Zen Pacific-Dredging
International Joint Venture

Executive Summary
報告摘要

River Trade Terminal at Tuen Mun Area 38 Supplementary EIA for Sand Extraction from the Brothers' Marine Borrow Area
補充環境評估內河碼頭建議採石沙區-大小磨刀島（內河碼頭）

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January 1998

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1. INTRODUCTION

Zen Pacific- Dredging International Joint Venture are seeking to utilise the sand reserves which lie within the gazetted marine borrow area adjacent to The Brothers' islands. The sand will be used for reclamation works in the construction of the River Trade Terminal (RTT) at Tuen Mun, adjacent to Area 38. The EIA determined the nature and extent of environmental impacts arising from sand borrowing and all related activities taking place concurrently around The Brothers.

1.1 THE NEED FOR THE DEVELOPMENT

The Tuen Mun RTT is strategically located in the mouth of the Pearl River Delta and is intended to act as a port of entry for small river vessels. The RTT is designed to maximise the capacity of the Hong Kong Harbour and discourage utilisation of the Ma Wan Channel by large numbers of small vessels thus reducing the risk of marine traffic accidents in the Ma Wan Fairway.

Sand for the reclamation is currently being imported from Mainland China to the site by trailer suction hopper dredger (TSHD) and Pelican barge. Zen-Pacific - Dredging International JV have identified the Brothers MBA as being a locally exploitable sand reserve from which supplies will be more reliable than those from the Mainland to meet the construction programme of the project. The Brothers MBA is the closest sand reserve to the RTT site and is therefore the most viable of the Hong Kong sand reserves for the given volumes of sand. Use of this sand reserve will also reduce the distance over which material needs to be transported thus minimising marine traffic impacts.

2. DREDGING PLAN

Zen Pacific - Dredging International JV intend to transport a maximum of 3.5 million m^3 of sand from an extension of the western pit previously used by the Airport Authority which is within the gazetted Marine Borrow Area to the RTT site. Figure 1 shows the location of the western extension and the authorised borrow area in the vicinity of The Brothers. The dredging operation would be largely confined to the main tidal channel and is to be undertaken using a split-hull TSHD of 5,000 m^3 hopper capacity equipped with twin suction pipes and inboard pumps and capable of dredging to -40mPD.

The sand will be transported to the RTT at Tuen Mun where it will be discharged into the reclamation area by pumping ashore. For every $1Mm^3$ of sand removed it will be necessary to remove approximately $0.7Mm^3$ of overburden. Overburden will be placed in the existing exhausted western pit by bottom dumping. It is intended that work will proceed on a 24-hour basis with an average weekly production of 150,000 to 200,000 m^3.

Mobilisation of equipment will commence in February 1998 and dredging is expected to commence in early March 1998 and will continue until the end of May 1998.

3. KEY ISSUES

During the winning of sand, the overflow process during sand dredging will cause sediment release to the marine environment. During the overflow period much of the fine clay and silt material present in the sand is washed overboard. However, when dredging the muddy materials such as the overburden, these overflow systems are prohibited in Hong Kong. The key environmental issues related to the works result from this release of fine particles into the marine environment. The works are therefore likely to generate a plume of suspended solids which has the potential to affect water quality, ecology and fisheries.

As the overburden in this area is not contaminated, release of contaminants is not an issue of concern for this project. Associated with the release of suspended solids is the impact on nutrients and dissolved oxygen. The sediment has the potential to use up dissolved oxygen in the water column. The sediment may also contain nutrients such as nitrogen which may be released as a result of the works. These potential impacts were assessed and quantified and found to meet the water quality assessment criteria which were derived from the Water Quality Objectives set under the Water Pollution Control Ordinance. The assessment indicated that at all times the works would not affect the water quality assessment criteria (WQACs) for these parameters.

The potential for releases of sediment in the water column to affect the seabed and benthos due to the process of sedimentation was also assessed. Levels of deposition were predicted to be low, approximately 0.5kg/sq m due to the nature of the material before it has time to consolidate. Sedimentation was found to be well within the natural range estimated for these waters.

The key issue is therefore the physical impact of suspended solids in the water column and the physical effects of dredging on the ecology.

4. EIA METHODOLOGY

The impact of the sediment plumes were simulated using the TELEMAC-3D hydrodynamic model of Hong Kong waters, coupled with a sediment plume model (SEDPLUME-RW3D).

Two tidal conditions were simulated for each scenario for the proposed dredging period:

- Dry season spring tide (diurnal tide); and
- Dry season neap tide (semi-diurnal tide).

This assessment is based on four core scenarios which have been modelled to investigate the potential effects of the proposed works:

- Scenario 1 - dredging and disposal of overburden;
- Scenario 2 - dredging of marine sand;
- Scenario 3 - dredging of alluvial sand;
- Scenario 4 - dredging of mixed loads of marine and alluvial sand

Sensitive receivers (SRs) were identified at the outset of the study and were included in the model so that impacts at these specific locations could be quantified. These are shown on Figure 1 and were:

- Gazetted beaches along the coastline extending from Tuen Mun to Tsuen Wan. There are currently six gazetted beaches along the Tuen Mun coastline and 8 within the Tsuen Wan District (including Ma Wan).
- Sea water intakes, for example for the China Light and Power (CLP) Power Station and WSD intakes located at Tsuen Wan, Tuen Mun and Tsing Yi.
- Fisheries and Fish Culture Zones (FCZ) e.g. Ma Wan FCZ, Kau Yi Chau Fishery and capture fisheries in the waters around the Brothers;
- Ecology, particularly the Chinese White Dolphin which is frequently found in the western waters of Hong Kong; fish; and conservation areas including Sites of Special Scientific Interest and the Sha Chau and Lung Kwu Chau Marine Park, which was designated in 1996 to conserve the area around the islands favoured by the dolphins.

Model output was generated to assess impacts using the Water Quality Assessment Criteria (WQAC) set for this study; impacts of suspended solids at the sensitive receivers across a tidal cycle; impacts of deposition; nutrient increases (in the form of inorganic nitrogen) and impacts on dissolved oxygen. The model produces conservative results as it assumes all of the material released into the water column enters at the surface rather than at the seabed. The model also does not allow for a density current that will occur resulting in the majority of the overflow material rapidly descending to the sea floor leaving less than 30% in suspension in the dredging plume.

5. EIA FINDINGS

The proposal to remove under 3.5Mm^3 of sand is minor in comparison to when 24Mm^3 of sand were dredged from the Brothers MBA for the new airport. However, there is a need to ensure that the release of fines can be minimised from the outset. Practical mitigation measures were defined at the start of the study so that their effect could be quantified by the model. All measures have been checked and agreed with Dredging International thus ensuring that these measures will be employed throughout the works. Measures are summarised in Table 1.

The effect of the works on the marine environment and associated sensitive receivers once these mitigation measures were in place is described below, together

with any further mitigation required. The assessment included a review of other EIAs for projects ongoing or due to commence in the area. Cumulative impacts were then quantified at the key sensitive receivers.

5.1 IMPACTS ON GAZETTED BEACHES

Of all the beaches assessed, the western most beaches in the Tsuen Wan area may potentially be affected by the predicted cumulative impacts. However:

- The model has predicted that at all times the WQAC will not be exceeded;
- Levels of solids generated in the bathing waters are below the threshold that may cause a visible impact;
- The works will largely be complete prior to the onset of the bathing season;
- Several of the beaches assessed are closed to the public anyway due to the poor quality of bathing water.

It was concluded that there would be no adverse impacts on bathing water at gazetted beaches.

5.2 IMPACTS ON COOLING WATER INTAKES

The model indicated that the works would not cause any detectable increases in suspended solids above background at the identified cooling water intakes. WQACs are therefore fully complied with and none of the specific criteria set by the operator for the intakes are exceeded as a result of the works.

5.3 IMPACTS ON MARINE ECOLOGY

a) Marine park

WQAC have been set to protect all aspects of marine ecology and should not be exceeded within the marine park. The model results indicated that there would be no exceedance of the WQACs even when cumulative impacts are considered, except at the marine park when extracting marine sand under neap tide conditions. This worst case scenario generates a short lived peak (less than 1 hour in duration) where suspended sediment levels exceed the WQACs by approximately 3mg/l. The exceedance of the WQAC is minimal and in reality unlikely to occur given the conservative nature of the model results. However, it has been recommended that the number of dredging cycles during neap tide conditions are reduced from approximately 12 per day to 8 whilst extracting marine sand thus reducing the volume of fines carried to the marine park, bringing the suspended sediment levels down below the WQACs.

b) Chinese White Dolphin

The assessment concluded that the Chinese White Dolphins will not be affected by the predicted levels of suspended solids. The dolphins frequent the waters in and around the Pearl River estuary where naturally they may be exposed to far greater levels of SS than those predicted by both the model and the cumulative impact assessment.

The general area of exceedance of WQACs is termed as the mixing zone. This was calculated and found to be limited in extent both spatially and temporally and absent when dredging alluvial sand. Figures 2 and 3 show the mixing zone for the worst case scenario i.e for marine sand extraction and for the typical scenario i.e. when dredging a mixture of marine and alluvial sand. The results indicated that the impact on the dolphins habitat would be minimal.

Dr Thomas Jefferson is an expert on the Chinese White Dolphin and has indicated that the dolphins may be attracted to the works in search of prey species disturbed by the dredging activities, though the chances of this are minimised through undertaking the majority of the works in the dry season (Jefferson, *pers comm*, September 1997). The natural distribution of the dolphins is such that they are present in such low densities around The Brothers' during the dry season that these impacts will largely be avoided if works are completed by the end of May before the dolphins begin to move into these waters. However, there is always the potential for a number of dolphins to be attracted to the works. The best form of mitigation is to educate workers prior to the onset of dredging and temporarily stop works if dolphins occur within an approximate 500m radius of the dredger (Jefferson, 1997). This practice will be audited during the works by an independent EM&A team to determine the effectiveness of this procedure as a mitigation measure. Education will be based on an information pack prepared by Dr. Jefferson.

c) Fish

Model results for sedimentation and suspended solids indicated that there would be no impacts on the benthos (due to minimal deposition) or phytoplankton (due to the limited extent of impacts in the surface waters). Consequently, higher organisms such as fish which would feed on plankton and benthic organisms will not be affected by the works. In addition, dissolved oxygen levels will remain within the WQACs which have been set to protect marine organisms including fish.

For short term peaks which may occur in the bed layer, fish have developed coping strategies to deal with plumes of sediment. At worst fish will swim away from the main area of impact, i.e. the mixing zone. Those that can withstand high levels of sediment will adopt other coping strategies such as "coughing". Generally, however, these peaks only occur in the bed layers of the marine water column which are naturally turbid and subject to high sediment loads during storm conditions. Peaks in the plume were found to be very short lived, persisting for less than one hour. On average, sediment concentrations will be <10mg/l in the surface waters, well within the range that fish and fry can easily tolerate.

5.4 IMPACTS ON FISHERIES

The ecological assessment has indicated that there will be no significant impacts on fish either from suspended solids, deposition or from secondary impacts associated with suspended solids in the marine environment. Capture fisheries will therefore not be affected by the works.

For FCZs, the extraction of pure marine sand was found to be the worst scenario when a cumulative impact of 7mg/l at Ma Wan may occur. As a result, suspended solids may typically reach 20mg/l. These levels are well below Agriculture and Fisheries Department's (AFD) assessment limit of 50mg/l. The works will be carefully monitored to ensure that impacts are avoided at Ma Wan. Under extreme conditions it may be necessary to reduce the number of dredging cycles undertaken at the Brothers over the course of a day.

6. ENVIRONMENTAL MONITORING AND AUDIT

6.1 MONITORING

The works will be the subject of an Environmental Monitoring and Audit (EM&A) programme to monitor impacts of the sediment plume at selected locations. All monitoring and audit work will be undertaken by an independent Environmental Team who will liaise with the Independent Checker (Environment), Resident Engineer, contractors and the EPD and other relevant HKSAR Government bodies.

The monitoring will seek to check the accuracy of the model predictions in terms of suspended solids both within the defined mixing zone and at the key sensitive receivers. The audit will involve both a review of monitoring results and a check that all of the mitigation measures summarised in Table 1 below are effectively carried out. The EM&A programme will also provide a forum for resolving any complaints received from the public or local fishermen etc. during the works or any problems experienced implementing mitigative measures.

a) Baseline Monitoring

The baseline data will be collected from the proposed monitoring stations and used to establish the suitability of the selected locations for control and impact stations. Monitoring will be undertaken on a twice daily basis three times a week for two weeks prior to the commencement of works. Duplicate sampling will enable statistical tests to be performed on the data.

b) Impact Monitoring

Monitoring will be continued three times a week throughout the works period and will be subject to a constant review. The monitoring programme will be flexible allowing for changes in monitoring stations when the Environmental Team and/or EPD consider it to be necessary. Six impact monitoring stations will be located around the mixing zone of the works and a further three stations will be located at the sensitive receivers i.e Lung Kwu Chau, Sha Chau and Ma Wan.

Action and limit levels will be set to trigger firstly a review of work practice to ensure the recommended mitigation measures are being employed and secondly, the implementation of further mitigation if considered necessary. Non compliance will result in a temporary reduction in the number of dredging cycles undertaken in a 24 hour period to reduce the release of fines into the marine environment.

During all monitoring works for the sand dredging activities, dolphin sightings will be recorded and their proximity to the works area will be estimated. Photographic records will be kept where possible to aid on-going studies of the Chinese White Dolphin.

6.2 ENVIRONMENTAL AUDIT

On site environmental audits by an Independent Checker (Environment) will be undertaken to ensure that appropriate environmental protection and pollution control mitigation measures are properly implemented.

The auditing will also involve reviewing and checking of the monitoring data as it arises to enable proactive measures to be taken to protect the Sensitive Receivers, and if necessary reduce the number of dredging cycles until an acceptable level of suspended sediment is achieved at the SRs.

7. CONCLUSIONS AND RECOMMENDATIONS

The model results, which are conservative, have indicated that the potential water quality impacts would meet the water quality assessment criteria agreed by the Director of Environmental Protection, and the Director of Agriculture and Fisheries agreed there would be no major nor prolonged adverse ecological impacts. Predicted increases in suspended solids fall well within the natural range experienced within these waters around north Lantau.

It has been concluded that the recommended mitigation measures are effective and can help to achieve both compliance with the water quality assessment criteria and environmental protection of the identified sensitive receivers.

It is therefore recommended that the works in the Brothers MBA proceed as proposed together with independent environmental monitoring and auditing.

Table 1 Schedule of Proposed Mitigation Measures

N°	Proposed Mitigation Measures and conditions to be enforced
1	The trailer will have a 5,000 m^3 capacity.
2	Only one pit will be worked at any one time
3	The dredger will be a split-hull trailer suction hopper dredger to ensure release of fines during dumping of overburden is less than 2.5% as modelled.
4	Marine Sand will be excavated in its pure form for the minimal amount of time until a mixture of 25:75 marine to alluvial sand can be obtained.
5	The hopper will as far as practicable be empty at the start of dredging (from a practical point of view approximately 300m^3 of water may remain in the hopper).
6	When dredging sand, the pumps of the dredger will be stopped while the vessel is turning outside the dredging area; this will reduce the overall duration of overflow and thus the amount of sediment released during each loading cycle;
7	During the neap tide, when dredging marine sand the number of dredging cycles per day should be reduced from 12 to 8 to reduce sediment release over this tidal condition and protect the marine park. This may extend dredging of marine sand from one week to approx. 10 days.
8	All workers will be made aware of the need to stop works in the event of a dolphin being sighted within 500m of the works. This will be checked by the independent Environmental Team on board the trailer dredger whilst dolphin monitoring is undertaken during the dredging operation and checked by an Idependent Checker (Environment) (IC(E)).
9	In the event that the monitoring results indicate a deterioration in water quality as a result of the works, dredging cycles will be reduced to a level which ensures the sensitive receivers are adequately protected. This will be subject to more comprehensive monitoring to the satisfaction of the Environmental Team, IC(E), AFD and EPD.

屯門區 38 號內河貿易碼頭

從大小磨刀島

海上採砂區進行採砂的

補充環境影響評估

報告摘要

安誠工程顧問有限公司

從大小磨刀島海上採砂區進行採砂的補充環境影響評估

報告摘要

一九九八年一月

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1. 引言

ZEN 太平洋挖砂國際合資企業正在尋求利用位於大小磨刀島附近的已刊憲的海上採砂區內的砂源．這些海砂將會用於鄰近 38 號區的屯門內河貿易碼頭(RTT)的填海工程．環境影響評估確定了因採砂以及同時在大小磨刀島附近進行的所有相關活動而引起的環境影響的性質和範圍．

1.1 開發的必要性

屯門內河貿易碼頭位於珠江三角洲出口處的重要策略位置，用於作爲內河小型船舶的入口．河內貿易碼頭旨在盡量擴大香港港口的容量，以及設法避免大量小型船舶取道馬灣航道，由此減少馬灣航道內發生海上交通意外的風險．

填海用砂現時是利用耙吸式挖泥船(TSHD)和鵜鶘大平底船從大陸運往施工現場．ZEN 太平洋挖砂國際合資企業已經認定大小磨刀島採海砂區可以作爲本地可利用的砂源。在符合工程施工計劃方面，它比由大陸供砂更加可靠．大小磨刀島海上採砂區是距離內河貿易碼頭最接近的砂源，因此是提供限量泥砂最爲可行的香港海砂區．利用此海砂區，也將縮短運輸物料所需要的距離，因此可以將對海上交通的影響減至最低程度．

2. 挖砂計劃

ZEN 太平洋挖泥國際合資企業準備將最多達三百五十萬立方米的海砂從以前由機場管理局使用的位於憲報公告的海上採砂區內的西區擴建段運往內河貿易碼頭．圖 1 標明了西部擴建坑以及位於大小磨刀島附近經批準的採砂區的位置．挖泥作業在很大程度上會局限於主要的感潮航道，使用配備型吸管和船內泵的具有 5,000 立方米挖泥容量以及能夠挖泥至-40mPD 的拼合式自航耙吸式挖泥船進行操作．

海砂將運往位於屯門的內河貿易碼頭．利用近岸泵吸法，在碼頭將海砂御入填海區．每挖掘一百萬立方米的海砂，將需要移走大約七十萬立方米的覆蓋層．將利用底卸的方法將覆蓋層放置在現時已挖空的西部坑內．作業將計劃 24 小時全面進行，每週平均產量達 150,000 至 200,000 立方米．

打算從 1998 年 2 月開始調動設備，挖泥作業計劃在 1998 年 3 月初開始，並且將持續至 1998 年 5 月末．

3. 主要事項

在採砂期間，挖砂時的溢流過程將引致沉降物釋放到海洋環境中．在溢流期間，海砂存在的許多細小的粘土和粉砂會被沖離挖泥船入海．然而，當採挖諸如覆蓋層的泥土物時，該等溢流系統在香港是禁止使用的．將細微泥砂排入海洋環境正是與此項作業相關的主要環境問題的原因所在．此項工程由此可能產生懸浮固體流而影響水質、生態和漁業．

由於此區域內的覆蓋層未受污染，因此釋放污染物不會成爲此項目中引起關注的問題．與釋放懸浮固體物相關的是對於營養物和溶解氧的影響．沉降物可能在水柱中耗盡溶解氧．此外，沉降物中也含有諸如可能由於從事此項目而釋放的氮等營養物．這些潛在的影響經評定、量化、發現符合“水質目標”中的水質評估標準．評定顯示此項工程在任何時候均不會因這些參數而影響水質評估標準(WQACs)．

該評估亦涉及沉降物釋放到水體中，可能因沉積過程而影響海底和底棲生物．預計沉積量少，大約爲 0.5 千克/平方米，由於沉降物需要一段時間凝聚．預計沉積率完全處於該水域內自然沉降率之內．

因此，主要問題是水體中懸浮固體物產生的物理性影響以及挖砂對於生態造成的物理性影響．

4. 環境影響評估方法

通過利用香港水域中的 TELEMAC-3D 流體動力模型，並結合懸浮物流模型(SEDPLUME-RW3D)，模擬了懸浮物流的作用．

爲預計挖泥期間的每一種方案模擬了兩種潮汐情形：

- 枯水季節的大潮（全日潮）；和
- 枯水季節的小潮（半全日潮）．

此項評估依據四個經模擬過的核心方案，調查建議項目的潛在影響：

- 方案 1 - 挖泥和覆蓋物的卸置
- 方案 2 - 海砂的挖掘

- 方案 3 -積砂的挖掘

- 方案 4 -海砂和積砂混合負載的挖掘

容易受影響的地區和生物在研究開始時已經識別，並且包括在模型內，因此，可以將對於這些特別位置產生的環境影響加以量化．這些位置如圖一所示，分別爲：

- 從屯門至荃灣，海岸沿線的憲報公告的泳灘．當前，在屯門海岸沿線有六個憲報公告的泳灘，在荃灣地區內有 8 個憲報公告的泳灘（包括馬灣）．

- 海水入口，例如中華電力公司(CLP)的電站和位於荃灣，屯門及青衣之水務處抽水口．

- 大小磨刀島附近水域內的漁業和魚類養殖區(FCZ)，例如馬灣魚類養殖區，交椅洲漁業和捕魚區．

- 生態，特別是在香港海港西經常發現的中華白海豚；魚類；和包括“具特別科學意義場地”與沙洲和龍鼓洲海岸公園在內的保育區（爲保護海豚喜愛之環島區而於 1996 年指定的公園）；

利用模擬計算結果及爲該項研究設定的水質評定標準(WQAC)評估各種影響因素：懸浮固體在容易受影響的地區及生物經過感潮週期受到的影響；沉積物影響；滋養物增加（以無機氮的形式）以及對於溶解氧的影響．模型通過假設所有釋放到水柱內的物質均進入表層而不是海底，而得出保守結果．此外，模型未包括因大多數溢流物快速下沉到海底所產生的密度流，以使只有少於 30%的懸浮物留於挖泥流內的情況．

5. 環境影響評估結果

與以前由大小磨刀島海上採砂區挖掘二千四百萬立方米海砂用於新機場相比，挖取三百五十萬立方米海砂的建議規模就顯得極小．然而，需要確保從一開始微粒泥砂的排放即可減至最小程度．實際之緩解措施自研究開始時即加以確定，使其結果可以通過模型計算加以量化．所有措施經檢定並與“挖泥國際企業”取得認同，由此確保這些措施將在整個挖砂工程中採用．採取的措施總結如表 1 所示．

一旦落實下述緩解措施，對於此項工程對於海上環境和相關容易受影響的地區和生物產生的影響，以及需要進一步緩解措施如下所述．這評估包括對於正在進行的項目或者由

於在本區域開始施工而產生的其它環境影響評估方面的評審．然後對於主要容易受影響的地區及生物的累積影響進行量化．

5.1 對於憲報公告的泳灘之影響

在評估的所有泳灘中，位於荃灣區最西部的海灘可能受到各預計累積影響因素的潛在影響．然而：

- 模型計算顯示在任何時候均不會超出水質評定標準範圍；
- 在浴場水域產生的固體物含量低於可能引起視覺影響的臨界值；
- 在游泳季節開始之前，此項工程將完成．
- 經評估的包括有數個浴場已因浴場水質低劣已對公眾關閉．

由此得出結論，對於憲報公告的泳灘水域不會產生不利影響．

5.2 對於冷卻水入口處的影響

模型表明，工程不會引起已知冷卻水抽水處之懸浮固體物含量超出本底值．因此，完全符合水質評定標準，工程不會引起抽水處已設定之任何個別指標超標．

5.3 對於海洋生態的影響

a)海岸公園

業已設定的水質評定標準適用於從各個方面保護海洋生態．在海岸公園範圍內，不應超出此標準．模型結果表明，除了在小潮條件下掘取海砂，即使考慮累積影響，海岸公園之水質亦不會超出水質評定標準．在最壞的情況下，可產生一個短暫的峰值（持續時間在 1 小時以下），在此結果下，懸浮沉降物含量超過水質評定標準接近 3 毫克/升．由於模型計算結果保守，超出水質評定標準的機會甚微，實際上不太可能超出標準．然而，報告建議在小潮條件下開採海砂時，挖泥週期從大約每天 12 次減少到 8 次，由此減少流入海岸公園的細微泥砂，使懸浮沉降物含量不超出水質評估標準．

b)中華白海豚

評定結果是，中華白海豚將不受預計懸浮固體物的影響．海豚經常出沒珠江口區域．在自然條件下，它們可能暴露於遠遠高於模型和累積影響評估預計的懸浮固體物含量的環

境下．

我們將超出水質評估標準的一般區域定義爲混合區．通過對於混合區的計算，發現其在空間上和時間上均有限，而當挖掘衝積砂時則不存在．圖 2 和 3 顯示在最壞情況下，即海砂開採和典型條件下，即當挖掘混合海砂和沖積砂時的混合區．結果表明，對於海豚生境之影響甚小．

Thomas Jefferson 博士是中華白海豚方面的專家．他認爲，盡管海豚可能因尋找因挖泥作業而受擾亂的捕食種類而吸引到工程近處，但是因工程的大部分在枯水季節展開，而使這種機會變得很少（ Thomas Jefferson 博士，“個人通訊”， 1997 年 9 月）．海豚的自然分佈是，它們在枯水季節期間出現在磨刀島周圍的密度極低．如果工程在海豚開始轉入該海域之前的五月底結束，則可很大程度上避免受到這些影響．然而，一定數量的海豚被吸引到工程附近的可能性是始終存在的．最佳的緩解措施是在挖泥開始之前就教育操作人員，如果海豚在挖泥船方圓 500 米的範圍內出現，則可暫時停止作業（ Jefferson,1997 年）．在作業期間，將由一支獨立的環境監察及審核小組審核這項措施，以便確定此步驟作爲緩解措施的有效性．教育將取材自 Jefferson 博士準備的資料．

c) 魚類

模型結果表明，沉積和懸浮固體物不會影響底棲生物（由於沉積量極小）或者浮游植物（由於對於表面海域只有有限程度的影響）．結果是，以浮游生物和底棲生物爲食的高層生物，例如魚類，將不受本工程的影響．此外，溶解氧含量將保持在用以保護海洋生物包括魚類而設定的水質評估標準範圍內．

對於在海底可能發生的短期高峰值，魚類已經具有適應沉積物流的能力．在最壞環境下，魚類將游離主要受影響的區域，例如混合區．那些可以忍受高含量沉降物的魚類將採取其它適應方式，例如“咳嗽”．然而，通常情　下，這些高沉降只在海洋水體的底層發生．該底層在條件下易於受高沉積負載影響或者是自然混濁的．發現沉降流內的高沉降峰發生時間很短，持續一小時以下．平均而言，表面海域內的沉降物濃度將<10 毫克/升，完全在魚類和魚苗容易忍受的範圍之內．

5.4 對於漁業的影響

生態評估表明，懸浮固體物、沉積或者來自與海洋環境下懸浮固體物相關次級影響對於魚類沒有重大影響．因此捕魚業不會受本工程影響．

在最壞的設定條件下，挖取純淨砂，會使馬灣的魚類養殖場產生 7 毫克/升懸浮固體物的

累積影響．結果，懸浮固體物在典型情　下可能達到 20 毫克/升．該含量大大低於漁農處所定的評價限量 50 毫克/升．將對工程進行小心監控，以避免對馬灣處產生影響．在極端條件下，可能需要減少在大小磨刀島處的挖泥週期數．

6. 環境監察和審核

6.1 監察

本工程將進行環境監察和審核(EM&A)計劃．此計劃用以在數個選擇地點監察沉降物的影響．所有監察和審核工作將由一支獨立的環保小組承擔．環保小組將與工程師、承建商和環保署及其他香港特別行政區有關政府機構聯絡．

監察將根據限定混合區範圍內以及主要容易受影響的地區及生物處兩者的懸浮固體物，檢查模型預測的精確性．審核將涉及檢討監察結果，並且檢查下表 1 內總結的所有爲減少影響採取之措施是否有效地加以落實．此外，環境監察及審核計劃還將召開會議，討論解　在工程期間收到的來自公眾或者本地漁民等的投訴，或者解決在實施減少環境影響措施中所遇到的問題．

a) 基線監察

將從建議的監察站收集基線數據，該數據將用來確定及選擇合適的參考取樣站及受影響取樣站位置．在工程開始之前的兩個星期，以每天兩次爲基礎，每週進行三次監察．利用重復抽樣法，將能夠對數據進行統計分析．

b) 影響監察

在整個工程期間，每週將連續進行三次監察，並且將不斷進行評價．監察計劃將具靈活性，當環保小組和/或者環保署成員認爲必要時，可改變監察站．六個影響監察站將位於工程之混合區週圍，另外三個站將位於易受影響的地區，即龍鼓洲、砂洲和馬灣．

首先，將設定採取措施和限制水平，檢討工程作業慣例，以便確保採取建議的緩解措施；其次，在認爲必要時實施進一步的緩解措施．若不符合規定，則將暫時減少 24 小時進行的挖泥次數，以減少微粒泥砂進入海洋環境．

在對海砂挖泥活動進行所有監察作業期間，將記錄海豚之出現以及估計它們與工程區之距離．在可能情況下，將保存照片記錄，以便幫助正在進行中的中華白海豚的研究．

6.2 環境審核

將由一個獨立機構承擔現場環境審核工作，以確保正確實施適當的環境保護和污染控制之緩解措施．

此外，審核還涉及檢討與復查監察數據，以便能夠提早採取預防措施，保護容易受影響的地區及生物．必要時可減少挖砂次數，直至在容易受影響的地區及生物處的懸浮沉降物達到可接受水平．

7. 結論和建議

較爲保守之模型結果表示，潛在的水質影響將符合環境保護署署長認同之水質評定標準．漁農處處長亦認同該工程不會產生任何較大的或長久的不良生態影響．在北大嶼山這些海域範圍內的懸浮固體物預計之增加量，保持在該區域自然變化範圍內．

結論是，所建議採取之緩解措施是有效的，且有助於達到在已知容易受影響的地區及生物的水質評估標準和環境保護之要求．

因此，建議在大小磨刀島海上採砂區內進行的工程，配合獨立的環境監察和審核，按照報告內訂定的方案進行．

表 1　建議之緩解措施進度表

編號	建議之緩解措施和落實的條件
1	挖砂船將具有 5,000 立方米的容量．
2	一次只在一個挖砂坑進行作業．
3	挖泥船將是拼合式自航耙吸式挖泥船，確保在卸除覆蓋物期間微粒的釋放量少於模型預測之 2.5%．
4	海砂將在最短時間內以其純淨的形式採取，直至海砂與沖積砂的混合比達到 25:75 ．
5	泥艙在開始挖砂時將盡可能空置（實際上，泥艙內可能剩余大約 300 立方米水）．
6	當挖砂時，挖泥船泵將在船舶轉向挖泥區外側時停止運行；這將減小總的溢流時間，因此減少每一次裝載期間釋放的沉降物數量．
7	在小潮期間，當挖海砂時，每天的挖掘次數應該從 12 次減至 8 次，以便減小在這種感潮條件下的沉降物釋放量，保護海岸公園．這可能使海砂挖掘延長一星期至大約 10 天．
8	將使所有工人意識到在工程地點方圓 500 米的範圍內看到海豚時，要停止作業．該行動將由在耙吸式挖泥船上的獨立環保小組成員進行檢查，同時在挖泥操作期間進行海豚監察．
9	在監控結果表明因工程造成水質轉壞時，挖泥週期將減少到某個程度，以確保保護容易受影響的地區及生物．爲此，需要進行更加全面的監察，達致環保小組、漁農處和環保署之各成員之要求．

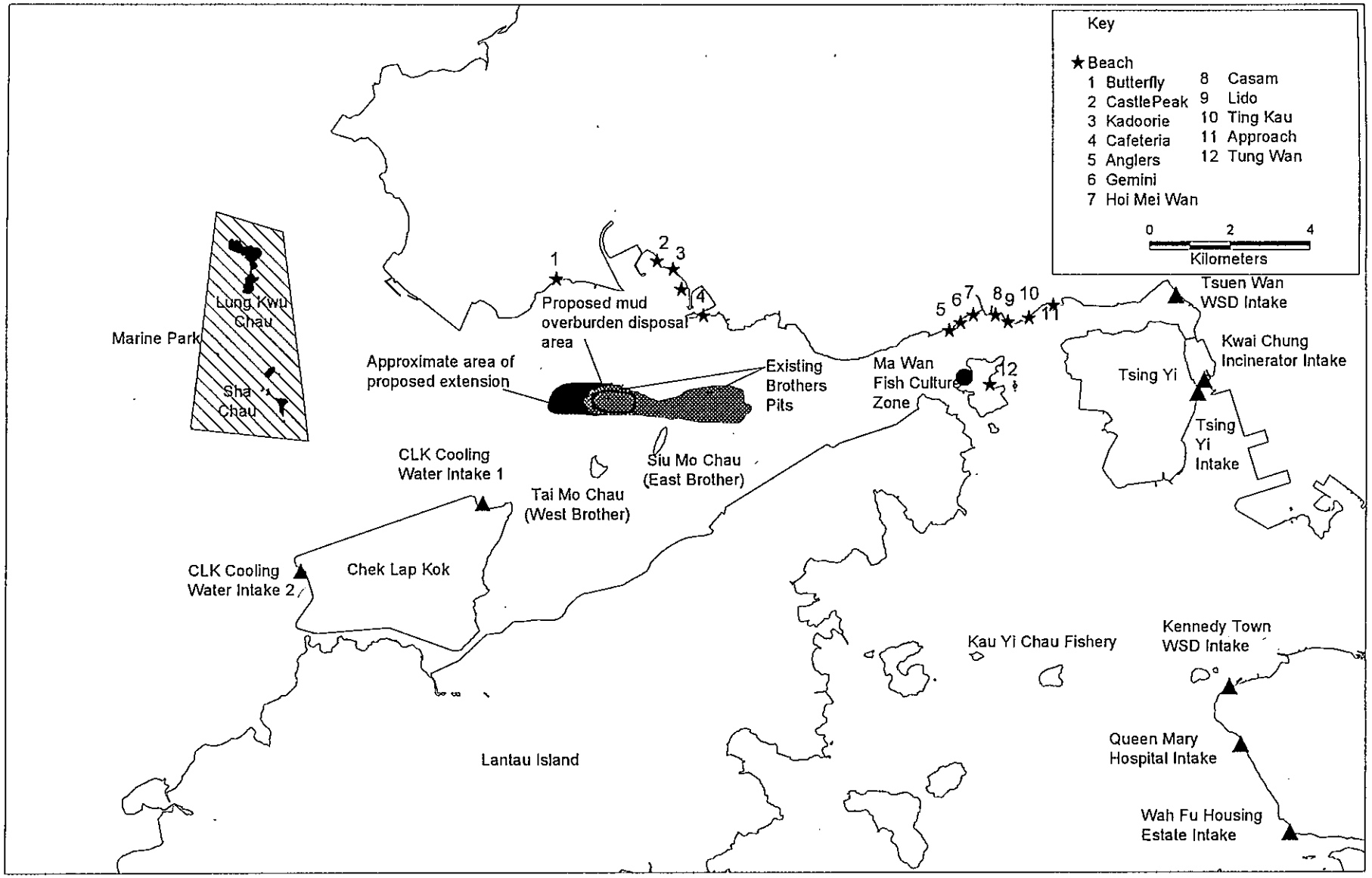

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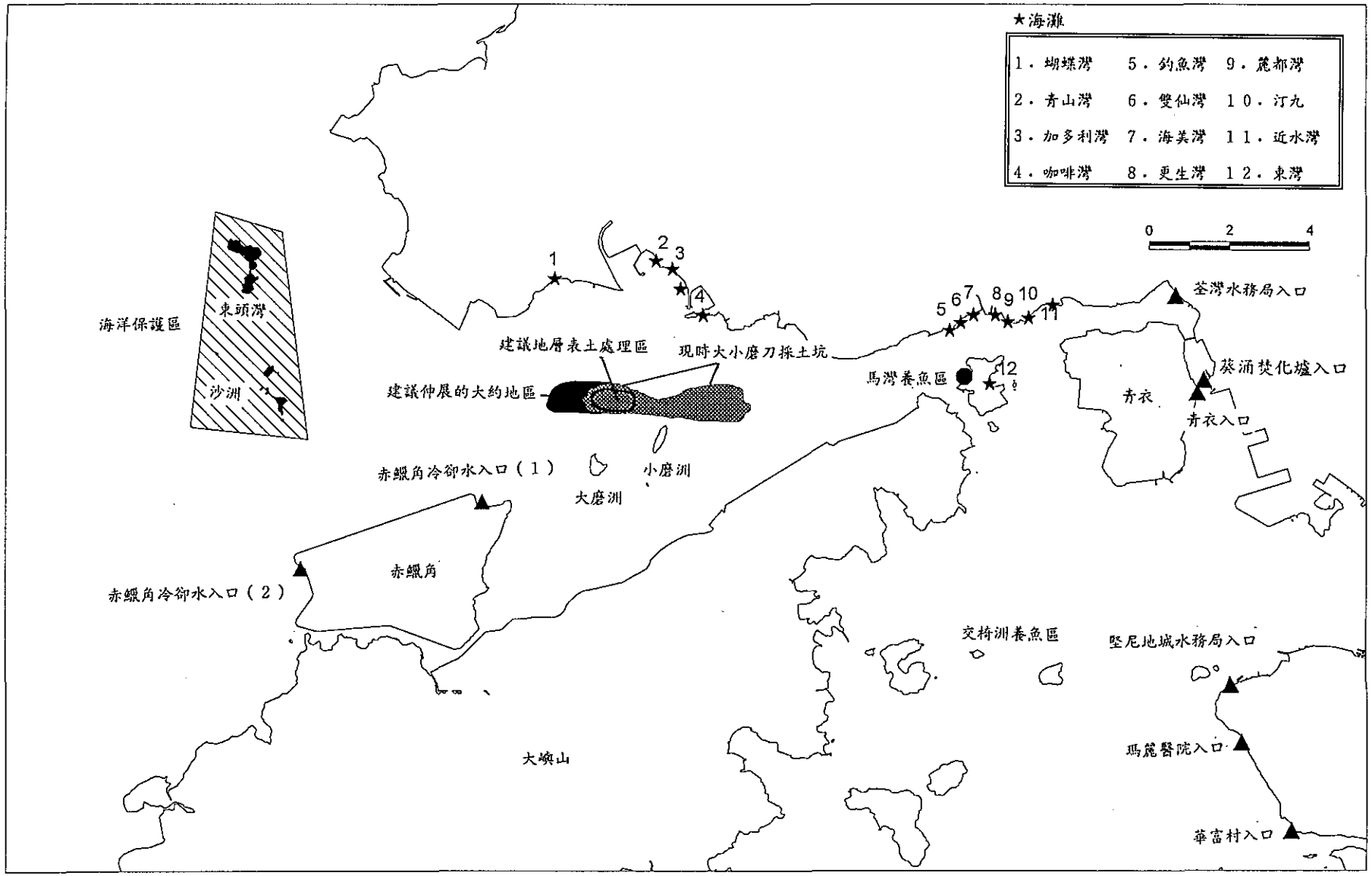
Figure 1 Study Area and Sensitive Receivers



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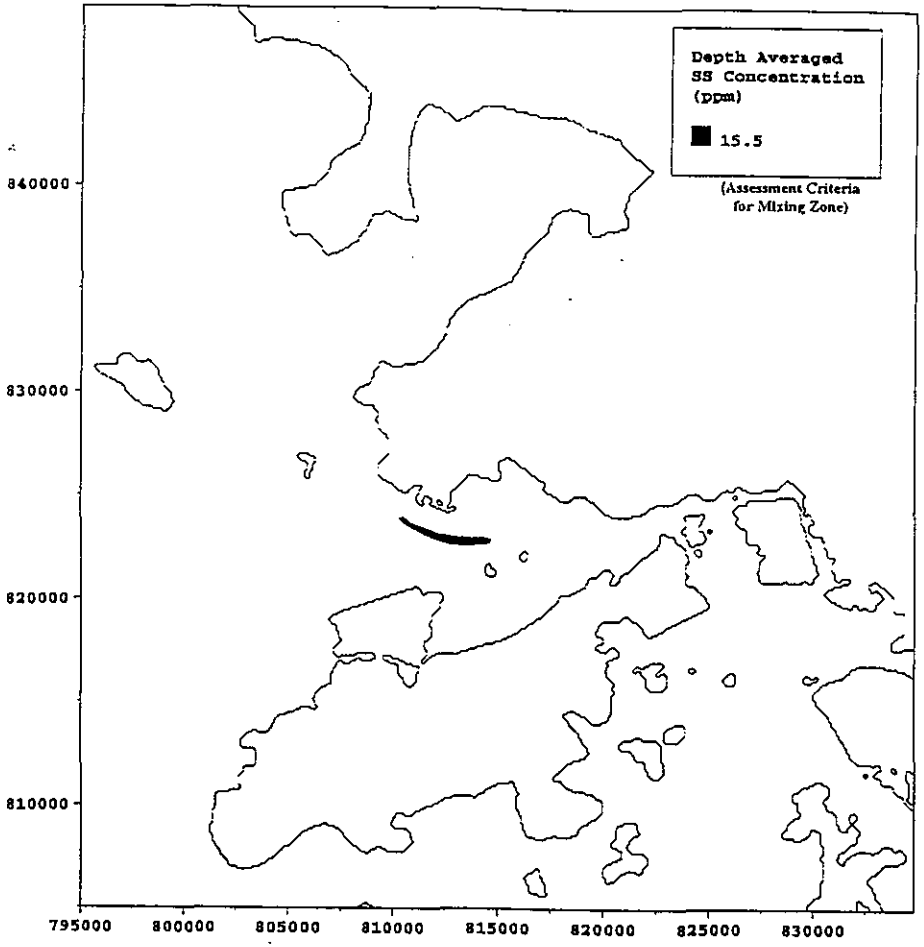
圖表一　研究地區及感應地方



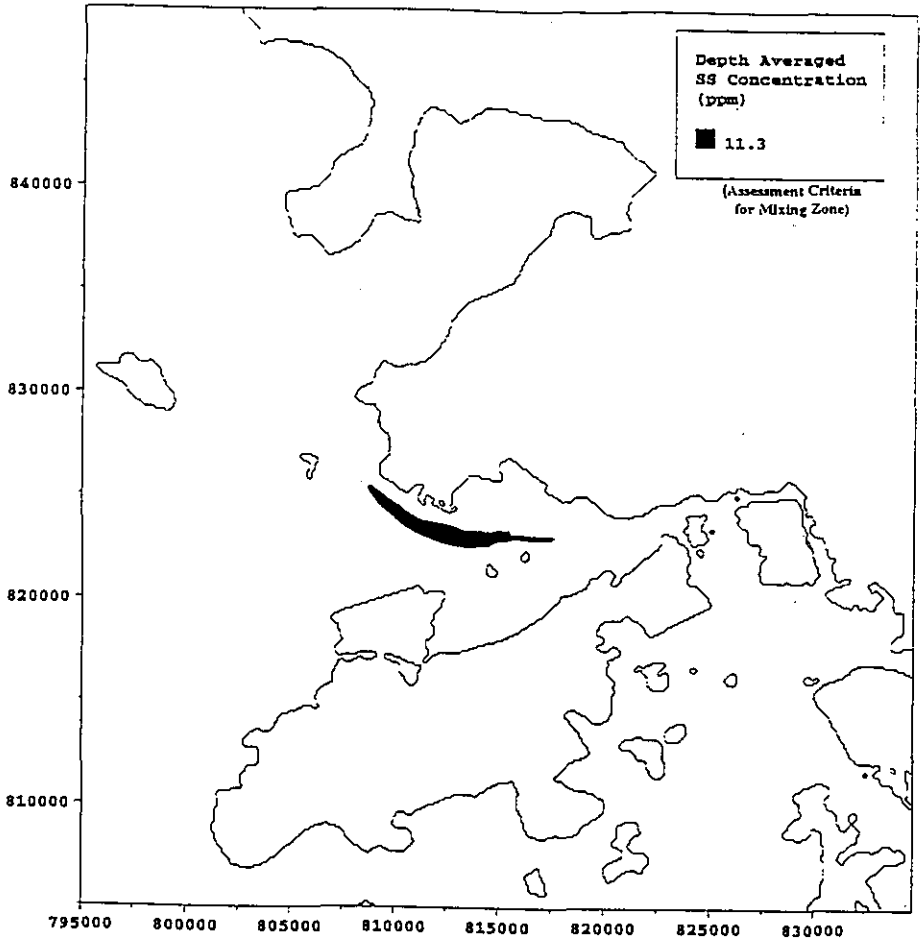


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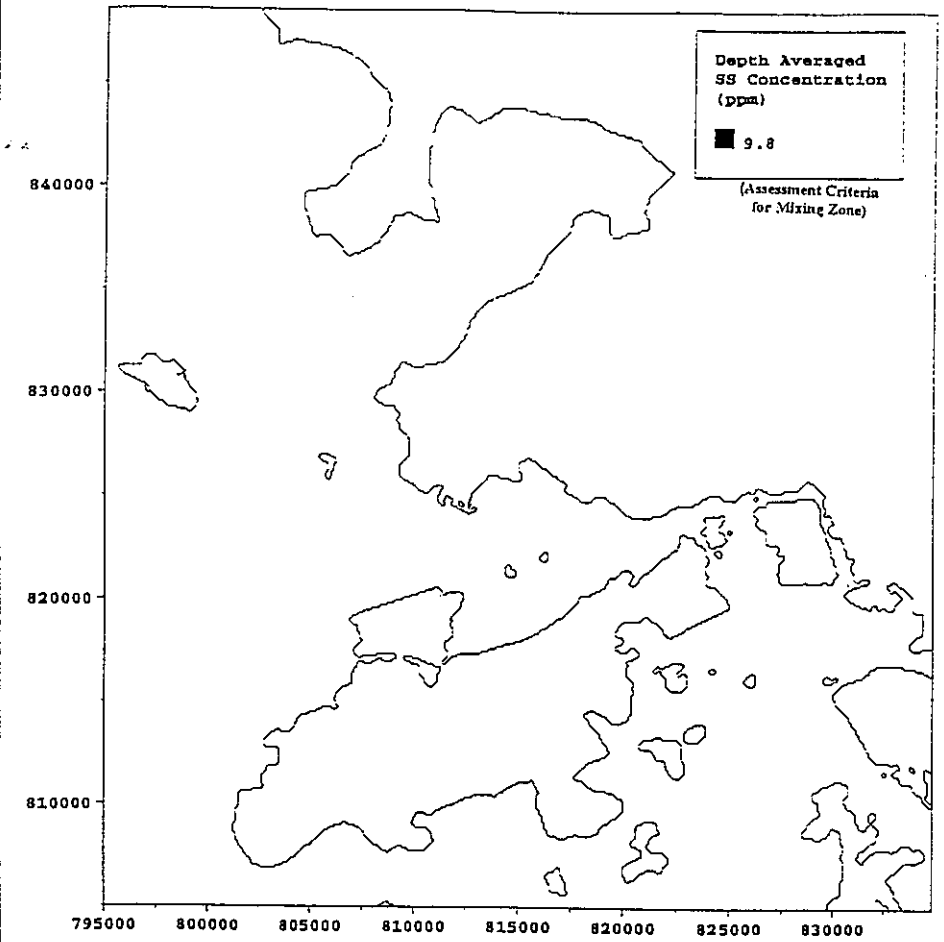
Figure 2 Mixing Zone for (a) spring tide & (b) neap tide for marine sand

圖表二 （a）在大潮及 （b）在小潮的海沙混合區



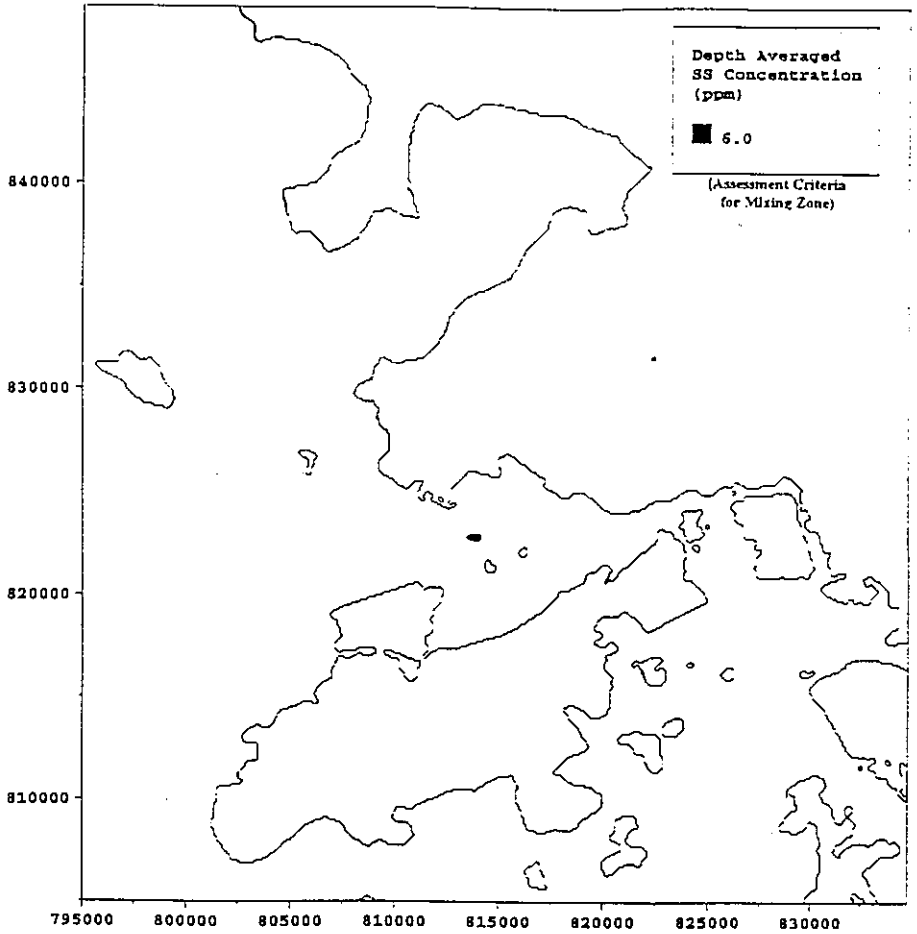


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Figure 3 Mixing Zone for (a) spring tide & (b) neap tide for mixture of marine and alluvial sand

圖表三 （a）在大潮及 （b）在小潮的海沙及礦沙混合區

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