Buffer WCZ |
|---|---|---|
| pH | 6.5 – 8.5<br>change due to waste discharge not to exceed 0.2 | 6.5 – 8.5<br>change due to waste discharge not to exceed 0.2 |
| Dissolved Oxygen (depth average) | ≥ 4 mg/L for 90% samples | ≥ 4 mg/L for 90% of samples*<br>≥ 5 mg/L for 90% of samples** |
| Dissolved Oxygen (bottom) | ≥ 2 mg/L for 90% samples | ≥ 2 mg/L for 90% of samples |
| Inorganic nitrogen (depth average) | Annual mean not to exceed 0.5 mg/L | Annual mean not to exceed 0.4 mg/L |
| Suspended Solids | < 30% increase over the ambient level | < 30% increase over the ambient level |
| *E. Coli* | Annual geometric mean not to exceed 610cfu/100mL (Secondary Contact Recreation Subzones) | Annual geometric mean not to exceed 610cfu/100mL (Secondary Contact Recreation Subzones and Fish Culture Subzones) |
| Toxicants | Not to be present at levels producing significant toxic effect | Not to be present at levels producing significant toxic effect |

**Notes:**

* For marine waters except Fish Culture Subzones

** For Fish Culture Subzones

**Table 3-1 Relevant WQOs at the North Western WCZ and the Western Buffer WCZ**

**Review of Standards for Toxicants**

3.2.6 Heavy metals and micro-organic pollutants such as Polyholorinated biphenyls (PCBs), Polychlorinated aromatic hydrocarbons (PAHs), TBT and chlorinated pesticides are toxicants. They are monitored by EPD for sediment quality but excluded from the EPD marine WQ monitoring programme. Heavy metals are of concern because of their toxicity, persistence and tendency for bioaccumulation.

3.2.7 Heavy metals enter the aquatic environment from both natural and anthropogenic sources. Large quantities of metals enter the environment through non-point sources, such as run-off and atmospheric deposition, in addition to point sources such as domestic and industrial wastewater discharges. Metals discharged into naturally turbid estuarine water can be rapidly bound onto the surface of fine suspended sediment particles by various adsorption processes. As the suspended sediment settles on the seabed, the associated metals are gradually buried and become immobilized in anoxic sediments.

3.2.8 PAHs are easily adsorbed to organic matter and inorganic particles in the water column. Bioavailability is often limited by the affinity of PAHs for sediment. The highest rates of bioaccumulation are found in fish and shellfish, although generally at concentrations lower than the surrounding sediment.

3.2.9 PCBs enter the marine environment where they degrade very slowly and tend to be adsorbed quickly by organic matter due to their hydrophobic nature. Environmental persistence and hydrophobic nature means that PCBs bio-accumulate in aquatic food chains such that toxins in the top predators can be sufficiently concentrated to initiate a population decline.

3.2.10 TBT enters the marine environment from a limited number of point sources, including dry docks and marinas, and many diffuse sources such as vessel hulls. Once in the water column, TBT readily comes out of solution and adsorbs to particulate matter and sediment. TBT is often of concern as many marine species are sensitive to its toxic effects even at a very low concentration.

3.2.11 Findings of our review on standards and criteria on toxicants are presented below, covering those of the United Kingdom (UK), European Union (EU), Japan, United States (US) and Australia/New Zealand (ANZ).

*National Rivers Authority (UK) Acute Toxicity Threshold*

3.2.12 These standards were set in 1995 by the UK National Rivers Authority (NRA), with respect to the environmental effects of pollutants often encountered in dredged material. However, the standards were set only for only a limited number of parameters, covering chromium VI, cadmium, zinc, PCBs and PAHs, as listed in Table 3-2.

*Proposed Marine Water Quality Standards of EU Shellfish Waters Directive*

3.2.13 EU Shellfish Waters Directive (79/923/EEC) was established to control marine water quality. Recently, the Department of Environment, Food & Rural Affairs (DEFRA) of the UK Government carried out a consultation study on shellfish water quality and proposed new imperative values on metals and organohalogens to the EU. The proposed values are summarised in Table 3-2.

*Japan Environmental Quality Standards*

3.2.14 The Environment Agency of Japan has set up Environmental Quality Standards for Water Pollutants. The relevant standards for toxicants are listed in Table 3-2. It should be pointed out that these numerical standards are for human heath and therefore they seem more stringent than those for aquatic life in marine water.

*USEPA: National Recommended WQ Criteria 2004*

3.2.15 USEPA has the National Recommended WQ Criteria 2004 for fresh water and saltwater. Two criteria have been introduced, Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC). 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 unacceptable effect, whereas 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 unacceptable effect. Table 3-2 lists the relevant saltwater criteria. As expected, the CCC values in general are lower than the CMC values.

*Australia/New Zealand Guidelines for Fresh and Marine Water Quality*

3.2.16 The ANZ guidelines provide a set of trigger values for different species protection levels (99%, 95%, 90% and 80%). The highest protection level (99%) has been chosen as the default value for ecosystems with high conservation value and is listed in Table 3-2. The ANZ guidelines have the most stringent values among those reviewed. For ecosystems that can be classified as highly disturbed, the 95% protection trigger values can still apply. However, depending on the state of the ecosystem, the management goals and the approval of the appropriate authority in consultation with the community, it can be appropriate to apply a less stringent guideline trigger value, say protection of 90% of species, or perhaps even 80%. Because of the variation of protection levels, the trigger values (99%) in the ANZ Guidelines have not been considered in our standard recommendation process in this EIA. However, the trigger value for silver has been adopted.

| **Parameters** | **UK NRA[a] Acute Toxicity Threshold (1995)** | **Proposed Imperative Values EU Directive[d]** | **Japan Environmental Quality Standard[e]** | **USEPA National Recommended WQ Criteria (saltwater, dissolved concentration)** | | **ANZ[f] Trigger values, 99% species protection** |
|---|---|---|---|---|---|---|
| | μg/L | μg/L | μg/L | CMC[b] (μg/L) | CCC[c] (μg/L) | μg/L |
| Metal content | | | | | | |
| Arsenic | - | 3000 | 10 | 69 | 36 | - |
| Cadmium | < 100.0 | 330 | 10 | 40 | 8.8 | 0.7 |
| Chromium (VI) | 156 | 1000 | 50 | 1100 | 50 | 7.7 |
| Copper | - | 10 | 40 | 4.8 | 3.1 | 0.3 |
| Lead | - | 100 | 10 | 210 | 8.1 | 2.2 |
| Mercury | - | 1 | 0.5 | 1.8 | 0.94 | 0.1 |
| Nickel | - | 100 | 10 | 74 | 8.2 | 7 |
| Silver | - | 10 | - | 1.9 | - | 0.8 |
| Zinc | 1.5 | 10 | - | 90 | 81 | 7 |
| PCBs | 10.0 (7 congenors) [g] | 0.3 (Total) | Not detectable | - | 0.03 (total) | - |
| PAHs | 0.2 – 10.0 | - | - | - | - | - |

| | UK NRA[a] Acute Toxicity Threshold (1995) | Proposed Imperative Values EU Directive[d] | Japan Environmental Quality Standard[e] | USEPA National Recommended WQ Criteria (saltwater, dissolved concentration) | | ANZ[f] Trigger values, 99% species protection |
|---|---|---|---|---|---|---|
| | ppm | | | | | |
| TBT | - | - | - | 0.37 | 0.01 | 0.0004 (Sn) |

Note:
- a Environmental effects of pollutants often encountered in dredged material. (Source: UK Environment Agency).
- b CMC – Criteria Maximum Concentration 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 unacceptable effect. (Source: USEPA)
- c CCC – Criterion Continuous Concentration 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 un unacceptable effect. (Source: USEPA)
- d The proposed imperative values for the metals and the suggested organohalogens, from Implementation of the Shellfish Waters Directive (79/923/EEC) Consultation Document (Department for Environment, Food & Rural Affairs, UK)
- e Environmental Quality Standards for Water Pollutants - Environmental Quality Standards for the Human Health. Standard values are the annual mean (Source: Environment Agency, Government of Japan)
- f Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000
- g The 7 congeners are 28, 52, 101, 118, 138, 153 and 180.

**Table 3-2 International Standards for Heavy Metals and Micro-Pollutants in Marine Environment**

*Numerical Standards for Toxicants Recommended for this EIA*

3.2.17 The numerical standards for toxicants listed in Table 3-3 are recommended for this EIA. Most of them are directly taken from USEPA National Recommended WQ Criteria 2004 for saltwater. The CMC values are recommended for assessment of the temporary pollution discharge such as the dredging impact in this Project and, the CCC for assessment of the regular pollution discharge impact such as the normal Dock operation. The missing values for silver (CCC) and PAHs are taken from other countries. The recommended criteria are in general stringent for salt water.

| Parameters | Criteria (µg/L, dissolved) (for temporary conditions) | Criteria (µg/L, dissolved) (for normal conditions) |
|---|---|---|
| Arsenic | 69 | 36 |
| Cadmium | 40 | 8.8 |
| Chromium (VI) | 1100 | 50 |
| Copper | 4.8 | 3.1 |
| Lead | 210 | 8.1 |
| Mercury | 1.8 | 0.94 |
| Nickel | 74 | 8.2 |
| Silver | 1.9 | 0.8 |
| Zinc | 90 | 81 |
| PCBs[a] | 0.03 | 0.03 |
| PAHs | 0.2 ppm | 0.2 ppm |
| TBT | 0.37 | 0.01 |

Note: [a] This criterion applies to total PCBs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

**Table 3-3 Standards for Heavy Metals and Micro-pollutants Recommended for this EIA**

3.2.18 In addition to setting the WQOs, WPCO specifies standards of effluents discharged into the WCZs through a licensing system. Effluents discharged into the marine waters of the North Western WCZ and the Western Buffer WCZ are required to comply with the standards listed in Table 3-4, taken from the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters as issued under the provisions of WPCO. The limits specified in the standards control the physical, chemical and microbial quality of effluents. Yiu Lian obtained a discharge licence for the operation of the Dock at Yam O Wan. There are two wastewater streams: (1) effluent arising from maintenance of vessels; and (2) effluent arising from domestic sewage. The discharge licence specifies the discharge limits for different determinants as shown in Table 3-5 and requires Yiu Lian to measure the concentrations of suspended solids and oil and grease once per ship hull cleaning and servicing operation. According to Yiu Lian's self-monitoring records, the effluent samples have been generally in compliance with the discharge limits.

| **Flow rate ($m^3$/day)** | **≤10** | **>10 and ≤200** | **>200 and ≤400** | **>400 and ≤600** | **>600 and ≤800** | **>800 and ≤1000** | **>1000 and ≤1500** | **>1500 and ≤2000** | **>2000 and ≤3000** | **>3000 and ≤4000** | **>4000 and ≤5000** | **>5000 and ≤6000** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Determinant | | | | | | | | | | | | |
| pH (pH units) | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 |
| Temperature ($^0$C) | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| Colour (lovibond units) (25mm cell length) | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| SS | 500 | 500 | 500 | 300 | 200 | 200 | 100 | 100 | 50 | 50 | 40 | 30 |
| BOD | 500 | 500 | 500 | 300 | 200 | 200 | 100 | 100 | 50 | 50 | 40 | 30 |
| COD | 1000 | 1000 | 1000 | 700 | 500 | 400 | 300 | 200 | 150 | 100 | 80 | 80 |
| Oil & Grease | 50 | 50 | 50 | 30 | 25 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Iron | 20 | 15 | 13 | 10 | 7 | 6 | 4 | 3 | 2 | 1.5 | 1.2 | 1 |
| Boron | 6 | 5 | 4 | 3.5 | 2.5 | 2 | 1.5 | 1 | 0.7 | 0.5 | 0.4 | 0.3 |
| Barium | 6 | 5 | 4 | 3.5 | 2.5 | 2 | 1.5 | 1 | 0.7 | 0.5 | 0.4 | 0.3 |
| Mercury | 0.1 | 0.1 | 0.1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Cadmium | 0.1 | 0.1 | 0.1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Other toxic metals individually | 2 | 1.5 | 1.2 | 0.8 | 0.6 | 0.5 | 0.32 | 0.24 | 0.16 | 0.12 | 0.1 | 0.1 |
| Total toxic metals[a] | 4 | 3 | 2.4 | 1.6 | 1.2 | 1 | 0.64 | 0.48 | 0.32 | 0.24 | 0.2 | 0.14 |
| Cyanide | 1 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.2 | 0.15 | 0.1 | 0.08 | 0.06 | 0.04 |
| Phenols | 0.5 | 0.5 | 0.5 | 0.3 | 0.25 | 0.2 | 0.13 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Sulphide | 5 | 5 | 5 | 5 | 5 | 5 | 2.5 | 2.5 | 1.5 | 1 | 1 | 0.5 |
| Total residual chlorine | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total nitrogen | 100 | 100 | 80 | 80 | 80 | 80 | 50 | 50 | 50 | 50 | 50 | 50 |
| Total | 10 | 10 | 8 | 8 | 8 | 8 | 5 | 5 | 5 | 5 | 5 | 5 |

| Flow rate ($m^3$/day) | ≤10 | >10 and ≤200 | >200 and ≤400 | >400 and ≤600 | >600 and ≤800 | >800 and ≤1000 | >1000 and ≤1500 | >1500 and ≤2000 | >2000 and ≤3000 | >3000 and ≤4000 | >4000 and ≤5000 | >5000 and ≤6000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| phosphorus | | | | | | | | | | | | |
| Surfactants (total) | 30 | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| *E. coli* (count/100ml) | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 |

(All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Notes: [a] Toxic metal includes antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium and other metals specified by EPD.

**Table 3-4 Standards for Effluents Discharged into the Marine Waters of Southern, Mirs Bay, Junk Bay, North Western, Eastern Buffer and Western Buffer Water Control Zones**

| Determinand | Limit |
|---|---|
| **Effluent arising from maintenance of vessels** | |
| Flow Rate ($m^3$/day) | 23 |
| Suspended Solid | 30 |
| Oil & Grease | 50 |
| **Effluent arising from domestic sewage** | |
| Flow Rate ($m^3$/day) | 2 |
| Chemical Oxygen Demand | 1000 |
| Suspended Solid | 500 |
| pH | 6-10 |
| Biochemical Oxygen Demand | 500 |
| Oil & Grease | 50 |
| *E. coli* (count /1000 ml) | 4000 |
| Total residual chlorine | 1 |

**Table 3-5 Discharge Limits Specified in the Discharge Licence for Dock Operations at Yam O Wan**

3.2.19 The Environment, Transport and Works Bureau Technical Circular (Works) No. 34/2002 sets the sediment quality criteria for sediment disposal through classification (Table 3-6). A total of 3 categories are defined, based on the contaminant levels of the sediment:

- **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 minimises 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) but 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.

The criteria set in ETWB TC(W) No. 34/2002 have been used to classify the seabed sediments at Yam O Wan and Tsing Yi. The sediment classification for both sites is presented in Tables 4-1 and 4-4.

| Contaminants | Lower Chemical Exceedance Level (LCEL) | Upper Chemical Exceedance Level (UCEL) |
|---|---|---|
| Metal (mg/kg dry wt.) | | |
| Cadmium | 1.5 | 4.0 |
| Chromium | 80 | 160 |
| Copper | 65 | 110 |
| Mercury | 0.5 | 1.0 |
| Nickel | 40 | 40 |
| Lead | 75 | 110 |
| Silver | 1 | 2 |
| Zinc | 200 | 270 |
| Metalloid (mg/kg dry wt.) | | |
| Arsenic | 12 | 42 |
| Organic-PAHs (ug/kg dry wt.) | | |
| Low Molecular Weight PAHs | 550 | 3160 |
| High Molecular Weight PAHs | 1700 | 9600 |
| Organic-non-PAHs (ug/kg dry wt.) | | |
| Total PCBs | 23 | 180 |
| Organometallics *( µg TBT/L in Interstitial water)* | | |
| Tributyltin | 0.15 | 0.15 |

**Table 3-6 Sediment Quality Criteria for the Classification of Sediment**

# 3.3 Description of Environment

3.3.1 The hydrodynamic model outputs of "Update on Cumulative Water Quality Impacts and Hydrological Effects of Coastal Developments and Upgrading of Assessment Tool, Agreement No. CE42/97" have been used to understand the baseline hydrodynamic conditions in the study area. The marine water monitoring data from EPD, as well as the marine water and sediment data sampled and tested under this EIA, have been used to define the baseline WQ and sediment quality conditions. All these findings are detailed in Section 3.5 of the EIA report.

**Hydrodynamic Conditions at the Existing Dock Site (Yam O Wan)**

3.3.2 The Dock is anchored in the sea with an average water depth of 20m. The distance from the Dock to the adjacent coastline of Lantau Island is about 400m. There are no major runoff discharges from the land to the site and the marine waters at Yam O Wan are mainly influenced by the local and regional oceanic and tidal flow characteristics, that are controlled by the Coriolis force, topography, tidal current, seasonal on-shore current and the Pearl River.

3.3.3 Because of the topographical confinement of Lantau Island and the New Territories, the local average tidal currents of peak ebb or flood flows are generally reciprocal, in the predominant direction of the west/southwest and the east/northeast. During flood tides, water flows to the west/southwest (Figure 3-2) and during ebbs to the east/northeast (Figure 3-3). The currents at the site are more influenced by the coastlines and the sheltered features of the bay. In the wet season, the maximum depth average velocity at the site is approximately 0.2 m/s (in the direction of southwest) and rapidly increases to 0.5 m/s further offshore during a typical spring flood flow. The peak ebb velocity is approximately 0.5 m/s (in the direction of northeast). The tidal currents in the dry season are similar, albeit slightly weaker.

**Hydrodynamic Conditions at the Proposed Dock Site (Tsing Yi)**

3.3.4 The Dock will be anchored in the sea with a water depth of 20-30m. The distance from the dock to the adjacent coastline of Tsing Yi is about 300m. There are no major runoff discharges from the Tsing Yi Island to the site and the marine waters are mainly influenced by the local and regional oceanic and tidal flow characteristics, similar to the existing site at Yam O Wan.

3.3.5 Because of the topographical confinement of Tsing Yi and Lantau Island, the tidal currents around the site are generally reciprocal, in the north/south direction and in line with Man Wan Channel and Ma Wan Fairway. During flood tides, water flows to the north/northwest (Figure 3-2) and during ebbs to the south/southeast (Figure 3-3).

3.3.6 In general, tidal currents along the western coast of Tsing Yi are strong and the strongest flows are located at Man Wan Channel and Ma Wan Fairway, with a depth average speed of 1.5 to 2 m/s during peak ebb and flood. The maximum depth average velocity at the site is approximately 0.5 m/s (in the direction of southeast) during a typical spring flood flow and also 0.5 m/s (in the direction of northeast) during an ebb flow in the wet season. The tidal currents during the dry season are similar, but slightly weaker. The water depth and strong currents at the site provide extremely good dilution and flushing conditions.

3.3.7 The salinity stratification in the study area is formed by the outward extension of the Pearl River fresh water at the upper layer and the intrusion of the South China Sea saline water at the lower layer during the wet season. The salinity stratification in the study area is not usually noticed during the dry season.

**Major Pollution Sources at the Existing Dock Site (Yam O Wan)**

3.3.8 The major pollution sources at the site are the domestic wastewater discharge and the industrial wastewater from Dock operations, and the sewage discharge from Siu Ho Wan Sewage Treatment Works, the outfall of which is located 5,780m to the southwest of the Dock. The locations of these major pollution sources are shown in Figure 3-4.

#### Major Pollution Sources at the Proposed Dock Site (Tsing Yi)

3.3.9 The major pollution sources in the vicinity of the site include the domestic wastewater discharge and the industrial wastewater from Yiu Lian Floating Dock No. 1 and Hongkong United Dockyards. Stonecutters Island Sewage Outfall is located to the east of Tsing Yi Island, some 4,080m away. The locations of these major pollution sources are shown in Figure 3-5.

## 3.4 Water Sensitive Receivers

3.4.1 Water sensitive receivers (WSRs) are defined as those users/occupants of the aquatic/marine environment whose uses of the environment could be impaired as a result of the proposed development. Areas of Hong Kong marine waters with major activities and uses include:

- Bathing beaches, secondary contact recreation areas, and seawater abstraction points
- Fish culture zones and marine conservation areas
- Disposal areas for dredged materials, public filling areas and major reclamation sites
- Disposal of treated effluent from major public sewage treatment works and outfalls

3.4.2 Beneficial uses have been defined in accordance with the requirements of the Hong Kong Planning Standards and Guidelines. Water sensitive receivers have been identified in these potentially affected areas under the broad designations of gazetted and non-gazetted bathing beaches, secondary contact recreation areas, water intakes, fish culture zones, marine conservation areas, the North Western Water Control Zone and the Western Buffer Water Control Zone. The WQOs for these individual water sensitive receivers/beneficial uses are presented in Appendix 3F.

3.4.3 Figure 3-6 and 3-7 shows locations of the WSRs subject to the potential impact from this Project. Most of the WSRs are located along the southern coasts of New Territories and at Ma Wan. The WSR closest to the existing or the proposed site is Ma Wan Fish Culture Zone and that closest to the new site is the gazetted Ma Wan Tung Wan Beach. The shortest distance between the project sites and the WSRs are listed in Table 3-7.

| Water Sensitive Receivers | Shortest Distance from the Existing Site (m) | Shortest Distance from the Proposed Site ( m) |
|---|---|---|
| Ma Wan Tung Wan Beach | 2450 | 3100 |
| Ma Wan Fish Cultural Zone | 1800 | 3700 |
| Approach Beach | 5550 | 3520 |
| Ting Kau Beach | 4970 | 3780 |

| | | |
|---|---|---|
| Lido Beach | 4540 | 3730 |
| Casam Beach | 4370 | 3780 |
| Hoi Mei Wan Beach | 4000 | 3700 |
| Gemini Beach | 3700 | 3690 |
| Anglers' Beach | 2750 | 4670 |
| Golden Beach | 6060 | 11000 |
| Cafeteria Beach | 6380 | 11300 |
| Kadoorie Beach | 6670 | 11600 |
| Castle Beach | 7050 | 12000 |
| Castle Peak Beach | 7250 | 12200 |

**Table 3-7 Water Sensitive Receivers**

## 3.5 Baseline Environmental Conditions

3.5.1 Marine water quality in Hong Kong is monitored through EPD's monitoring programme for the purposes of indicating the state of health of marine waters; assessing compliance with the statutory WQOs; revealing long-term changes in water quality; and providing a basis for the planning of pollution control strategies.

3.5.2 In addition, water and sediment samples at the existing Dock site and sediment samples at the proposed Dock site were collected and tested in this EIA study.

3.5.3 EPD's monitoring data in the relevant WCZs, as well as the data collected from this EIA study, has been used for determining the baseline environmental conditions.

**EPD Water Quality and Sediment Monitoring**

3.5.4 EPD's marine monitoring programme covers 94 water and 60 sediment sampling stations in the open sea, semi-enclosed bays and typhoon shelters. The water quality at those stations is monitored monthly and the seabed sediment quality monitored twice a year. The monitoring results are summarised and published in EPD's Annual Marine Water Quality Reports.

3.5.5 A number of EPD water and sediment monitoring stations are located around the Study Area. There are a total of 6 open seawater monitoring stations (NM1, NM2, NM3, NM5, NM6 and NM8) and 4 sediment monitoring stations (NS2, NS3, NS4 and NS6) in the North West WCZ where the existing Dock is located (Figures 3-8 and 3-9). A total of 4 seawater monitoring stations (WM1, WM2, WM3 and WM4) and 2 sediment monitoring stations (WS1 and WS2) are located in the Western Buffer WCZ, in which the proposed Dock site lies (Figures 3-8 and 3-9). The nearest EPD water and sediment monitoring stations to the existing and proposed Dock sites are NM1 and NS2 in the North West WCZ and WM3 / WM4 and WS1 in the Western Buffer WCZ respectively. The WQ data monitored in 2004 from those stations is among the most up-to-date information available and has been used to derive the baseline WQ conditions in this EIA. In addition, the EPD sediment monitoring stations in typhoon shelters used for the comparison with the sediment quality at the existing site are shown in Figure 3-9.

**Water and Sediment Sampling and Test, Elutriate Test and Bioaccumulation Test**

3.5.6 Water and sediment samples at both the existing and proposed Dock sites have been collected and tested to understand the current environmental conditions at these two locations. In addition, an elutriate test has been carried out for the sediment samples taken at both sites. The objective of conducting the elutriate test is to investigate the potential impact resulting from the sediment-bonded pollutants being released into the ambient marine water during the small scale dredging for the dock relocation. Results were used for assessing the potential water quality impacts arising from the dredging activities at both the existing and the proposed sites. The assessment results were presented in Section 3.7.

3.5.7 A bioaccumulation test has also been undertaken for one composite sediment sample collected at the existing Dock site to provide data for evaluation of the bioaccumulation potential of benthic organisms. As there is no statutory evaluation procedure for bioaccumulation test in Hong Kong, the US Food and Drug Administration Actions Levels for Poisonous or Deleterious Substances in Fish and Shellfish for Human Food and the World Health Organisation safety margins on consumption of the biota, have been applied where appropriate. The bioaccumulation test results are presented in Section 3.7.

3.5.8 Sampling locations at the existing and proposed Dock sites are shown in Figures 3-10 and 3-11, respectively. The location of the reference sediment sample for bioaccumulation test is shown in Figure 3-12.

*Marine Water Sampling and Test*

3.5.9 Duplicate seawater samples at the existing Dock site were collected from 4 locations (1, 2, 3 and 4) at 1m from seabed, mid-depth and 1m below the water surface on 21 May and 4 June 2005 when there was no operation on the floating dock.

3.5.10 Table 3-8 lists the parameters, reporting limits and referenced method for the seawater in-situ monitoring and laboratory analysis. The test results are presented in Tables 3-15 and 3-16.

| Parameters | Referenced Method | Reporting Limit |
|---|---|---|
| Dissolved Oxygen (DO) | Not applicable | 0.1mg/L<br>1% saturation |
| pH<br>Redox potential | Not applicable | --- |
| Metal content (Total and dissolved analysis)<br>- Chromium (Cr)<br>- Cadmium (Cd)<br>- Copper (Cu)<br>- Nickel (Ni) | USEPA 6020A, Cold Vapour Atomic Absorption for mercury | <br>1.0µg/L<br>0.2µg/L<br>1.0µg/L<br>1.0µg/L |

| Parameters | Referenced Method | Reporting Limit |
|---|---|---|
| - Lead (Pd)<br>- Zinc (Zn)<br>- Mercury (Hg) | | 1.0µg/L<br>5.0µg/L<br>0.04µg/L |
| Metalloid content: (Total and dissolved analysis)<br>Arsenic (As) | USEPA 6020A | 1.0µg/L |
| Suspended Solids (SS) | APHA 2540D | 2mg/L |
| Five Day Biochemical Oxygen Demand ($BOD_5$) | APHA 5210B | 0.5mg/L |
| Total Polychlorinated Biphenyls (PCBs)<br>- Calculated from summation of 18 PCB Congeners: PCB 8, PCB 18, PCB 28, PCB 44, PCB 52, PCB 66, PCB 77, PCB 101, PCB 105, PCB 118, PCB 126, PCB 128, PCB 138, PCB 153, PCB 169, PCB 170, PCB 180 and PCB 187 | USEPA 8270C | 0.01µg/L |
| Polyaromatic Hydrocarbons (PAHs)<br>- Low molecular weight PAHs (LMW)<br>Naphthalene, Acenaphtylene, Acenaphtene, Fluorene, Phenanthrene, Anthracene<br>- High molecular weight PAHs (HMW)<br>Chrysene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenz(ah)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene, Benzo(ghi)perylene | USEPA 8270C | 1.0µg/L<br><br>1.0µg/L |
| Tributyltin | UNEP/IOC/IAEA | 1ng/L |

**Table 3-8 Requirements of Seawater Sample Analysis**

3.5.11 An additional marine water sample each was collected close to EV3 and PV6 on 27 July 2005 for elutriate sample preparation.

*Sediment Sampling and Test*

3.5.12 Sediment samples were collected at 16 locations (EV1-16) at the existing Dock site from 25 June to 2 July 2005 and at 6 locations (PV1-6) at the proposed Dock site from 21 to 23 June 2005. The sampling locations are shown in Figures 3-10 and 3-11. A reference sample was collected at ST1 (shown in Figure 3-12), which is one of the reference stations of the sediment toxicity control test for the Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau.

3.5.13 Vibrocore samples of 1m to 6m in length were collected at each location except for EV3-4, EV7-8 and EV11-12 where grab samples were collected instead, due to the sandy nature at these locations. Sediment samples at each individual depth (0.0-0.9, 0.9-1.9, 1.9-2.9 and 4.9-5.9m) were analysed in accordance with ETWB TC(W) No. 34/2002.

3.5.14 Particle size distribution (PSD) for sediment samples at each location was analysed using composite samples by homogenising equal portions of samples available at each of the sample locations.

3.5.15 Table 3-9 lists the parameters, reporting limits and referenced method for the sediment laboratory analysis. The test results are presented in Tables

3-18 to 3-20.

| Parameters | Referenced Method | Reporting Limit |
|---|---|---|
| Metal content (mg/kg dry wt.)<br>- Chromium (Cr)<br>- Cadmium (Cd)<br>- Copper (Cu)<br>- Nickel (Ni)<br>- Lead (Pd)<br>- Zinc (Zn)<br>- Mercury (Hg)<br>- Silver (Ag) | USEPA 6020A | <br>8<br>0.2<br>7<br>4<br>8<br>20<br>0.05<br>0.1 |
| Metalloid content (mg/kg dry wt.)<br>Arsenic (As) | USEPA 6020A | <br>1 |
| Total Polychlorinated Biphenyls (PCBs) (ug/kg dry wt.)<br><br>- Calculated from summation of 18 PCB Congeners: PCB 8, PCB 18, PCB 28, PCB 44, PCB 52, PCB 66, PCB 77, PCB 101, PCB 105, PCB 118, PCB 126, PCB 128, PCB 138, PCB 153, PCB 169, PCB 170, PCB 180 and PCB 187 | USEPA 8270C | 3 |
| Polyaromatic Hydrocarbons (PAHs) (ug/kg dry wt.)<br>- Low molecular weight PAHs (LMW)<br>Naphthalene, Acenaphtylene, Acenaphtene, Fluorene, Phenanthrene, Anthracene<br><br>- High molecular weight PAHs (HMW)<br>Chrysene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenz(ah)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene, Benzo(ghi)perylene | USEPA 8270C | <br>55<br><br><br>170 |
| Tributyltin (in interstitial water) (ug TBT/L in Interstitial water) | UNEP/IOC/IAEA | 0.015 |
| Particle Size Distribution | GEO Report 36 | Not applicable |

**Table 3-9 Requirements of Sediment Sample Analysis**

### *Elutriate Test*

3.5.16 Elutriate samples were prepared from selected sediment samples and seawater samples collected on 27 July 2005. There were 6 elutriate samples for analysis, 4 of them from the existing Dock site and 2 from the proposed site. Blank seawater samples were analysed to establish the background water quality conditions at the sites.

3.5.17 Table 3-10 summarises the sediment samples used in preparation of the elutriate samples. Equal portions of the selected sediment samples were homogenised to form a composite sediment sample. This was then mixed with seawater collected at the respective locations to form the elutriate sample in accordance with the elutriation method recommended by USACE.

| Elutriate Sample | Selected Sediments | Sediment Sample locations |
|---|---|---|
| Elutriate PV1, PV2, PV3 (PS) | PV1, PV2, PV3 | PS |
| Elutriate PV4, PV5, PV6 (PS) | PV4, PV5, PV6 | PS |
| Elutriate EV1, EV2, EV3 & EV4 (ES) | EV1, EV2, EV3 & EV4 | ES |
| Elutriate EV5, EV6, EV9 & EV10 (ES) | EV5, EV6, EV9 & EV10 | ES |
| Elutriate EV7, EV8, EV11 & EV12 (ES) | EV7, EV8, EV11 & EV12 | ES |
| Elutriate EV13, EV14, EV15 & EV16 (ES) | EV13, EV14, EV15 & EV16 | ES |

(PS - Proposed Site, ES - Existing Site)

**Table 3-10 Elutriate Samples**

3.5.18 Table 3-11 lists the parameters, reporting limits and referenced method for the elutriate sample analysis. The test results are summarised in Tables 3-30 and 3-34.

| Parameters | Referenced Method | Reporting Limit |
|---|---|---|
| Metal content (Total and dissolved analysis)<br>- Chromium (Cr)<br>- Cadmium (Cd)<br>- Copper (Cu)<br>- Nickel (Ni)<br>- Lead (Pd)<br>- Zinc (Zn)<br>- Mercury (Hg) | USEPA 6020A Cold Vapour Atomic Absorption for mercury | <br>1.0µg/L<br>0.2µg/L<br>1.0µg/L<br>1.0µg/L<br>1.0µg/L<br>5.0µg/L<br>0.04µg/L |
| Metalloid content: (Total and dissolved analysis)<br>Arsenic (As) | USEPA 6020A | <br>1.0µg/L |
| Total Organic Carbon (TOC) | APHA 5310B | 5mg/L |
| Total Polychlorinated Biphenyls (PCBs)<br>- Calculated from summation of 18 PCB Congeners: PCB 8, PCB 18, PCB 28, PCB 44, PCB 52, PCB 66, PCB 77, PCB 101, PCB 105, PCB 118, PCB 126, PCB 128, PCB 138, PCB 153, PCB 169, PCB 170, PCB 180 and PCB 187 | USEPA 8270C | 0.01µg/L |
| Polyaromatic Hydrocarbons (PAHs)<br>- Low molecular weight PAHs (LMW)<br>Naphthalene, Acenaphtylene, Acenaphtene, Fluorene, Phenanthrene, Anthracene<br>- High molecular weight PAHs (HMW)<br>Chrysene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenz(ah)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene, Benzo(ghi)perylene | USEPA 8270C | <br>1.0µg/L<br><br>1.0µg/L |
| Tributyltin | UNEP/IOC/IAEA | 1ng/L |

**Table 3-11 Requirements of Elutriate Sample Analysis**

*Biological Screening Test*

3.5.19 Following consultation with EPD, one composite sample for category M sediments collected from the existing site was made for the biological screening tests (Table 3-12). This was because contamination level of the Category H sediments does not exceed 10 times above the UCEL and the biological screening test is not required in accordance with ETWB TC(W) No. 34/2002.

3.5.20 The layers at the samples classified as Category M sediment as shown in Table 3-13 were selected to form a representative composite sample for the biological screening test. The reasons for selecting these layers are also detailed in Table 3-21. The test results are summarised in Table 3-21.

| Test Type | Species | Reference Method | End points |
|---|---|---|---|
| 10-day burrowing amphipod | *Leptocheirus plumulosus* | USEPA (1994) | Survival |
| 20-day burrowing polychaete | *Neanthes arenaceodentata* | PESP (1995) | Dry weight |
| 48-96 hour bivalve | *Mytitlus spp.* | PESP (1995) | Normality survival |

**Table 3-12 Sediment Biological Screening Test**

| Sediment Location | Depth (m) | Remarks |
|---|---|---|
| EV6 | 0.90 - 1.90 | The concentration of arsenic exceeds LCEL and is the highest among all layers of the same location. In addition, the concentrations of zinc and copper which are the main pollutants of paint, are higher than those in sediment layer between 4.9m and 5.9m. |
| EV10 | 1.90 – 2.90 | The concentration of mercury exceeds LCEL. |
| EV13 | 0.90 – 1.90 | The concentration of lead exceeds LCEL. |
| EV13 | 1.90 – 2.90 | The concentration of copper exceeds LCEL. |
| EV14 | 0.90 – 1.90 | The concentration of arsenic exceeds LCEL and is the highest among all layers of the same location. |

**Table 3-13 The Mixture of Composite Sediment Sample for Biological Screening Test for Category M Sediment**

*Bioaccumulation Test*

3.5.21 From the sediment sample testing, the seabed at the existing Dock at Yam O Wan was found to be contaminated, and the concentrations of Zn, Cu, Hg and Ag exceed UCEL.

3.5.22 In order to provide data for evaluation of the bioaccumulation potential on benthic organisms, a bioaccumulation test was conducted with reference to the USEPA Guidance Manual on Bedded Sediment Bioaccumulation Test. A 28-day exposure bioaccumulation test was conducted for one composite sediment sample, one reference sediment sample and one negative control sample using a local clam species, *Gafrarium tumidum*. Parameters selected for analysis of sediments (including the composite sample, reference sample and negative control sample) and body burdens was based on the chemical analysis results of the sediment sample test.

3.5.23 The local species was selected because it is one of the three local bivalves species (*Tapes philipinarium*, *Circe scripta* and *Gafrarium tumidum*) recommended for the bioaccumulation test by the only study so far in Hong Kong on this subject - *Toxic Effect of Dredged Sediment of Hong Kong Coastal Waters on Clam* (by City University). After reviewing the availability of these species, adult *Gafrarium tumidum* was used.

3.5.24 In order to provide a full picture on the potential bioaccumulation impact on marine animals caused by contaminants with exceedances of UCEL, the tissue of the *Gafrarium tumidum* used for the bioaccumulation test was analysed for zinc, copper, mercury and silver.

3.5.25 A composite sample using equal portions of the sediment samples collected at EV4, EV11 and EV12 was made for the bioaccumulation test to represent the worst-case scenario. The test results are summarised in Tables 3-22 to 3-27.

**Water Quality Conditions**

3.5.26 Water quality in the North Western WCZ is dominantly influenced by local effluent discharges from three major sewage outfalls (Pillar Point, San Wai and Siu Ho Wan Sewage Treatment Works) and the Pearl River.

3.5.27 Water quality in the Western Buffer WCZ is mainly influenced by the discharge of effluents from the Stonecutters Island Sewage Treatment Works, the amount of effluent from which reached 1.4 million $m^3$/day in 2003.

3.5.28 The EPD monthly marine water monitoring data at NM1 (close to the existing site) and WM3 / WM4 (close to the proposed site) in 2004 are listed in Table 3-14.

3.5.29 The data in Table 3-14 show that the baseline WQ in the vicinity of the sites is generally good, in compliance with WQOs for dissolved oxygen, pH and total inorganic nitrogen. However the bacteria concentrations (*E. coli*) at WM3 and WM4 are high. The high levels of *E. coli* at these stations are likely caused by the discharge of effluents from the local sewage treatment works described in the above.

3.5.30 Results of the duplicate marine water samples collected at 4 locations at the existing Dock site are presented in Tables 3-15 and 3-16. The average concentrations are also determined using all the sample results and are listed at the bottom of the tables. The spatial variations can be smoothed out after averaging, and the average concentrations can be used as a typical WQ condition at the site.

3.5.31 The data in Tables 3-15 and 3-16 shows that the baseline WQ at the existing Dock site is generally good, in compliance with WQOs and the recommended standards for normal conditions (Table 3-3), except for copper. The dissolved copper in the marine water at the site exceeded the recommended standard (3.1μg/L) for all the samples tested.

### Sediment Quality Conditions

3.5.32 The EPD sediment monitoring station of NS2 is close to the existing site at Yam O Wan and the station WS1 is close to the proposed site at Tsing Yi. The 5-year (2000-2004) sediment quality data at these two stations is listed in Table 3-17.

3.5.33 The data in Table 3-17 summarises the baseline sediment quality in the open waters and typhoon shelters in the vicinity of the study areas. All contaminant levels of the marine sediment in open waters are below the LCEL, indicating that the sediment quality is good. The sediment quality at NS5 (Tuen Mun typhoon shelter) is also good as all contaminant levels are below the LCEL. However, the contaminant level of silver and zinc exceeded the LCEL and copper exceeded the UCEL at VS21 (Government Dockyard).

3.5.34 The results of the sediment samples at 16 locations of the existing Dock site at Yam O Wan, their averages as well as the referenced sample are presented in Table 3-18. The sediment results from EPD's sediment monitoring stations at NS2 and NS5 (Tuen Mun typhoon shelter) are also included in the table for comparison.

| Water Quality Parameter | Relevant WQOs for North Western WCZ | NM1 (North Western) | Relevant WQOs for Western Buffer WCZ | WM3 (Western Buffer) | WM4 (Western Buffer) |
|---|---|---|---|---|---|
| pH | 6.5-8.5 change due to waste discharge not to exceed 0.2 | 8.0 (7.8-8.2) | 6.5-8.5 change due to waste discharge not to exceed 0.2 | 8.0(7.9-8.2) | 8.0(7.9-8.2) |
| Turbidity (NTU) | Not reduce light transmission substantially from the normal level (Bathing Beach Subzones) | 14.3(4.5-21.7) | Not reduce light transmission substantially from the normal level (Bathing Beach Subzones) | 11.9(8.1-14.9) | 13.7(9.3-22.0) |
| Temperature (°C) | Change due to waste discharge not to be greater than 2°C | 23.1(16.0-27.5) | Change due to waste discharge not to be greater than 2°C | 23.4(15.9-28.5) | 23.4(15.8-28.7) |
| Salinity (ppt) | Change due to waste discharge not to exceed 10% of natural ambient level | 31.7(28.0-33.4) | Change due to waste discharge not to exceed 10% of natural ambient level | 32.2(27.9-33.8) | 31.7(26.1-33.6) |
| Dissolved Oxygen (mg $L^{-1}$) | ≥ 4mg/L for 90% samples | 5.3(3.7-7.4) | ≥ 4mg/L for 90% samples | 5.9(4.8-7.5) | 5.8(4.0-7.5) |
| Dissolved Oxygen (mg $L^{-1}$) at Bottom | ≥ 2mg/L for 90% of samples | 5.2(3.5-7.4) | ≥ 2mg/L for 90% of samples | 5.8(4.6-7.5) | 5.6(3.6-7.5) |
| $BOD_5$ (mg $L^{-1}$) | Not exceed 3mg/L for waste discharge (water gathering ground subzones) | 0.7(0.3-1.1) | Not exceed 3mg/L (water gathering ground subzones) | 0.9(0.2-1.4) | 0.8(0.3-1.3) |
| Suspended Solids (mg $L^{-1}$) | <30% increase over the ambient level | 11.0(3.7-25.7) | <30% increase over the ambient level | 8.0(2.8-12.0) | 10.6(3.9-24.0) |
| Total Inorganic Nitrogen (mg $L^{-1}$) | Annual mean not to exceed 0.5mg/L | 0.35(0.18-0.54) | Annual mean not to exceed 0.4mg/L | 0.29(0.19-0.46) | 0.30(0.18-0.45) |
| Unionised Ammonia (mg $L^{-1}$) | The annual mean <0.021 mg/L | 0.006(0.002-0.009) | The annual mean <0.021 mg/L | 0.006(0.003-0.014) | 0.005(0.002-0.008) |
| Chlorophyll-a (µg $L^{-1}$) | N/A | 1.9(0.6-6.1) | N/A | 2.8(0.5-7.4) | 3.1(0.5-8.1) |
| *E. coli* (cfu 100m$L^{-1}$) | Annual geometric mean not to exceed 610cfu/100ml (secondary contact recreation subzones) | 1400(460-4600) | Annual geometric mean not to exceed 610cfu/100ml (secondary contact recreation subzones) | 2400(770-25000) | 1300(260-19000) |

Notes: Data from Marine Water Quality in *HK* 2004
Data presented are depth averaged, except as specified.
Data presented are annual arithmetic means except for *E. coli* which are geometric means
Data enclosed in brackets indicate the ranges.

**Table 3-14 EPD Marine Water Quality Monitoring Data in Year 2004**

| Sample Location and Depth | | Heavy Metals (Total) | | | | | | | | Heavy Metals (Dissolved) | | | | | | | | Other Parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | BOD | TSS | Total PCB | LMW PAH | HMW PAH | TBT | DO | Redox | pH |
| | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | mg/L | mg/L | ug/L | ug/L | ug/L | ng/L | mg/L | mV | pH unit |
| No. 1 | S | <0.2 | <1 | 370 | 4.4 | 8.7 | 125 | 9.8 | <0.04 | <0.2 | <1 | **8.2** | <1 | <1 | 13 | <1 | <0.04 | 1.4 | 9.0 | <0.01 | <1 | <1 | <1 | 6.51 | 395.3 | 8.18 |
| No. 1 | M | 0.2 | <1 | 390 | 4.5 | 2.3 | 135 | <1 | <0.04 | <0.2 | <1 | **11** | <1 | <1 | 23 | <1 | <0.04 | 1.1 | 7.1 | <0.01 | <1 | <1 | <1 | 4.44 | 378.1 | 8.09 |
| No. 1 | B | <0.2 | <1 | 335 | 4.5 | 1.2 | 103 | 2.5 | <0.04 | <0.2 | <1 | **6.4** | <1 | <1 | 11 | <1 | <0.04 | 1.3 | 13 | <0.01 | <1 | <1 | <1 | 4.15 | 365.9 | 8.11 |
| No. 2 | S | <0.2 | <1 | 335 | 4.5 | 4.6 | 200 | 5.8 | <0.04 | <0.2 | <1 | **17** | <1 | <1 | 31 | <1 | <0.04 | 0.9 | 9.0 | <0.01 | <1 | <1 | <1 | 6.13 | 356.8 | 8.15 |
| No. 2 | M | 0.3 | <1 | 550 | 4.4 | 8.5 | 215 | 5.1 | <0.04 | <0.2 | <1 | **9.2** | <1 | <1 | 8.8 | <1 | <0.04 | 0.9 | 10 | <0.01 | <1 | <1 | <1 | 4.45 | 355.3 | 8.10 |
| No. 2 | B | <0.2 | <1 | 665 | 4.4 | 3.4 | 205 | 6.6 | 0.02 | <0.2 | <1 | **9.2** | <1 | <1 | 9.8 | <1 | <0.04 | 1.2 | 8.8 | <0.01 | <1 | <1 | <1 | 4.16 | 353.6 | 8.12 |
| No. 3 | S | <0.2 | <1 | 290 | 4.7 | 1.8 | 170 | <1 | 0.05 | <0.2 | <1 | **3.8** | <1 | <1 | 12 | <1 | <0.04 | 1.0 | 11 | <0.01 | <1 | <1 | <1 | 5.70 | 350.7 | 8.15 |
| No. 3 | M | <0.2 | <1 | 300 | 4.5 | 3.4 | 150 | <1 | <0.04 | <0.2 | <1 | **3.8** | <1 | <1 | 12 | <1 | <0.04 | 1.0 | 11 | <0.01 | <1 | <1 | <1 | 5.39 | 340.3 | 8.15 |
| No. 3 | B | 0.4 | <1 | 330 | 4.5 | <1 | 689 | <1 | 0.03 | <0.2 | <1 | **5.7** | <1 | <1 | 12 | <1 | <0.04 | 1.1 | 9.7 | <0.01 | <1 | <1 | <1 | 4.22 | 331.2 | 8.14 |
| No. 4 | S | <0.2 | <1 | 290 | 4.7 | 2.9 | 180 | <1 | <0.04 | <0.2 | <1 | **5.7** | <1 | <1 | 18 | <1 | <0.04 | 1.6 | 14 | <0.01 | <1 | <1 | <1 | 6.14 | 332.4 | 8.19 |
| No. 4 | M | 0.2 | <1 | 280 | 4.3 | 5.8 | 119 | 5.1 | <0.04 | <0.2 | <1 | **3.9** | <1 | <1 | 8.3 | <1 | <0.04 | 1.4 | 11 | <0.01 | <1 | <1 | <1 | 4.98 | 332.7 | 8.14 |
| No. 4 | B | <0.2 | <1 | 290 | 4.4 | 3.3 | 119 | 3.6 | 0.02 | <0.2 | <1 | **4.2** | <1 | <1 | 9.0 | <1 | <0.04 | 1.5 | 10 | <0.01 | <1 | <1 | <1 | 4.72 | 345.8 | 8.15 |
| Avg | - | - | - | 369 | 4.5 | 4.2 | 201 | - | - | - | - | **7.3** | - | - | 14.0 | - | - | 1.2 | 10.3 | - | - | - | - | - | - | - |
| Criteria[1] | - | - | - | - | - | - | - | - | - | 40 | 1100 | 4.8 | 74 | 210 | 90 | 69 | 1.8 | - | - | 0.03 | 0.2 ppm | | 0.37 ug/L | - | - | - |
| Criteria[2] | - | - | - | - | - | - | - | - | - | 8.8 | 50 | 3.1 | 8.2 | 8.1 | 81 | 36 | 0.94 | - | - | 0.03 | 0.2 ppm | | 0.01 ug/L | - | - | - |

Notes: S, M and B stand for surface, middle and bottom correspondingly. The underlined numbers indicating the levels exceeding the recommended criteria listed in Table 3-3.

1 Criteria for temporary conditions recommended this EIA

2 Criteria for normal conditions recommended this EIA

**Table 3-15 Marine Water Quality Results at Yam O Wan (Collection Date: 21 May 2005)**

| Sample Location and Depth | | Heavy Metals (Total) | | | | | | | | Heavy Metals (Dissolved) | | | | | | | | Other Parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | BOD | TSS | Total PCB | LMW PAH | HMW PAH | TBT | DO | Redox | pH |
| | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | mg/L | mg/L | ug/L | ug/L | ug/L | ng/L | mg/L | mV | pH unit |
| No. 1 | S | 0.6 | <1 | 215 | 4.6 | 6.5 | 66 | <1 | <0.04 | <0.2 | <1 | **5.7** | <1 | <1 | 10 | <1 | <0.04 | 0.5 | 9.9 | <0.01 | <1 | <1 | <1 | 6.96 | 330.0 | 8.26 |
| No. 1 | M | 0.7 | <1 | 230 | 4.6 | 2.1 | 49 | <1 | <0.04 | <0.2 | <1 | **5.2** | <1 | <1 | 8.2 | <1 | <0.04 | 0.5 | 19 | <0.01 | <1 | <1 | <1 | 6.30 | 301.4 | 8.21 |
| No. 1 | B | 0.5 | <1 | 270 | 4.5 | 1.7 | 60 | <1 | <0.04 | <0.2 | <1 | **6.2** | <1 | <1 | 8.3 | <1 | <0.04 | <0.5 | 8.7 | <0.01 | <1 | <1 | <1 | 5.87 | 304.7 | 8.20 |
| No. 2 | S | 0.7 | <1 | 240 | 4.5 | 2.3 | 60 | <1 | <0.04 | <0.2 | <1 | **4.7** | <1 | <1 | 7.4 | <1 | <0.04 | <0.5 | 6.0 | <0.01 | <1 | <1 | <1 | 6.68 | 307.9 | 8.21 |
| No. 2 | M | 0.3 | <1 | 225 | 4.5 | <1 | 53 | 7.2 | <0.04 | <0.2 | <1 | **5.0** | <1 | <1 | 7.1 | <1 | <0.04 | <0.5 | 7.5 | <0.01 | <1 | <1 | <1 | 6.30 | 309.7 | 8.19 |
| No. 2 | B | 0.4 | <1 | 225 | 4.4 | 1.8 | 65 | <1 | <0.04 | <0.2 | <1 | **5.5** | <1 | <1 | 7.7 | <1 | <0.04 | <0.5 | 4.4 | <0.01 | <1 | <1 | <1 | 5.94 | 315.0 | 8.21 |
| No. 3 | S | 0.9 | <1 | 240 | 4.5 | 10 | 91 | 4.5 | <0.04 | 0.4 | <1 | **6.8** | <1 | 4.2 | 19 | <1 | <0.04 | <0.5 | 7.2 | <0.01 | <1 | <1 | <1 | 6.95 | 312.2 | 8.06 |
| No. 3 | M | 0.2 | <1 | 235 | 4.5 | 1.9 | 63 | <1 | <0.04 | <0.2 | <1 | **6.4** | <1 | 1.4 | 13 | <1 | <0.04 | <0.5 | 6.8 | <0.01 | <1 | <1 | <1 | 6.48 | 311.7 | 8.19 |
| No. 3 | B | 0.7 | <1 | 215 | 4.3 | 2.4 | 85 | <1 | <0.04 | <0.2 | <1 | **6.1** | <1 | <1 | 10 | <1 | <0.04 | <0.5 | 5.4 | <0.01 | <1 | <1 | <1 | 5.99 | 309.5 | 8.20 |
| No. 4 | S | 0.3 | <1 | 240 | 4.4 | 4.4 | 60 | 2.1 | <0.04 | <0.2 | <1 | **6.4** | <1 | <1 | 9.5 | <1 | <0.04 | <0.5 | 6.3 | <0.01 | <1 | <1 | <1 | 5.96 | 310.0 | 8.20 |
| No. 4 | M | <0.2 | <1 | 240 | 4.5 | 6.0 | 103 | 3.4 | <0.04 | <0.2 | <1 | **6.6** | <1 | 1.3 | 12 | <1 | <0.04 | <0.5 | 9.5 | <0.01 | <1 | <1 | <1 | 5.82 | 320.3 | 8.21 |
| No. 4 | B | 0.5 | <1 | 215 | 4.5 | 1.4 | 83 | 8.2 | <0.04 | <0.2 | <1 | **6.8** | <1 | <1 | 11 | <1 | <0.04 | <0.5 | 21 | <0.01 | <1 | <1 | <1 | 5.75 | 318.7 | 8.21 |
| Avg | | - | - | 233 | 4.5 | 3.7 | 70 | - | - | - | - | **6.0** | - | - | 10.3 | - | - | - | 9.3 | - | - | - | - | - | - | - |
| Criteria[1] | - | - | - | - | - | - | - | - | - | 40 | 1100 | 4.8 | 74 | 210 | 90 | 69 | 1.8 | - | - | 0.03 | 0.2 ppm | | 0.37 ug/L | - | - | - |
| Criteria[2] | - | - | - | - | - | - | - | - | - | 8.8 | 50 | 3.1 | 8.2 | 8.1 | 81 | 36 | 0.94 | - | - | 0.03 | 0.2 ppm | | 0.01 ug/L | - | - | - |

Notes: S, M and B stand for surface, middle and bottom correspondingly. The underlined numbers indicating the levels exceeding the recommended criteria listed in Table 3-3.
1 Criteria for temporary conditions recommended this EIA
2 Criteria for normal conditions recommended this EIA

**Table 3-16 Marine Water Quality Results at Yam O Wan (Collection Date: 4 June 2005)**

| Sediment Quality Parameter | Lower Chemical Exceedance Level | Upper Chemical Exceedance Level | NS2 (North Western) | WS1 (Western Buffer) | NS5 (Typhoon Shelter in North Western) | VS21 (Typhoon Shelter in Victoria Harbour) |
|---|---|---|---|---|---|---|
| Particle Size Fractionation <63µm (%w/w) | - | - | 65 (41-79) | 76 (27 – 95) | 67.15 (39-85) | 96.66 (89-100) |
| Electrochemical Potential (mV) | - | - | -138 ((-186) – (-84)) | -184 ((-263) – (-108)) | -196.7 ((-286)-(-85)) | -317.2 ((-388)-(-97)) |
| Total Solids (%w/w) | - | - | 54 (50 – 62) | 48 (38 – 65) | 47.5 (39-68) | 36.8 (31-44) |
| Total Volatile Solids (%w/w) | - | - | 6.2 (5 – 7.0) | 6.6 (4 – 9.0) | 7 (5.8-8.4) | 8.45 (7.4-9.4) |
| Chemical Oxygen Demand (mg/kg) | - | - | 14000 (10000 - 17000) | 15000 (11000 - 19000) | 18900 (15000-22000) | 16890 (9900-21000) |
| Total Carbon (%w/w) | - | - | 0.6 (0.5 – 1.0) | 0.7 (0.5 – 1.1) | 0.66 (0.5-0.9) | 0.55 (0.5-0.8) |
| Ammonical Nitrogen (mg/kg) | - | - | 3 (0.1 – 8.2) | 17.6 (5.8 – 38) | 8.78 (0.1-28) | 12.52 (2-29) |
| Total Kjeldahl Nitrogen (mg/kg) | - | - | 303 (220 – 370) | 397 (200 – 570) | 344 (170-680) | 358 (310-410) |
| Total Phosphorus (mg/kg) | - | - | 182 (130 – 220) | 183 (110 – 240) | 193 (86-330) | 204 (180-230) |
| Total Sulphide (mg/kg) | - | - | 23 (2 – 64) | 101 (13 – 210) | 122.9 (1-370) | 197.32 (8-630) |
| Total Cyanide (mg/kg) | - | - | <0.1 (<0.1 – 0.1) | 0.1 (<0.1 – 0.3) | 0.14 (<0.1-0.3) | 0.14 (<0.1-0.3) |
| Arsenic (mg/kg) | 12 | 42 | 10 (7.5 – 14.0) | 9.4 (4.7 – 13.0) | 8.88 (6.8-11.0) | 8.8 (7.3-9.7) |
| Cadmium (mg/kg) | 1.5 | 4 | <0.1 (<0.1 – 0.1) | 0.1 (<0.1 – 0.2) | 0.24 (<0.1-0.4) | 0.31 (0.1-0.5) |
| Chromium (mg/kg) | 80 | 160 | 33 (25 – 43) | 38 (13 – 51) | 34.3 (26-49) | 53.2 (50-56) |
| Copper (mg/kg) | 65 | 110 | 31 (27 – 42) | 46 (9 – 85) | 45.2 (13-83) | 127.9 (29-180) |
| Lead (mg/kg) | 75 | 110 | 37 (32 – 50) | 38 (15 – 49) | 44.8 (27-60) | 51.6 (34-65) |
| Mercury (mg/kg) | 0.5 | 1 | 0.09 (0.06 – 0.15) | 0.16 (<0.05 – 0.49) | 0.08 (<0.05-0.12) | 0.15 (<0.05-0.21) |
| Nickel (mg/kg) | 40 | 40 | 20 (15 – 27) | 22 (8 – 27) | 19.6 (16-22) | 31.7 (28-36) |
| Silver (mg/kg) | 1 | 2 | 0.5 (0.3 – 1.0) | 0.9 (0.5 – 2.0) | 0.5 (0.2-1.0) | 1.6 (1.0-2.0) |

| Sediment Quality Parameter | Lower Chemical Exceedance Level | Upper Chemical Exceedance Level | NS2 (North Western) | WS1 (Western Buffer) | NS5 (Typhoon Shelter in North Western) | VS21 (Typhoon Shelter in Victoria Harbour) |
|---|---|---|---|---|---|---|
| Zinc (mg/kg) | 200 | 270 | 94 (73 – 130) | 102 (31 – 150) | 137.5 (87-200) | 210 (110-270) |
| Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4) | 23 | 180 | 18 (18 – 18) | 18 (18 – 18) | 18 (18-18) | 20.67 (18-25) |
| Low molecular weight PAHs (LMW) (µg/kg) (5) (6) (9) | 550 | 3160 | 90 (90 – 90) | 90 (90 – 90) | 90 (90-90) | 95.83 (90-117) |
| High molecular weight PAHs (HMW) (µg/kg) (7) (8) (9) | 1700 | 9600 | 44 (27 – 65) | 95 (22 – 187) | 135.9 (19-291) | 194.65 (49-5284) |

Notes:
1. Data from Marine Water Quality in *HK* 2004. Data presented are arithmetic means; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB TC(W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002-2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely: Acenaphthene, Acenaphthylene, Anthracene, Flourene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002-2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely: Fluoranthene, Pyrene, Benzo(a) anthracene, Chrysene, Benzo(b) fluoranthene, Benzo(k)fluoranthene, Benzo(a) pyrene, Dibenzo(a,h) anthracene, Benzo(g,h,i) perylene and Indeno(1,2,3-cd) pyrene.
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (2000-2004).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

**Table 3-17 EPD Sediment Quality Monitoring Data in Years 2000-2004**

| Sample Location and Depth | | Heavy Metals | | | | | | | | | Other Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Ni | Pb | Zn | Hg | As | Ag | LMW PAH | HMW PAH | Total PCBs | TBT |
| | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | ug/kg | ug/kg | ug/kg | ug/L |
| EV1 | 0.0-0.9 | <0.2 | 37 | 53 | 15 | 54 | 120 | 0.43 | 11 | 0.9 | <55 | <170 | <3 | <0.015 |
| EV1 | 0.9-1.9 | 0.2 | 36 | 30 | 17 | 58 | 100 | ***0.60*** | ***15*** | 0.2 | <55 | <170 | <3 | <0.015 |
| EV1 | 1.9-2.9 | <0.2 | 33 | 24 | 16 | 62 | 91 | **1.3** | 12 | 0.9 | <55 | <170 | <3 | <0.015 |
| EV1 | 4.9-5.9 | <0.2 | 21 | 9.0 | 11 | 26 | 53 | 0.30 | 7.1 | <0.1 | <55 | <170 | <3 | <0.015 |
| EV2 | 0.0-0.9 | 0.2 | 36 | 36 | 16 | 56 | 110 | ***0.96*** | ***14*** | 1.0 | <55 | <170 | <3 | <0.015 |
| EV2 | 0.9-1.9 | <0.2 | 31 | 23 | 15 | 62 | 89 | **2.0** | ***15*** | 1.0 | <55 | <170 | <3 | <0.015 |
| EV2 | 1.9-2.9 | <0.2 | 31 | 21 | 16 | 58 | 84 | **1.8** | 11 | ***1.4*** | <55 | <170 | <3 | <0.015 |
| EV2 | 4.9-5.9 | <0.2 | 18 | 8.0 | 7.1 | 23 | 42 | **1.3** | 9.2 | ***1.3*** | <55 | <170 | <3 | <0.015 |
| EV3 | Grab | <0.2 | 17 | 29 | 11 | 29 | 87 | **1.2** | 6.5 | 0.6 | <55 | <170 | <3 | <0.015 |
| EV4 | Grab | 0.4 | 35 | **470** | 25 | ***99*** | **1300** | ***0.61*** | ***13*** | ***1.5*** | 110 | 470 | <3 | <0.015 |
| EV5 | 0.0-0.9 | 0.2 | 30 | 37 | 12 | 45 | 92 | **1.1** | 12 | **1.2** | <55 | <170 | <3 | <0.015 |
| EV5 | 0.9-1.9 | <0.2 | 33 | 53 | 14 | 47 | 95 | 0.45 | 11 | 0.3 | <55 | <170 | <3 | <0.015 |
| EV5 | 1.9-2.9 | 0.2 | 32 | 62 | 14 | 53 | 100 | 0.49 | 10 | 0.4 | <55 | <170 | <3 | <0.015 |
| EV5 | 4.9-5.9 | <0.2 | 29 | 22 | 15 | 57 | 89 | 0.50 | ***13*** | 0.2 | <55 | <170 | <3 | <0.015 |
| EV6 | 0.0-0.9 | <0.2 | 33 | 25 | 17 | 69 | 95 | 0.50 | ***13*** | <0.1 | <55 | <170 | <3 | <0.015 |
| EV6 | 0.9-1.9 | <0.2 | 34 | 24 | 17 | <8 | 180 | 0.43 | ***14*** | <0.1 | <55 | <170 | <3 | <0.015 |
| EV6 | 1.9-2.9 | <0.2 | 32 | 20 | 17 | 47 | 79 | 0.47 | ***13*** | <0.1 | <55 | <170 | <3 | <0.015 |
| EV6 | 4.9-5.9 | 0.3 | 23 | 14 | 9.2 | 43 | 68 | 0.25 | ***14*** | <0.1 | <55 | <170 | <3 | <0.015 |
| EV7 | Grab | <0.2 | 20 | 38 | 13 | 42 | 110 | 0.24 | 6.3 | 0.2 | <55 | <170 | <3 | <0.015 |
| EV8 | Grab | <0.2 | 30 | 48 | 19 | 45 | 150 | 0.45 | 8.0 | ***1.8*** | <55 | <170 | <3 | <0.015 |
| EV9 | 0.0-0.9 | 0.2 | 35 | **69** | 14 | 61 | 120 | ***0.85*** | 12 | ***2.2*** | <55 | <170 | <3 | <0.015 |
| EV9 | 0.9-1.9 | <0.2 | 29 | 31 | 12 | 40 | 79 | 0.21 | 11 | 0.3 | <55 | <170 | <3 | <0.015 |
| EV9 | 1.9-2.9 | 0.2 | 33 | **67** | 13 | 41 | 95 | **1.3** | 10 | 0.5 | <55 | <170 | <3 | <0.015 |
| EV9 | 4.9-5.9 | <0.2 | 19 | 17 | 6.5 | 48 | 57 | 0.21 | 7.7 | 0.2 | <55 | <170 | <3 | <0.015 |
| EV10 | 0.0-0.9 | <0.2 | 37 | 29 | 19 | 70 | 100 | 0.40 | **14** | 0.2 | <55 | <170 | <3 | <0.015 |
| EV10 | 0.9-1.9 | <0.2 | 33 | 23 | 18 | 59 | 89 | 0.50 | **13** | 0.1 | <55 | <170 | <3 | <0.015 |
| EV10 | 1.9-2.9 | <0.2 | 33 | 21 | 17 | 58 | 88 | ***0.52*** | 12 | <0.1 | <55 | <170 | <3 | <0.015 |
| EV10 | 4.9-5.9 | <0.2 | 23 | 12 | 10 | 31 | 58 | 0.13 | 11 | <0.1 | <55 | <170 | <3 | <0.015 |
| EV11 | Grab | <0.2 | 17 | ***69*** | 11 | 47 | **350** | 0.22 | 5.8 | 0.2 | 85 | <170 | <3 | <0.015 |

| Sample Location and Depth | | Heavy Metals | | | | | | | | | Other Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Ni | Pb | Zn | Hg | As | Ag | LMW PAH | HMW PAH | Total PCBs | TBT |
| | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | ug/kg | ug/kg | ug/kg | ug/L |
| EV12 | Grab | 0.3 | 28 | ***67*** | 18 | 55 | **340** | 0.27 | 9.0 | 0.3 | <55 | <170 | <3 | <0.015 |
| EV13 | 0.0-0.9 | <0.2 | 34 | 40 | 16 | 46 | 98 | 0.11 | 11 | 0.3 | <55 | <170 | <3 | <0.015 |
| EV13 | 0.9-1.9 | 0.2 | 41 | 63 | 19 | ***89*** | 110 | 0.23 | 12 | 0.6 | <55 | <170 | <3 | <0.015 |
| EV13 | 1.9-2.9 | 0.3 | 42 | ***79*** | 20 | 59 | 120 | 0.23 | 11 | 0.5 | <55 | <170 | <3 | <0.015 |
| EV13 | 4.9-5.9 | <0.2 | 17 | 7.2 | 8.1 | 19 | 40 | 0.27 | 10 | <0.1 | <55 | <170 | <3 | <0.015 |
| EV14 | 0.0-0.9 | <0.2 | 36 | 27 | 19 | 65 | 95 | 0.49 | ***14*** | 0.1 | <55 | <170 | <3 | <0.015 |
| EV14 | 0.9-1.9 | 0.2 | 35 | 27 | 17 | 60 | 100 | 0.38 | ***18*** | 0.2 | <55 | <170 | <3 | <0.015 |
| EV14 | 1.9-2.9 | <0.2 | 34 | 26 | 18 | 59 | 95 | 0.48 | ***15*** | 0.2 | <55 | <170 | <3 | <0.015 |
| EV14 | 4.9-5.9 | <0.2 | 32 | 19 | 17 | 42 | 78 | ***0.51*** | 11 | <0.1 | <55 | <170 | <3 | <0.015 |
| EV15 | 0.0-0.9 | 0.2 | 41 | 45 | 19 | 59 | 110 | 0.36 | ***13*** | 0.3 | <55 | <170 | <3 | <0.015 |
| EV15 | 0.9-1.9 | <0.2 | 32 | 25 | 18 | 57 | 92 | **1.1** | ***14*** | ***1.6*** | <55 | <170 | <3 | <0.015 |
| EV15 | 1.9-2.9 | <0.2 | 31 | 23 | 16 | 62 | 86 | **1.6** | ***14*** | **2.9** | <55 | <170 | <3 | <0.015 |
| EV15 | 4.9-5.9 | <0.2 | 16 | 7.9 | 8.4 | 36 | 38 | **1.1** | 7.9 | 1.0 | <55 | <170 | <3 | <0.015 |
| EV16 | 0.0-0.9 | 0.2 | 32 | 28 | 16 | 61 | 100 | **2.0** | ***14*** | **2.2** | <55 | <170 | <3 | <0.015 |
| EV16 | 0.9-1.9 | <0.2 | 30 | 22 | 16 | 62 | 84 | ***0.55*** | ***13*** | 0.1 | <55 | <170 | <3 | <0.015 |
| EV16 | 1.9-2.9 | <0.2 | 32 | 25 | 17 | 61 | 89 | **1.3** | ***14*** | 0.5 | <55 | <170 | <3 | <0.015 |
| EV16 | 4.9-5.9 | <0.2 | 20 | 9.0 | 9.6 | 29 | 49 | ***0.69*** | ***14*** | 0.9 | <55 | <170 | <3 | <0.015 |
| Average | - | 0.24 | 30 | 42 | 15 | 52 | 128 | ***0.68*** | 12 | 0.76 | <55[a] | <170[a] | <3 | <0.015 |
| ST1 | Grab | 0.3 | 43 | 50 | 22 | 43 | 110 | <0.05 | 10 | 0.6 | <55 | <170 | <3 | <0.015 |
| NS2 | - | <0.1 | 33 | 31 | 20 | 37 | 94 | 0.09 | 10 | 0.5 | 90 | 44 | 18 | - |
| NS5 | - | 0.24 | 34.3 | 45.2 | 19.6 | 44.8 | 137.5 | 0.08 | 8.88 | 0.5 | 90 | 135.9 | 18 | - |

Notes:

(a) The underlined, bold and italic numbers indicating the levels exceeding the LCEL listed in Table 3-6. The bold numbers with shaded area indicating the levels exceeding the UCEL listed in Table 3-6.

(b) Results of the reference sediment (ST1),EPD's NS2 and NS5 (Tuen Mun typhoon shelter) are listed for comparison.

**Table 3-18 Sediment Quality Results at the Existing Site**

3.5.35 The data in Table 3-18 shows that the seabed at the existing Dock site at Yam O Wan is contaminated with heavy metals. The concentration levels of copper, lead, zinc, mercury, arsenic and silver from some of the samples exceed LCEL or UCEL specified in ETWBTC(W) No. 34/2002. In accordance with the Circular, the sediment at the existing dock site belongs to Category H. The classification of the sediment is further discussed in Section 4.

3.5.36 As shown in Table 3-18, the average concentrations of most heavy metal contaminants in the seabed at the existing site are similar to those at the adjacent seabed and the Tuen Mun typhoon shelter, and some are actually lower. Only the averaged mercury level at the site is higher than those in the surroundings. However, this level (0.68 mg/L) is less than that in most of the typhoon shelters (e.g Causeway Bay (VS12) 0.72 mg/L, To Kwa Wan (VS20) 1.09 mg/L) and Kwun Tong (VS14) 1 mg/L[1]).

3.5.37 The 16 sediment sampling stations are located within an area of less than 650m in diameter. The results indicate no particular pattern of a spatial distribution of contaminants as shown in Figure 3-13. Table 3-19 lists the number of samples of each individual contaminant concentration exceeding LCEL and UCEL. Since two sampling techniques (vibrocore and grab) have been used, the numbers are separately listed by technique. The results show that among the 6 heavy metal contaminants of concern, mercury and arsenic are the most critical components as most of the sediment samples show their exceedance of LCEL.

| | | Cd | Cr | Cu | Ni | Pb | Zn | Hg | As | Ag | LMW PAH | HMW PAH | Total PCBs | TBT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vibrocore | Total no | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | >LCEL | 0 | 0 | 3 | 0 | 0 | 0 | 18 | 20 | 4 | 0 | 0 | 0 | 0 |
| | >UCEL | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 3 | 0 | 0 | 0 | 0 |
| Grab | Total no | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | >LCEL | 0 | 0 | 3 | 0 | 1 | 3 | 2 | 1 | 2 | 0 | 0 | 0 | 0 |
| | >UCEL | 0 | 0 | 1 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 3-19 Number of Sediment Samples with Contaminants exceeding LCEL and UCEL at the Existing Site**

3.5.38 The results of the sediment testing of the samples at 6 locations of the proposed Dock site at the north western coast of Tsing Yi as well as the referenced sample are presented in Table 3-20. The sediment quality data at EPD's monitoring stations WS1 and VS21 (Government Dockyard typhoon shelter) are also included in the table for comparison.

[1] EPD Marine Water Quality in Hong Kong, 2004

| Sample Location and Depth | | Heavy Metals | | | | | | | | | Other Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Ni | Pb | Zn | Hg | As | Ag | LMW PAH | HMW PAH | Total PCBs | TBT |
| | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | µg/kg | µg/kg | µg/kg | µg/L |
| PV1 | 0.0-0.9 | <0.2 | 33 | 17 | 19 | 38 | 77 | 0.15 | 8.0 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV1 | 0.9-1.9 | <0.2 | 29 | 13 | 16 | 33 | 72 | 0.25 | 5.8 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV1 | 1.9-2.9 | <0.2 | 30 | 10 | 19 | 28 | 72 | 0.31 | 5.0 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV1 | 4.9-5.9 | <0.2 | 31 | 11 | 17 | 30 | 74 | 0.30 | 5.1 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV2 | 0.0-0.9 | <0.2 | 32 | 18 | 17 | 57 | 84 | 0.46 | 10 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV2 | 0.9-1.9 | <0.2 | 33 | 15 | 18 | 42 | 77 | 0.28 | 7.4 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV2 | 1.9-2.9 | <0.2 | 33 | 12 | 21 | 39 | 81 | 0.47 | 4.7 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV2 | 4.9-5.9 | <0.2 | 31 | 12 | 17 | 30 | 73 | 0.21 | 5.3 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV3 | 0.0-0.9 | 0.4 | 35 | ***83*** | 17 | ***110*** | 120 | 0.48 | 9.4 | 0.5 | 140 | ***2840*** | <3 | <0.015 |
| PV3 | 0.9-1.9 | 0.3 | 38 | 32 | 18 | 65 | 110 | 0.47 | 10 | 0.5 | <55 | <170 | <3 | <0.015 |
| PV3 | 1.9-2.9 | <0.2 | 33 | 17 | 18 | 48 | 83 | 0.35 | 8.1 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV3 | 4.9-5.9 | <0.2 | 33 | 11 | 18 | 28 | 80 | 0.21 | 3.6 | <0.1 | <55 | <170 | <3 | <0.015 |
| PV4 | 0.0-0.9 | 0.3 | 39 | 40 | 18 | 73 | 130 | 0.39 | 10 | 0.4 | <55 | <170 | <3 | <0.015 |
| PV4 | 0.9-1.9 | <0.2 | 33 | 25 | 16 | 62 | 86 | ***0.90*** | 9.2 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV4 | 1.9-2.9 | <0.2 | 33 | 18 | 17 | 78 | 79 | 0.40 | 7.4 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV4 | 4.9-5.9 | <0.2 | 33 | 15 | 17 | 43 | 80 | 0.27 | 6.5 | 0.1 | <55 | <170 | <3 | <0.015 |
| PV5 | 0.0-0.9 | <0.2 | 35 | 42 | 18 | ***79*** | 92 | 0.39 | 8.3 | 0.4 | <55 | <170 | <3 | <0.015 |
| PV5 | 0.9-1.9 | <0.2 | 33 | 20 | 16 | ***78*** | 78 | 0.50 | 7.6 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV5 | 1.9-2.9 | <0.2 | 30 | 11 | 15 | 28 | 74 | 0.11 | 4.1 | 0.1 | <55 | <170 | <3 | <0.015 |
| PV5 | 4.9-5.9 | <0.2 | 33 | 16 | 16 | 51 | 77 | 0.18 | 7.9 | 0.1 | <55 | <170 | <3 | <0.015 |
| PV6 | 0.0-0.9 | <0.2 | 31 | 17 | 14 | 59 | 78 | ***0.65*** | 8.6 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV6 | 0.9-1.9 | <0.2 | 31 | 16 | 16 | 40 | 75 | 0.41 | 7.7 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV6 | 1.9-2.9 | <0.2 | 32 | 12 | 18 | 32 | 79 | 0.25 | 4.8 | 0.2 | <55 | <170 | <3 | <0.015 |
| PV6 | 4.9-5.9 | <0.2 | 33 | 18 | 16 | 53 | 81 | ***0.55*** | 7.7 | 0.2 | <55 | <170 | <3 | <0.015 |
| Average | | 0.3 | 33 | 21 | 17 | 51 | 84 | 0.37 | 7.2 | 0.25 | <55[a] | <170[a] | <3 | <0.015 |
| ST1 | Grab | 0.3 | 43 | 50 | 22 | 43 | 110 | <0.05 | 10 | 0.6 | <55 | <170 | <3 | <0.015 |
| WS1 | | 0.1 | 38 | 46 | 22 | 38 | 102 | 0.16 | 9.4 | 0.9 | 90 | 95 | 18 | |
| VS21 | | 0.31 | 53.2 | **127.9** | 31.7 | 51.6 | ***210*** | 0.15 | 8.8 | 1.6 | 95.83 | 194.65 | 20.67 | |

Notes: (a) The underlined, bold and italic numbers indicating the levels exceeding the LCEL listed in Table 3-6.
(b) The bold numbers with shade area indicating the levels exceeding the UCEL listed in Table 3-6.
(c) Results of the reference sediment (ST1), EPD's WS1 and VS21 (Government Dockyard) are listed.
(d) The surface layer HMW PAH concentration at PV3 is excluded in the calculation due to its anomaly.

**Table 3-20 Sediment Quality Results at the Proposed Site**

3.5.39 The data in Table 3-20 show that the seabed at the proposed dock site at Tsing Yi is already slightly contaminated with heavy metals and organic-PAHs. The concentration levels of copper, lead, mercury and High Molecular Weight PAHs exceed LCEL at PV3, PV4, PV5 and PV6. The classification of the collected sediment samples at the proposed site is illustrated in Figure 3-14. Based on the criteria of ETWB TC(W) No. 34/2002, the sediments at the proposed Dock site belong to Category M. The details on the classification of the sediment samples collected at the proposed site are further presented in Section 4.

3.5.40 As shown in Table 3-20, the average concentrations of most heavy metal contaminants at the proposed site are similar to those at the adjacent seabed and the Government Dockyard typhoon shelter, and some are lower. Only the averaged mercury level at the site is slightly greater than those in the surroundings.

*Biological Screening Test Results*

3.5.41 The biological screening test results for the sediment samples collected from the existing site are summarised in Table 3-21. The marine sediment failed in 2 of 3 biological screening tests, resulting in an overall “fail”. This implies that if marine disposal is required, then confined marine disposal should be adopted. However, as this project will not require disposal of marine sediment as all dredged mud will be reused for backfilling on site.

| Type of Composite Sample | Biological Screening Test | | | Overall Result |
|---|---|---|---|---|
| | 10-day Amphipod | 20-day Polychaete | 48-hour Bivalve | |
| Category M | Pass | Fail | Fail | **Fail** |

**Table 3-21 Sediment at the Existing Site - Biological Test Results Summary**

*Bioaccumulation Test Results for the Existing Site*

3.5.42 A local clam species, *Gafrarium tumidum,* which was collected from a clean area on the eastern coast of the New Territories, was used for the bioaccumulation test for both the composite sample and reference sample. The composite sample was made up using the sediments collected at EV4, EV11 and EV12 to present the worst-case scenario and the reference sediment was collected from ST1, a control station adopted in a local EM&A programme on sediment toxicity[2]. The rationale for using the composite sample was provided in Sections 3.5.21 to 3.5.25. The bioaccumulation testing results and relevant assessment criteria are shown in Table 3-22. Details of the test method, test particulars, the number of animals at start of the test, percentage of animals recovered alive, water quality data, statistical analysis and quality control data are presented in Appendix 3D.

3.5.43 The World Health Organisation does not have action levels for specific food

[2] Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau

types but have specified overall oral intake limits for copper, zinc, silver and mercury. However, these values cannot provide a direct comparison with the assessment results - they can only provide an indication of the maximum allowable consumption of food that a person can ingest without causing any adverse health effects based on the contamination level of food.

3.5.44 As shown in Table 3-22, it was found that the mercury concentration in the organism of the composite sample meet both the Hong Kong's Maximum Permitted Concentration of Certain Metals Present in Specified Food and the USEPA's Food and Drug Administration (FDA) Action Levels for Poisonous or Deleterious Substance in Human Food and Animal Feed. However, as there is no available FDA level or Hong Kong standard for copper, zinc and silver, the bioaccumulation test results have been compared directly with testing results for the reference sample collected at ST1 (Figure 3-12) for statistical significance.

| Contaminant | Reference Sediment - Concentration of Cu in Organism Tissue after the Bioaccumulation Test, mg/kg | Composite Samples - Concentration of Cu in Organism after the Bioaccumulation Test, mg/kg | Maximum Permitted Concentration of Certain Metals Present in Specified Food[1], mg/kg | Action Levels for Poisonous or Deleterious Substance in Human Food and Animal Feed[2], mg/kg | Oral Intake Limit of World Health Organisation (WHO) |
|---|---|---|---|---|---|
| Copper | 3.62 | 4.06 | N/A | N/A | The upper limit of safe range of mean population intake[3]:<br>3.0 mg Cu/day for child (6-10 yrs old)<br>12.0 mg Cu/day for adult male<br>10.0 mg Cu/day for adult female |
| Zinc | 9.00 | 9.68 | N/A | N/A | Estimate for provisional maximum tolerable daily intake for man 0.3-1.0 mg/kg body weight[4] |
| Silver | 1.38 | 1.40 | N/A | N/A | 10g of silver nitrate taken orally is a lethal dose of man[5] |
| Mercury (Methylmercury) | 0.06 | 0.07 | 0.5 | 1 | The tolerable recommended weekly intake is 200ug. (WHO, 1989)[6] |

*Notes:*

1. *Chapter 132V Food Adulteration (Metallic Contamination) Regulations of the Public Health and Municipal Services Ordinance (HK)*
2. *The Food and Drug Administration (FDA) for Poisonous or Deleterious Substance.*
3. *Environmental Health Criteria – 200, WHO & Copper: Essentiality and toxicity, The Newsletter of the International Programme on Chemical Safety, Issue 10, December 1996*
4. *WHO Food Additives Series 17, Summary of Toxicological Data of Certain Food Additives, 1982*
5. *WHO Food Additives Series 12, Summary of Toxicological Data of Certain Food Additives, 1977*
6. *Environmental Health Criteria – 118, WHO*

**Table 3-22 Bioaccumulation Testing Results for the Existing Site and Available Assessment Criteria**

3.5.45 According to the USEPA Testing Manual for Evaluation of Dredged Material Proposed for Ocean Disposal, in the absence of FDA levels for the concerned contaminants, the concentrations of contaminants in tissues of organisms are compared to contaminant concentrations in tissues of organisms similarly exposed to reference sediment. If the tissue concentrations of contaminants of concern in organisms exposed to the dredged material do not statistically exceed those of organisms exposed to the reference sediment, then the dredged material meets the Limiting Permissible Concentration for bioaccumulation. The Limiting Permissible Concentration of the solid phases of dredged material is defined in paragraph 227.27 (b) of Title 40 Code of Federal Regulations as: "*Concentration that will not cause unreasonable acute or chronic toxicity or sublethal adverse effects based on bioassay results using appropriate sensitive marine organisms in the case of suspended particulate phase, or appropriate sensitive benthic marine organisms in the case of the solid phase; and which will not cause accumulation of toxic materials in the human food chain.*"

3.5.46 The concentration of the concerned metals in organism tissue at the t-test initiation and termination are presented in Tables 3-23 to 3-26. The threshold value for assessing significance in the t-test is 0.05. It is judged as insignificant if above this value. Otherwise it is significant. The t-test results indicated that there is no significant difference for copper, silver and mercury between the composite sample and the reference sample. This reveals that the marine sediment at the existing site meets the Limiting Permissible Concentration of USEPA for bioaccumulation test in terms of copper, silver and mercury. According to the USEPA guideline, the dredged material can therefore be considered suitable for unconfined aquatic disposal.

| Sample | Concentration of Cu at test initiation (mg/kg dry weight) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3.20 | | | | | | |
| | Concentration of Cu at test termination (mg/kg dry weight) | | | | | | |
| | Replicate 1 | Replicate 2 | Replicate 3 | Replicate 4 | Replicate 5 | Mean | SD |
| Composite sample | 4.40 | 3.50 | 4.70 | 4.00 | 3.70 | 4.06 | 0.49 |
| Reference sediment | 2.90 | 3.10 | 4.00 | 4.60 | 3.50 | 3.62 | 0.69 |
| Result of t-test (one tail, hypothesized mean difference = 0, assuming equal variance):<br>**Insignificantly different**, t critical=1.86, t stat=1.16, p=0.1398 | | | | | | | |

**Table 3-23 Concentration of Copper in Organism Tissue at Test Initiation and Termination**

| Sample | Concentration of Zn at test initiation (mg/kg dry weight) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 9.00 | | | | | | |
| | Concentration of Zn at test termination (mg/kg dry weight) | | | | | | |
| | Replicate 1 | Replicate 2 | Replicate 3 | Replicate 4 | Replicate 5 | Mean | SD |
| Composite sample | 9.80 | 9.60 | 9.50 | 9.70 | 9.80 | 9.68 | 0.13 |
| Reference sediment | 7.90 | 9.00 | 9.30 | 9.60 | 9.20 | 9.00 | 0.65 |
| Result of t-test (one tail, hypothesized mean difference = 0, assuming unequal variance): **Significantly different**, t critical=2.132, t stat=2.287, p=0.042 | | | | | | | |

**Table 3-24 Concentration of Zinc in Organism Tissue at Test Initiation and Termination**

3.5.47 However, the t-test results (Table 3-24) show that the tissue concentration of zinc statistically exceeds that of organisms exposed to the reference sediment. The overall probability is 0.042 which is marginally below 0.05. The composite sample was mixed using the 3 samples of the highest zinc concentration (EV4, EV11 and EV12, Table 3-18) including the abnormal sample of EV4 with a zinc concentration of 1,300mg/kg. The average zinc concentration of the three samples is 663mg/kg as compared to the average zinc concentration of only 91mg/kg for the remaining 43 samples. As such, the bioaccumulation test results using the extreme samples are a reflection of the extreme case rather than a representation of the general sediment toxicity at the existing site. As such, the overall bioaccumulation potential is anticipated to be insignificant.

| Sample | Concentration of Ag at test initiation (mg/kg dry weight) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1.30 | | | | | | |
| | Concentration of Ag at test termination (mg/kg dry weight) | | | | | | |
| | Replicate 1 | Replicate 2 | Replicate 3 | Replicate 4 | Replicate 5 | Mean | SD |
| Composite sample | 1.30 | 1.60 | 1.50 | 1.30 | 1.30 | 1.40 | 0.14 |
| Reference sediment | 1.50 | 1.10 | 1.60 | 1.40 | 1.30 | 1.38 | 0.19 |
| Result of t-test (one tail, hypothesized mean difference = 0, assuming equal variance): **Insignificantly different**, t critical=1.86, t stat=0.187, p=0.4280 | | | | | | | |

**Table 3-25 Concentration of Silver in Organism Tissue at Test Initiation and Termination**

| Sample | Concentration of Hg at test initiation (mg/kg dry weight) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.064 | | | | | | |
| | Concentration of Hg at test termination (mg/kg dry weight) | | | | | | |
| | Replicate 1 | Replicate 2 | Replicate 3 | Replicate 4 | Replicate 5 | Mean | SD |
| Composite sample | 0.07 | 0.07 | 0.07 | 0.08 | 0.07 | 0.07 | 0.01 |
| Reference sediment | 0.06 | 0.06 | 0.07 | 0.08 | 0.07 | 0.06 | 0.03 |
| Result of t-test (one tail, hypothesized mean difference = 0, assuming unequal variance): **Insignificantly different**, t critical=2.015, t stat=1.301, p=0.125 | | | | | | | |

**Table 3-26 Concentration of Mercury in Organism Tissue at Test Initiation and Termination**

3.5.48 The "Tissue:Sediment" ratio is also commonly used for the evaluation of the bioaccumulation testing results. This ratio was first used by Battelle Northwest Laboratory for further interpretation of the bioaccumulation test results for marine disposal. The "Tissue:Sediment" ratio is obtained using the following equation:

$R_1=C_t/C_s$

Where $R_1$ = Tissue:Sediment ratio

$C_t$ = Contaminant level in tissue at test termination

$C_s$ = Contaminant level in sediment

3.5.49 The calculated "Tissue:Sediment" ratio for all concerned metals is presented in Table 3-27. The "Tissue:Sediment" ratio of the composite sample is below those of the reference sample for copper, zinc and silver, which is an indication that the bioaccumulation potential of the composite samples is lower than those of the reference sediment. For mercury, the "Tissue/Sediment" ratio is just 0.006 higher than those of the reference sample, indicating the difference in the bioaccumulation potential in terms of mercury between the composite sample and the reference sample is negligible.

3.5.50 One disadvantage of using the "Tissue:Sediment" ratio calculated above is that it cannot reflect the increase of contaminant levels in the testing organism due to its exposure to the marine sediment. The "Tissue (increased contamination level):Sediment" ratio, calculated using the following equation, has therefore been used for further evaluation:

$R_2 = (C_2-C_1)/C_s$

Where $R_2$ = Tissue(increased contamination level)/Sediment

$C_1$ = Contaminant level in tissue at test initiation
$C_2$ = Contaminant level in tissue at test termination
$C_s$ = Contaminant level in sediment

3.5.51 $R_2$ of the composite sample are low and comparable to those of the reference samples, except for silver. For silver, $R_2$ of the reference sediment is much higher than those of the composite sample, likely a result of the low silver level in the sediment and the bioaccumulation of silver in the organism. From the above, it can be concluded the bioaccumulation potential caused by the marine sediment at the existing site is insignificant.

3.5.52 In view of the above, and with the removal of the point source pollution upon relocation of the floating dock, the bioaccumulation potential of the marine sediment at the existing site is anticipated to be insignificant

3.5.53 The water quality in the vicinity of the existing site is generally good. However, some of the marine sediments collected at the existing site are contaminated with heavy metals. The proposed dredging work may cause potential water quality impacts on adjacent water sensitive receivers. Detailed assessment is provided in Section 3.7.

3.5.54 The biological screening tests results indicated that marine sediment at the existing site is not suitable for open sea disposal. However, the proposed decommissioning works will not result in any surplus sediment requiring disposal, as all the marine mud will be reused on site. The bioaccumulation test was undertaken to assess the bioaccumulation potential on benthic organisms at the existing site. Results show that the bioaccumulation potential is insignificant. With the marine sediment left on site, bioaccumulation potential on benthic organisms is expected to be insignificant.

3.5.55 The water quality in the vicinity of the proposed site are generally good. The dredging work at the proposed site may cause a water quality impact as some of the marine sediments are contaminated with heavy metals. A detailed water quality assessment has therefore been undertaken to quantify the potential impact. The assessment results are presented in Section 3.7.

3.5.56 After the relocation of the Dock, the water quality at Yam O Wan will improve. However, there will be potential water quality impact at the Tsing Yi due to the new wastewater discharges from the Dock. The potential water quality impact at Tsing Yi arising from discharges from the Dock is assessed in Section 3.7.

| Contaminants of concern[8] | Test sediment to which test organism[5] is exposed for a 28-day test period | Contaminant Concentration in organism tissue[2] after 28 days (mg/kg dry weight) | Increase in tissue concentration[2] after 28 days (mg/kg dry weight) | Concentration in sediment (mg/kg dry weight) | "Tissue: Sediment" ratio ($R_1$)[6] | "Tissue (increased contamination level): Sediment" ratio ($R_2$)[7] | Comments |
|---|---|---|---|---|---|---|---|
| Cu | Composite sample[3] | 4.06 | 0.86 | 160 | 0.025 | 0.005 | $R_1$ and $R_2$ of composite sample are lower than those of the reference sediment. It is concluded that the bioaccumulation potential of the composite sample is lower than the reference sediment |
| | Reference sediment[4] | 3.62 | 0.42 | 50 | 0.072 | 0.008 | |
| Zn | Composite sample[3] | 9.68 | 0.68 | 740 | 0.013 | 0.001 | $R_1$ of composite sample is lower than those of the reference sediment and $R_2$ of composite sample is comparable to those of the reference sediment. This indicates that the bioaccumulation potential between the composite sample and reference sample is negligible. |
| | Reference sediment[4] | 9.00 | 0.00 | 110 | 0.082 | 0 | |
| Ag | Composite sample[3] | 1.40 | 0.10 | 0.8 | 1.75 | 0.125 | $R_1$ and $R_2$ of composite sample are lower than those of the reference sediment. It is concluded that the |

| Contaminants of concern[8] | Test sediment to which test organism[5] is exposed for a 28-day test period | Contaminant Concentration in organism tissue[2] after 28 days (mg/kg dry weight) | Increase in tissue concentration[2] after 28 days (mg/kg dry weight) | Concentration in sediment (mg/kg dry weight) | "Tissue: Sediment" ratio ($R_1$)[6] | "Tissue (increased contamination level): Sediment" ratio ($R_2$)[7] | Comments |
|---|---|---|---|---|---|---|---|
| | Reference sediment[4] | 1.38 | 0.08 | <0.05 | 27.6[1] | 1.6[1] | bioaccumulation potential of the composite sample is lower than the reference sediment |
| Hg | Composite sample[3] | 0.07 | 0.006 | 0.66 | 0.106 | 0.009 | $R_1$ and $R_2$ of composite sample are comparable to those of the reference sediment, indicating the bioaccumulation potential is negligible |
| | Reference sediment[4] | 0.06 | 0.004 | 0.6 | 0.1 | 0.007 | |

Notes:

1. Ag concentration in sediment was assumed to be 0.05 mg/kg to give the lowest estimate of "Tissue:Sediment" ratio.
2. Tissue concentration is calculated based on the average tissue concentrations calculated from the replicate tests.
3. The composite sample was made up using sediments collected at EV4, EV11 and EV12 to present the worst-case scenario.
4. The reference sediment was collection from ST1 (Figure 3-12).
5. A local clam species, *Gafrarium tumidum*, which was collected from the eastern coast of the New Territories (an area considered to be free of sediment contamination), was used for the bioaccumulation test
6. R1=Ct/Cs

   Where $R_1$ = Tissue:Sediment ratio, $C_t$ = Contaminant level in tissue at test termination, Cs = Contaminant level in sediment
7. R2 = (C2-C1)/Cs

   Where R2 = Tissue (increased contamination level)/Sediment, C1 = Contaminant level in tissue at test initiation,

   C2 = Contaminant level in tissue at test termination, Cs = Contaminant level in sediment
8. These heavy metals are selected for bioaccumulation test because the concentration of these heavy metals collected from the existing site exceeded the UCEL.

**Table 3-27 Bioaccumulation Potential of Selected Contaminant in Sediments Collected from the Existing Site**

### Summary of Baseline Environmental Conditions

3.5.57 The baseline water quality in and around both the existing and the proposed new sites is generally good and in compliance with the relevant WQOs. However, copper levels at the both sites exceed the recommended water quality standards.

3.5.58 The seabed sediment at the existing site is contaminated with heavy metals, and is classified as Category H because it failed the biological screen test. The level of the sediment contamination at the existing site is lower or comparable to those in the typhoon shelters. The main contaminants of concern at the existing site are zinc, copper, mercury and silver. However, the bioaccumulation test conducted shows that their bioaccumulation potential is limited and insignificant. Based on the marine water quality measured on site, those contaminants in the sediment do not appear to have any measurable effects on the marine water at the existing site.

3.5.59 The seabed sediment at the proposed site is slightly polluted with heavy metals and organic PAHs and is also classified as Category M.

3.5.60 Although the project will involve limited dredging during the decommissioning of the Dock at the existing site and commissioning at the new site, all the dredged material will be reused and no disposal of surplus dredged material will be required.

3.5.61 In view of the baseline environmental conditions, the proposed works and other aspects of the project, the main potential water quality impact will likely be associated with the elevation of SS and the heavy metals during the limited dredging works and the elevation of the heavy metals at the new site during the operation of the Dock.

## 3.6 Assessment Methodology

3.6.1 Relocation of the existing Yiu Lian Dock from Yam O Wan to Tsing Yi involves three different phases, i.e. decommissioning of the existing Dock at Yam O Wan, commissioning of the Dock at Tsing Yi and the normal Dock operations at the new location. Each phase involves different works that have potential impacts on the WSRs.

3.6.2 The works at each phase and their potential impacts on the WQ and WSRs have been identified and their potential WQ impacts predicted using models. An emission inventory of pollution sources arising from the Project has been established. The relevant standards and criteria have been used to determine the mixing zone where the pollution level exceeds the criteria. The cumulative WQ impacts from other floating docks around Tsing Yi during the operation stage have been assessed.

3.6.3 Several parameters need to be estimated in order to predict the WQ impacts using models. The methods for the WQ impact assessment, estimation of the relevant parameters and the assumptions made are presented and discussed below.

**Suspended Sediment Suspension due to Dredging for Retrieval of the Anchor Blocks at Yam O**

3.6.4 As discussed in Section 2, a suction dredger will be used to remove the sediment deposit on top of and surrounding the anchor blocks at Yam O, as illustrated in Appendix 3E.

3.6.5 This process is similar to water jetting and may release up to 20% of the fine sediments. Assuming an in situ sediment dry density of 1340 kg/m$^3$, the sediment loss rate can be estimated as follows:

$$20\% \times 1340\ [kg/m^3] \times R_d\ [m^3/hr] \times S_f\ [\%] = 268\ R_d\ S_f\ [kg/hr]$$

where $R_d$ is the dredging rate, and $S_f$ is the percentage of the fine sediments, defined as silt and clay, in the seabed sediment.

3.6.6 The potential use of a grab dredger to remove possible rocks has much less water quality impact than the use of the suction dredger to remove the marine mud, and will not need to be further assessed unless there is demonstrated water quality concern resulting from the proposed mud dredging.

**Suspended Sediment Suspension due to Dredging for Fixing the Anchor Blocks at Tsing Yi**

3.6.7 As discussed in Section 2, a grab dredger (capacity from 6 to 8 m$^3$) without a silt curtain will be used to install anchor blocks at the new site in Tsing Yi. The sediment loss rate from the dredging using a grab dredger without a silt curtain can be estimated with a S-Factor of 12-25 kg/m$^3$ (John, *et al.* 2000[3]). Following the previously approved EIA study reports [4] [5], a S-factor of 17.5 kg/m$^3$ is recommended for this assessment.

3.6.8 The dredged marine mud from one anchor block will be placed in the pit created from dredging the previous anchor block. Although the dredging and backfilling will be taking place alternatively, over the entire dredging period for each anchor block, both activities are taking place concurrently and in the close vicinity to each other, leading to a cumulative effect. By the time the dredging is completed, the backfilling process is also completed. As such, by ignoring the sediment loss during the dredging process, the backfilling rate can be conservatively assumed to be the same as the dredging rate. Therefore the total SS release rate will be the sum of

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[3] Scoping the Assessment of Sediment Plumes from Dredging; S A John, S L Challinor, M Simpson, T N Burt, J Spearman; CIRIA C547, 2000

[4] Lamma Power Station Navigation Channel Improvement (Hyder, 2002)

[5] EIA for the Construction of an International Them Part in Penny's Bay of North Lantau and Its Essential Associated Infrastructure (ERM, 2000)

the fine sediment releases from both the dredging and backfilling processes. Following a previous study[6], 5% loss of fine sediment is assumed for the sediment leakage rate during the backfilling process.

3.6.9 As such, the combined sediment loss rate will be

$$17.5\ [kg/m3] \times R_d\ [m^3/hr] + 5\% \times R_d\ [m^3/hr] \times S_f\ [\%] \times 1340\ [kg/m^3]$$

$$= 17.5\ R_d + 67\ R_d\ S_f\ [kg/hr].$$

**Pollutants Release due to Dredging**

3.6.10 The contaminants in the seabed can be released into the water column in associated with the sediment loss by the dredging operation. Elutriate testing has been conducted for the seabed sediment at both the existing and proposed dock sites and the results have been used for impact prediction and assessment.

**Domestic Wastewater Generation due to Dock Operation**

3.6.11 The volume of the domestic wastewater generated from the dock operation has been estimated using the number of the staff on board and DSD Sewerage Manual. The domestic wastewater will be treated on board to the standards specified by the Discharge Licence prior to discharge to the marine water. The residual water quality impact has been assessed.

**Industrial Wastewater Generated from Dock Operation**

3.6.12 The amount of the industrial wastewater generated from Dock operations has been estimated using the historical records. The main activity generating industrial wastewater on the Dock is the hull washing. After treatment, wastewater is discharged to the sea from the deck of the Dock. Samples at the wastewater discharge point were collected and tested and the results have been used for the impact assessment.

**Prediction Model**

3.6.13 The water quality impact during the relocation is mainly from the dredging at the existing site and dredging and backfilling at the proposed site. These are limited in both scale (just under 7,000 $m^3$ at the existing site and around 9,000 $m^3$ at the new site) and time (for about 9 weeks in total at 4 hours per day).

3.6.14 Potential water quality impacts may arise from the wastewater discharge from the new floating dock at Tsing Yi during its normal operation, but the scale of the discharge is small (100$m^3$/day of industrial wastewater and

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[6] Measurements of Sediment Transport after Dumping from Trailing Suction Hopper Dredgers in the East Tung Lung Chau Marine Borrow Area, Report to GEO/CED, Dredging Research Ltd (1996),

<10m³/day of domestic wastewater).

3.6.15 As such, the potential water quality impact during both the relocation and the operation is expected to be small. The potential water quality impacts on the WSRs during relocation were quantified using the following theoretical solution of the advection and diffusion equation in a horizontal 2-D steady-state flow – the Gaussian Dispersion Model (John, *et al*. 2000[1]; Fischer, 1979[7]):

$$C(x, y) = \frac{\dot{M}}{u\sqrt{4\pi Dx/u}} \exp\left(-\frac{y^2 u}{4Dx}\right)$$

Where x = distance in the flow direction (m)

y = distance in the cross-flow direction (m)

$\dot{M}$ = pollution line source (kg/s/m)

u = velocity (m/s)

C = pollution concentration ($kg/m^3$)

D = dispersion coefficient ($m^2/s$)

The necessary tidal and current data was obtained from the EPD study "Update on Cumulative Water Quality and Hydrological Effect of Coastal Development and Upgrading of Assessment Tool". The particle size distribution and chemical characteristics were determined from the Sampling and Testing Programme.

3.6.16 The settling velocity was conservatively assumed to be zero. As the sediment release will be close to the seabed, any suspended sediment is expected to settle back to the seabed quickly. As such, the model prediction using the zero settling velocity assumption will be conservative. However, this is partially offset by the fact that, for simulating the bottom release, the 2-D depth averaged model tends to overestimate the water quality impact in the surface layer and to underestimate the water quality in the bottom layer.

3.6.17 The wastewater generated from the future Dock operations at Tsing Yi will be discharged into the surface layer of the marine water by free fall. The potential water quality impact on WSRs during operation was assessed using the following theoretical solution of the advection and diffusion equation in a 3-D steady-state flow (Fisher, 1979[4]):

7 Mixing in inland and coastal waters, Fischer, Hugo B. 1979

$$C(x, y, z) = \frac{\dot{M}}{4\pi Dx} \exp\left[-\frac{(y^2+z^2)u}{4Dx}\right]$$

Where $x$ = distance in the flow direction (m)

$y$ = distance in the cross-flow direction (m)

$Z$ = distance in the vertical direction (m)

$\dot{M}$ = pollution point source (kg/s)

$u$ = velocity (m/s)

$C$ = pollution concentration ($kg/m^3$)

$D$ = dispersion coefficient ($m^2/s$)

A multiplier of 2 can be applied to the predicted results in the case of a surface discharge to cater for the confinement of the water surface in a 3D space.

3.6.18 Some works for Dock decommissioning at Yam O and for Dock commissioning at Tsing Yi will be carried out concurrently, thus leading to cumulative water quality effects. As the water quality model is linear in nature, the predicted pollution levels at WSRs resulting from each individual pollution source can be arithmetically superimposed to derive the cumulative pollution level. During the operation, the two existing floating docks (Yiu Lian Floating Dock No.1 and United Dockyard) at Tsing Yi may also generate potential water quality impacts at the WSRs and these cumulative WQ effects were assessed using the model results for individual discharges.

3.6.19 This method provides a speedy and conservative estimate of any elevation of pollution levels in receiving waters resulting from small scale pollutant releases, and has been previously used in approved EIAs, including Lamma Power Station Navigation Channel Improvement and Peng Chau Helipad EIA.

3.6.20 However, this method is based on the assumption of a steady-state flow. As the nearest WSR is some 2km away from either of the existing or new sites, peak velocities tend to generate a conservative prediction. The tidal currents in the northwest of Lantau were therefore conservatively assumed to be constant, equivalent to the peak flood flow during the flood tide and to the peak ebb flow during the ebb tide.

3.6.21 For the 2-D Gaussian Dispersion Model, a typical dispersion coefficient of 1 $m^2/s$ is adopted in this assessment. In assessing the wastewater discharges using the 3-D steady state advection and diffusion model, a range of diffusion coefficients between 0.1 and 1.0 $m^2/s$ have been tested and a conservative result is adopted.

**Treatment of Toxicant Sediment**

3.6.22 The seabed at the existing Dock site is contaminated, according to the chemical analysis of the sediment samples. Further tests were carried out to evaluate the bioaccumulation potential of the toxic contaminants on marine benthic organisms. A review of the international practice on how to treat contaminated sediments has been conducted (Appendix 3A). Recommendations for handling and treating contaminated marine sediment were then made for the site based on the review of the international practice, the sediment toxicity and its bioaccumulation potential (Section 3.7).

## 3.7 Impact Evaluation

**Decommissioning of the Existing Floating Dockyard at Yam O Wan**

3.7.1 Decommissioning of the existing floating dockyard involves cutting the chains connecting the Dock to the concrete anchor blocks and removal of the blocks from the seabed. The blocks are likely buried by marine deposits and the removal of marine deposits by a suction dredger is required in order to recover the blocks. The removal of the marine deposits is the only process during the decommissioning of the existing Dock that may lead to potential water quality impacts.

3.7.2 There are a total of 28 anchor blocks and it will take about 2 days to retrieve each block. Details of the decommissioning method and programme are presented in Section 2.

3.7.3 One suction dredger will be deployed for retrieval of the blocks. The dredging area for each block will be within an area of 10m×10m, up to a depth of 5 m. The potential use of a grab dredger to remove possible rocks has much less water quality impact than the use of the suction dredger to remove the marine mud, and has therefore not been further assessed unless there is a demonstrated water quality concern resulting from the proposed dredging works.

3.7.4 Marine deposits on the top of the blocks will be removed first. The marine deposit depth on the top of the blocks is estimated at 1.5m.

3.7.5 The maximum total volume of the sediment dredged for retrieval of one block is estimated at approximately 246 $m^3$ based on the following calculation (also see Figure 3-15):

(A): Pyramid volume (top area:10m×10m, bottom area:6m×6m, Height:5m) = 327 $m^3$
(B): Block volume = 5m x 4.6m x 3.5 m = 81 $m^3$
Volume of the sediment to be dredged = (A) – (B) = 246 $m^3$

3.7.6 The maximum volume of sediment to be dredged for removal of the 28 blocks at the existing site is approximately 28 x 246 = 6,888 $m^3$ in total.

3.7.7 It is estimated to take approximately 4 hours to complete the dredging for removing one anchor block. As such, the maximum dredging rate will be 61.5$m^3$/hour, or 0.017$m^3$/s.

*Suspended Solids Elevation*

3.7.8 Table 3-28 summarises the results of the particle size distribution of the sediments at the existing site. The difference between the samples taken by vibrocore and grab is noticeable and the average results of the samples taken using vibrocore, which have a high percentage of silt and clay, have been used for estimate of the fine sediment contribution.

3.7.9 Fine sediments have been defined as silt and clay, making up 85.1% of the total sediment on average.

3.7.10 The maximum SS releasing rate due to the dredging and dumping is estimated in the following using the method (discussed in Section 3.6):

$268 R_b S_f$

$= 268 \text{ kg/m}^3 \times 0.017 \text{ m}^3\text{/s} \times 85.1\% = 3.88$ [kg/s]

| Sample Location | Depth | Sampling | Gravel (%) | Sand (%) | Silt and Clay (%) |
|---|---|---|---|---|---|
| EV1 | 0.00-6.00m | Vibrocore | 4 | 9 | 87 |
| EV2 | 0.00-6.00m | Vibrocore | 7 | 14 | 79 |
| EV5 | 0.00-6.00m | Vibrocore | 7 | 7 | 86 |
| EV6 | 0.00-6.00m | Vibrocore | 1 | 5 | 64 |
| EV9 | 0.00-6.00m | Vibrocore | 4 | 9 | 87 |
| EV10 | 0.00-6.00m | Vibrocore | 4 | 12 | 84 |
| EV13 | 0.00-6.00m | Vibrocore | 6 | 9 | 85 |
| EV14 | 0.00-6.00m | Vibrocore | 0 | 3 | 97 |
| EV15 | 0.00-6.00m | Vibrocore | 2 | 8 | 90 |
| EV16 | 0.00-6.00m | Vibrocore | 2 | 6 | 92 |
| Average for vibrocore samples | | | **3.7** | **8.2** | **85.1** |
| EV3 | | Grab | 11 | 44 | 45 |
| EV4 | | Grab | 1 | 10 | 89 |
| EV7 | | Grab | 3 | 54 | 43 |
| EV8 | | Grab | 2 | 8 | 90 |
| EV11 | | Grab | 35 | 27 | 38 |
| EV12 | | Grab | 13 | 20 | 67 |
| Average for grab samples | | | **10.8** | **27.1** | **62** |

**Table 3-28 Summary of Particle Size Distribution at the Existing Site**

3.7.11 The ambient SS level at Yam O Wan was approximate 10 mg/L (Tables 3-15 and 3-16) and 11 mg/L at the EPD marine water routine monitoring station of NM1 close to the existing dock site (Table 3-14). An average SS level of 10.5 mg/L is used as the ambient SS concentration for the assessment. As such the maximum increase in SS level allowed is estimated at 3.15 mg/L (30% of the ambient SS concentration) in accordance with WQO for the North Western WCZ.

3.7.12 At the existing Dock site, the water depth is about 20m and the peak current velocity during a typical spring flood ranges from 0.2 to 0.5m/s, flowing southwest. Using a constant velocity of 0.2m/s, the flood tide mixing zone where SS level increase exceeds 3.15 mg/L and will cover up to 1510m downstream of the flow direction and 150m in the cross-flow direction (see Table 3-29). However, all the WSRs are in the upstream of the existing Dock and are not affected by the sediment plume during the flood tide. If the current velocity increases to 0.5m/s, the flood tide mixing zone will be reduced to 605m downstream and 60m in the cross-flow direction. In the remainder of the water quality impact assessment, a velocity of 0.2m/s has been conservatively adopted as the peak flood velocity of the existing site.

3.7.13 The peak ebb velocity at the existing site is approximately 0.5m/s, flowing northeast. The ebb tide mixing zone measures 605m in the flow direction and 60m in the cross-flow direction (Table 3-29). The nearest WSR, Ma Wan Fish Culture Zone, is some 1800m from the existing Dock and is well away from the influence of the mixing zone.

3.7.14 The overall mixing zone (a combination of the flood tide mixing zone and ebb tide mixing zone) is predicted to measure 2115m in the flow direction and 150m in the cross-flow direction.

| Flood Tide | | | Ebb Tide | | |
|---|---|---|---|---|---|
| Velocity = 0.2m/s<br>Depth = 20m<br>SS Releasing rate = 3.88kg/s | | | Velocity = 0.5m/s<br>Depth = 20m<br>SS Releasing rate = 3.88kg/s | | |
| **Flow Direction (m)** | **Cross-Flow Direction (m)** | **SS Elevation (mg/l)** | **Flow Direction (m)** | **Cross-Flow Direction (m)** | **SS Elevation (mg/l)** |
| 500 | 0 | 5.47 | 400 | 0 | 3.87 |
| 1000 | 0 | 3.87 | 500 | 0 | 3.46 |
| **1510** | **0** | **3.15** | **605** | **0** | **3.15** |
| 1600 | 0 | 3.06 | 700 | 0 | 2.93 |
| 2000 | 0 | 2.74 | 800 | 0 | 2.74 |
| 600 | 50 | 4.74 | 200 | 20 | 5.14 |
| 600 | 100 | 4.06 | 200 | 50 | 3.70 |
| **600** | **150** | **3.13** | **200** | **60** | **3.12** |
| 600 | 160 | 2.93 | 200 | 70 | 2.55 |
| 500 | 150 | 3.12 | 100 | 60 | 2.51 |
| 700 | 150 | 3.09 | 300 | 60 | 3.07 |
| 800 | 150 | 3.04 | 1800 | 0 | 1.82 |

**Table 3-29 Predicted SS Elevation Resulting from Dredging for Retrieval of Anchor Blocks at the Existing Site**

3.7.15 Due to the strong tidal currents, the suspended sediment generated from the works at the existing site can unlikely cross the Kap Shui Mun channel and affect the Ma Wan Fish Culture Zone. As such, the predicted SS elevation of 1.82 mg/l at the fish culture zone is overly estimated. According to the Department of Agriculture, Fisheries and Conservation, the SS tolerance level of a fish culture zone is generally at 50 mg/l. The predicted SS level at Ma Wan Fish Culture Zone is just under 12 mg/l (10 mg/l baseline + 1.82 mg/l elevation) and is well within the tolerance level. The potential oxygen depletion resulting from the SS is negligible (0.04mg/l) based on the following calculation with reference to a previous EIA [8]:

$$DO_{Dep} = C * SOD * K * 0.001$$

Where $DO_{Dep}$ = Dissolved Oxygen depletion (mg/l)

C = Suspended Solids concentration (kg/m$^3$)

SOD = Sediment Oxygen Demand (15,000 mg/kg for North Western Waters region with reference to EPD Marine Monitoring data)

K = Daily oxygen uptake factor (set at 0.23)

[8] EIA Study for Disposal of Contaminated Mud in East of Sha Chau Marine Borrow Pit, ERM, 1997

*Contaminant Releases*

3.7.16 In addition to an increase in SS levels, dredging can also cause the release of the contaminants contained in the sediment. Table 3-30 lists results of the elutriate tests of the sediments at the existing Dock site.

3.7.17 The elutriate test results indicate that the only contaminant of concern is dissolved copper (compared to the criteria for temporary condition of Table 3-3). The contaminant levels of the elutriate tests can be conservatively assumed to be the contaminant level at the dredging location (say within 5 m) during dredging.

3.7.18 The elutriate test shows a dissolved copper level of 13 µg/L, exceeding the criteria for the receiving water of 4.8 µg/L (Table 3-3, for temporary conditions).

3.7.19 The water quality at the existing site is influenced by the existing Dock operation. According to the long-term water quality monitoring results for the East Sha Chau mud pit programme at a number of stations within the region of western water, the long-term trend of Cu between April 2001 and August 2005 was around 2 µg/L. Using this Cu level as the baseline level outside the immediate influence of the existing Dock operation, a dilution of 3 will be sufficient to reduce the Cu elevation during dredging to comply with the water quality criteria. Based on the Gaussian Dispersion Model prediction, such a dilution can be achieved within 45m from the immediate influence of the existing Dock operation, as shown in Table 3-31.

3.7.20 All the WSRs are remote from the works site (the nearest is 1800m away). The dissolved copper elevation at the WSRs will be negligible. It can be concluded that the water quality impact of the dissolved copper level elevation at the WSRs resulting from the proposed works at the existing site is negligible.

3.7.21 As the sediment at the existing site is classified as Category H and there is no sufficient information regarding the sediment release rate for the proposed suction dredging method although it is considered to be comparable to that for water jetting, silt curtains as illustrated in Appendix 3G are recommended to be adopted during the dredging to further reduce the potential water quality impact.

| Sample Identification | Heavy Metals (Total) | | | | | | | | Heavy Metals (Dissolved) | | | | | | | | Other Parameters | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | TOC | Total PCB | LMW PAH | HMW PAH | TBT |
| | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | mg/L | µg/L | µg/L | µg/L | ng/L |
| EV1, EV2, EV3 & EV4 (ES) | <0.2 | <1 | 530 | 14 | 6.0 | 420 | <1 | <0.04 | <0.2 | 3.6 | **14** | 2.6 | <1 | 29 | <1 | <0.04 | <5 | <0.01 | <1 | <1 | 300 |
| EV5, EV6, EV9 & EV10 (ES) | <0.2 | <1 | 500 | 14 | 6.6 | 240 | <1 | <0.04 | <0.2 | 3.6 | **13** | 2.3 | <1 | 35 | <1 | <0.04 | 5 | <0.01 | <1 | <1 | 11 |
| EV7, EV8, EV11 & EV12 (ES) | <0.2 | <1 | 640 | 17 | 6.9 | 230 | <1 | <0.04 | <0.2 | 3.9 | **13** | 2.4 | <1 | 31 | <1 | <0.04 | 8 | <0.01 | <1 | <1 | 120 |
| EV13, EV14, EV15 & EV16 (ES) | <0.2 | <1 | 520 | 14 | 6.5 | 170 | <1 | <0.04 | <0.2 | 3.7 | **13** | 2.5 | <1 | 33 | <1 | <0.04 | 8 | <0.01 | <1 | <1 | 34 |
| Average | <0.2 | <1 | 548 | 15 | 6.5 | 265 | <1 | <0.04 | <0.2 | 3.7 | **13** | 2.5 | <1 | 32 | <1 | <0.04 | | <0.01 | <1 | <1 | 116 |
| Existing Site | <0.2 | <1 | 500 | 15 | 8.4 | 190 | <1 | <0.04 | <0.2 | 3.1 | **12** | 2.8 | <1 | 31 | <1 | <0.04 | 6 | <0.01 | <1 | <1 | <1 |

Notes: The bold numbers indicating the levels exceeding the recommended criteria for a temporary condition listed in Table 3-3.

**Table 3-30 Summary Results of Elutriate Sample Analysis at the Existing Site**

| Flood Tide | | | Ebb Tide | | |
|---|---|---|---|---|---|
| Velocity = 0.2m/s<br>Depth = 20m | | | Velocity = 0.5m/s<br>Depth = 20m | | |
| Flow Direction (m) | Cross-Flow Direction (m) | Dilution | Flow Direction (m) | Cross-Flow Direction (m) | Dilution |
| 5 | 0 | 1 | 5 | 0 | 1 |
| 20 | 0 | 2 | 20 | 0 | 2 |
| 45 | 0 | 3 | 45 | 0 | 3 |
| 100 | 0 | 4.5 | 100 | 0 | 4.5 |

**Table 3-31 Predicted Dilution around the Existing Site**

*Handling, Treatment and Disposal of the Contaminated Sediment at the Existing Site*

3.7.22 The options for handling contaminated sediments depend on various factors, including legislation, the nature of contaminants, quantity, the future use of the area, technology, cost and social acceptability. The handling and treatment options can be categorised as follows:

- leaving the sediments in place
- in-situ treatment
- ex-situ treatment and disposal

3.7.23 A literature review of these three options together with their applications has been conducted and a copy of the review is attached in Appendix 3A. The findings of the review have been utilised in the following assessment.

3.7.24 The option of leaving sediments in place allows the contaminants to degrade under natural conditions. Its key advantage is to minimise the risk of re-suspending sediment by avoiding dredging or handling activities. This option also avoids the generation of environmental impacts of the by-products from treatment, and is also the most economical option. This option is appropriate when the source of contamination was ceased. However this option may not be viable if the area is to be re-developed.

3.7.25 In-situ sediment treatment includes capping, solidification/stabilisation, biological treatment, chemical treatment and ground freezing. In consideration of the cost and the effectiveness, in-situ capping is a potentially economical and effective approach for remediation of contaminated sediment. A number of sites have been treated by in-situ capping operations world-wide. The major advantage of capping is that the need to remove contaminated sediments is eliminated. However, its use will depend on the surrounding current velocity, as the imported capping material could be scoured away under strong currents, thereby requiring frequent replacement. Some disturbance of the contaminated sediment is expected during the placement of clean capping material. This option is not viable if the area will be used for navigation or require reclamation for future development, both of which could disturb the cap.

3.7.26 Ex-situ treatment and disposal involves dredging and therefore potential for resuspension of sediments. The contaminated sediment is removed from the original site and delivered to the treatment or disposal facilities. There are several treatment and disposal methods available, including biological treatment, dechlorination, solvent extraction, soil washing, thermal desorption, solidification/stabilisation (S/S), incineration and confined disposal facilities (CDFs). Among these treatments, S/S is most commonly adopted in Hong Kong for the treatment of contaminated sediment/soil. The advantages of this method are that the treated sediment (in the form of concrete) can be used as public fill. As the marine sediment contains high water content pre-treatment to remove the water is required for this method. Off-site treatment methods usually require secondary treatment of the by-products such as wastewater, noxious emissions and solid waste.

3.7.27 There is no known plan to re-develop or reclaim the Yam O site. The TBT contamination level at the site, which was reported some 10 years ago to be high (ranging from 16 – 12,760 ng TBT/g[9]) was below the detection limit (0.015 µg TBT/L) in the sampling and testing exercise of this EIA Study. The significant reduction in the TBT level in the sediment is likely a result of a significant reduction in the number of ships with TBT-containing paints received by the Dock, and the natural degradation of the TBT in the sediment. The levels of the other main contaminants in the sediment, i.e. copper, zinc, mercury and arsenic are not atypically higher than those in the typhoon shelters of Hong Kong, nor higher than those in the other parts of the coastal region in the North Western Waters (as shown in Figure 3-9). Moreover, the Dock operation is unlikely to be the source of the mercury contamination in the sediment according to the analysis of Dock activities, and literature search. The two sampling exercises for deriving the pollution load inventory also indicated very low levels of mercury in the effluent discharged from the existing floating dock (Table 3-39). The bioaccumulation test results also indicated that the bioaccumulation potential of benthic organisms is insignificant.

3.7.28 A total of five floating docks were once operating concurrently around the existing site at Yam O during part of the 1990s. Yiu Lian Floating Dock No. 3 is the last one remaining at the site. The marine sediment was kept in place after the decommissioning of the other floating docks. No significant environmental impact resulting from the marine sediment at the old dock sites has been reported in spite of the then much more contaminated sediment as reported in the EIA of United Floating Dock to Tsing Yi (July 1996). In view of the above, and with reference to both the international and the local practice, the treatment method of leaving the sediment in

[9] EIA Report for 40,000 Ton Lifting Capacity Floating Dock at Yam O, North Lantau Prepared by Hyder Consulting Limited for Hong Kong United Dockyards Ltd. April 1995

place is considered to be the best option and is recommended for the existing Dock site at Yam O Wan. The contaminants will be capped by natural sediment deposition and the biodegradable contaminants will continue to degrade under natural conditions.

**Commissioning of the Dock at Tsing Yi**

3.7.29 The commissioning of the floating dockyard at the new site will require minor dredging works in order to provide holding pits for fixing the 28 anchor blocks. The dredged sediment will then be reused to backfill the pits. The dredging and backfilling are the only processes that may lead to potential water quality impacts.

3.7.30 Thirteen to seventeen anchor blocks will be installed first. The Dock will then be towed and anchored to these anchor blocks. The remaining anchor blocks will be retrieved from the existing site and installed at the new site. The installation works will be undertaken at the same time as the decommissioning of the old site. Details of the construction method and program were presented in Section 2.

3.7.31 One dredging vessel will be deployed for installation of the blocks at the proposed site and it will take approximately one day to fix each block.

3.7.32 For installation of each block, a holding pit will be dredged using a grab dredger. The pit will have an inverted pyramidal shape and a rectangular base with a height of 5m as shown in Figure 3-15. The holding pit measures 6m x 6m at the bottom and 10m x 10m at the seabed surface. The total volume of the sediment to be dredged for installation of each block is estimated at 326.7m$^3$.

3.7.33 The marine mud dredged for the first holding pit will be temporarily stored on the barge. After the first anchor block is lowered into the pit, the dredging for the second pit will begin and the dredged marine mud will be transferred directly to backfill the first pit. Similarly, the dredged marine mud for the third pit will be transferred directly to backfill the second pit, and so on. The marine mud from the first holding pit that was temporarily stored in the barge will finally be used to backfill the last pit.

3.7.34 The dredging time required to install one anchor block will be approximately 4 hours. Apart from the dredging for the first pit and backfilling for the last pit, the dredging and backfilling for each pit will take place concurrently. As both the dredging and backfilling will release sediment into the water column, both the total sediment released from the works and the sediment release rate during the works for those intermediate pits will be more than those during the dredging works for the first pit or the backfilling works for the last pit. As such, the following water quality impact assessment for the proposed works at the Tsing Yi site has been based on the worst case scenario – concurrent dredging and backfilling works for the intermediate mooring pits. The dredging rate is estimated to be 81.7 m$^3$/hour, or 0.023 m$^3$/s. According to Section 3.6, this will also be the dumping rate. The total volume of the sediment to be dredged for installation of the 28 blocks is estimated at 28 x 326.7$m^3$ = 9148 $m^3$.

*Suspended Solids Suspension*

3.7.35 Table 3-32 lists summary results of the particle size distribution at the proposed site and the average of the results has been used for the SS spill rate calculation. Fine sediments have been defined as silt and clay, making up 94.3% of the sediment, on average, at the new dock location.

| Sample Location | Depth | Sampling | Gravel (%) | Sand (%) | Silt and Clay (%) |
|---|---|---|---|---|---|
| PV1 | 0.00-6.00m | Vibrocore | 0 | 7 | 93 |
| PV2 | 0.00-6.00m | Vibrocore | 0 | 4 | 96 |
| PV3 | 0.00-6.00m | Vibrocore | 0 | 7 | 93 |
| PV4 | 0.00-6.00m | Vibrocore | 0 | 5 | 95 |
| PV5 | 0.00-6.00m | Vibrocore | 0 | 5 | 95 |
| PV6 | 0.00-6.00m | Vibrocore | 0 | 6 | 94 |
| Average for vibrocore samples | | | **0** | **5.7** | **94.3** |

**Table 3-32 Summary Results of Particle Size Distribution at the Proposed Site**

3.7.36 The maximum SS releasing rate due to the dredging and backfilling is estimated in the following using the method discussed in Section 3.6:

$17.5\ R_d + 67\ R_d\ S_f$

$= 17.5\ kg/m^3 \times 0.023\ m^3/s + 5\% \times 1340\ kg/m^3 \times 0.023\ m^3/s \times 94.3\%$

= 1.856 [kg/s]

3.7.37 The ambient SS level at Tsing Yi is approximately 9.3 mg/L on average (Table 3-14). As such, the maximum increase in SS level allowed is 2.79 mg/L (30% of the ambient SS concentration) in accordance with WQO for the Western Buffer WCZ.

3.7.38 At the Tsing Yi site, the water depth is about 25m with a peak flood velocity ranging from 0.5 to 1.5 m/s flowing north / northwest. Under a velocity of 0.5m/s, the flood tide mixing zone where the SS elevation exceeds 2.79 mg/L can extend to 113m downstream in the flow direction and 26m in the cross-flow direction. If the flow velocity is increased to 1.5 m/s, the flood tide mixing zone is reduced to less than 40m in the flow direction and less than 10m in the cross-flow direction. For the remainder of the water quality impact assessment, a constant velocity of 0.5m/s has been conservatively adopted as the flood velocity at the Tsing Yi site.

3.7.39 The peak ebb velocity at the Tsing Yi site ranges from 0.5 to 2 m/s, flowing towards south and southeast and a constant velocity of 0.5m/s has been conservatively adopted for prediction. The predicted maximum ebb tide mixing zone also measures 113m in the flow direction and 26m in the cross-flow direction.

3.7.40 Table 3-33 summarises the modelling results. It can be seen that, the maximum size of the overall mixing zone where the SS elevation may exceed 30% above the baseline level, will be within an area of 226m in the flow direction and 26m in the cross-flow direction.

3.7.41 The nearest WSR is the Ma Wan Tung Wan Beach, located to the northwest over 3km away from the proposed Dock site. It is not affected by the dredging and backfilling works during the ebb tide and is well outside the flood tide mixing zone. The model predictions indicate that the SS elevation due to the dredging / backfilling for installation of the anchor blocks during the flood tide is only 0.53 mg/L and 0.49 mg/L at the Ma Wan Tung Wan Beach and Ma Wan Fish Culture Zone respectively, well within the acceptable level. The same conclusion also applies to the other WSRs except that the SS elevation at those WSRs will be much less.

| **Flood or Ebb Tide** | | |
|---|---|---|
| **Velocity = 0.5m/s**<br>**Depth = 25m**<br>**SS Releasing rate = 1.856 kg/s** | | |
| **Flow Direction (m)** | **Cross-Flow Direction (m)** | **SS Elevation(mg/l)** |
| 10 | 0 | 9.37 |
| 50 | 0 | 4.19 |
| 100 | 0 | 2.96 |
| **113** | **0** | **2.79** |
| 120 | 0 | 2.70 |
| 150 | 0 | 2.42 |
| 200 | 0 | 2.09 |
| 40 | 10 | 4.33 |
| 40 | 20 | 3.43 |
| **40** | **26** | **2.76** |
| 40 | 30 | 2.32 |
| 30 | 26 | 2.67 |
| 50 | 26 | 2.75 |
| 80 | 26 | 2.54 |
| 3100 | 0 | 0.53 |
| 3700 | 0 | 0.49 |

**Table 3-33 Predicted SS Elevation Resulting from Dredging and Backfilling at the Proposed Site**

3.7.42 Due to the strong tidal currents, the suspended sediment generated from the works at the Tsing Yi site can unlikely cross the Ma Wan Channel and affect the Ma Wan Tung Wan Beach or Ma Wan Fish Culture Zone. As such, the predicted SS elevation for those two WSRs is overly estimated. According to the Department of Agriculture, Fisheries and Conservation, the SS tolerance level of a fish culture zone is generally at 50 mg/l. The predicted SS level at Ma Wan Fish Culture Zone is 10.5mg/l (10 mg/l baseline + 0.49 mg/l elevation) and is well within the tolerance level. The potential oxygen depletion resulting from the SS at the fish culture zone has also been estimated using the same method described in Section 3.7.15. The estimated oxygen depletion is only 0.036 mg/l and negligible.

*Contaminant Releases*

3.7.43 In addition to the increase in SS level, dredging and placement of marine mud can also release the contaminants contained in the marine mud. Table 3-34 lists results of the elutriate tests for the sediment samples taken at the proposed Dock site. These results indicate that only copper levels may be of concern. The average dissolved copper level is 16 µg/L, exceeding the criteria for the receiving water of 4.8 µg/L (Table 3-3, for temporary conditions).

3.7.44 The existing water quality at the Tsing Yi site is influenced by the operation of Yiu Lian Floating Dock No.1 and possibly United Dockyard. According to the long-term water quality monitoring results for the East Sha Chau mud pit programme at a number of stations within the region of western water, the long-term trend of Cu between April 2001 and August 2005 was around 2 µg/L. Using this Cu level as the baseline level outside the immediate influence of the existing Dock operation, a dilution of 3.5 will be sufficient to reduce the Cu elevation during the works to comply with the water quality criteria. Based on the Gaussian Dispersion Model prediction, such a dilution can be achieved within 60m from the immediate influence of the existing dock operation, as shown in Table 3-35.

3.7.45 As all the WSRs are over 3000m away from the Tsing Yi site, it can be concluded that the water quality impact of the dissolved copper level elevation resulting from the proposed works at the Tsing Yi site is negligible.

| Sample Identification | Heavy Metals (Total) | | | | | | | | Heavy Metals (Dissolved) | | | | | | | | Other Parameters | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | Cd | Cr | Cu | Ni | Pb | Zn | As | Hg | TOC | Total PCB | LMW PAH | HMW PAH | TBT |
| | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | mg/L | ug/L | ug/L | ug/L | ng/L |
| PV1, PV2, PV3 (PS) | <0.2 | <1 | 700 | 16 | 6.2 | 230 | <1 | <0.04 | <0.2 | <1 | **14** | 3.0 | <1 | 28 | <1 | <0.04 | <5 | <0.01 | <1 | <1 | 14 |
| PV4, PV5, PV6 (PS) | <0.2 | <1 | 590 | 15 | 6.1 | 160 | <1 | <0.04 | <0.2 | <1 | **17** | 2.5 | <1 | 31 | <1 | <0.04 | 7 | <0.01 | <1 | <1 | <1 |
| Average | <0.2 | <1 | 645 | 16 | 6.2 | 195 | <1 | <0.04 | <0.2 | <1 | **16** | 2.8 | <1 | 30 | <1 | <0.04 | 7* | <0.01 | <1 | <1 | 14* |
| Proposed Site | <0.2 | <1 | 530 | 16 | 7.1 | 230 | <1 | <0.04 | <0.2 | <1 | **14** | 2.3 | <1 | 31 | <1 | <0.04 | 7 | <0.01 | <1 | <1 | <1 |

Notes: The bold numbers indicating the levels exceeding the recommended criteria for a temporary condition listed in Table 3-3.
* indicating the maximum number.

**Table 3-34 Summary Results of Elutriate Sample Analysis at the Proposed Site**

| Flood or Ebb Tide | | |
|---|---|---|
| Velocity = 0.5m/s<br>Depth = 25m | | |
| **Flow Direction (m)** | **Cross-Flow Direction (m)** | **Dilution** |
| 5 | 0 | 1 |
| 20 | 0 | 2 |
| 50 | 0 | 3.2 |
| 60 | 0 | 3.5 |
| 100 | 0 | 4.5 |

**Table 3-35 Predicted Dilution around the Proposed Site**

#### Relocation Phase - Cumulative WQ Impacts

3.7.46 The small scale dredging at the existing site and the proposed site will take place simultaneously during certain periods as shown in the works programme in Appendix 2A. However, there will be no other planned dredging works in the area during that period. The cumulative impacts from the dredging at these two sites are assessed and discussed below.

3.7.47 The WSRs of concern are located at Ma Wan (Ma Wan Tung Wan Beach and Ma Wan Fish Culture Zone), to the northeast of the existing site and to the north of the proposed new site. The pollutants generated from the existing dock site can flow to the northeast towards the WSRs only during the ebb tide, whereas the pollutants generated from the proposed dock site can flow to the north towards the WSRs only during the flood tide. These flow patterns are clearly shown in Figures 3-2 and 3-3. Thus, there can be no concurrent impacts on the WSRs at Ma Wan or the coasts of southern New Territories, resulting from the simultaneous works at the both sites, since ebb and flood tides cannot occur at the same time.

#### Operation Phase Impact

3.7.48 After the Dock decommissioning, a series of the small pits left from retrieving the anchor blocks at Yam O are expected to be filled quickly by the natural sediment transport. With no further pollution discharges from the Dock, the contaminated sediment at the site will be gradually covered by the natural and clean sediment depositions. As such, no adverse water quality impact is expected at the Yam O site during the operation phase.

3.7.49 During the future Dock operations at Tsing Yi, both domestic wastewater generated from the workers on board the Dock and the industrial wastewater generated from Dock operations, will be discharged into marine waters after appropriate treatment. The residual water quality impact, as well as the cumulative water quality impact from other existing pollution discharges, is assessed below:

*<u>Domestic Wastewater Discharge during Dock Operations</u>*

3.7.50 During the Dock operations, domestic sewage will be generated from the workers on board the Dock. The sewage at the existing Dock is currently collected and treated through a Sasakura Super Trident Sewage Treatment Plant installed on board the Dock before discharge. The treatment system has a design capacity of 3.6 kg/day Biochemical Oxygen Demand (BOD) and a design effluent quality of less than 50 mg/L BOD. The discharge point of the Sewage Treatment Plant is shown in Figure 3-16. A discharge license has been obtained from EPD with the conditions listed in Table 3-36.

| Determinand | Limit | Determinand | Limit |
|---|---|---|---|
| Flow rate ($m^3$/day) | 2 | Biochemical Oxygen Demand (5 days, 20°C) (mg/L) | 500 |
| Chemical Oxygen Demand (mg/L) | 1000 | Oil & Grease (mg/L) | 50 |
| Suspended Solids (mg/L) | 500 | *E. coli* (count/100ml) | 4000 |
| pH (pH units) | 6-10 | Total residual chlorine (mg/L) | 1 |

**Table 3-36 Limitations on Discharge of Effluent Arising form Domestic Sewage**

3.7.51 The same sewage collection and treatment system will be used during Dock operations at the Tsing Yi site. The potential water quality impact of the sewage discharge is assessed as follows:

3.7.52 The number of workers on board during Dock operations varies from 80 up to a maximum of 110. The volume of domestic wastewater generated by Dock operations has been estimated using the DSD Sewerage Manual (SM). Effluent samples at the discharge point were collected and the results have been used for this impact assessment.

3.7.53 Table 3-37 shows the domestic effluent characteristics based on the testing results of the sample taken on 19 August 2005 at the discharging point. The relevant standards of effluents discharged in the Western Buffer WCZ are also included in the table for comparison. The discharge volume has been estimated using a flow factor of 0.06 $m^3$/day/person in accordance with SM and the maximum staff number of 110 on board. The calculated BOD loading based on the maximum staff number of 110 on board is 2.53 kg/day based on the Guidelines for the Design of Small Sewage Treatment Plant, which is lower than the design capacity of 3.6 kg/day.

| Population No. | Volume m3/day | $BOD_5$ mg/L | COD mg/L | TSS mg/L | O&G mg/L | $TRCl_2$ mg/L | pH pH unit | D.O. mg/L | *E. coli* CFU/100mL |
|---|---|---|---|---|---|---|---|---|---|
| 110 | 6.6 | 5* | 580* | **22*** | <10* | <0.5* | 6.8* | 4.2* | <100* |
| Licensed Discharge Standards | <10 | 500 | 1000 | 500 | 50 | 1 | 6-10 | - | 4000 |

Notes:
The bold numbers indicate the levels exceeding the relevant WQO. The standards are taken from WPCO TM.
* The testing results of the sample taken at the discharge point on 19 August 2005.

**Table 3-37 Domestic Effluent Characteristics**

3.7.54 The domestic effluents could meet the standards for effluents discharged into the marine waters of the Western Buffer WCZ. Some parameters of the effluents could even meet the WQOs such as pH, DO, *E. coli* for this WCZ. The WQO has not set standards for COD and $BOD_5$ in the marine water. The ambient SS level at Tsing Yi is approximately 8.8 mg/L. In accordance with WQO, the SS standard in the marine water is defined as 11.44 mg/L (less than 30% increase over the ambient level). The SS concentration of 22 mg/L in the effluents is greater than this standard. The mixing zone required for the SS dilution and impacts are assessed below.

3.7.55 According to the Water Quality Objectives, the net increase in SS allowed in the marine water is 2.64 mg/L (8.8[mg/L]x30%). The discharge rate of the SS is estimated to be 5.04mg/s (22[mg/L] x 6.6[$m^3$/day] x 1000[L/$m^3$] / (8x60x60[s/day])) with an assumption of an effluent flow rate of 6.6 $m^3$ over 8 hrs. For a velocity of 0.5 m/s flowing to north / northwest during a typical spring flood flow in the wet season, even at the location close to the discharging point, say 10m downstream, the SS level is predicted at only $8x10^{-5}$ mg/L using the Gaussian Model described in Section 3.6 and a conservative diffusion coefficient of 0.1 $m^2$/s, which is well below the net SS increase of 2.64 mg/L allowed and is negligible (see Table 3-38). The same conclusion applies to the ebb flow condition with the water depth of 25m and a velocity of 0.5 m/s flowing to the direction of south / southeast in a wet season. As such the domestic effluents discharged due to Dock operations can meet the discharging standards of the Western Buffer WCZ and their impacts on the receiving water are limited to the immediate vicinity of the discharge point. It is concluded that the domestic effluents discharged from the dock operation at the proposed site will not have an impact on adjacent WSRs.

| **Flood or Ebb Tide** | | |
|---|---|---|
| **Velocity = 0.5m/s**<br>**Depth = 25m**<br>**SS Releasing rate = $5.04\times10^{-6}$ kg/s** | | |
| Flow Direction (m) | Cross-Flow Direction (m) | SS Elevation (mg/l) |
| 1 | 0 | 0.00025 |
| 2 | 0 | 0.00018 |
| 5 | 0 | 0.00011 |
| 10 | 0 | 0.00008 |

**Table 3-38 Predicted SS Elevation Resulting from Domestic Wastewater Discharge at Tsing Yi Site during the Operation Stage**

*Industrial Wastewater Discharge During Dock Operations*

3.7.56 Dock operation hours are from 8am to 5pm during a normal weekday. Staff will be required to work overtime during the night, Sundays, and public holidays if necessary. Of all the dock operations, hull washing is the main activity that generates industrial wastewater. The industrial wastewater is currently discharged into the marine water after mechanical screening. After relocation, the industrial wastewater will also go through an effective settling tank system for further treatment before discharge as shown in Figure 3-17.

3.7.57 The number of ships received for repair and maintenance varies year by year depending on the market. The volume of industrial wastewater generated from Dock operations is estimated using historical records. Samples at the wastewater discharging point (mesh screen) were collected and tested and the results have been used for the impact assessment. The location of the industrial wastewater discharge points (mesh screens) is shown in Figure 3-16.

3.7.58 The Yiu Lian Floating Dock No.3 serves mainly international ships. The overall maintenance time per ship is 1 to 2 weeks. Hull washing for a ship usually takes one day (8 hrs) and water consumption is estimated to be between 80 and 100 $m^3$ per ship. The washing water is potable water supplied from the land to the Dock. The wastewater discharge rate of 3.472 L/s (100 $m^3$/8hr) has been used in the impact assessment. Table 3-39 lists the industrial effluent characteristics based on the testing results of the two samples taken during hull washing. One sample was taken at source (before screening) on 6 August 2005 when the "New Yard Express" was being serviced and the other sample was taken at the discharge point (after screening) on 19 August 2005 when "Wan Hai 305" (was being serviced). The relevant WPCO TM standards for effluents discharged into the marine waters of the Western Buffer WCZ are also included in the table for comparison, based on a daily flow rate of 100 $m^3$. The relevant toxic heavy metal standards (in their total form) have been applied.

3.7.59 If the samples are taken at the same time, the pollution concentrations at the source are expected to be higher than at the discharging point because of the screening effects. The effluent sample results shown in Table 3-39 indicate that, in general, the dissolved copper and zinc concentrations of both samples are of the same order and that the total metal concentrations at the source are higher than or of the same order as the discharge point. For conservative purposes, the concentrations at the discharge point measured on 19 August 2005 were used in the subsequent assessment for the future Dock operation.

3.7.60 From Table 3-39, two contaminants from hull washing could not meet the standards for effluents discharged into the marine waters. They are the total copper level (6,200 μg/L) and the total toxic metals (6.45 mg/L). As such, the wastewater should be further treated before discharge. The proposed treatment system is illustrated in Figure 3-17, which will be subject to further engineering design to achieve a high removal efficiency (90% to 98%) for the non-dissolved heavy metals and non-dissolved Cu in particular in order to comply with the effluent discharge standards. The removal efficiency of the settling system mainly depends on the retention time and the density of the particles. The Stonecutters Island sewage treatment works currently achieves a SS removal rate of 85% with a retention time of 1.3 hours. The sewage treated in this works is mainly municipal wastewater and the SS in the municipal sewage mainly comprises of biomass, which is light in weight. This proposed settling system has a retention time of 2 hours and Cu has a much higher density than biomass SS. As such this settling system should easily achieve a removal efficiency of over 90% for the non-dissolved Cu and other heavy metals. However, should the pilot trial during the design stage indicate the need for further improvement in order to ensure the compliance with the discharge standards, a longer retention time shall be adopted or, the addition of a chemical dosage and flocculent process shall be considered to include the removal of soluble form of the heavy metals.

3.7.61 Based on the measured data, Cu is the main pollutant in the wastewater. The removal of Cu to the acceptable level will also enable the compliance of the effluent with the discharge standards in terms of the total toxic heavy metals. A removal rate of 90% for the non-dissolved Cu or a removal rate of 76% for the total Cu will ensure the compliance with the discharge standard. In the subsequent assessment, a removal rate of 90% was assumed for the non-dissolved Cu, a removal rate of 75% was assumed for SS and no removal was conservatively assumed for all the dissolved matters.

3.7.62 By comparison with the recommended marine water quality criteria (Table 3-3, for normal conditions), the dissolved copper of 1,000 μg/L in the effluent is much greater than the criterion of 3.1 μg/L and the dissolved zinc of 84 μg/L is slightly above the criterion of 81 μg/L. In addition, SS of 52 mg/L in the effluent will be reduced to 13 mg/L after treatment assuming a 75% removal rate, just over the receiving water quality criterion of 11.44 mg/L (less than 30% increase over the ambient level of 8.8 mg/L). Potential impacts of the effluents discharged into the marine waters on WSRs have been assessed and described below, with the modelling predictions summarised in Table 3-40.

3.7.63 The discharge rate of dissolved copper is estimated at 3.47mg/s, assuming an effluent flow rate of 100 $m^3$ over 8 hrs with a dissolved copper concentration of 1 mg/L in the effluent. The same flow rate is used in the estimate of other components in the effluent. For a velocity of 0.5 m/s, even at the location closest to the discharge point, say at the surface layer of 5m downstream, the resulting elevation of the dissolved copper level is predicted at only 1.1 μg/L, using a conservative diffusion coefficient of 0.1 $m^2/s$. The elevation of the dissolved copper level is reduced to 0.11 μg/L for a diffusion coefficient of 1 $m^2/s$. As the baseline Cu level outside the immediate influence of the existing dock (Yiu Lian Floating Dock No.1 and United Dockyard) operation is only 2μg/L, the Cu level elevation resulting from this Dock operation will not lead to any non-compliance with the assessment criteria (4.8 µg/L). In the following assessment of SS and zinc, a diffusion coefficient of 0.1 $m^2/s$ has been conservatively adopted.

3.7.64 Using the same flow rate and SS concentration of 13 mg/L, the SS discharge rate can be estimated to be 45.1 mg/s, which is predicted to result in a negligible SS level (less than 0.02 mg/L) in the immediate vicinity of the discharge point.

3.7.65 Because both the domestic and industrial effluents can be discharged at the same time, the discharge rate of the SS from Dock operations can reach up to 50.14 (5.0+45.1) mg/s. With an SS discharge rate increasing from 45.1 to 50.14 mg/s, the above conclusions are still valid. At 5m, the SS level is predicted to be less than 0.02 mg/L, well below the allowed net SS increase of 2.64 mg/L.

3.7.66 For dissolved zinc, its level of 84 µg/L in the effluent is only slightly greater than the receiving water quality standard of 81 µg/L. Taking into account the low ambient zinc level (31 µg/L), it can be concluded that with the significant dilution of the receiving water, the impacts of dissolved zinc on marine waters due to the effluent discharge will be confined to the immediate vicinity of the discharge location.

3.7.67 There is no standard for TBT in the WPCO TM and so TBT levels in the effluent cannot be directly compared with the WPCO TM. However, as Yiu Lian will not receive any ships containing TBT paint in the proposed site, TBT pollution due to the future dock operation is not expected after Dock relocation.

| | Heavy Metals (Total) | | | | | | | | Heavy Metals (Dissolved) | | | | | | | | Other parameters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Cd** | **Cr** | **Cu** | **Ni** | **Pb** | **Zn** | **As** | **Hg** | **Cd** | **Cr** | **Cu** | **Ni** | **Pb** | **Zn** | **As** | **Hg** | **LMW PAH** | **HMW PAH** | **Total PCB** | **BOD5** | **COD** | **TSS** | **O&G** | **$TRCl_2$** | **pH** | **DO** | ***E. coli*** | **TBT** |
| | µg/L | | | | | | | | | | | | | | | | | | | mg/L | | | | | pH unit | mg/L | CFU/100 mL | mg/L |
| At source | <0.2 | <1 | 5300 | 82 | 120 | 770 | <1 | <0.04 | <0.2 | <1 | **790** | 6.5 | 17 | **130** | <1 | <0.04 | <1 | <1 | <0.01 | 1 | NA | **9.7** | <10 | <0.5 | 7.2 | 5.7 | NA | 39 |
| At outlet | <0.2 | 1.9 | 6200 | <1 | 2.3 | 230 | 8.5 | 0.08 | <0.2 | <1 | **1000** | <1 | <1 | **84** | <1 | 0.08 | <1 | <1 | <0.01 | 2 | NA | **52** | <10 | NA | 8.1 | 5.4 | NA | 4.6 |
| Assessment Results | - | - | - | - | - | - | - | - | - | - | 0.11 | - | - | <81 | - | - | - | - | - | - | - | <0.06 | - | - | - | - | - | - |
| Assessment Criteria | - | - | - | - | - | - | - | - | 8.8 | 50 | 3.1 | 8.2 | 8.1 | 81 | 36 | 0.94 | 0.2 ppm | | 0.03 (total) | - | - | 2.64 | - | - | - | - | - | 0.37µg/L* /0.01µg/L** |
| Standard | 100 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 100 | - | - | - | - | - | - | - | - | Not allowed | Not allowed | Not allowed | 500 | 1000 | 500 | 50 | 1 | 6-10 | - | 4000 | - |

Notes:

The bold numbers indicate the levels exceeding the relevant marine water criteria.

The bottom line is the standards of effluents discharged into the Western Buffer WCZ from WPCO TM.

* Criteria for temporary conditions recommended this EIA

** Criteria for normal conditions recommended this EIA

**Table 3-39 Industrial Effluent Characteristics**

| Flood or Ebb Tide | | | | |
|---|---|---|---|---|
| Velocity = 0.5m/s | | | | |
| Discharge Rate: Dissolved Cu = 3.47 mg/s, SS = 45.1 mg/s, Dissolved Zn = 292 µg /s | | | | |
| **Flow Direction (m)** | **Cross-Flow Direction (m)** | **Dissolved Cu Elevation (mg/l)** | **SS Elevation (mg/l)** | **Dissolved Zn Elevation (µg /l)** |
| 1 | 0 | 0.0055 | 0.072 | 0.465 |
| 2 | 0 | 0.0028 | 0.036 | 0.232 |
| 5 | 0 | 0.0011 | 0.014 | 0.093 |
| 10 | 0 | 0.0005 | 0.007 | 0.046 |

**Table 3-40 Model Predictions of Water Quality Impacts Resulting from Industrial Effluent Discharges at Tsing Yi during the Operation Stage**

*Cumulative WQ Impacts*

3.7.68 There are two other dockyards in the west and south western coast of Tsing Yi currently in operation. These are the Yiu Lian Floating Dock No.1 and the United Dockyard. The Yiu Lian Floating Dock No.1 is located to the north, approximately 400m away from the proposed site for the Yiu Lian Floating Dock No.3, and the United Dockyard further north, approximately 1,800m away from the proposed site. The major pollution sources are indicated in Figure 3-5.

3.7.69 The domestic wastewater generated from Dock No.1 is collected by a holding tank and transported to shore for treatment. Therefore, it has no contribution to the cumulative impacts. The domestic wastewater generated from the United Dockyard is discharged into the marine water after treatment. The United Dockyard has the same capacity as Yiu Lian Floating Dock No.3 and holds a discharge licence for domestic effluent. As discussed previously, the impacts of the domestic effluents are limited to the immediate vicinity of the discharge points, i.e. within 10m from the respective discharge points (Table 3-38). There will be no overlapping of the effluent plumes generated by the discharges from Yiu Lian Floating Dock No.3 and the United Dockyard. As such there will be no concurrent water quality impacts of the domestic effluent discharged from the other sources on the adjacent WSRs.

3.7.70 The Yiu Lian Floating Dock No.1 discharges the industrial effluents at a rate of 50-80 $m^3$ per ship per day and the United Dockyard 80-100 $m^3$ per ship per day (same as Yiu Lian Floating Dock No.3). The impacts of the industrial effluent discharge from Dock operations are confined to the immediate vicinity of the discharge points (Table 3-40), i.e. within 10m from the respective discharge points. There will be no overlapping of the effluent plumes and therefore no cumulative water quality impacts from the industrial effluent discharged from the other docks on the adjacent WSRs.

*Effect of Non-TBT Paints during the Future Dock Operation*

3.7.71 After the Dock relocation, the Ship Receiving Procedure described in Appendix 3B will be fully implemented. No ships using TBT-based antifouling paint will be received at the Dock. As such, there will be no TBT contamination from the future Dock operations at Tsing Yi. An extensive literature review of TBT-free antifouling paints has been conducted to identify the TBT free paints commonly used on the market, their characteristics and potential environmental impacts. The review included twelve antifouling products from five international paint suppliers. A full review report on the non-TBT paints is attached in Appendix 3C.

3.7.72 The most common and widely used TBT-free antifouling paint is copper-based. This type of paint commonly contains cuprous oxide as the primary biocide for the provision of an antifouling function. It may also contain booster biocide(s) to enhance antifouling capabilities of the paint. Biocide-free antifouling coatings are currently available on the market but not commonly used due to lower effectiveness. Antifouling paints using natural biocides are still under development.

3.7.73 Most of the biocides and booster biocides commonly found in the antifouling paints are classified as "R50" in terms of the European Economic Community (EEC) r-phrase (risk phrase). This is the same category as most TBT compounds, indicating that they are very toxic to aquatic organisms. R-phrases are assigned by the EEC, which first created a List of Dangerous Substances in 1967, classifying substances according to health hazards; or referred to as CEPE (European Council of the Paint, Printing Ink and Artists' Colours Industry) hazard classification. Copper is the most commonly used biocide, but also one of the most toxic. SeaNine 211 is one of the most common booster biocides and also the most toxic. However, SeaNine 211 breaks down rapidly into substances that are much less toxic than the original form. Moreover, the half-life of SeaNine 211 is much shorter than that of TBT and the shorter half-life of SeaNine 211 reduces its bioaccumulation potential. Research suggests that oysters are unaffected by non-TBT paints (it is known that oysters are adversely affected by TBT) and no adverse environmental consequences have been reported since copper replaced TBT in antifouling paints. Both the International Maritime Organisation (IMO) and GreenPeace concluded that copper is less harmful than TBT.

3.7.74 Other toxic substances are also found in the antifouling paints but in trace amounts. Potential impacts from these substances would therefore, be insignificant.

3.7.75 Releasing TBT-free antifouling paints into marine waters during Dock operations would still pose a potential impact on the aquatic organisms. However, proper environmental control measures and good practice can significantly reduce or even avoid releasing toxic antifouling substances into the marine environment. The commonly adopted environmental control measures and good practice include not performing paint spraying in high winds, provision of sheeting to prevent spray drift and avoiding washing residues into the sea. Those control measures have been recommended (in Section 3.8) for future Dock operations at Tsing Yi.

3.7.76 Research also suggests that the key environmental concern for antifouling biocides resulting from their leaching into marine environment during ship navigation.

#### Impact on the Sediment Transport Regime and on Aquatic Organisms

3.7.77 The scale of dredging for the relocation of the Dock is small. A series of the small depressions in the seabed left after the removal of the anchor blocks at the existing site will be filled by natural sediment transport. All dredged material at the Tsing Yi site will be used for backfill, which may lead to some localised seabed level increase on top of the holding pits at the Tsing Yi site. This site will be occupied by the Dock and hence the localised seabed level increase will not pose any impact to other water users. The local tidal velocity will not be affected in spite of a small and localised reduction in water depth as the tidal flow always finds the easiest route in such an open water. The composition and quality of the seabed sediment will remain unchanged. However, the backfilled material is relatively loose as compared to the original seabed. As such, the critical shear stress required to suspend a given particle size in the loose seabed material will be less than originally needed, leading to some localised increase in sediment erosion and hence in sediment suspension. This effect is expected to be short term, much smaller than the above predicted dredging and backfilling impacts and therefore is unlikely a cause for concern. After the relocation, the Dock is chained to the anchor blocks buried in the seabed, posing little blockage to passing tidal flows at the proposed site. Other than the sediment release during dredging and the subsequent SS transport and deposition, significant impacts on seabed sediment erosion and deposition during and after the relocation of the Dock are not expected. The negligible impact on marine water quality and on the sediment transport regime means that any significant impact on aquatic organisms in the study area is unlikely.

3.7.78 During the Dock relocation, it is anticipated that one lifting boat and one to two dredging boat will be deployed. These working boats will be stationary at their respective sites. In addition, there will be one barge for transporting the anchor blocks from the existing site to the proposed site, approximately once every two days. The project areas at Tsing Yi and Yam O Wan are close to existing busy shipping channels, and the vessels used in the relocation are unlikely to induce any significant effects on aquatic organisms.

3.7.79 Based on the water quality assessment criteria and the above impact assessment, it can be concluded that the relocation of the floating dock from Yam O Wan to Tsing Yi will not cause significant impacts on aquatic organisms during either the construction or operation stage.

## 3.8 Mitigation Measures

**Dock Decommissioning**

3.8.1 The dredging for removing the anchor blocks at the existing site and the dredging and backfilling for fixing the anchor blocks at the new site could result in potential impacts on the marine environment. The extent of the impacts is directly related to the fine sediment release rate, which is a function of the dredging or backfilling rate.

3.8.2 In order to minimise the potential impacts, the dredging rate during the removal of the anchor blocks at the existing site should not exceed 61.5$m^3$/hour. As the seabed sediment at the existing site is contaminated and some belongs to Category H, a frame type silt curtain should be deployed during dredging to enclose the dredging area so that any potential water quality of the dredging can be further minimised. The silt curtain shall be extended from the seabed to at least 2 metres above the dredging rig.

3.8.3 The dredging or the backfilling during the commissioning works at the Tsing Yi site should not exceed 81.7 $m^3$/hour.

3.8.4 Any increase in the dredging or backfilling rate shall require a review and re-assessment of the potential water quality impact to ensure compliance with the relevant water quality criteria.

3.8.5 The EM&A programme recommended in this EIA should be fully implemented. If results exceed the action level during the relocation and is found to be a result of this project, the dredging rates should be further reduced to ensure the compliance with the WQOs and the water quality criteria recommended in this EIA.

**Dock Operation**

3.8.6 It is not feasible to collect and store a large volume of hull washing waters on the Dock and have a zero discharge. Currently, all industrial wastewater generated from the existing Dock operations goes through a fine mesh screen system before discharge into the sea. This mesh screen system should be cleaned regularly to ensure it is fully functional. A new settling system for further treatment as illustrated in Figure 3-17 should be installed on board the Dock at the new site. With the natural floor gradient of the Dock, wastewater generated on the Dock will flow to the existing conduit on the side wings. A new bilge wells will be fixed permanently on the Dock to collect the wastewater inside the conduit. Portable air driven pumps with flexible pipes will be used to transfer the wastewater from the bilge well to the portable sedimentation tanks. Should there be any unacceptable non-compliance with the effluent discharge standards, a chemical dosage and flocculation process should be added to the above treatment system to further remove the fine particles and soluble form of the contaminants.

3.8.7 After Dock relocation, a fully auditable procedure as described in Appendix 3B - Ship Receiving Procedure should be in place to ensure that no ships using TBT-containing paint will be received during the future operation of the Dock at Tsing Yi.

3.8.8 The following environmental control measures and practices should be adopted during the application or removal of antifouling paints in order to minimise the release of antifouling biocides to the surrounding environment:

*<u>During application of antifouling paint</u>*

- Provision of a bounded area for the preparation of antifouling paints to avoid accidental spillage into the sea;
- Treating any spillage with a suitable absorbent, which would be disposed of as chemical waste;
- Not performing paint spraying in high winds; and
- Provision of sheeting to prevent spray drift.

*<u>During removal of antifouling paint</u>*

- Segregating wash waters from non-contaminated water;
- Proper segregation and control of wastewater stream and abrasive blasting grits;
- Avoid washing residues directly into the sea; and
- Treating the paint scrapings as chemical waste.

*<u>During sand blasting</u>*

- Cleaning up blasting residues (abrasive grit and plaint flakes) immediately after the blasting activities to avoid these washing into the sea; and
- Close off wastewater drains on the floating dock whenever there are cleaning and blasting activities.

## 3.9 Residual Impacts

3.9.1 With the implementation of the mitigation measures as recommended, the residual water quality impact during both the construction stage and the operation stage as summarised in Tables 3-41 to 3-44, will be minimal.

| Water Quality Parameters | SS | Dissolved Copper | Other Pollutants | Dissolved Oxygen Depletion |
|---|---|---|---|---|
| Elevation at WSRs | Negligible (1.82mg/l at the nearest WSR - Ma Wan Fish Culture Zone without mitigation measures. If the silt curtain is employed, no water quality impact is expected.) | Negligible | Negligible | Negligible |

| | | | | |
|---|---|---|---|---|
| Mixing Zone | 2115m × 150m | 1 µg/L or 8% above the baseline in the vicinity of the works location and compliant with the assessment criteria outside the immediate influence of the Dock operation | Meeting the assessment criteria at the works location | N/A |

**Table 3-41 Residual Water Quality Impact at the Existing Site during the Decommissioning Stage**

| Water Quality Parameters | SS | Dissolved Copper | Other Pollutants | Dissolved Oxygen Depletion |
|---|---|---|---|---|
| Elevation at WSRs | Negligible (0.53mg/l at the nearest WSR - Ma Wan Tung Wan Beach) | Negligible | Negligible | N/A |
| Mixing Zone | 226m × 26m | 2 µg/L or 14% above the baseline in the vicinity of the works location and compliant with the assessment criteria outside the immediate influence of the existing docks operating in the area. | Meeting the assessment criteria at the works location | N/A |

**Table 3-42 Residual Water Quality Impact at Tsing Yi during the Commissioning Stage**

| Water Quality Parameters | SS | Dissolved Copper | Other Pollutants | Dissolved Oxygen Depletion | *E. coli* |
|---|---|---|---|---|---|
| Elevation at WSRs | Negligible | N/A | Negligible | N/A | Negligible |
| Mixing Zone | Meeting the assessment criteria at the works location | N/A | Meeting the assessment criteria at the works location | N/A | Meeting the assessment criteria at the works location |

**Table 3-43 Residual Water Quality Impact Resulting from the Domestic Wastewater Discharge from the Dock at Tsing Yi during the Operation Stage**

| Water quality parameters | SS | Dissolved Copper | Dissolved Zinc | Other Pollutants |
|---|---|---|---|---|
| Elevation at WSRs | Negligible | Negligible | Negligible | Negligible |
| Mixing Zone | Meeting the assessment | Meeting the assessment | Meeting the assessment | Meeting the assessment |

| | | | | |
|---|---|---|---|---|
| | criteria at the works location | criteria at the works location | criteria at the works location | criteria at the works location |

**Table 3-44 Residual Water Quality Impact Resulting from the Industrial Wastewater Discharge from the Dock at Tsing Yi during the Operation Stage**

## 3.10 Environmental Monitoring and Audit Requirements

**Dock Relocation**

3.10.1 An environmental audit procedure should be in place to ensure the full implementation of the recommended mitigation measures.

3.10.2 Although the assessment shows that there will be no significant water quality impact on WSRs during relocation, the main water quality impact is the potential elevation of SS. Regular monitoring of the SS level near the existing site during the decommissioning stage and near the new site during the commissioning stage, is recommended. This is to ensure the compliance with the water quality standards. Details of the monitoring locations and frequency are provided in a separate EM&A Manual.

**Dock Operation**

3.10.3 It is recommended to monitor industrial effluent quality monthly for the first 6 months of the operation of the relocated dock in Tsing Yi. Details of the EM&A procedures are presented in a separate EM&A Manual.

## 3.11 Conclusions

3.11.1 Relocation of the existing Yiu Lian floating dock No.3 at Yam O Wan to the south western coast of Tsing Yi requires small-scale dredging at the existing site if retrieval of anchor blocks is required, and small-scale dredging and backfilling at the new site in order to install the anchor blocks. The dredging and backfilling are the only works that will lead to potential water quality impacts during the relocation works. The key environmental issue of the dredging and backfilling is the potential release of SS and associated contaminants into the water column, thus affecting the marine environment and WSRs. The operation phase impact of this Project is mainly related to the wastewater discharge generated from future Dock operations at Tsing Yi. The potential impacts have been quantitatively assessed and mitigation measures recommended.

3.11.2 Descriptive standards for toxicants are used in Hong Kong. In order to undertake a quantitative assessment in this EIA, however, numerical standards are required. Therefore, a review of relevant international standards and criteria has been conducted and numerical standards for toxicants have been recommended for this EIA.

3.11.3 The baseline marine water at both the existing dock site and the proposed dock site is good, and in compliance with WQOs. However, the copper concentration in the marine water is relatively high, already exceeding the recommended criteria. The pollution level of the other toxic components can meet the recommended criteria. The seabed sediment at the existing Dock site is contaminated with heavy metals, in particular mercury and arsenic as revealed from Table 3-19, and is classified as Category H under ETWB TC(W) No. 34/2002. However, with reference to the industrial effluent characterization of the Dock as shown in Table 3-39, these two contaminants are not of any concern. The seabed sediment at the proposed site at Tsing Yi is also slightly contaminated with copper, lead, mercury and organic-PAHs, and is classified as Category M.

3.11.4 The potential WQ impacts due to relocation and future operation have been quantified using the mathematical models. The mixing zones where the pollutant levels cannot meet the criteria have been predicted. The nearest WSR to the existing site is Ma Wan Fish Culture Zone, 1800m away and only potentially affected by the anchor blocks removal works during the ebb tide. The SS mixing zone is only 605m in the flow direction and 60m in the cross-flow direction during the ebb tide, well away from all the WSRs. The water quality impact in terms of the other pollutants is confined to the very vicinity of the existing Dock site. As the sediment at the existing site is classified as Category H and there is no sufficient information regarding the sediment release rate for the proposed suction dredging method although it is considered to be comparable to that for water jetting, a silt curtain is recommended to be adopted during the dredging process to further reduce the potential water quality impact. The nearest WSR of the commissioning works at the Tsing Yi site is Ma Wan Tung Wan Beach, over 3000m away and only potentially affected by the commissioning works during the flood tide. The SS mixing zone is 113m in the flow direction and 26m in the cross-flow direction during the flood tide, again well away from the proposed dock site. The potential water quality impact in terms of the other pollutants is limited to the very vicinity of the commissioning works.

3.11.5 The most critical WQ parameters of concern during the relocation are SS and to a much lesser extent, copper and TBT. However, all potential water quality impacts during the relocation have been found to be small and acceptable. It is concluded that the proposed works associated with the dock relocation will not have a significant effect on the WSRs provided that recommended mitigation measures are implemented.

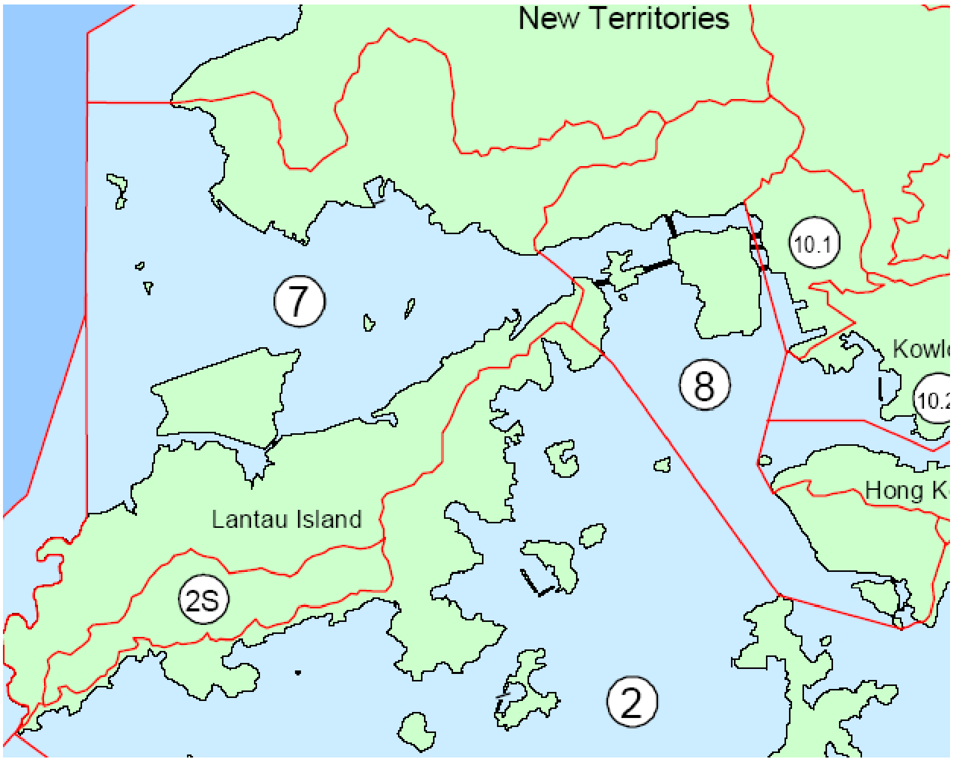
3.11.6 Although the seabed sediment at the existing dock site at Yam O Wan is contaminated and is classified as Category H, the bioaccumulation test show an insignificant bioaccumulation potential for benthic organisms. Both the chemical tests and the bioaccumulation test show no imminent need to remove the marine sediments. The site is not planned for any new development. There is no area of high marine ecological value present in and around the project site. Taking into account the above and the results of the international practice review, leaving the contaminated sediments in place, letting them become capped by natural sediment and then degrade under natural conditions, is considered to be the best option and is recommended.

3.11.7 The potential operation impacts of this Project are related to the domestic wastewater discharged by workers on board the Dock and the industrial wastewater discharged from hull washing.

3.11.8 The industrial wastewater generated from the existing dock operation currently goes through a fine mesh screen system before discharge. After relocation, a settling treatment system will be added as a mitigation measure to further treat the industrial wastewater. TBT will not be present in the effluents in the future Dock operation as Yiu Lian will no longer receive ships with TBT-containing paints. The potential water quality impact of the industrial wastewater discharge is negligible.

3.11.9 Domestic wastewater generated on the Dock will continue to be collected and treated and then discharged to marine waters, following the current practice of the existing dock operation. The domestic effluent can meet the standards for discharge. Flow rate has been estimated using the maximum number of workers on board and the flow factors from the DSD SM. The potential WQ impacts of the effluent discharged into the marine water have been predicted to be confined to a small area (few meters from the discharging point) and will be negligible.

3.11.10 The potential cumulative effects of the effluent discharge from Yiu Lian Dock No.1 and No.3 and the United Dockyard on the WSRs have been found to be minimal. At the time of this EIA study, no other concurrent works or projects have been identified, that could lead to a cumulative water quality impact during the relocation.




Source: EPD marine water quality in HK 2004. (7) - North Western WCZ, (8) – Western Buffer WCZ

**Figure 3-1 Locations of the North Western WCZ and Western Buffer WCZ**

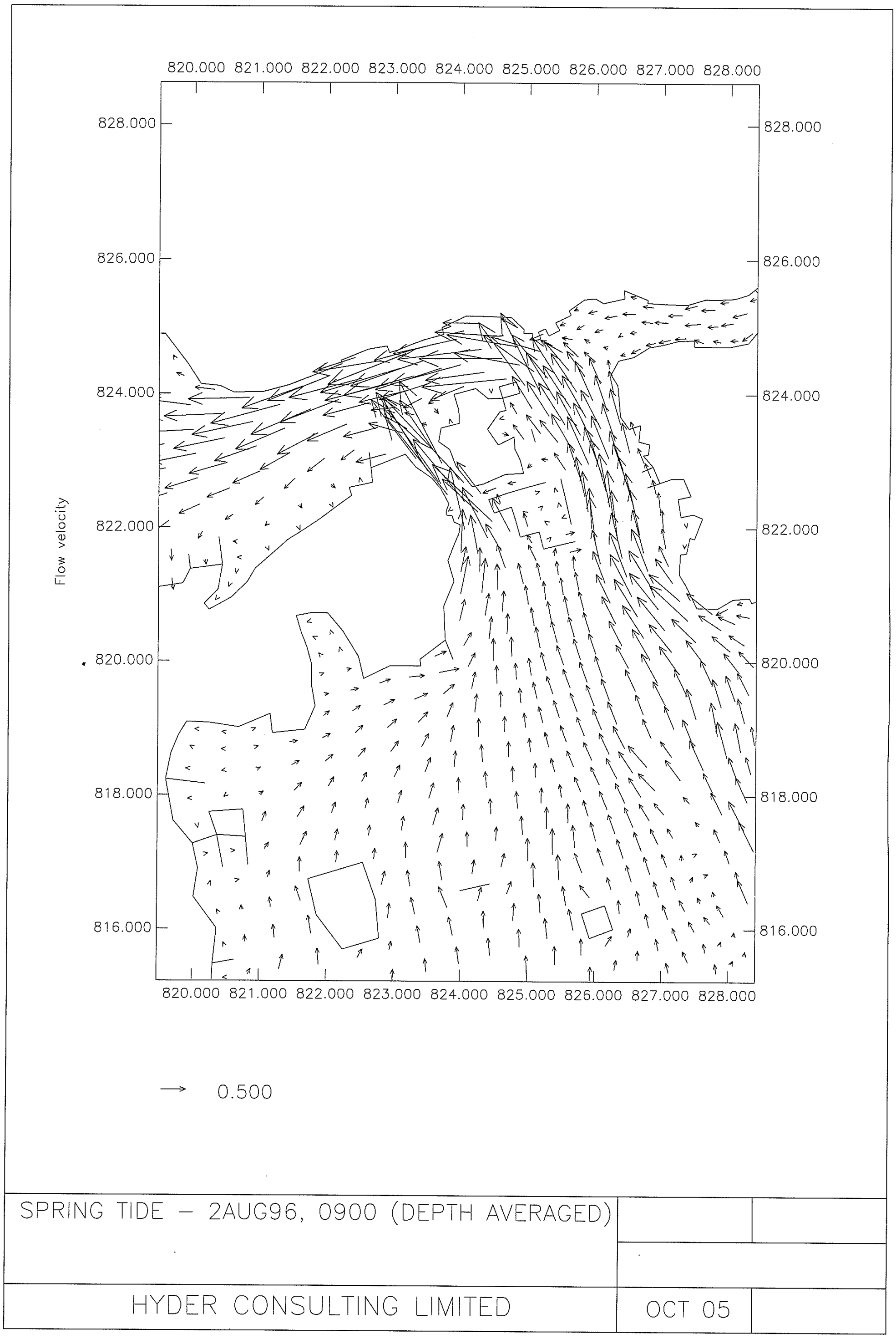



**Figure 3-2 Depth Average Peak Velocities during a Typical Flood Tide in a Wet Season**

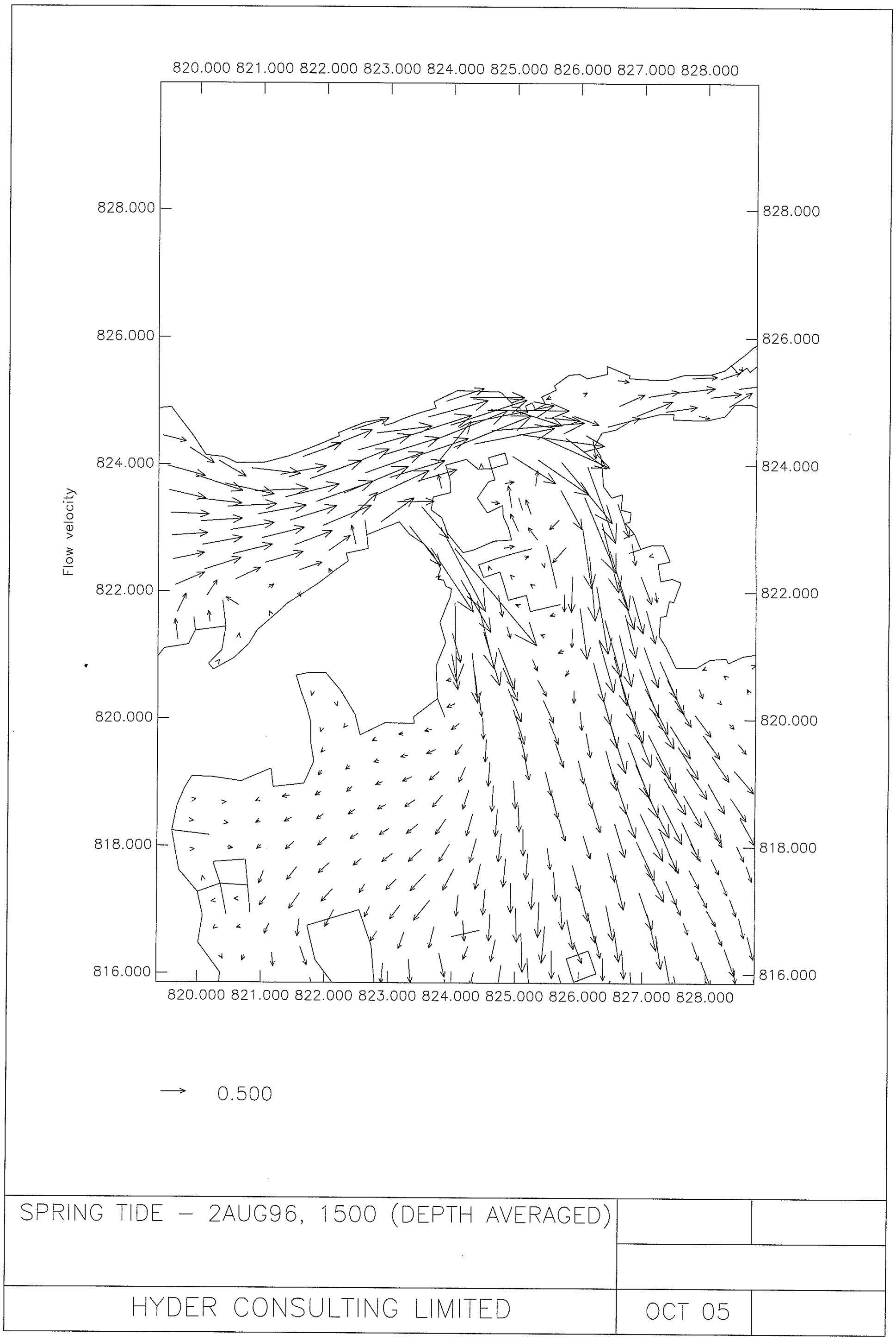
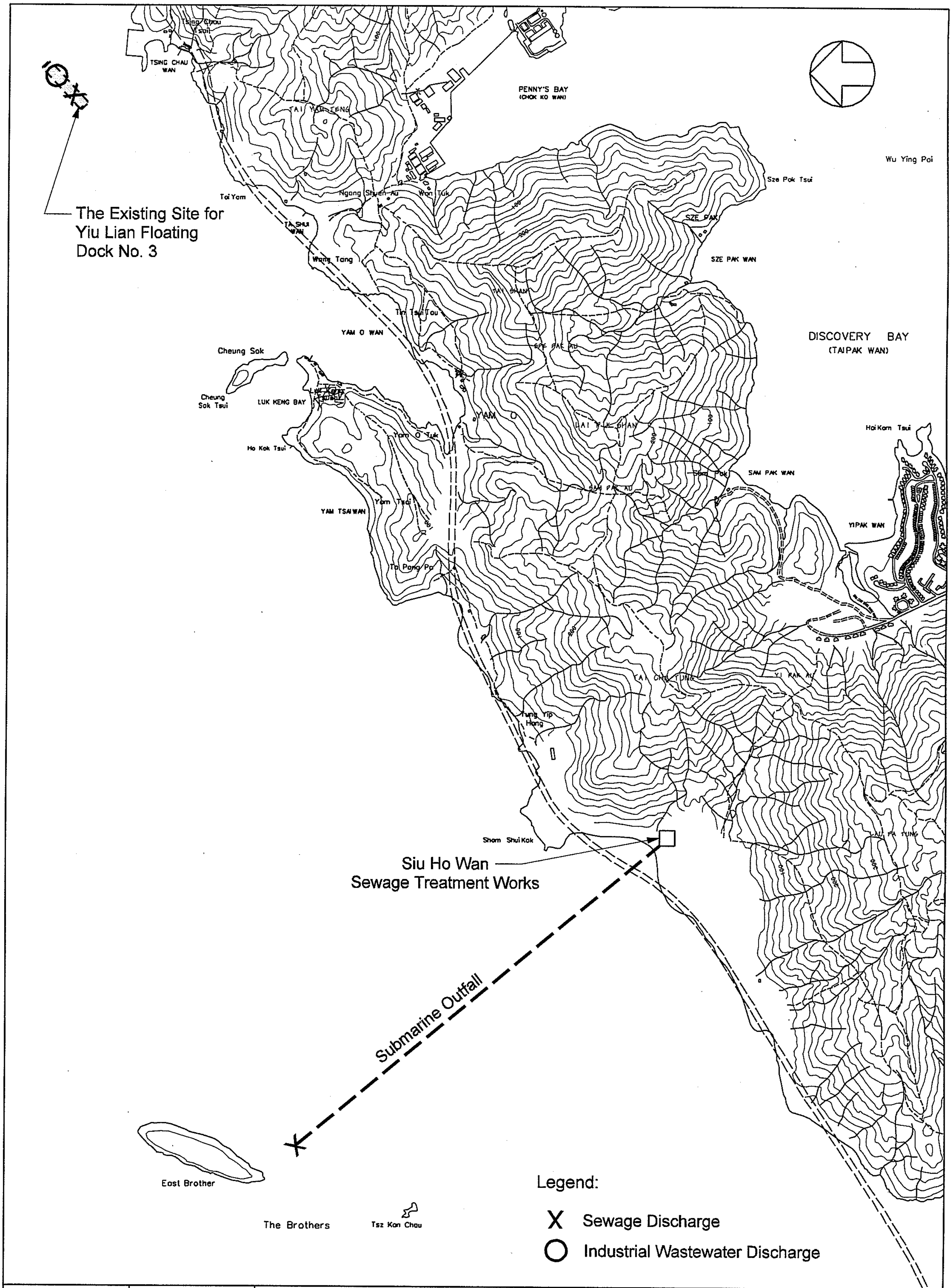



**Figure 3-3 Depth Average Peak Velocities during a Typical Ebb Tide in a Wet Season**




| CONSULTANT | CLIENT | DRAWING TITLE | | |
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| Hyder Consulting | 友聯船廠有限公司<br>Yiu Lian Dockyards Limited | Relocation of Yiu Lian Floating Dock No. 3<br><br>The Locations of Major Pollution Sources at the Existing Site | DESIGNED T. NIP<br>DRAWN T. KWAN<br>APPROVED G.Y. LI<br>DATE 02-03-2006<br>SCALE 1 : 27500 | CHECKED S. OR<br>CHECKED T. NIP<br>© Copyright Reserved<br>All dimensions are in mm unless shown otherwise.<br>No measurement should be taken from drawing directly. |
| | | | DRG. NO. Figure 3-4. | REV. – |

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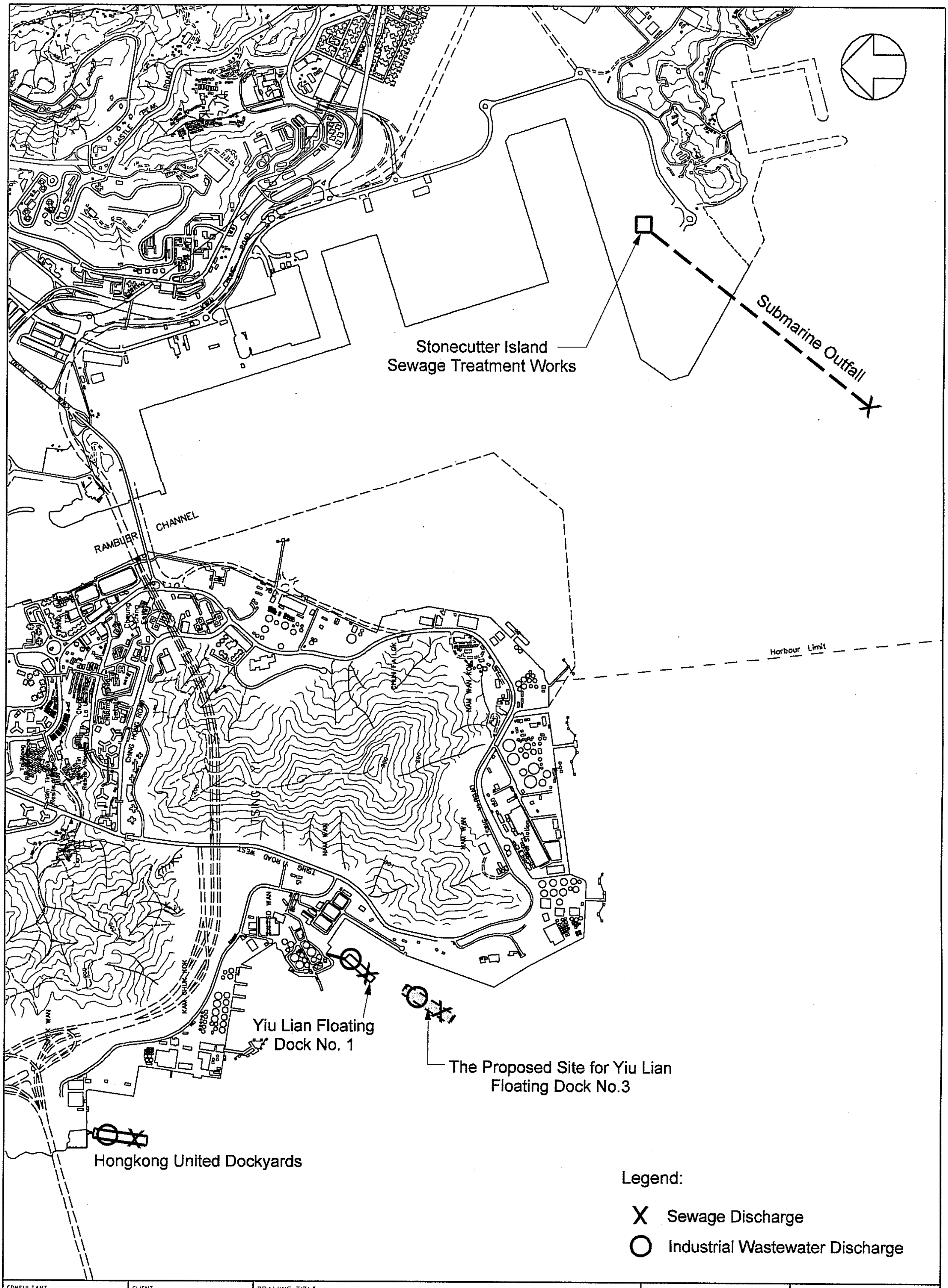


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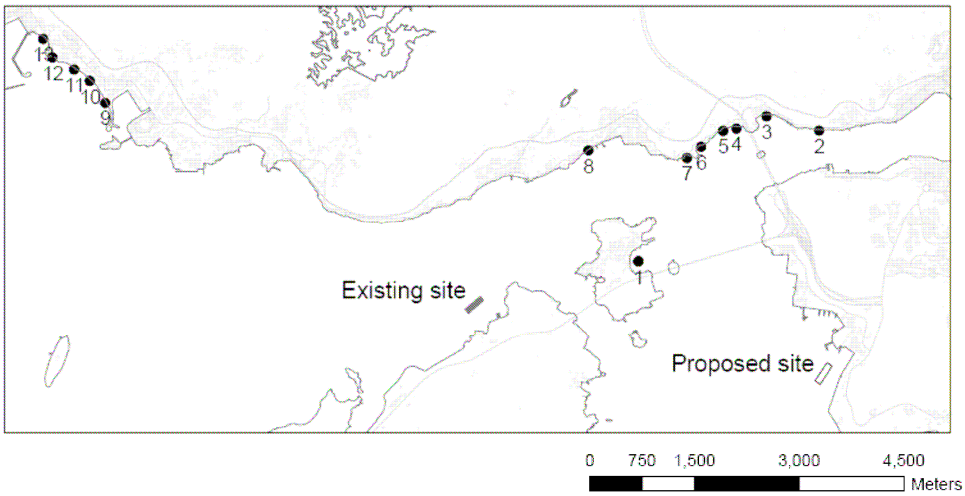



**Legend**

1 – Ma Wan Tung Wan Beach
2 – Approach Beach
3 – Ting Kau Beach
4 – Lido Beach
5 – Casam Beach
6 – Hoi Mei Wan Beach
7 – Gemini Beach
8 – Anglers' Beach
9 – Golden Beach
10 – Cafeteria Old Beach
11 – Cafeteria New Beach
12 – Kadoorie Beach
13 – Castle Peak Beach

**Figure 3-6 Locations of Adjacent Beaches**

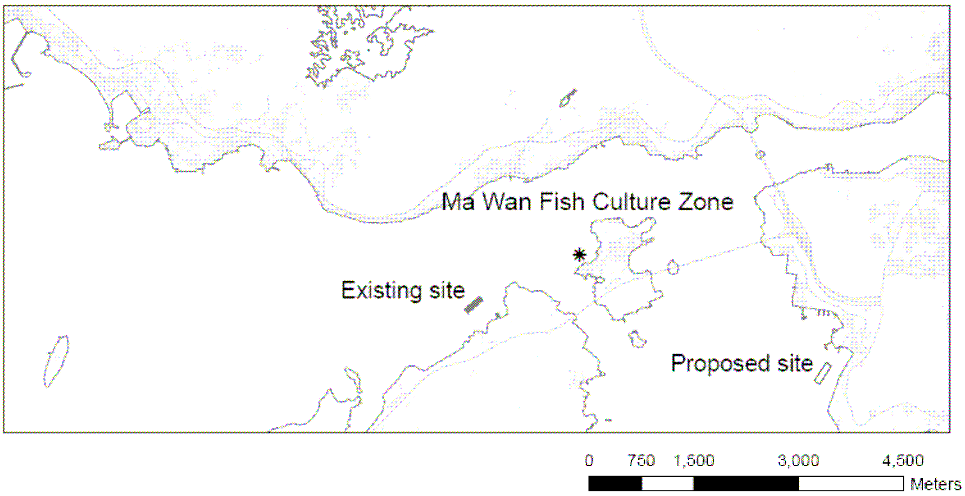
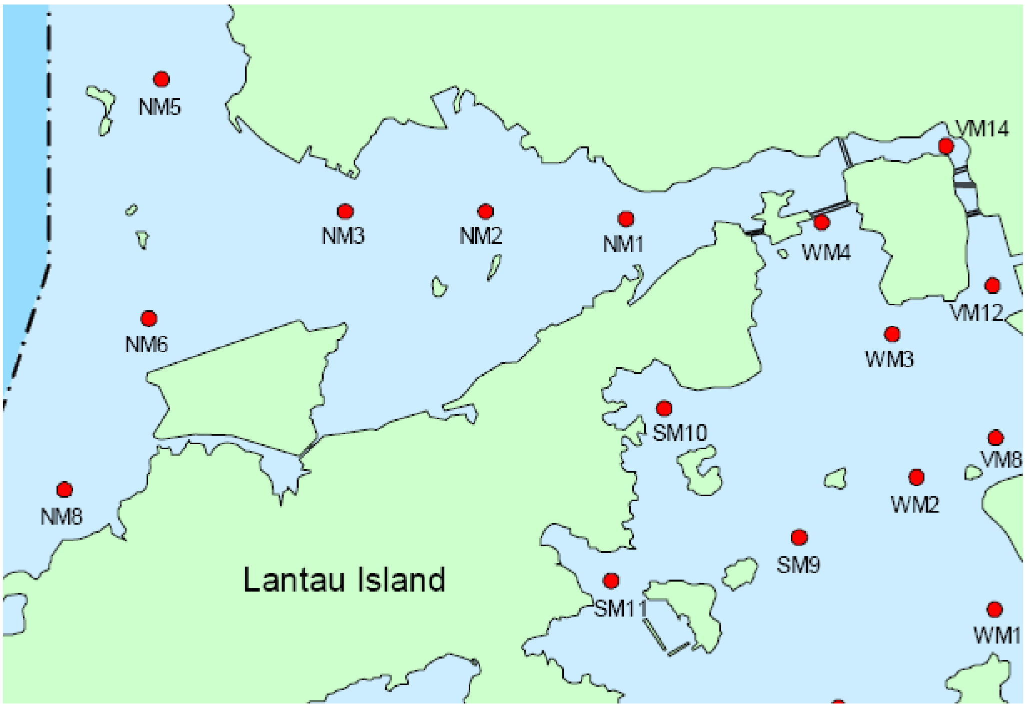
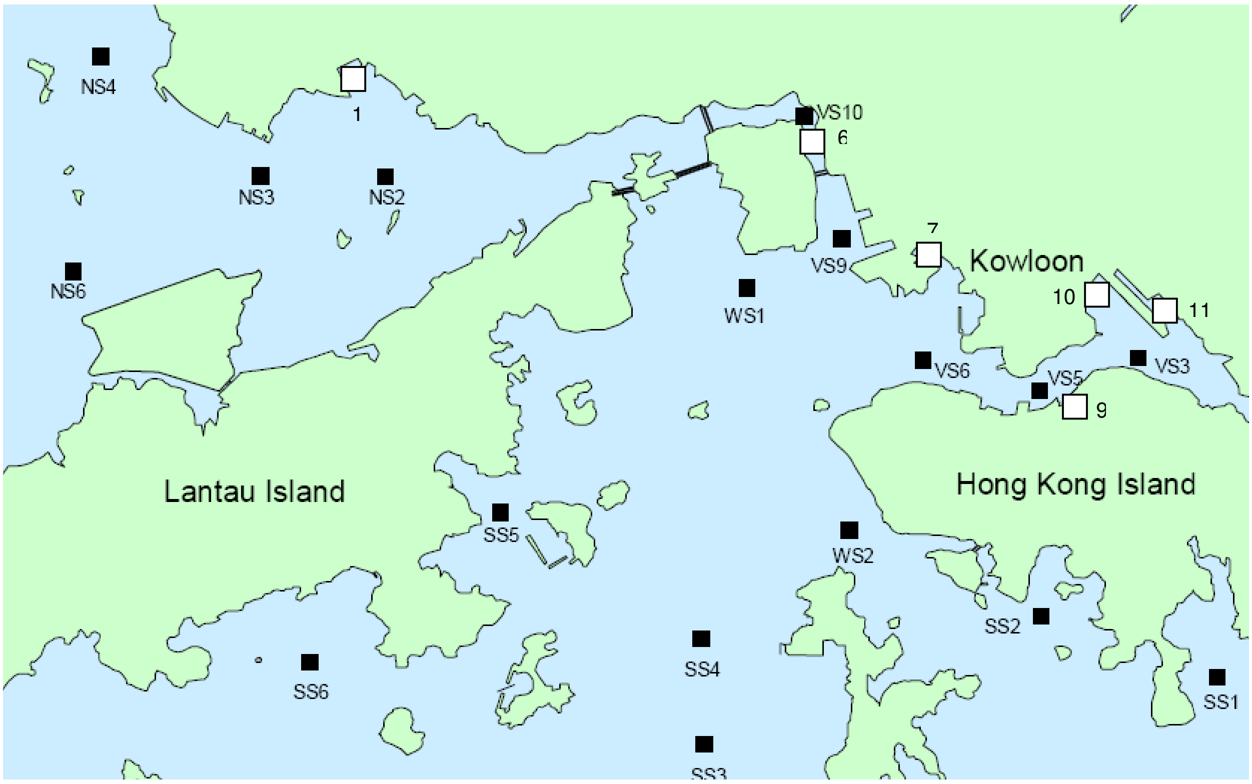



**Figure 3-7 Locations of Adjacent Fish Culture Zones**




Source: EPD marine water quality in HK 2004

**Figure 3-8 EPD Water Quality Monitoring Stations**

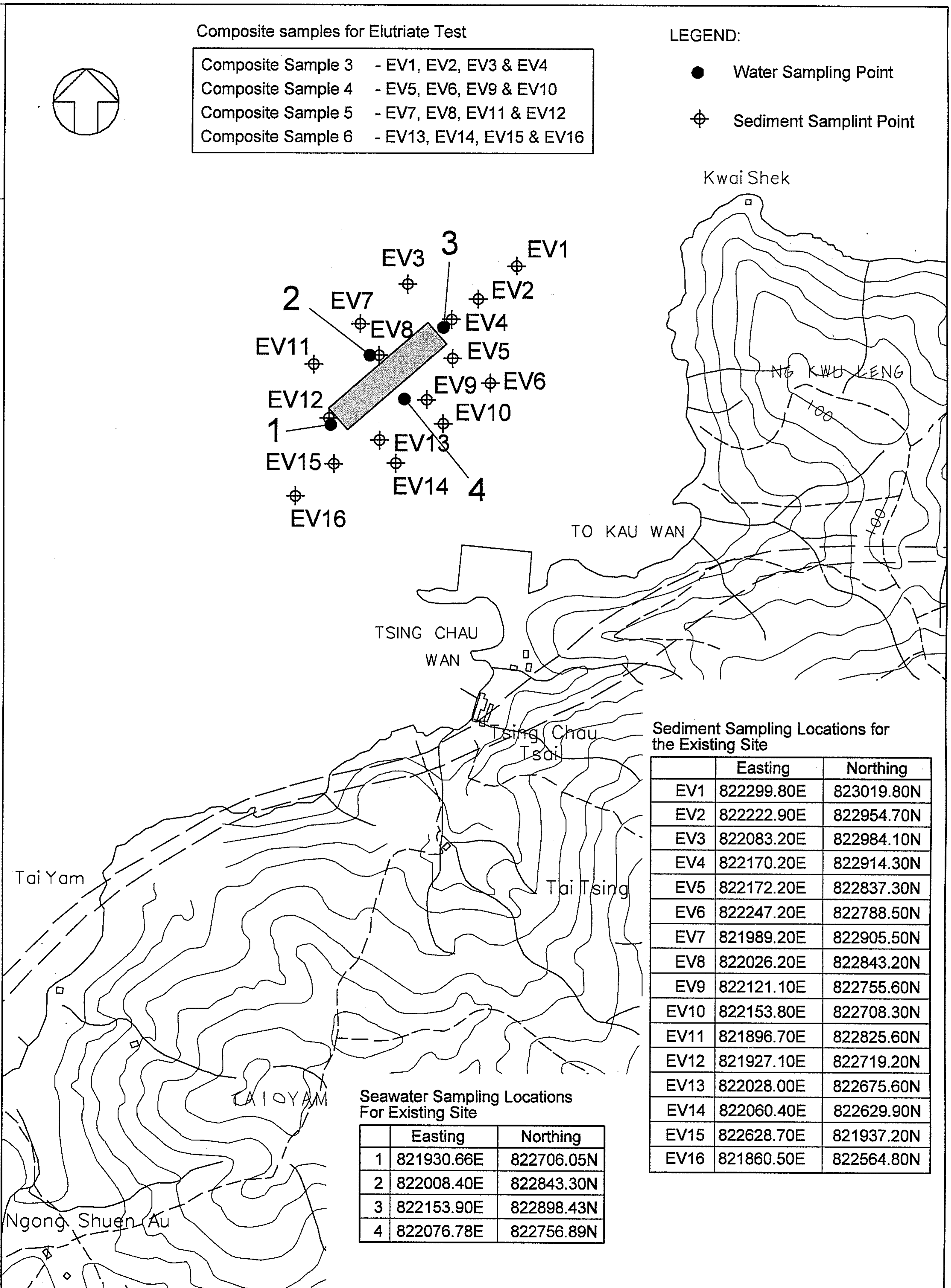



| Typhoon Shelters | Monitoring Stations |
|---|---|
| 1 Tuen Mun | NS5 |
| 6 Rambler Channel | VS17 |
| 7 Government Dockyard | VS21 |
| 9 Causeway Bay | VS12 |
| 10 To Kwa Wan | VS20 |
| 11 Kwun Tong | VS14 |

■ Sediment Monitoring Station in open waters

□ Sediment Monitoring Station in typhoon shelters

**Figure 3-9 EPD Sediment Quality Monitoring Stations in Typhoon Shelters and Open Waters of Hong Kong**




### Seawater Sampling Locations For Existing Site

| | Easting | Northing |
|---|---|---|
| 1 | 821930.66E | 822706.05N |
| 2 | 822008.40E | 822843.30N |
| 3 | 822153.90E | 822898.43N |
| 4 | 822076.78E | 822756.89N |

### Sediment Sampling Locations for the Existing Site

| | Easting | Northing |
|---|---|---|
| EV1 | 822299.80E | 823019.80N |
| EV2 | 822222.90E | 822954.70N |
| EV3 | 822083.20E | 822984.10N |
| EV4 | 822170.20E | 822914.30N |
| EV5 | 822172.20E | 822837.30N |
| EV6 | 822247.20E | 822788.50N |
| EV7 | 821989.20E | 822905.50N |
| EV8 | 822026.20E | 822843.20N |
| EV9 | 822121.10E | 822755.60N |
| EV10 | 822153.80E | 822708.30N |
| EV11 | 821896.70E | 822825.60N |
| EV12 | 821927.10E | 822719.20N |
| EV13 | 822028.00E | 822675.60N |
| EV14 | 822060.40E | 822629.90N |
| EV15 | 822628.70E | 821937.20N |
| EV16 | 821860.50E | 822564.80N |

CONSULTANT: Hyder Consulting

CLIENT: 友聯船廠有限公司 Yiu Lian Dockyards Limited

DRAWING TITLE:

## Location of Yiu Lian Floating Dock No. 3

### Sampling Locations at the Existing Site

| | | | |
|---|---|---|---|
| DESIGNED | C. LEE | CHECKED | S. OR |
| DRAWN | T. KWAN | CHECKED | C. LEE |
| APPROVED | G.Y. LI | | |
| DATE | 14-10-2005 | | |
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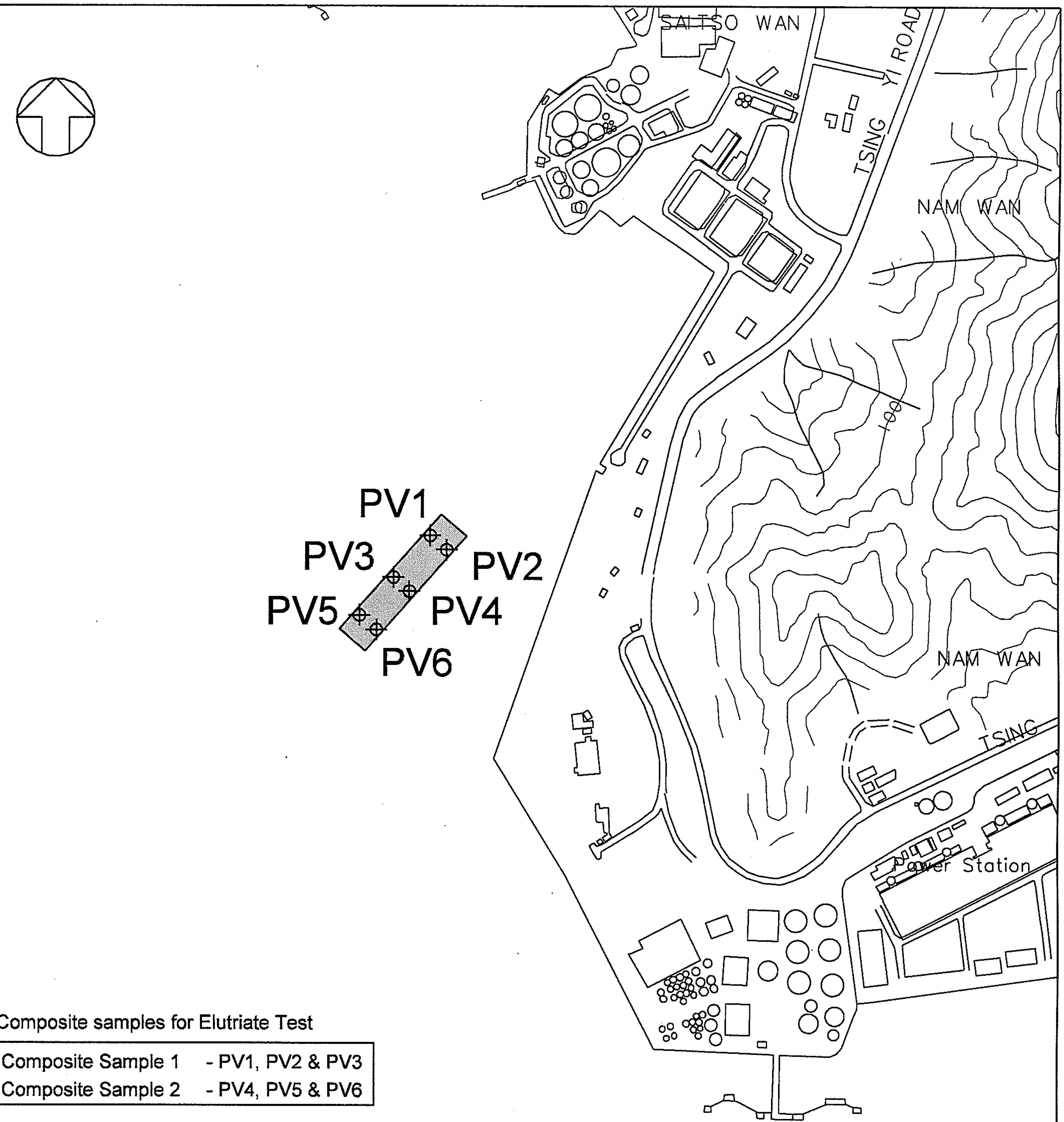


Composite samples for Elutriate Test

| | |
|---|---|
| Composite Sample 1 | - PV1, PV2 & PV3 |
| Composite Sample 2 | - PV4, PV5 & PV6 |

Sediment Sampling Locations for the Proposed Site

| | Easting | Northing |
|---|---|---|
| PV1 | 827127.90E | 821692.10N |
| PV2 | 827155.80E | 821668.10N |
| PV3 | 827065.60E | 821621.60N |
| PV4 | 827092.50E | 821597.90N |
| PV5 | 827008.10E | 821557.50N |
| PV6 | 827036.80E | 821533.20N |

LEGEND:

⌖ Sediment Samplint Point

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CONSULTANT: Hyder Consulting

CLIENT: 友聯船廠有限公司 Yiu Lian Dockyards Limited

DRAWING TITLE:

## Location of Yiu Lian Floating Dock No. 3

Sampling Locations at the Proposed Site

| | | | |
|---|---|---|---|
| DESIGNED | C. LEE | CHECKED | S. OR |
| DRAWN | T. KWAN | CHECKED | C. LEE |
| APPROVED | G.Y. LI | | |
| DATE | 14-10-2005 | | |
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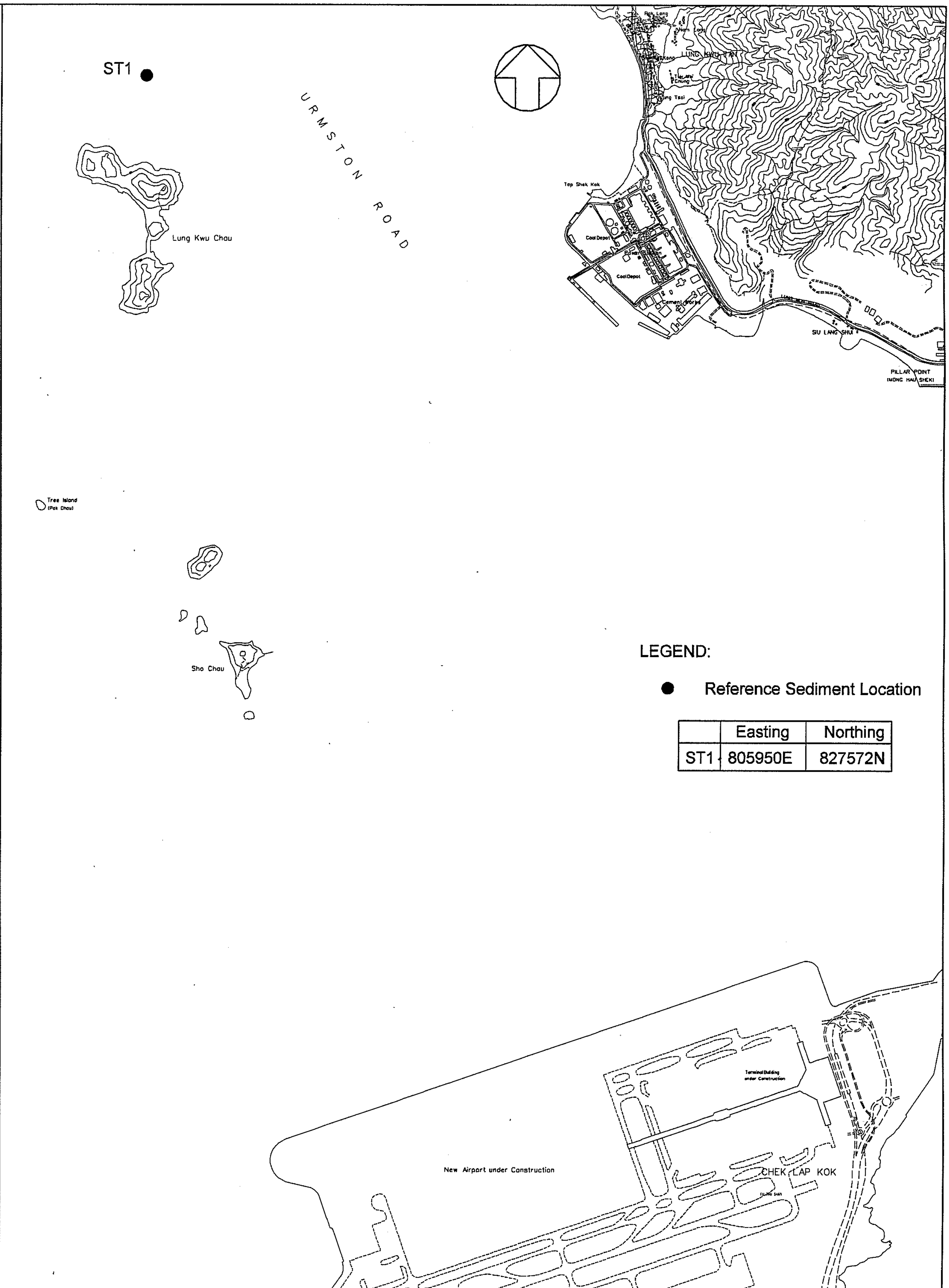


LEGEND:

● Reference Sediment Location

| | Easting | Northing |
|---|---|---|
| ST1 | 805950E | 827572N |

CONSULTANT

Hyder Consulting

CLIENT

友聯船廠有限公司
Yiu Lian Dockyards Limited

DRAWING TITLE

Location of Yiu Lian Floating Dock No. 3

Sampling Locations of Reference Sediment

| | | | |
|---|---|---|---|
| DESIGNED | C. LEE | CHECKED | S. OR |
| DRAWN | T. KWAN | CHECKED | C. LEE |
| APPROVED | G.Y. LI | © Copyright Reserved All dimensions are in mm unless shown otherwise. No measurement should be taken from drawing directly. | |
| DATE | 14-10-2005 | | |
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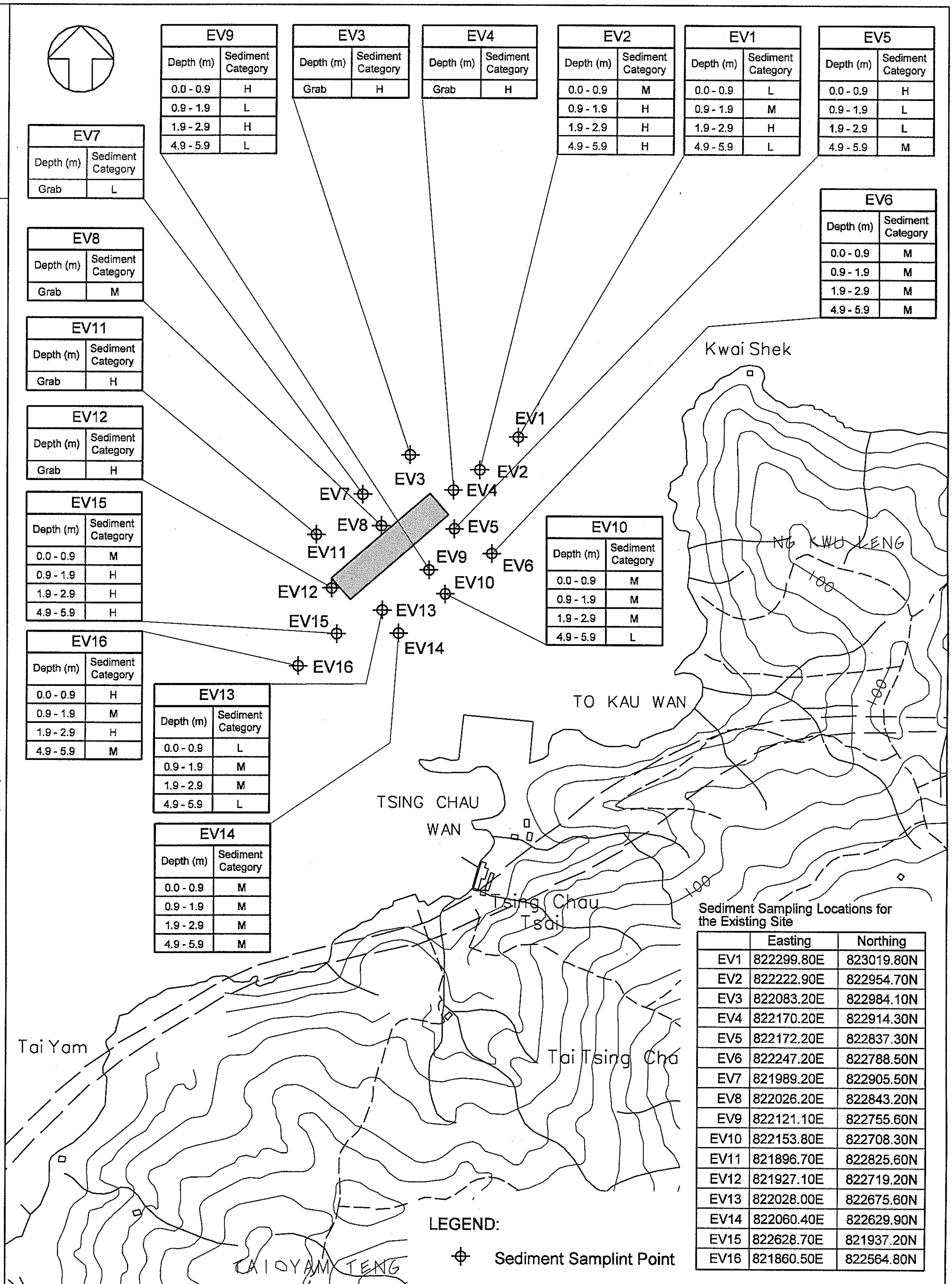


**EV9**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | H |
| 0.9 - 1.9 | L |
| 1.9 - 2.9 | H |
| 4.9 - 5.9 | L |

**EV3**

| Depth (m) | Sediment Category |
|---|---|
| Grab | H |

**EV4**

| Depth (m) | Sediment Category |
|---|---|
| Grab | H |

**EV2**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | H |
| 1.9 - 2.9 | H |
| 4.9 - 5.9 | H |

**EV1**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | L |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | H |
| 4.9 - 5.9 | L |

**EV5**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | H |
| 0.9 - 1.9 | L |
| 1.9 - 2.9 | L |
| 4.9 - 5.9 | M |

**EV7**

| Depth (m) | Sediment Category |
|---|---|
| Grab | L |

**EV6**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | M |
| 4.9 - 5.9 | M |

**EV8**

| Depth (m) | Sediment Category |
|---|---|
| Grab | M |

**EV11**

| Depth (m) | Sediment Category |
|---|---|
| Grab | H |

**EV12**

| Depth (m) | Sediment Category |
|---|---|
| Grab | H |

**EV15**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | H |
| 1.9 - 2.9 | H |
| 4.9 - 5.9 | H |

**EV10**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | M |
| 4.9 - 5.9 | L |

**EV16**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | H |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | H |
| 4.9 - 5.9 | M |

**EV13**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | L |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | M |
| 4.9 - 5.9 | L |

**EV14**

| Depth (m) | Sediment Category |
|---|---|
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | M |
| 4.9 - 5.9 | M |

Sediment Sampling Locations for the Existing Site

| | Easting | Northing |
|---|---|---|
| EV1 | 822299.80E | 823019.80N |
| EV2 | 822222.90E | 822954.70N |
| EV3 | 822083.20E | 822984.10N |
| EV4 | 822170.20E | 822914.30N |
| EV5 | 822172.20E | 822837.30N |
| EV6 | 822247.20E | 822788.50N |
| EV7 | 821989.20E | 822905.50N |
| EV8 | 822026.20E | 822843.20N |
| EV9 | 822121.10E | 822755.60N |
| EV10 | 822153.80E | 822708.30N |
| EV11 | 821896.70E | 822825.60N |
| EV12 | 821927.10E | 822719.20N |
| EV13 | 822028.00E | 822675.60N |
| EV14 | 822060.40E | 822629.90N |
| EV15 | 822628.70E | 821937.20N |
| EV16 | 821860.50E | 822564.80N |

LEGEND:

⌖ Sediment Samplint Point

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DRAWING TITLE:

Relocation of Yiu Lian Floating Dock No. 3

The Sediment Classification of the Collected Sediment Samples at the Existing Site

| | | | |
|---|---|---|---|
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| DRAWN | T. KWAN | CHECKED | T. NIP |
| APPROVED | G.Y. LI | | |
| DATE | 02-03-2006 | | |
| SCALE | 1 : 10000 | | |


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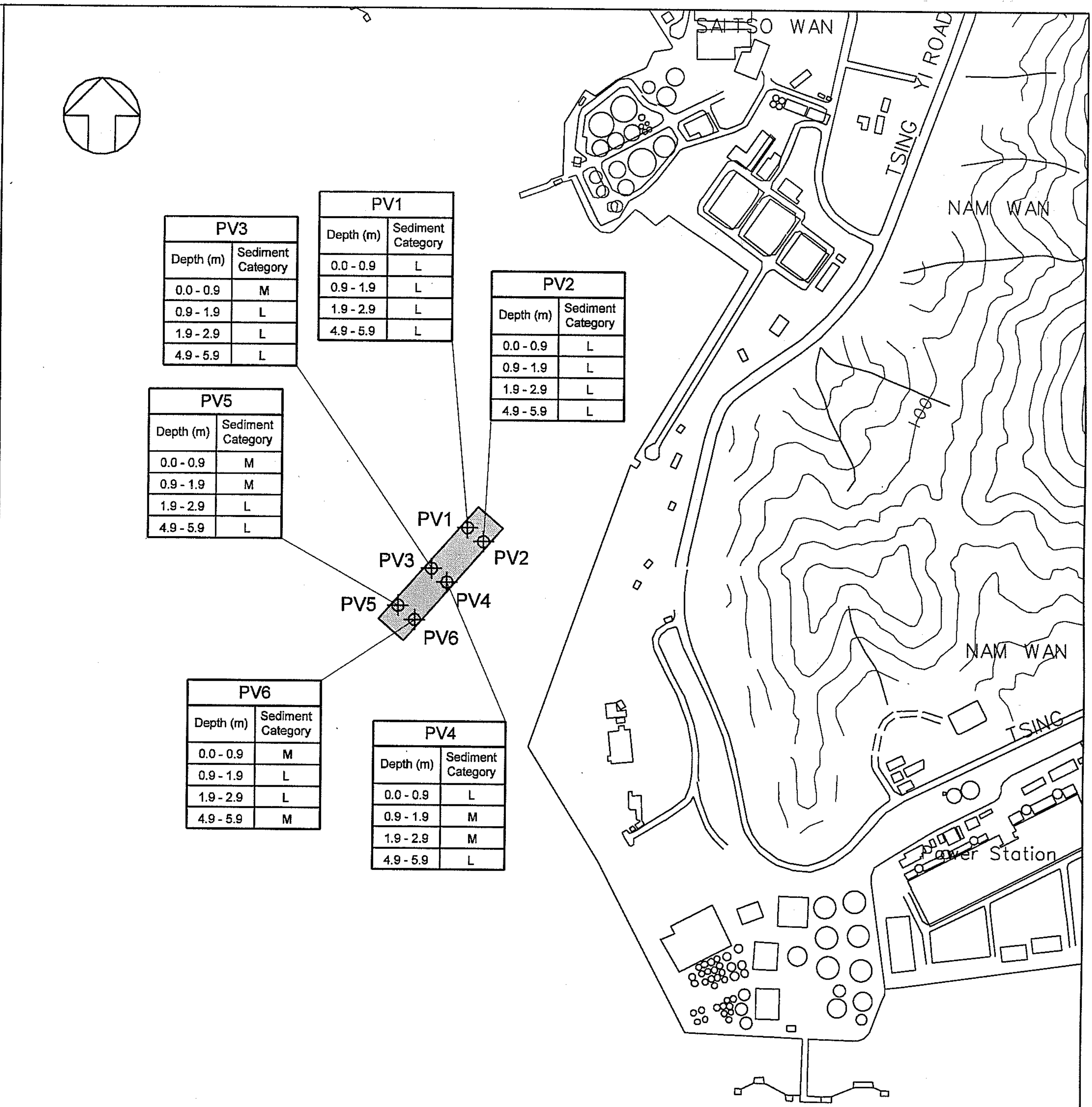
DRG. NO. Figure 3-13

REV. -




| PV1 | |
|---|---|
| Depth (m) | Sediment Category |
| 0.0 - 0.9 | L |
| 0.9 - 1.9 | L |
| 1.9 - 2.9 | L |
| 4.9 - 5.9 | L |

| PV2 | |
|---|---|
| Depth (m) | Sediment Category |
| 0.0 - 0.9 | L |
| 0.9 - 1.9 | L |
| 1.9 - 2.9 | L |
| 4.9 - 5.9 | L |

| PV3 | |
|---|---|
| Depth (m) | Sediment Category |
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | L |
| 1.9 - 2.9 | L |
| 4.9 - 5.9 | L |

| PV4 | |
|---|---|
| Depth (m) | Sediment Category |
| 0.0 - 0.9 | L |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | M |
| 4.9 - 5.9 | L |

| PV5 | |
|---|---|
| Depth (m) | Sediment Category |
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | M |
| 1.9 - 2.9 | L |
| 4.9 - 5.9 | L |

| PV6 | |
|---|---|
| Depth (m) | Sediment Category |
| 0.0 - 0.9 | M |
| 0.9 - 1.9 | L |
| 1.9 - 2.9 | L |
| 4.9 - 5.9 | M |

Sediment Sampling Locations for the Proposed Site

| | Easting | Northing |
|---|---|---|
| PV1 | 827127.90E | 821692.10N |
| PV2 | 827155.80E | 821668.10N |
| PV3 | 827065.60E | 821621.60N |
| PV4 | 827092.50E | 821597.90N |
| PV5 | 827008.10E | 821557.50N |
| PV6 | 827036.80E | 821533.20N |

LEGEND:

⊕ Sediment Samplint Point

CAD REF.

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CONSULTANT: Hyder Consulting

CLIENT: 友聯船廠有限公司 Yiu Lian Dockyards Limited

DRAWING TITLE

**Relocation of Yiu Lian Floating Dock No. 3**

**The Sediment Classification of the Collected Sediment Samples at the Proposed Site**

| | | | |
|---|---|---|---|
| DESIGNED | T. NIP | CHECKED | S. OR |
| DRAWN | T. KWAN | CHECKED | T. NIP |
| APPROVED | G.Y. LI | | |
| DATE | 02-03-2006 | | |
| SCALE | 1 : 10000 | | |
| DRG. NO. | Figure 3-14 | REV. | - |

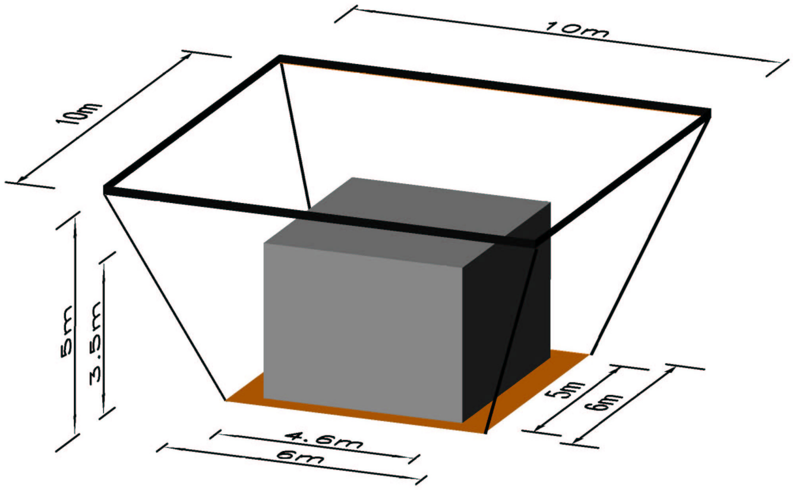
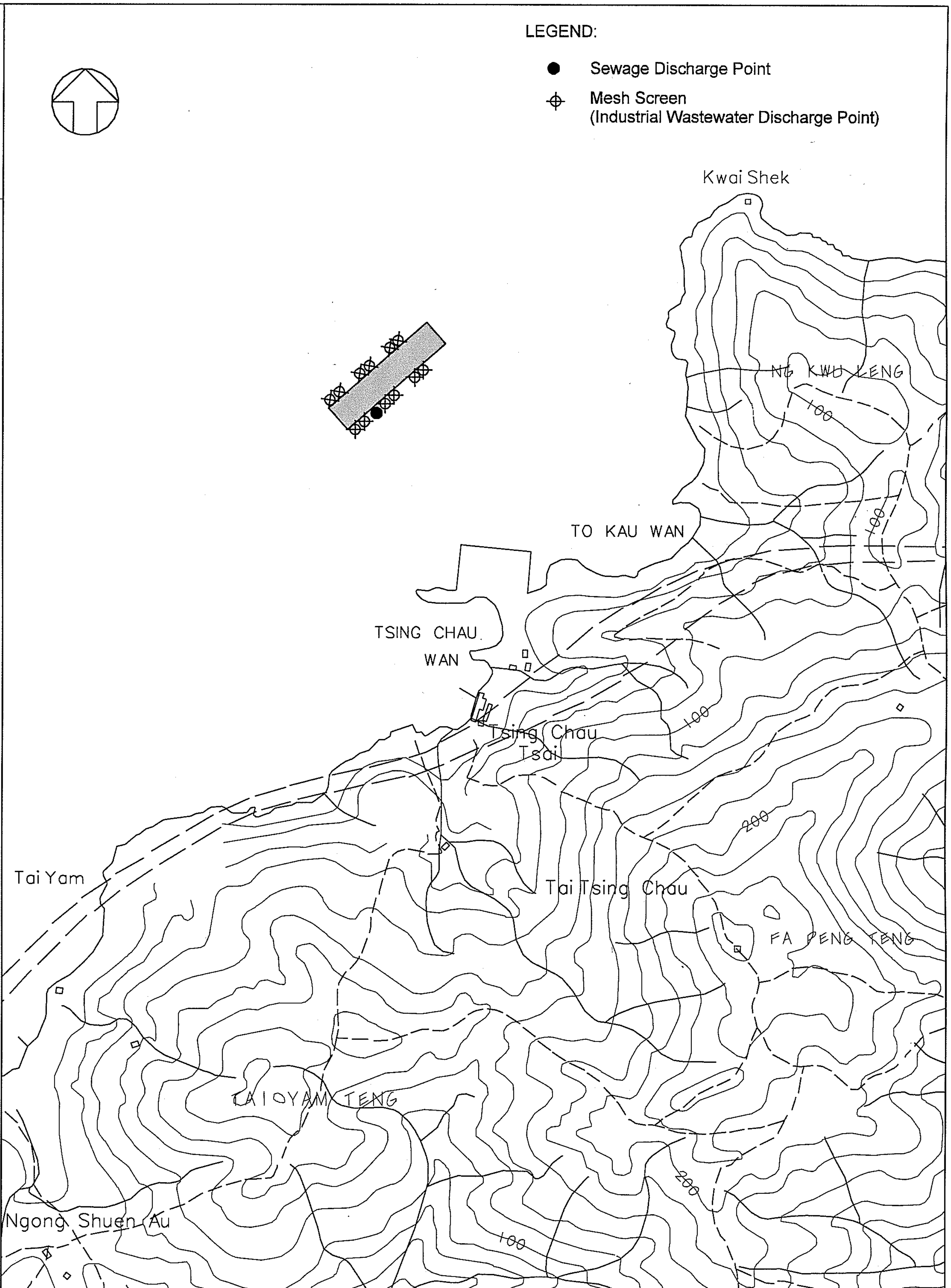



**Figure 3-15 The Pit and the Anchor Block**




| CONSULTANT | CLIENT | DRAWING TITLE | | | | |
|---|---|---|---|---|---|---|
| Hyder Consulting | 友聯船廠有限公司 Yiu Lian Dockyards Limited | Location of Yiu Lian Floating Dock No. 3<br>The Discharge Points of the Dock | DESIGNED | C. LEE | CHECKED | S. OR |
| | | | DRAWN | T. KWAN | CHECKED | C. LEE |
| | | | APPROVED | G.Y. LI | © Copyright Reserved. All dimensions are in mm unless shown otherwise. No measurement should be taken from drawing directly. | |
| | | | DATE | 14-10-2005 | | |
| | | | SCALE | 1 : 10000 | | |
| | | | DRG. NO. | Figure 3-16 | REV. | - |

CAD REF.

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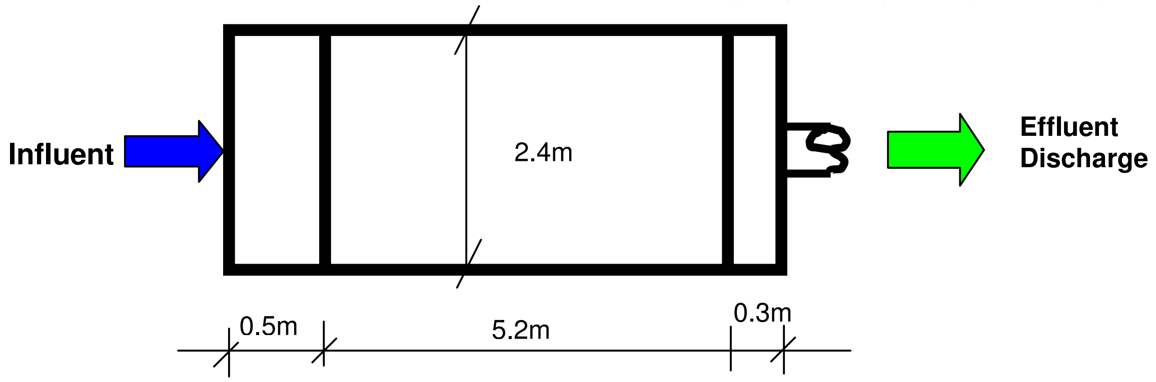
**Design Criteria:**

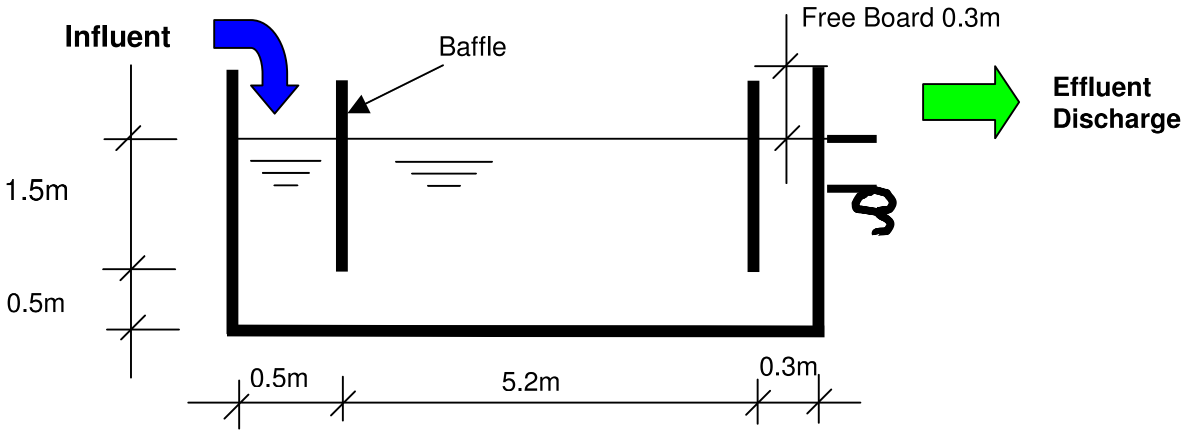
- Daily flow rate = 100$m^3$/day (8 hours operation)
- Average flow rate = 12.5$m^3$/hr
- Peak flow rate = 2 * Average flow rate = 25$m^3$/hr
- Equivalent hydraulic retention time = 2 hours at peak flow rate (by gravity sedimentation)
- Surface loading = 20$m^3$/$m^2$/d at peak flow rate
- Weir loading = 250$m^3$/m/d at peak flow

**Proposed Configuration**

- 3 pumps, connected in lead-lag mode and each of maximum flow rate of 8.33$m^3$/hr (peak flow of 25$m^3$/hr divided by 3 pumps), will be used to pump the wastewater to the 3 sedimentation tanks.
- The sedimentation tanks will be connected in parallel.
- The operation principle is to activate 1 pump first and the wastewater will be diverted to a designated (i.e. 1st) sedimentation tank. When the incoming wastewater flow is greater than the pump capacity, the 2nd pump will be activated. The same principle applies to the 3rd pump.
- A flow distributor will be installed at the inlet of the sedimentation tanks to ensure wastewater is evenly distributed to each sedimentation tank when the pumps are operating in lead-lag mode.




**Plan Layout of the Settling Tank** *(not in scale)*




**Cross-section of the Settling Tank** *(not in scale)*

**Figure 3-17 Schematic Design of the Settling Tank**

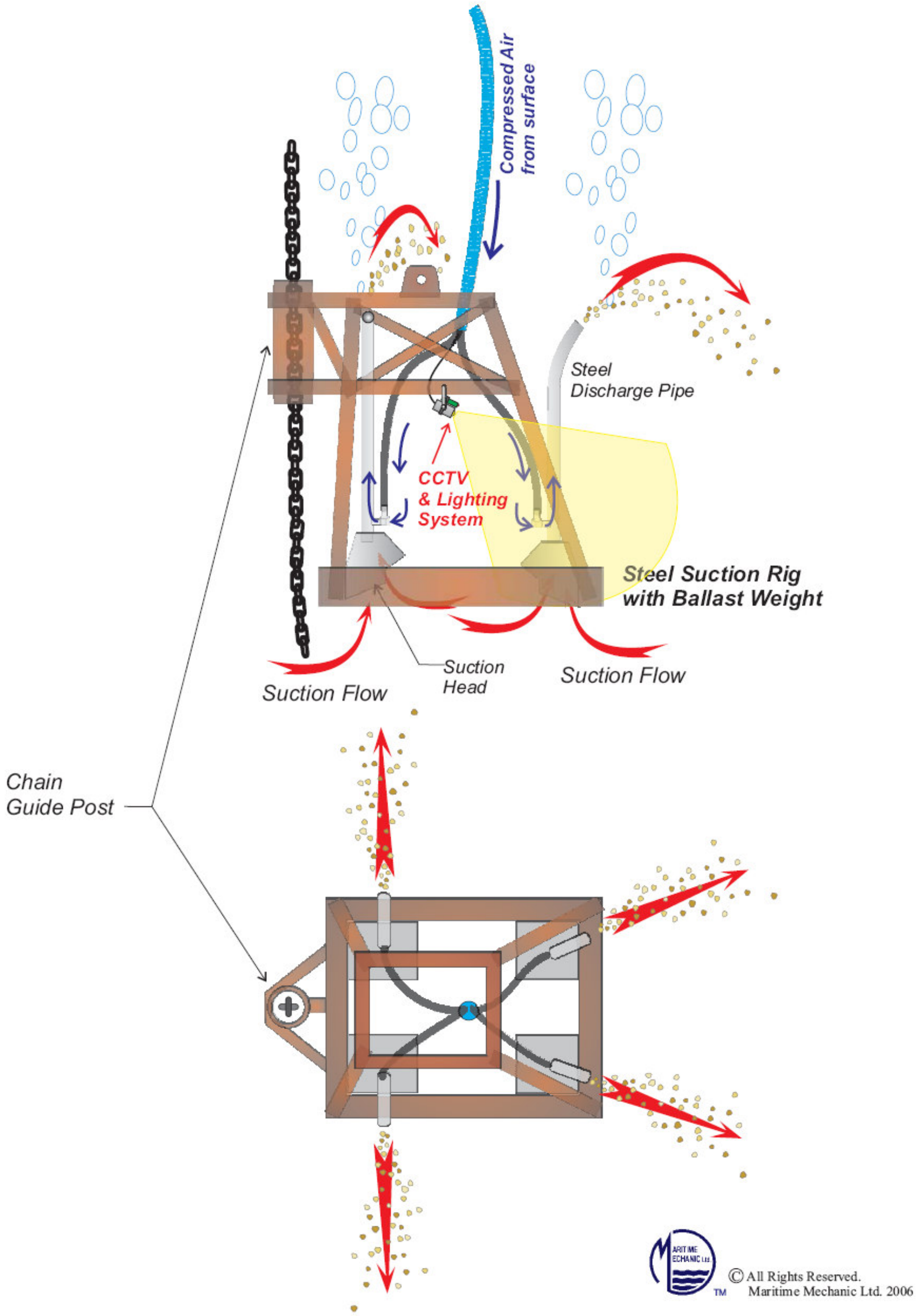



**Figure 3-18 The Design of Airlift Suction Dredge Rig**