Agreement No CE89/95
Supplementary Environmental Impact Assessment for Dredging of the Anchorage Area for Stonecutters Island Naval Base

Executive Summary

May 1996

Mott Connell Limited

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1. INTRODUCTION

E.1 The objectives of this Supplementary Environmental Impact Assessment (EIA) are summarised as follows:

(i) to define the nature and extent of the environmental impacts arising from the proposed dredging activities associated with the provision of an anchorage area for the Stonecutters' Naval Base;

(ii) to identify any unacceptable environmental impact associated with the implementation of the works; and

(iii) to recommend measures to minimise any adverse impacts to within established standards and guidelines.

E.2 The present Study supplements the findings of the Environmental Impact Assessment of the Stonecutters Island South Shore Naval Facilities (Agreement No. CAO B18) and focuses on the assessment of the impacts associated with the provision of two Class A and two Class B mooring buoys.

2. ENVIRONMENTAL SETTING

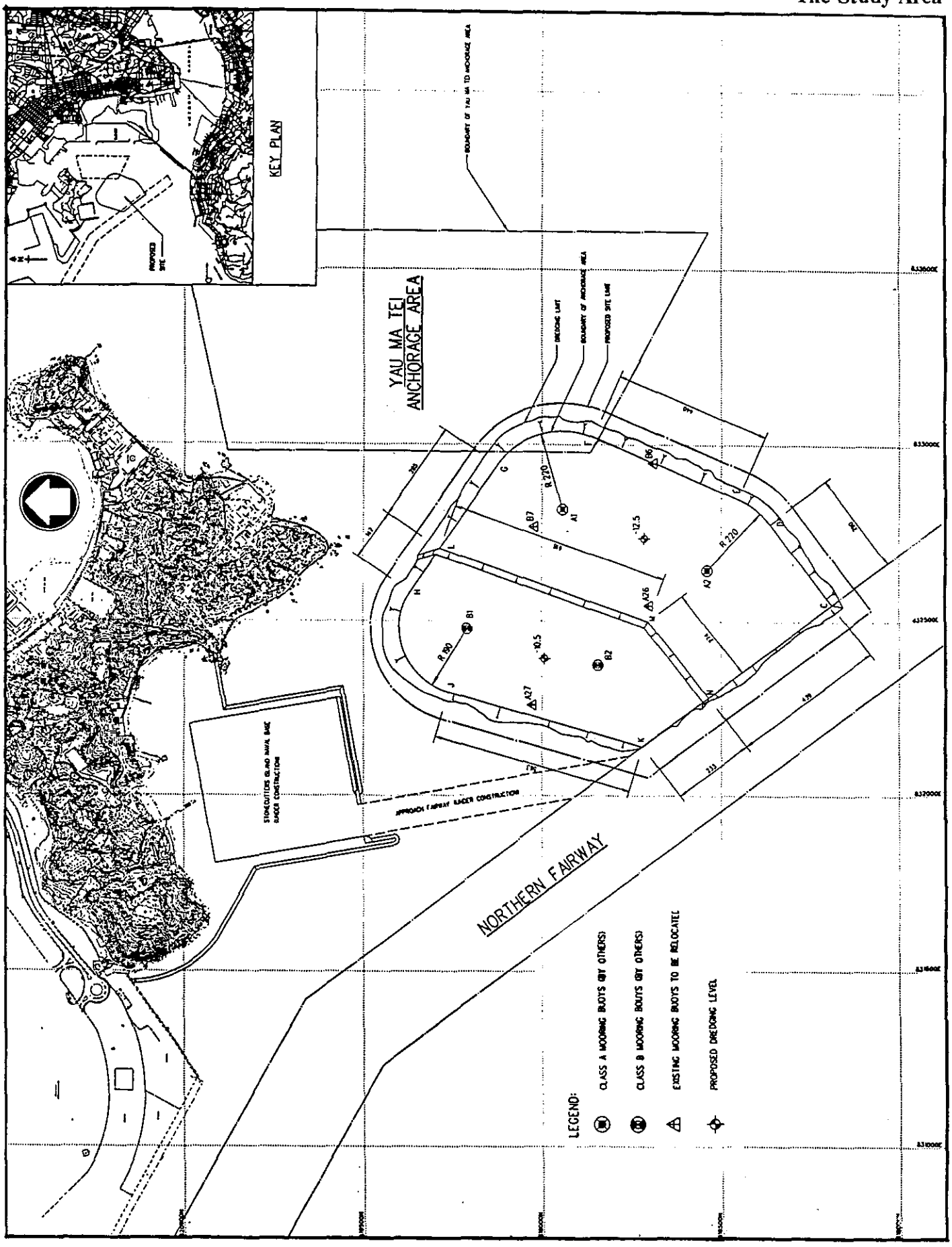
E.3 Stonecutters' Island is 77 hectares in area and located 2.1km west of the Kowloon Peninsula. To the north west and west is Container Terminal 8 (CT8) Development and to the north and north east is the West Kowloon Reclamation (WKR). In 1992 Stonecutters' Island was joined to the Kowloon peninsula by land reclamation associated with the CT8 and WKR projects.

E.4 In 1993, reclamation work started on the construction of a new Hong Kong Government Dockyard within the north basin already occupied by the HMS Tamar Naval Base. Construction of the buildings for the Dockyard started in January 1994 and was completed in 1995. Construction of Stonecutters' Naval Base and access channel located on the Southern Shore of Stonecutters Island as illustrated on Figure E.1 is currently being undertaken.

E.5 The vast majority of ships now calling at Hong Kong enter and leave the port via the Western Approaches (the East Lamma Channel) and those proceeding to and from the berths within harbour limits use the Northern Fairway. The Director of Marine has advised that while he has tentative plans to re-align parts of the Northern Fairway, these proposals would have little effect on the Stonecutters' Naval Base and its associated Anchorage Area.

E.6 On average, about 1,500 ocean-going vessels and China ferries arrive and depart from berths within harbour limits each month. On the basis that 5% of these vessels use the Sulphur Channel or the North Green Island Fairway (as advised by the Marine Department during the EIA for Stonecutters Island South Shore Naval Facilities) the average number of vessels using the Northern Fairway each month is 1,350 inward bound and 1,350 outward bound. This equates to 90 vessels per day (45 inward and 45 outward).

Figure E.1
The Study Area



E.7 On the basis of the foregoing it may surmised that the provision of the four new mooring buoys will not significantly contribute to overall vessel traffic in this area either during or following their construction.

Future Environment

E.8 External factors which will affect future conditions within the Study Area, include alterations to circulation rates or changes in sediment transport and deposition patterns as a consequence of major reclamation and dredging projects planned at various time horizons. Reclamations which could affect the local hydrodynamic regime in the longer term, include Container Terminal No. 9 and the Tsuen Wan Bay Further Reclamation which is scheduled to be developed around the year 2005. The existing boundary of the Yau Ma Tei Typhoon Shelter will need to be modified to accommodate the new anchorage area for Stonecutters Naval Base. Marine Department have advised that an amendment to the Schedule of the Shipping and Port Control Regulations, Cap 313 is in progress.

Assessment Criteria

E.9 For this Supplementary EIA, both the Water Quality Objectives for Victoria Harbour and the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM) (WPCO Cap 358 S.21) were adopted as the legislative criteria to be adhered to.

Sediment Transport and Deposition

E.10 The seasonal and diurnal variations in sediment transport and deposition in Hong Kong' western waters are well documented. Data collected under a Geotechnical Engineering Office programme confirmed the dominant effect of oceanic waters in preventing the ingress of suspended sediments from the Pearl River to Hong Kong's coastal waters on the flood tide. The same study confirmed that on the ebb tide, sediment deposition takes place in the Western Harbour. Deposition in this area is temporary as material is known to be reworked by wave and tidal action.

Water Quality Sensitive Receivers

E.11 Sensitive receivers within the area of influence are mainly confined to seawater/cooling water intakes during the construction period as illustrated on Figure E.2. "Beneficial Use 3 as a habitat for marine life and a resource for human exploitation" is also ascribed to the Victoria Harbour Water Control Zone and, as such, the protection of the marine waters is a basic tenet for the construction of the mooring buoys.

3. KEY ISSUES TO BE ADDRESSED

E.12 Construction works required to provide the new anchorage area for the four permanent mooring buoys include dredging to a depth of between -10.5 and -12.5mCD by removing an estimated 2.3Mm^3 of marine deposits. The quality of the material to be dredged will determine any constraints on the dredging methods adopted as well as the disposal of the spoil. Sediment quality and the potential release of pollutants to the receiving waters during dredging and disposal of the marine deposits were therefore key issues to be addressed through this Study.

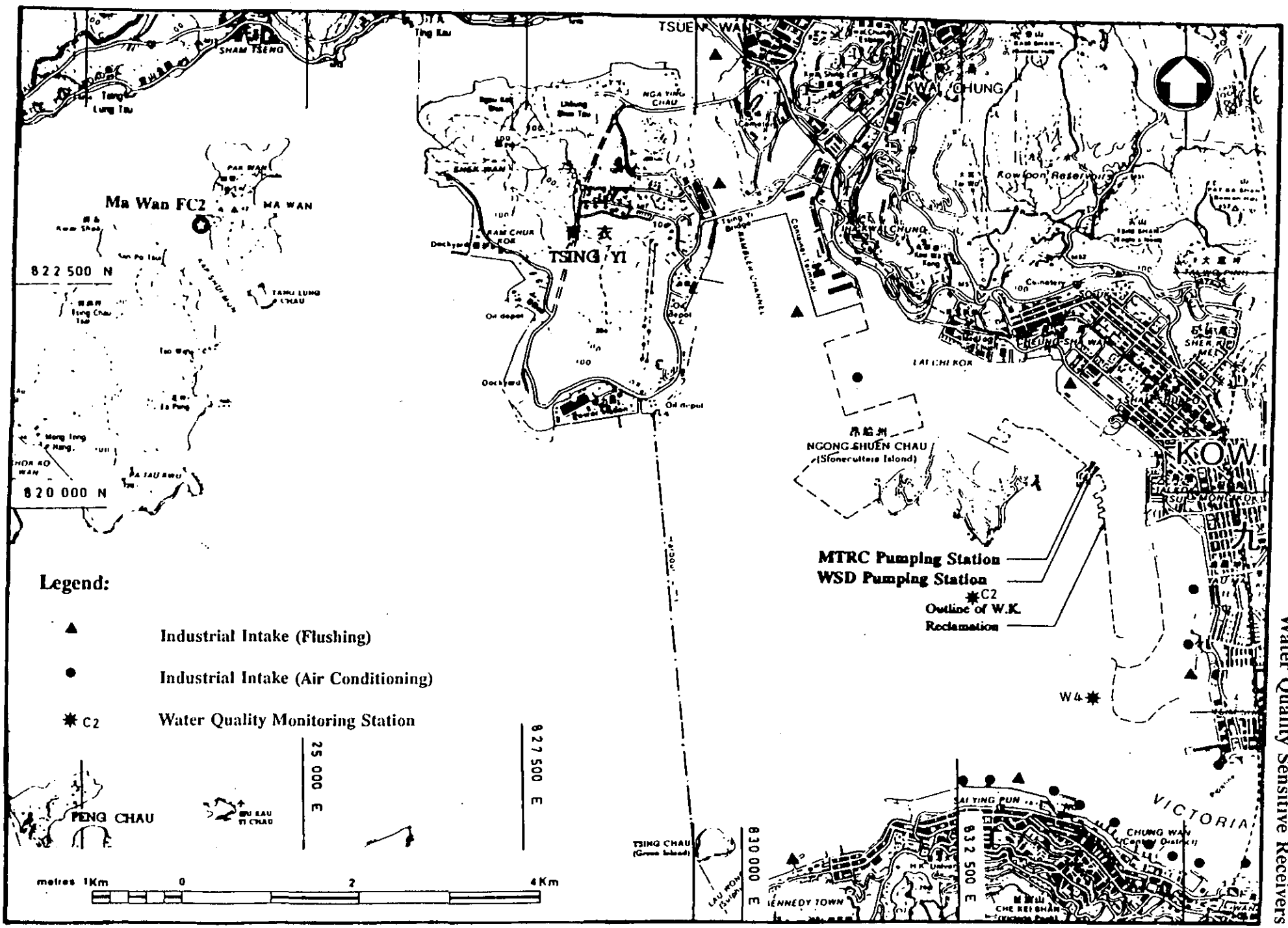


Figure E.2 Water Quality Sensitive Receivers

E.13 Once the anchorage area has been established the local tidal regime could be affected by changes in bathymetry which could in turn alter the existing sediment transport and deposition patterns both locally and further afield. The key issue to be addressed in connection with the post construction phase relates to the extent of any changes in the tidal and sedimentation regimes.

E.14 Key issues which were addressed through this assessment may be summarised as follows:

(i) the definition of the extent of the potential sediment contamination through a sediment quality study;

(ii) determination of the response of the marine environment to the potential release into the water column of trace metals and organic micropollutants from the material being dredged using the results of the sediment quality study, elutriate test results and sediment plume simulations; and

(iii) identification of the mitigation measures to minimise the impacts of dredging to within established standards and guidelines.

Sediment Plume Simulations

E.15 Once in suspension, fine sediment will be carried by the tidal currents and dispersed, possibly over a large area depending on tidal conditions. During transport by the tidal currents, the fine sediment will tend to flocculate forming larger particles which will settle under gravity on the seabed. The rate of settling for cohesive sediments will depend on the concentration and on the local tidal currents. Once the tidal currents become sufficiently weak, the sediment will settle to the seabed and begin to consolidate. If the tidal currents become large enough, the settled material will be eroded and put back into suspension for further transport by the tidal currents where the rate of erosion will depend on the tidal currents and the degree of consolidation which may have taken place. The WAHMO sediment plume model was thus designed to simulate these processes of transport, deposition and re-erosion for narrow sediment plumes formed during dredging or dumping activities and was adopted as the main assessment tool for this study.

Scenarios Simulated by the Sediment Plume Model

E.16 The sediment plume model SEDPLUME has been used to simulate two Scenarios for dredging of the Stonecutters Naval Base Anchorage Area:

(i) Scenario 1 simulated dredging of the anchorage area with trailing suction dredgers; and

(ii) Scenario 2 simulated dredging of the anchorage area with grab dredgers.

Scenarios Simulated by the Sediment Transport Model

E.17 The sediment transport model was used to simulate baseline and completed scenarios for the dredging of the anchorage area for both spring and neap tides during the wet and dry seasons.

4. CONSTRUCTION PHASE

E.18 Reference criteria for this Project were primarily the WQO's defined under the Water Pollution Control Ordinance, however as one of the beneficial uses for this Water Control Zone is protection of marine life specific reference was also made to guidelines and standards applied by, inter alia, the USEPA and Environment Canada. Reference was made to the National Ocean Services Technical Memorandum which provided details of the biological effects of sediment sorbed sediments, testing procedures and the apparent effects threshold values for metal, organic and inorganic pollutants. The latter are referred to the lower end of the range of concentrations at which biological effects have been observed in a wide range of organisms (ER-L) as shown in Table E1.

Table E.1 Reference Criteria and Guidelines for the Protection of Marine Life and Water Quality

Parameter	Guidelines for Protection of Marine Life and Californian Water Quality Standard (WQS)	Comments
pH	> 6.5 < 8.5	existing conditions acceptable in terms of the overall WQO's and the protection of marine life
Cd	marine life : 0.005 mg/l (USEPA)	well documented evidence to suggest tolerance of marine organisms to Cd is higher than freshwater organisms. Cd chemistry particularly affected by brackish conditions (dredging in the dry season so well mixed water column will prevail). Acute and chronic thresholds for marine organisms documented as being 96 and 31 ppm respectively. Wide range of apparent effects thresholds. ER-L in sediments is 5ppm.
Pb	marine life : 0.050 mg/l (USEPA)	Lethal concentration of Pb 0.1ppm with effects increasing in presence of Ni and Zn. Organolead compounds more toxic than inorganic forms. ER-L 35ppm in sediments.
Hg	marine life : 0.10 ug/l (USEPA)	Acute toxicity to marine organisms >3.5ppm, organomercury considerably more toxic than inorganic forms. ER-L of 0.15ppm
Cr	marine life : 0.100mg/l (USEPA)	Toxicity of Cr affected greatly by speciation. Acute toxicity to marine life of Cr (VI) occurs in the range of 2,000 to 105,000ppm. Acute toxicity to Cr (III) observed at concentrations of 10,300 to 31,500 ppm (USEPA). No overall apparent effects threshold able to be defined as the data are wide ranging. ER-L of 80 ppm.
Cu	marine life : 0.050mg/l (USEPA)	Effects on marine life observed between 5 and 600 ppm. Effect on Crassostrea gigas found to be of the order of 400 ppm. ER-L of 70 ppm

Table E.1 Reference Criteria and Guidelines for the Protection of Marine Life and Water Quality (Cont'd)

Parameter	Guidelines for Protection of Marine Life and Californian Water Quality Standard (WQS)	Comments
Ni	marine life : 0.100mg/l (USEPA)	Toxicity influenced by hardness and salinity. Toxic to marine organisms at concentrations as low as 38 ppm (LC50 for 96 hours for estuarine fish species). No apparent effect threshold on the basis of the data available. ER-L of 30 ppm.
Zn	marine life : 0.100 mg/l (USEPA)	Data suggest sublethal effects 50 - 125 ppm and almost always acute effects observed at >260 ppm. LC_{50} for estuarine fish reported to range from 192 to 320,000 ppm. ER-L of 120ppm.
Amm-N	marine life : 0.400 mg/l (unionised as NH_3) (USEPA)	
DDT	marine life : 0.001ppm as 24 hour average with no exceedance of 0.13ppm (USEPA)	Acute toxicity of DDE in saltwater at 14ppm. ER-L of DDT 1ppb ER-L of DDE 2ppb ER-L total DDT 3 ppb
Tributyl Tin	marine life : adverse impacts on gastropods and molluscs but levels for protection of marine life not included in the specification obtained.	no conclusions drawn on tin or TBT from the data collected in the research programme.
PCB's	marine life : <0.001ug/l (USEPA)	Acute toxicity of PCB's in saltwater >10ppm although oyster larvae affected at 400ppb. ER-L of 50ppb

E.19 A summary of the data obtained from the laboratory testing are given in Table E.2.

Table E.2 Contribution of Pollutants from Sediments to the Water Column

Parameters	Elutriate I - Seawater	Elutriate II - Seawater	Elutriate III - Seawater	Average Concentration of Additional Load
Range of pH value	7.6 - 7.9	7.7 - 7.8	7.9 - 8.0	7.6 - 8.0
Redox potential, mV at 25°C in elutriate	-72 to -61	-64 to -56	-60 to -63	-
Total organic carbon content, mg C/L	<1	<1	<1	<1
Copper content, μg/L	1	0.5	0.5	0.7
Nickel content, μg/L	2.5	24	8.5	11.7
Zinc content mg/L	<0.05	<0.05	<0.05	<0.05
Lead content, μg/L	1.5	n.d.	n.d	1.5
Cadmium content, μg/L	0.5	0.1	0.2	0.3
Chromium content, μg/L	3	1.5	7	3.8
Mercury content, μg/L	<1	<1	<1	<1
Ammoniacal nitrogen content, mg N/L	7.15	1.38	7.82	5.45
Organic nitrogen content, mg N/L	6.69	0.92	7.35	5.0
Total inorganic nitrogen content, mg N/L	3.55	0.20	2.05	1.9

n.d. seawater concentration below detection level therefore not able to determine the actual extent of the release.

E.20 Comparing the results with the reference criteria given in Table E.1 it may be surmised that the release of contaminants from the sediments (even using trailing suction dredgers) would not cause the criteria for protection of marine life to be exceeded, nor would the cumulative load (i.e. seawater plus pollutant released from sediment) exceed the stated criteria. It should be however noted in the case of mercury, and PCB's the detection limit is higher than the standard given. It is also worthy of note that despite the extensive studies conducted by and on behalf of USEPA, there were no conclusions drawn on toxic effects (thresholds or lethal doses) for TBT.

E.21 The percentage release of contaminants from the bound form to the aqueous phase has been calculated and is $\leq$ 0.1% for all the metals and organic pollutants tested.

Disposal of Spoil

E.22 In order to assess the likelihood of heavy metal contamination in the area of proposed dredging for the Stonecutters Island Naval Base a suite of sampling and testing of the in situ marine sediments was carried out. On the basis of the results of the sediment quality study and the interpretation of all the survey and vibrocore level data, it was estimated that approximately 2.3Mm^3 (in situ volume) of soft marine clay will need to be removed by dredging. Of this volume approximately 1.5Mm^3 is classified as "contaminated". Thus, using a bulking factor of 1.3 for the dredged material, the volumes of contaminated and uncontaminated mud to be disposed of become 1.82Mm^3 and 1.17Mm^3 respectively.

Impacts on Marine Traffic

E.23 Depending on the construction programme adopted up to 4 barges and 3 tugs may be required to dispose of the marine deposits on a daily basis. In their letter of 29 February 1996 (Ref (53) in PA/S 909/2/87) Marine Department have advised that:

(i) the Contractor will need to apply for the promulgation of an "Notice to Mariners" from MD before any marine work is carried out.

(ii) all working craft are required to remain within the work site during the dredging operation;

(iii) all dredgers and barges should proceed along the appropriate fairways while leaving/entering the work site;

(iv) all working craft involved in the project work should not await in the adjacent Yau Ma Tei Anchorage; and

(v) passage through western harbour should be specified.

5. POST CONSTRUCTION IMPACT ASSESSMENT

E.24 The change in bathymetry in the anchorage area once dredging has been completed may alter the existing sediment deposition and erosion rates. Recourse has been made to mathematical models of the WAHMO suite to determine the need and extent of any maintenance dredging requirements. The modelling work comprised the following main elements:

(i) tidal flow modelling determined the effects of the dredged anchorage area on the local tidal flow regime, and

(ii) sediment transport modelling of the natural, or background, sediment regime simulated any effects of the anchorage area on sediment flows and deposition and determined possible rates of sedimentation within the anchorage area.

Scenarios Simulated in the Tidal Flow Modelling

E.25 Two layouts for the flow model simulations have been considered, the baseline and completed scenarios. The baseline scenario simulated conditions which will occur immediately prior to the construction of the anchorage area. This scenario included reclamations for Container Terminal 8, West Kowloon, Central Phase I and II, Hong Kong Convention and Exhibition Centre, Stonecutters Site for Mid-Stream Operations and the Stonecutters Naval Base breakwaters and also included dredging for the access to Container Terminal 8, the access channel to the naval base and the naval per se. The completed scenario then included the dredged anchorage area. Each of the scenarios have been modelled for the wet and dry season spring and neap tides.

E.26 Comparing of the results from the tidal flow simulations for the baseline and completed cases, it is apparent that the dredging for the anchorage area has no discernable difference on tidal flows in the region around the anchorage area. The only noticeable difference is that the anchorage area, having been dredged, is represented by two layer in the flow model for the Completed Scenario but current speeds in the new lower layer are very low showing that total flows through the anchorage area do not change significantly.

Sediment Transport

E.27 Sediment transport and deposition rates were estimated using the MUDFLOW model. The predictions of annual siltation rates show that once the anchorage area has been dredged, up to 4cm/year of mud will be deposited to the west and up to 2cm/year will be deposited to the eastern side of the anchorage area.

6. MITIGATION MEASURES

E.28 Specific measures to reduce the impacts of dredging on the marine environment include:

- reduction of sediment losses through application of low impact dredging methods. Sediment losses estimated herein could be reduced by about 80% through employment of trailing suction dredgers, and grab dredgers could reduce the impact by approximately 50%. If closed grabs are used the high vertical accuracy which can be attained will further reduce the sediment losses. Turbidity generation may still be high during closing and hoisting due to improper closing or debris/silt sticking to the sides of the grab.

- by controlling the dredging (and production) rates the impacts on the water column can be reduced. For trailing suction dredgers production rates should be controlled at 20,000m^3/day, and for grab dredgers this should be 12,800m^3 per day on the basis of the foregoing assessments;

E.29 Once constructed the anchorage area may require infrequent maintenance dredging, to maintain the required 0.5m clearance. On the basis of the modelling results this would be once every ten, or so years.

7. CONCLUSIONS

On the basis of the foregoing assessment, the following conclusions have been drawn:

(i) the water quality objectives for dissolved oxygen, ammonia, and nutrients can be achieved regardless of the dredging scenario considered;

(ii) the water quality objectives for suspended solids will be exceeded unless mitigation measures are applied as shown below:

	Contaminated Deposit	**Uncontaminated Deposit**
Total Volume	**1.8Mm^3**	**1.2Mm^3**
Mitigation Measures Proposed		
(a) Grab dredger	• closed grabs must be used for contaminated spoil • control production rate of 12,800m^3/day • low impact dredging can reduce sediment losses by 50% compared to unmitigated scenario • closed grabs further reduce sediment losses • ensuring proper closing and hoisting of grab will further reduce impacts • controlling dredging rates • sediment release rates no greater than 1.2kg/s	• control production rate of 12,800m^3/day • low impact dredging can reduce sediment losses by 50% compared to unmitigated scenario • closed grabs further reduce sediment losses • ensuring proper closing and hoisting of grab will further reduce impacts • controlling dredging rates • sediment release rates no greater than 1.2kg/s
(b) Trailing Suction Dredger	N/A	• controlling dredging rates to <20,000m^3/day • controlling sediment losses to 1% of dredging rate • use of trailing suction dredgers only during dry season • use of trailing suction dredgers only on slack or flooding tide • sediment release rates no greater than 1.2kg/s
Disposal Location	East Sha Chau Contaminated Mud Pits	East Ninepins or South Cheung Chau
Residual Impact	No residual impact outwith anchorage area	No residual impact outwith anchorage area

(iii) heavy metal and other organic pollutant releases from the solid to aqueous phase will be less than 0.1% of the source material in the sediment and will comply with all the Guidelines proposed for the protection of marine life as shown below:

Parameter	**Guidelines for Protection of Marine Life**	**Average Concentration of Pollutant Released to Water Column During Dredging**
pH	> 6.5 < 8.5	7.6 - 8.0
Cd	marine life : 0.005 mg/l (USEPA)	0.3 μg/l
Pb	marine life : 0.050 mg/l (USEPA)	1.5 μg/l
Hg	marine life: 0.10 μg/l (USEPA)	< 1 μg/l
Cr	marine life : 0.100mg/l (USEPA)	3.8 μg/l
Cu	marine life : 0.050mg/l (USEPA)	0.7 μg/l
Ni	marine life : 0.100mg/l (USEPA)	11.7 μg/l
Zn	marine life : 0.100 mg/l (USEPA)	<0.05 mg/l
Amm-N	marine life : 0.400 mg/l (unionised as NH_3) (USEPA)	5.45 mgN/l
DDT	marine life : 0.001ppm as 24 hour average with no exceedance of 0.13ppm (USEPA)	1 μg/l
Tributyl Tin	marine life : adverse impacts on gastropods and molluscs but levels for protection of marine life not included in the specification obtained.	10 μg/l
PCB's	marine life : <0.001ug/l (USEPA)	1 μg/l

(iv) no other sensitive receivers (seawater intakes) will be adversely affected either during or following construction;

(v) an estimated 1.8Mm^3 of material to be dredged is contaminated, and will be disposed of at the East Sha Chau Contaminated Mud Pits. This material will be need to be dredged using a closed end grab dredger in accordance with the requirements of the Fill Management Committee and the Environmental Protection Department;

(vi) an estimated 1.2Mm^3 of material has been defined, through the sediment quality study, as being uncontaminated and will be disposed of at either East Ninepins or South Cheung Chau according to the requirements of the Fill Management Committee and the Environmental Protection Department; and

(viii) siltation rates to the west and east of the anchorage area are forecast to be 2cm and 4cm/year respectively. This means that maintenance dredging will on average be required every ten, or so, years to maintain the required clearance.

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Our Ref: RMB/AWZ/JW/lh/T448/00.01

2 August 1996

Civil Engineering Department
Port Works Division
5/F Civil Engineering Building
101 Princess Margaret Road
Homantin
Kowloon

Attn: Mr. Norman Ng Kwok-cheung

Dear Sirs

Agreement No. CE 89/95
Supplementary Environmental Impact Assessment
for Dredging of Anchorage Area for
Stonecutters Island Naval Base

We refer to your fax of 5 July, (6) in PWO CE 89/95 P6.4 and subsequent telephone conversations (Ng/Watker-Zeris) (Ng/Bradley). Attached please find 20 copies of the approved modified pages of text as an Addendum to the Executive Summary. These changes will also be issued to the attached list.

Yours faithfully
for MOTT CONNELL LTD.

Joanna Whiteford

Joanna Whiteford

Encl

c.c. EPD - Atn: Mr. Ho Man-Wu (6 copies)
Regional Council, Chief Librarian (3 copies)
Urban Council, Chief Librarian (3 copies)
Sham Shui Po District Office, District Officer (1 copy)
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5. POST CONSTRUCTION IMPACT ASSESSMENT

E.22 The change in bathymetry in the anchorage area once dredging has been completed may alter the existing sediment deposition and erosion rates. Recourse has been made to mathematical models of the WAHMO suite to determine the need and extent of any maintenance dredging requirements. Modelling work comprised the following main elements:

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E.24 Comparing the results from the tidal flow simulations for the baseline and completed cases, it is apparent that the dredging for the anchorage area has no discernable difference on tidal flows in the region around the anchorage area. The only noticeable difference is that the anchorage area, having been dredged, is represented by two layers in the flow model for the Completed Scenario. Current speeds in the new lower layer are very low showing that total flows through the anchorage area will not change significantly.

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- by controlling the dredging (and production) rates the impacts on the water column can be reduced. For trailing suction dredgers production rates should be controlled at 20,000m^3/day, and for grab dredgers this should be 12,800m^3 per day on the basis of the foregoing assessments;

E.27 Once constructed the anchorage area may require infrequent maintenance dredging, to maintain the required 0.5m clearance. On the basis of the modelling results this would be once every ten, or so years.

7. CONCLUSIONS

E.28 On the basis of the foregoing assessment the following conclusions have been drawn:

(i) the water quality objectives for dissolved oxygen, ammonia, and nutrients can be achieved regardless of the dredging scenario considered;

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(iv) no other sensitive receivers (seawater intakes) will be adversely affected either during or following construction;

(v) an estimated 1.8Mm^3 of material to be dredged is contaminated, and will be disposed of at the East Sha Chau Contaminated Mud Pits. This material will be need to be dredged using a closed end grab dredger in accordance with the requirements of the Fill Management Committee and the Environmental Protection Department;

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